SEDAR

Southeast Data, Assessment, and Review

SEDAR 100
Stock Assessment Report

Gulf Gray Triggerfish

August 2026

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

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SECTION I: Introduction

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Introduction

SEDAR 100 addressed the stock assessment for Gulf gray triggerfish. The process consisted of an in-person Data Workshop, an internally run assessment process by the lead assessment agency, and an in-person Review Workshop.

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

The final Stock Assessment Report (SAR) for gray triggerfish was disseminated to the public in August 2026. The Gulf Fishery Management Councils' Scientific and Statistical Committee (SSC) will review the SAR. The SSC is tasked with recommending whether the assessments represent Best Available Science, whether the results presented in the SARs are useful for providing management advice and developing fishing level recommendations for the Council. An SSC may request additional analyses be conducted or may use the information provided in the SAR as the basis for their Fishing Level Recommendations (e.g., Overfishing Limit and Acceptable Biological Catch).

1 SEDAR PROCESS DESCRIPTION

SouthEast Data, Assessment, and Review (**SEDAR**) is a cooperative Fishery Management Council process initiated in 2002 to improve the quality and reliability of fishery stock assessments in the South Atlantic, Gulf of Mexico, and US Caribbean. SEDAR is managed by the three Regional Fishery Management Councils in the Southeast in coordination with NOAA Fisheries, the Interstate Marine Fisheries Commissions (Atlantic States MFC and Gulf States MFC), and the Florida Fish and Wildlife Conservation Commission (FL FWC).

SEDAR seeks to improve the quality and reliability of stock assessments, improve the quantitative basis of fishery management actions, and increase the relevance of research and monitoring programs in the Southeast Region. It emphasizes constituent and stakeholder participation in assessment development, transparency in the assessment process, and a rigorous and independent scientific review of completed stock assessments.

SEDAR is often organized around two workshops and a series of webinars. First is the Data Workshop, during which fisheries, monitoring, and life history data are reviewed and compiled. The second stage is the Assessment Process, which is conducted via a workshop and/or a series

of webinars, during which assessment models are developed and population parameters are estimated using the information provided from the Data Workshop. The final step is the Review Workshop, during which independent experts review the input data, assessment methods, and assessment products. The completed assessment, including the reports of all 3 stages and all supporting documentation, is then forwarded to the Council SSC for certification as 'appropriate for management' and development of specific management recommendations.

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

2 GULF GRAY TRIGGERFISH MANAGEMENT OVERVIEW

2.1 Reef Fish Fishery Management Plan and Amendments

Original FMP:

The Reef Fish Fishery Management Plan was implemented in November 1984. The regulations, designed to rebuild declining reef fish stocks, included: (1) prohibitions on the use of fish traps, roller trawls, and powerhead-equipped spear guns within an inshore stressed area; and, (2) data reporting requirements.

Description of Action	FMP/Amendment	Effective Year
Allowed 2-day charter-for-hire possession limit on trips that extend beyond 24 hours, provided the vessel has two licensed operators aboard, and each passenger can provide a receipt to verify the length of the trip. Limited other fishermen fishing under a bag limit to a single day possession limit. Established a longline and buoy gear boundary at approximately the 50 fathom depth contour west of Cape San Blas, Florida and the 20 fathom depth contour east of Cape San Blas, inshore of which the directed harvest of reef fish with longlines and buoy gear was prohibited and the retention of reef fish captured incidentally in other longline operations (e.g., sharks) was limited to the recreational bag limit. Limited trawl vessels to the recreational size and bag limits of reef fish. Established fish trap permits, allowing up to a maximum of 100 fish traps per permit holder. Prohibited the use of entangling nets for directed harvest of reef fish. Retention of reef fish caught in entangling nets for other fisheries was	Amendment 1	1990

limited to the recreational bag limit. Established the fishing year to be January 1 through December 31.		
Commercial reef fish permit moratorium established for three years	Amendment 4	1992
Fish trap endorsement and three year moratorium established	Amendment 5	1994
Extended commercial reef fish permit moratorium until January 1996.	Amendment 9	1994
Commercial reef fish permit moratorium extended until December 30, 2000. Reef fish permit requirement established for headboats and charter vessels.	Amendment 11	1996
10-year phase-out of fish traps in EEZ established (February 7, 1997 – February 7, 2007).	Amendment 14	1997
Established a 12" total length minimum size limit.	Amendment 16B	1999
Commercial reef fish permit moratorium extended until December 31, 2005.	Amendment 17	2000
(1) Prohibits vessels from retaining reef fish caught under recreational bag/possession limits when commercial quantities of Gulf reef fish are aboard, (2) adjusts the maximum crew size on charter vessels that also have a commercial reef fish permit and a USCG certificate of inspection (COI) to allow the minimum crew size specified by the COI when the vessel is fishing commercially for more than 12 hours, (3) prohibits the use of reef fish for bait except for sand perch or dwarf sand perch, and (4) requires electronic VMS aboard vessels with federal reef fish permits, including vessels with both commercial and charter vessel permits (implemented May 6, 2007).	Amendment 18A	2006
Also known as Generic Essential Fish Habitat (EFH) Amendment 2. Established two marine reserves off the Dry Tortugas where fishing for any species and anchoring by fishing vessels is prohibited.	Amendment 19	2002
3-year moratorium on reef fish charter/headboat permits established	Amendment 20	2003
Continued the Steamboat Lumps and Madison-Swanson reserves for an additional six years, until June 2010. In combination with the initial four-year period (June 2000-June 2004), this allowed a total of ten years in which to evaluate the effects of these reserves.	Amendment 21	2003
Permanent moratorium established for commercial reef fish permits.	Amendment 24	2005

Permanent moratorium established for charter and headboat reef fish permits, with periodic reviews at least every 10 years.	Amendment 25	2006
Addressed the use of non-stainless steel circle hooks when using natural baits to fish for Gulf reef fish effective June 1, 2008, and required the use of venting tools and dehooking devices when participating in the commercial or recreational reef fish fisheries effective June 1, 2008.	Amendment 27	2008
Reduced the harvest of gray triggerfish in order to end overfishing and rebuild the stock. Adjusted the allocation of gray triggerfish catches between recreational and commercial fisheries to 79% and 21%, respectively, and set management thresholds and targets to comply with the Sustainable Fisheries Act (SFA) ($F_{30\%SPR}$). Increased the minimum size limit for gray triggerfish to 14" fork length.	Amendment 30A	2008
Established additional restrictions on bottom longline gear in the eastern Gulf of Mexico to reduce bycatch of endangered sea turtles. (1) Prohibits the use of bottom longline gear shoreward of the 35-fathom contour from June through August; (2) reduces the number of longline vessels operating in the fishery through an endorsement provided only to vessel permits with a demonstrated history of landings, on average, of at least 40,000 pounds of reef fish annually with fish traps or longline gear during 1999-2007; and (3) restricts the total number of hooks that may be possessed onboard each reef fish bottom longline vessel to 1,000, only 750 of which may be rigged for fishing. The boundary line was initially moved from 20 to 50 fathoms by emergency rule effective May 18, 2009. That rule was replaced on October 16, 2009 by a rule under the Endangered Species Act moving the boundary to 35 fathoms and implementing the maximum hook provisions.	Amendment 31	2010
Modified the gray triggerfish rebuilding plan based on a 2011 gray triggerfish update assessment, which determined that the stock was not rebuilding on target. Reduced the commercial and recreational annual catch limits to 64,100 and 241,200 pounds whole weight respectively, and reduced the commercial and recreational annual catch targets to 60,900 and 217,100 pounds whole weight respectively. A fixed closed season from June 1 through July 31 was established for the commercial	Amendment 37	2013

and recreational sectors. Established a commercial trip limit of 12 gray triggerfish, and a recreational bag limit of 2 gray triggerfish per angler bag limit within the 20 reef fish aggregate bag limit.		
Set the minimum stock size threshold for gray triggerfish equal to 50% of the biomass at maximum sustainable yield.	Amendment 44	2017
Established a 9-year rebuilding timeline for gray triggerfish and retains the annual catch limits and annual catch targets set in Reef Fish Amendment 37. Reduces the recreational bag limit to 1-fish per person per day, increases the recreational minimum size limit to 15-inches fork length, and creates a January – February recreational closed season in addition to the current June 1 – July 31 closure during spawning for the commercial and recreational sector. Increases the commercial trip limit to 16 fish.	Amendment 46	2018

2.2 Generic Amendments

Generic Sustainable Fisheries Act Amendment: partially approved and implemented in **November 1999**, set the Maximum Fishing Mortality Threshold (MFMT) for most reef fish stocks at $F_{30\%}$ SPR. Estimates of maximum sustainable yield, Minimum Stock Size Threshold (MSST), and optimum yield were disapproved because they were based on SPR proxies rather than biomass based estimates.

Generic ACL/AM Amendment: Established in-season and post-season accountability measures for all stocks that did not already have such measures defined. This includes the "other shallow-water grouper species" complex. The accountability measure states that if an ACL is exceeded, in subsequent years an in-season accountability measure will be implemented that would close fishing when the ACL is reached or projected to be reached.

2.3 Emergency and Interim Rules

Emergency Rule - Implemented May 18, 2009 through October 28, 2009: Prohibited the use of bottom longline gear to harvest reef fish east of 85°30′ W longitude in the portion of the exclusive economic zone (EEZ) shoreward of the coordinates established to approximate a line following the 50–fathom (91.4–m) contour as long as the 2009 deepwater grouper and tilefish quotas are unfilled. After the quotas have been filled, the use of bottom longline gear to harvest reef fish in water of all depths east of 85°30′ W longitude are prohibited [74 FR 20229].

Emergency Rule - Implemented May 3, 2010 through November 15, 2010: NMFS issued an emergency rule to temporarily close a portion of the Gulf of Mexico EEZ to all fishing [75 FR 24822] in response to an uncontrolled oil spill resulting from the explosion on April 20, 2010 and subsequent sinking of the Deepwater Horizon oil rig approximately 36 nautical miles (41 statute miles) off the Louisiana coast. The initial closed area extended from approximately the mouth of the Mississippi River to south of Pensacola, Florida and covered an area of 6,817 square statute miles. The coordinates of the

closed area were subsequently modified periodically in response to changes in the size and location of the area affected by the spill. At its largest size on June 1, 2010, the closed area covered 88,522 square statute miles, or approximately 37 percent of the Gulf of Mexico EEZ.

2.4 Framework Actions

Framework Action: Modification to Gray Triggerfish Catch Limit
This framework action, effective July 29, 2021, increases the gray triggerfish annual catch limits (ACLs) and targets. The stock ACL is increased to 456,900 lb ww; the commercial ACL to 95,949 lb ww; the commercial annual catch target (ACT) to 88,273 lb ww; the recreational ACL to 360,951 lb ww; and the recreational ACT to 274,323 lb ww.

Framework Action: Modification of Gray Triggerfish Commercial Trip Limits
This framework action, effective September 1, 2023, increases the gray triggerfish commercial trip limit to 25 fish per vessel per trip.

2.5 Management Program Specifications

Table 2.5.1. General Management Information

Species/Management Unit	Gray Triggerfish
Management Unit Definition	Gulf of Mexico
Management Entity	Gulf of Mexico Fishery Management Council
Management Contacts SERO / Council	Ryan Rindone - GMFMC Frank Helies – SERO
Current stock exploitation status	Not experiencing overfishing (2018)
Current stock biomass status	Not overfished (2018)

Table 2.5.2. Specific Management Criteria
Note: mp = million pounds; gw = gutted weight.

Criteria	Current- SEDAR 43 (2015)		Proposed: SEDAR 100 (2024)	
	Definition	Value	Definition	Value
MSST	(1-M)*SSB_{MSY} M=0.28	6.043 trillion eggs	0.5*BMSY	SEDAR 100
MFMT	F_{MSY}	0.248	F_{MSY} or proxy from the most recent stock assessment (median from probabilistic analysis)	SEDAR 100
MSY	F_{MSY}	0.248	Yield at F_{MSY} , landings and discards, pounds and numbers (median from probabilistic analysis)	SEDAR 100
F_{MSY}	F_{MSY}	0.248		
SSB_{MSY}	Equilibrium SSB @ F_{MSY}	11.129 trillion eggs	Spawning stock biomass (median from probabilistic analysis)	SEDAR 100
F Targets (i.e., F_{OY})	75% of F_{MSY}	0.186	75% F_{MSY}	SEDAR 100
Yield at F_{Target} (Equilibrium)	Equilibrium Yield @ FOY		landings and discards, pounds and numbers	SEDAR 100
M		0.28	Mean natural mortality across ages	SEDAR 100
Terminal F	Geometric mean 2008-2010	0.153	Exploitation	SEDAR 100
Terminal Biomass[1]	SSB_{2010}	6.043 trillion eggs	Biomass	SEDAR 100
Exploitation Status	$F_{CURRENT}$/MFMT	0.621	F/MFMT	SEDAR 100
Biomass Status[1]	$SSB_{CURRENT}$/MSST	0.543	B/MSST B/B_{MSY}	SEDAR 100

Table 2.5.3. General projection information.

First Year of Management	2026 Fishing Year
Interim basis	- Finalized landings where available; else, - Average from last three years of finalized landings
Projection Outputs	By stock and fishing year
Landings	**pounds and numbers**
Discards	**pounds and numbers**
Exploitation	F & Probability F>MFMT
Biomass (total or SSB, as appropriate)	SSB & Probability SSB>MSST (and Prob. SSB>B_{MSY} if under rebuilding plan)
Recruits	Number

Table 2.5.4. Base Run Projections Specifications. Long Term and Equilibrium conditions.

Criteria	Definition	If overfished	If overfishing	Not overfished, no overfishing
Projection Span	Years	$T_{Rebuild}$	10	10
Projection Values	$F_{Current}$	X	X	X
	F_{MSY} (proxy)	X	X	X
	75% F_{MSY}	X	X	X
	$F_{Rebuild}$	X		
	F=0	X		

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

The following should be provided regardless of whether the stock is healthy or overfished:

- OFL: yield at F_{MSY} and $F_{30\%\ SPR}$ proxy
- OY: yield at 75% for $F_{30\%\ SPR}$
- Equilibrium MSY and equilibrium OY

If the stock is overfished, the following should also be provided:

- $F_{REBUILD}$ and the yield at $F_{REBUILD}$ (where the rebuilding time frame is 10 years)

The SSC typically recommends OFL and ABC yield streams for 3-5 years from the first year of projections. Yield streams provided by assessment scientists should go beyond five years. If a 10-year rebuilding plan is needed, yield streams should be provided for at least 10 years.

Table 2.5.5. Quota Calculation Details

Current Quota Value (2025)	Stock ACL: 456,900 lb ww
Next Scheduled Quota Change	2026
Annual or averaged quota?	Annual
Does the quota include bycatch/discard?	No- Landed only

2.6 Management and Regulatory Timeline

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

Federal Harvest Restrictions – Trip Limits*

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

First Yr In Effect	Last Yr In Effect	Effective Date	End Date	Fishery	Bag Limit Per Person/Day	Trip Limit Per Boat/Day	FR Reference	Amendment Number or Rule Type
1997	2013	1/1/97	6/9/13	Rec	20 reef fish aggregate bag limit	-		RF 1
2013	2018	6/10/13	1/15/18	Rec	2 fish w/in 20 reef fish aggregate bag limit	-	78 FR 27084	RF 37
2018	-	1/16/18	-	Rec	1 fish w/in 20 reef fish aggregate bag limit	-	82 FR 59523	RF 46
2013	2018	6/10/13	1/15/18	Comm	-	12 fish	78 FR 27084	RF 37
2018	2023	1/16/18	-	Comm	-	16 fish	82 FR 59523	RF 46
2023	-			Comm	-	25 fish	*Pending*	

Federal Harvest Restrictions – Size Limits*

*Size limits do not apply during closures

First Yr In Effect	Last Yr In Effect	Effective Date	End Date	Fishery	Size Limit	Length Type	FR Reference	Amendment Number or Rule Type
1999	2008	11/1/99	7/2/08	Both	12"	TL	64 FR 57403	RF 16B
2008	2018; Rec only	7/3/08	1/15/2018; Rec only	Both	14"	FL		
2018	-	1/16/18	-	Rec	15"	FL	82 FR 59523	RF 46

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

First Yr In Effect	Last Year in Effect	Effective Date	End Date	Fishery	Closure Type	First Day Closed	Last Day Closed	FR Reference	Amendment Number or Rule Type
2012	2012	6/11/12	12/31/12	Rec	Quota	6/11/12	12/31/12		
2013	-	5/9/13	-	Both	Seasonal	1-Jun	31-Jul	78 FR 27084	RF 37
2013	2013	10/15/13	12/31/13	Rec	Quota	10/15/13	12/31/13		
2014	2014	5/1/14	12/31/14	Rec	Quota	5/1/14	12/31/14		
2015	2015	2/7/15	12/31/15	Rec	Quota	2/7/15	12/31/15		
2016	2016	6/1/16	12/31/16	Rec	Quota	6/1/16	12/31/16		
2017	2017	1/1/17	12/31/17	Rec	Quota	1/1/17	12/31/17		
2012	2012	7/1/12	12/31/12	Comm	Quota	7/1/12	12/31/12		
2017	2017	11/17/17	12/31/17	Comm	Quota	11/17/17	12/31/17		
2018	2018	1/1/18	-	Rec	Seasonal	1-Jan	end of February	82 FR 59523	RF 46
2018	2018	8/8/18	12/31/18	Rec	Quota	8/8/18	12/31/18		
2018	2018	10/7/18	12/31/18	Comm	Quota	10/7/18	12/31/18		
2019	2019	5/11/19	12/31/19	Rec	Quota	5/11/19	12/31/19		
2019	2019	11/26/19	12/31/19	Comm	Quota	11/26/19	12/31/19		
2020	2020	5/2/20	12/31/20	Rec	Quota	5/2/20	12/31/20		
2021	2021	9/15/21	12/31/21	Rec	Quota	9/15/21	12/31/21		

Federal Harvest Restrictions – Spatial Restrictions

Area	First Yr In Effect	Effective Date	End Date	Fishery	First Day Closed	Last Day Closed	Restriction in Area	FR Reference	Amendment Number or Rule Type	FR Section	Amendment Number or Rule Type
Gulf of Mexico Stressed Areas	1984	11/8/84	Ongoing	Both	Year round		Prohibited powerheads for Reef FMP	49 FR 39548	Original Reef Fish FMP	641.7	Original Reef Fish FMP
	1984	11/8/84	Ongoing	Both	Year round		Prohibited pots and traps for Reef FMP	49 FR 39548	Original Reef Fish FMP	641.7	Original Reef Fish FMP
Alabama Special Management Zones	1994	2/7/94	Ongoing	Both	Year round		Allow only hook-and line gear with three or less hooks per line and spearfishing gear for fish in Reef FMP	59 FR 966	Reef Fish Amendment 5	641.23	Reef Fish Amendment 5
EEZ, inside 50 fathoms west of Cape San Blas, FL	1990	2/21/90	Ongoing	Both	Year round		Prohibited longline and buoy gear for Reef FMP	55 FR 2078	Reef Fish Amendment 1	641.7	Reef Fish Amendment 1

EEZ, inside 20 fathoms east of Cape San Blas, FL	1990	2/21/90	Ongoing	Both	Year round		Prohibited longline and buoy gear for Reef FMP	55 FR 2078	Reef Fish Amendment 1	NA	Reef Fish Amendment 1
EEZ, inside 50 fathoms east of Cape San Blas, FL	2009	5/18/09	10/15/09	Both	18-May	28-Oct	Prohibited bottom longline for Reef FMP	74 FR 20229	Emergency Rule	622.34	Emergency Rule
EEZ, inside 35 fathoms east of Cape San Blas, FL	2009	10/16/09	5/25/10	Both	Year round		Prohibited bottom longline for Reef FMP	74 FR 53889	Sea Turtle ESA Rule	223.206	Sea Turtle ESA Rule
	2010	5/26/10	Ongoing	Rec	Year round		Prohibited bottom longline for Reef FMP	75 FR 21512	Reef Fish Amendment 31	622.34	Reef Fish Amendment 31
	2010	5/26/10	Ongoing	Com	1-Jun	31-Aug	Prohibited bottom longline for Reef FMP	75 FR 21512	Reef Fish Amendment 31	622.34	Reef Fish Amendment 31
Madison-Swanson	2000	6/19/00	6/2/04	Both	Year round		Fishing prohibited except HMS[1]	65 FR 31827	Reef Fish Regulatory Amendment	622.34	Reef Fish Regulatory Amendment

	2004	6/3/04	8/19/21	Both	1-May	31-Oct	Fishing prohibited except surface trolling	70 FR 24532 74 FR 17603	Reef Fish Amendment 21 Reef Fish Amendment 30B	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
	2004	6/3/04	8/19/21	Both	1-Nov	30-Apr	Fishing prohibited	70 FR 24532 74 FR 17603	Reef Fish Amendment 21 Reef Fish Amendment 30B	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
	2021	8/20/21	Ongoing	Both	Year round		Fishing prohibited	86 FR 38416	RF Framework Action	622.34	Reef Fish Regulatory Amendment
Steamboat Lumps	2000	6/19/00	6/2/04	Both	Year round		Fishing prohibited except HMS[1]	65 FR 31827	Reef Fish Regulatory Amendment	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
	2004	6/3/04	Ongoing	Both	1-May	31-Oct	Fishing prohibited except surface trolling	70 FR 24532 74 FR 17603	Reef Fish Amendment 21 Reef Fish Amendment 30B	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
	2004	6/3/04	Ongoing	Both	1-Nov	30-Apr	Fishing prohibited	70 FR 24532 74 FR 17603	Reef Fish Amendment 21 Reef Fish Amendment 30B	622.34	Reef Fish Amendment 30B Supplement
	2021	8/20/21	Ongoing	Both	Year round		Fishing prohibited	86 FR 38416	RF Framework Action	622.34	Reef Fish Framework Action
The Edges	2010	7/24/09	Ongoing	Both	1-Jan	30-Apr	Fishing prohibited	74 FR 30001	Reef Fish Amendment 30B Supplement	934 622.34	Sanctuary Designation Essential Fish Habitat Amendment 3

20 Fathom Break	2014	7/5/13	Ongoing	Rec	1-Feb	31-Mar	Fishing for SWG prohibited[2]	78 FR 33259	Reef Fish Framework Action	641.23	Reef Fish Amendment 5
Flower Garden	1992	1/17/92	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	56 FR 63634	Sanctuary Designation	635.71 622.34	Tortugas Amendment Essential Fish Habitat Amendment 3
Riley's Hump	1994	2/7/94	8/18/02	Both	1-May	30-Jun	Fishing prohibited	59 FR 966	Reef Fish Amendment 5	622.34	Essential Fish Habitat Amendment 3
Tortugas Reserves	2002	8/19/02	Ongoing	Both	Year round		Fishing prohibited	67 FR 47467	Tortugas Amendment	622.34	Essential Fish Habitat Amendment 3
Pulley Ridge	2006	1/23/06	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	70 FR 76216	Essential Fish Habitat (EFH) Amendment 3	622.34	Essential Fish Habitat Amendment 3
McGrail Bank	2006	1/23/06	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	70 FR 76216	Essential Fish Habitat (EFH) Amendment 3	622.34	Essential Fish Habitat Amendment 3
Stetson Bank	2006	1/23/06	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	70 FR 76216	Essential Fish Habitat (EFH) Amendment 3	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

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

Federal Harvest Restrictions – Gear – Gulf
*Area specific gear restrictions are documented under spatial restrictions

Gear Type	First Yr In Effect	Last Yr In Effect	Effective Date	End Date	Gear/Harvesting Restrictions	FR Reference	FR Section	Amendment Number or Rule Type
Poison	1984	Ongoing	11/8/84	Ongoing	Prohibited for Reef FMP	49 FR 39548	641.24	Original Reef Fish FMP
Explosives	1984	Ongoing	11/8/84	Ongoing	Prohibited for Reef FMP	49 FR 39548	641.24	Original Reef Fish FMP
Pots and Traps	1984	1994	11/23/84	2/6/94	Established fish trap permit	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	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	55 FR 2078	641.22	Reef Fish Amendment 1
	1994	1997	2/7/94	2/7/97	Moratorium on additional commercial trap permits	59 FR 966	641.4	Reef Fish Amendment 5
	1997	2007	3/25/97	2/7/07	Phase out of fish traps begins	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 permitted reef fish, stone crab, or spiny lobster traps.	62 FR 67714	622.39	Reef Fish Amendment 15
	2007	Ongoing	2/8/07	Ongoing	Traps prohibited	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	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)	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	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]	71 FR 45428	622.31	Reef Fish Amendment 18A

Vertical Line	2008	Ongoing	6/1/08	Ongoing	Requires non-stainless steel circle hooks and dehooking devices	74 FR 5117	322.41	Reef Fish Amendment 27
	2008	2013	6/1/08	9/3/13	Requires venting tools	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	75 FR 21512	622.34	Reef Fish Amendment 31

Federal Quota History - Commercial

Year	Effective Date	End Date	Fishery	ACT	ACL	Units	FR Reference	Amendment Number or Rule Type
2005	1/1/05	12/31/05	Comm			gw		
2006	1/1/06	12/31/06	Comm	N/A		gw		
2007	1/1/07	12/31/07	Comm			gw		
2008	1/1/08	12/31/08	Comm	80,000	N/A	ww		
2009	1/1/09	12/31/09	Comm	93,000		ww		
2010	1/1/10	12/31/10	Comm	106,000		ww		
2011	1/1/11	12/31/11	Comm	106,000		ww		
2012	1/1/12	12/31/12	Comm	51,290	64,100	ww		
2013	1/1/13	12/31/13	Comm	54,802	54,802	ww		
2014	1/1/14	12/31/14	Comm	60,900	64,100	ww		
2015	1/1/15	12/31/15	Comm	60,900	64,100	ww		
2016	1/1/16	12/31/16	Comm	60,900	64,100	ww		
2017	1/1/17	12/31/17	Comm	60,900	64,100	ww		
2018	1/1/18	12/31/18	Comm	60,900	64,100	ww		
2019	1/1/19	12/31/19	Comm	60,298	63,498	ww		
2020	1/1/20	12/31/20	Comm	60,900	64,100	ww		
2021	1/1/21	7/28/21	Comm	60,900	64,100	ww		
2021	7/29/21	12/31/21	Comm	88,273	95,949	ww	86 FR 34159	RF FA
2022	1/1/22	12/31/22	Comm	88,273	95,949	ww		
2023	1/1/23	12/31/23	Comm	88,273	95,949	ww		
2024	1/1/24	12/31/24	Comm	88,273	95,949	ww		

ACT for the commercial sector was established 8/1/2008

Gutted weight was used prior to 2008; after, whole weight was used

Federal Quota History- Recreational

Year	Effective Date	End Date	Fishery	ACT	ACL	Units	FR Reference	Amendment Number or Rule Type
2008	1/1/08	12/31/08	Rec	306,000	394,000	ww		
2009	1/1/09	12/31/09	Rec	356,000	426,000	ww		
2010	1/1/10	12/31/10	Rec	405,000	457,000	ww		
2011	1/1/11	12/31/11	Rec	405,000	457,000	ww		
2012	1/1/12	12/31/12	Rec	217,100	217,100	ww		
2013	1/1/13	12/31/13	Rec	217,100	241,200	ww		
2014	1/1/14	12/31/14	Rec	217,100	241,200	ww		
2015	1/1/15	12/31/15	Rec	30,107	54,207	ww		
2016	1/1/16	12/31/16	Rec	177,123	201,223	ww		
2017	1/1/17	12/31/17	Rec	0	19,987	ww		
2018	1/1/18	12/31/18	Rec	217,100	241,200	ww		
2019	1/1/19	12/31/19	Rec	217,100	241,200	ww		
2020	1/1/20	12/31/20	Rec	217,100	241,200	ww		
2021	1/1/21	7/28/21	Rec	274,323	360,951	ww		
2021	7/29/21	12/31/21	Rec			ww	86 FR 34159	RF FA
2022	1/1/22	12/31/22	Rec	274,323	360,951	ww		
2023	1/1/23	12/31/23	Rec	274,323	360,951	ww		
2024	1/1/24	12/31/24	Rec	274,323	360,951	ww		

No ACL or ACT was in place prior to 2008.

3 ASSESSMENT HISTORY AND REVIEW

Management of Gray Triggerfish (*Balistes capriscus*) in the US Gulf of America began in 1984 with the implementation of the Gulf Council Reef Fish Fishery Management Plan. At that time, no formal assessment of the population dynamics of Gulf Gray Triggerfish had been conducted. Gray Triggerfish was the only Balistid of 40 species of reef fish in the management unit. Two assessments of Gray Triggerfish were conducted in 2001 using different versions of a generalized Aggregated Surplus Production Model (ASPIC; Porch 2001; Valle et al. 2001). Based on the definition of the maximum fishing mortality threshold (MFMT) of $F_{20\%SPR}$, both assessments indicated that the stock was overfished and undergoing overfishing. Fishing mortality rates were 65-70% above sustainable levels. Biomass estimates were highly sensitive to parameter input restrictions, and all but one model run indicated that the stock had been severely overfished from the beginning of the time series. This was considered unrealistic as Gray Triggerfish was not a desirable target species. Additionally, the effect of the 12-inch Total Length minimum size limit implemented in 1999 was unknown. Therefore, no new regulations were implemented based on the results of these assessments.

The SEDAR 9 benchmark stock assessment was completed in 2006 using a state space age-structured production model (SS-ASPM; SEDAR 2006). The stock was determined to be undergoing overfishing but it was uncertain whether the stock was also overfished. Based on the definition of MFMT ($F_{30\%SPR}$), the reference fishing mortality was estimated to be 62% too high (F_{2004}/MFMT = 1.62). The review panel also examined a biomass-based fishing mortality rate (F_{MSY}) but felt this measure was unacceptable because it was sensitive to the stock-recruitment relationship which was poorly estimated. The Review Panel stated that no conclusion could be made as to whether the stock was overfished, although it appeared to be approaching an overfished condition. Based on the definition of the minimum stock size threshold (MSST) of spawning stock biomass ($SSB_{20\%SPR}$), the reference stock biomass was estimated to be slightly above MSST (SSB_{2004}/MSST = 1.0 to 1.2).

The SEDAR 9 Update Assessment was conducted in 2011 to update the 2006 SEDAR 9 benchmark assessment of Gray Triggerfish in the US Gulf of America (SEDAR 2011). Commercial and recreational fisheries statistics, in addition to fishery-independent data were updated through 2010. Any changes in data since SEDAR 9 were incorporated in the assessment. Fishery-dependent and -independent indices of abundance were constructed with updated data using the same methodology as in the benchmark assessment. The same state space age-structured production model used in SEDAR 9 (SS-ASPM) was applied to the update assessment. The final model used an average (rather than time varying) shrimp bycatch, incorporated an index of Gulf-wide shrimp effort, and used an updated age-length key and von Bertalanffy growth function. Results suggested that the stock was overfished and experiencing overfishing. The results of the assessment were implemented in Amendment 37 which specified an Acceptable Biological Catch (ABC) of 305,300 pounds whole weight based on assumed low recruitment in the near-term projections. As part of the 2011 update assessment, a statistical catch-at-age model (Stock Synthesis; Methot and Wetzel 2013) was evaluated as an alternative to SS-ASPM in an effort to characterize some of the potential error associated with the model fit and to determine if Stock Synthesis could be used for future assessments. Model results were similar, despite differences in recruitment and historic fishery assumptions. Although management advice from the 2011 update assessment was based on the SS-ASPM model results,

the Gulf Council's Scientific and Statistical Committee (SSC) approved of the use of Stock Synthesis in future assessments.

As a result of concern over the effects on catchability of Gray Triggerfish of recently implemented regulations mandating the use of circle hooks in the reef fish fishery in the Gulf, an analysis of the stock status controlling for this effect was conducted in 2013. Analysis of unpublished data indicated the implementation of circle hook regulations resulted in a 47% decrease in catchability of Gray Triggerfish, suggesting the stock was above levels estimated in 2011. However, the stock status did not change; therefore, the results were not used to develop new management advice.

The SEDAR 43 standard stock assessment was conducted in 2015 using Stock Synthesis with data through 2013 (SEDAR 2015). Notable updates included revised growth and natural mortality parameters, using the combined video survey, and treating shrimp bycatch as a 100% dead discard fishery of age-0 fish (previously it was modeled as direct harvest of age-1 equivalent fish). The SEDAR 43 stock assessment indicated that Gray Triggerfish was no longer experiencing overfishing but was still overfished. During review, the SSC deemed the SEDAR 43 model best available science but did not recommend new catch levels because SEDAR 43 estimates were higher than the rebuilding levels implemented at the time. Out of concern over low recruitment, declining indices of abundance and SSB, and the lack of recovery of the stock, the SSC requested guidance from the Gulf Council on how to proceed following SEDAR 43. In response, the Gulf Council requested additional projections with the SEDAR 43 model to develop a new Gray Triggerfish rebuilding plan, with a new rebuilding timeline of nine years (through 2025) ultimately implemented in Amendment 46.

The SEDAR 62 standard stock assessment was conducted in 2019-2020 but was halted towards the end of the project (i.e., no assessment report was produced). During the SEDAR 62 Data/Assessment Workshop, results of a comparative analysis of ages determined from otoliths and spines was presented. The study clearly demonstrated that ages were underestimated from reading spines. Consequently, the SEDAR 62 Stock Assessment Panel decided to abandon the previous SEDAR 43 model configuration based on ages determined from spines in favor of a model that was based on ages determined from otoliths. This necessitated a change from a model built on age compositions using age-based selectivity to a model build on length compositions using length-based selectivity, essentially a total reconfiguration of the model. The updated model, building on the past benchmark and including new growth, landings, discards, indices, and compositions had serious convergence issues due to conflicting signals in the data. Ultimately, the assessment was halted due to a number of unanticipated complications that could not be overcome within the assessment schedule.

Following the withdrawal of the SEDAR 62 standard stock assessment, an interim analysis was conducted for Gray Triggerfish in 2020 (SEFSC 2020). Interim assessments are designed to occur between regular stock assessments conducted through SEDAR to provide the opportunity to adjust harvest recommendations based on current stock conditions. Catch advice for 2021 was produced in the interim analysis by applying an index-based harvest control rule, buffered through a three-year average, to the combined video index updated through 2019. The interim analysis increased the ABC from 305,300 pounds whole weight to 456,900 pounds whole weight

for the 2021 fishing year on the basis of a 1.5 time increase in the video index average for 2017-2019 relative to 2011-2013. No adjustments to the Overfishing Limit (OFL) were made in the interim analysis. In September 2020, the Gulf Council's SSC determined the interim analysis was suitable for providing ABC catch advice through 2023.

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4 REGIONAL MAPS

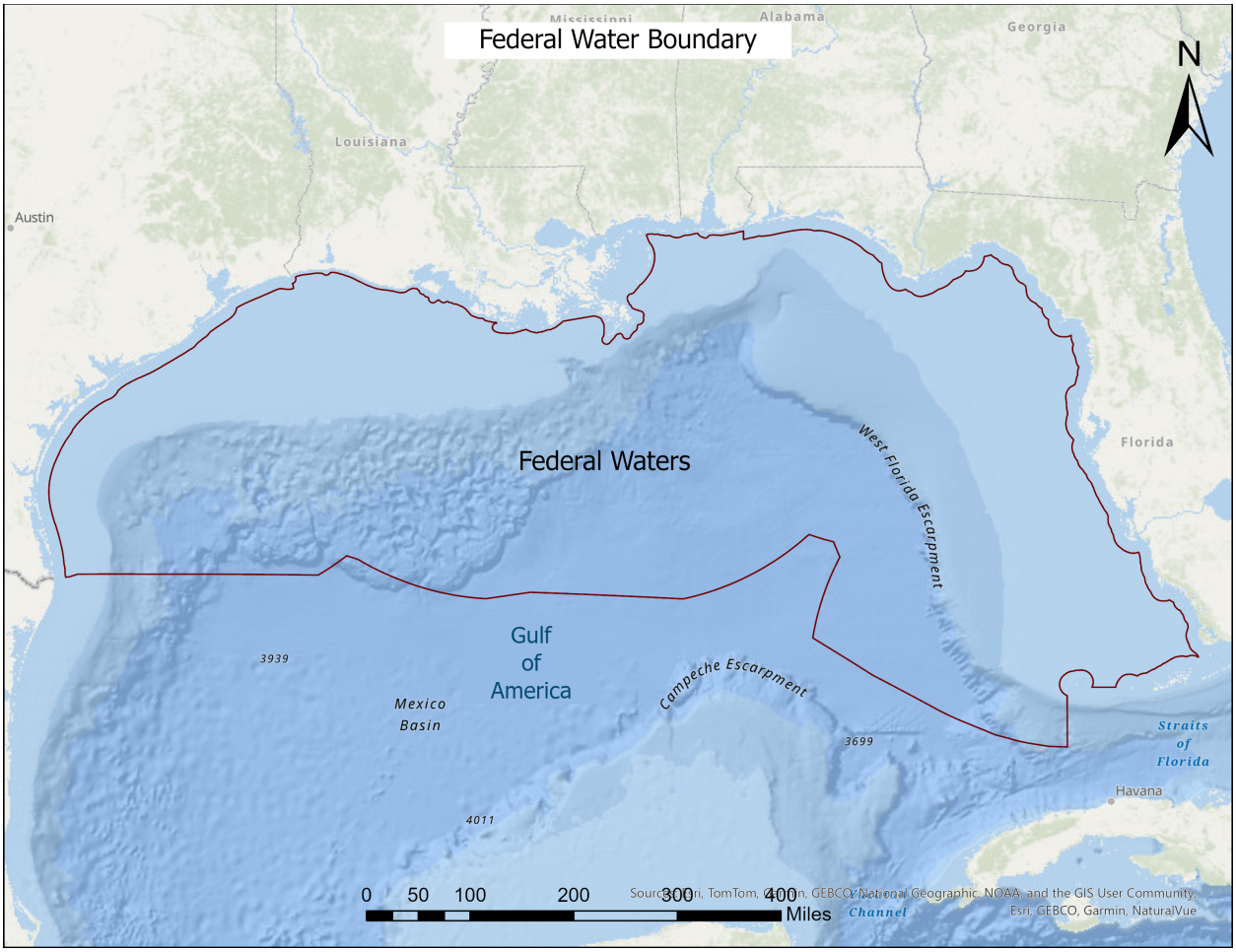

Figure 4.1 Gulf Council Fishery Management Boundaries.

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 100

Gulf Gray Triggerfish

SECTION II: Data Workshop Report

February 2026

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

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1 INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 100 Data Workshop was held August 19-22, 2025, in Tampa, FL. In addition to the in-person workshop, a series for webinars were held before (May and July 2025) and after (September 2025) the meeting. The Data Workshop report was scheduled to be completed in early November 2025 but due to a lapse in funding for NOAA, it was delayed.

1.2 TERMS OF REFERNCE

Objective: Evaluate and revise the SEDAR 43 Gulf gray triggerfish base model, with data through 2024, where possible. Employ assessment best practices and necessary revisions in order to provide a model that describes the population dynamics of the stock and is capable of producing management advice.

1. Explore the appropriateness of an age-based, length-based, and hybrid (age- and length-based) approaches for describing fleet and survey selectivity.
2. Use the Marine Recreational Information Program's Access Point Angler Intercept Survey and Fishing Effort Survey to inform catch and effort for the recreational sector. Consider state-specific catch, effort, and discards from state surveys as applicable (Florida: State Reef Fish Survey; Alabama: Snapper Check; Mississippi: Tails 'n Scales [effort]; Louisiana: LA Creel; Texas: TPWD Creel).
    - Describe any annual differences in the magnitude of landings from the previous assessment greater than 10%, with assistance from the NOAA Office of Science and Technology.
3. Review available life history information, including the ageing methodology. Update growth curves, age and length data, and the natural mortality estimates.
    - Summarize, describe, and tabulate length and age data by year and fleet/survey and area through the terminal year of the assessment where possible.
    - Explore the validity and representativeness of length and age data and ageing methodology across ageing facilities and cooperators.
    - Explore differences in growth parameters if length and/or age sampling methods differ from the previous assessment. Utilize appropriate models and diagnostics to describe sex, population and region-specific growth, as warranted and applicable.
    - Develop age-length keys and Conditional Age at Length as appropriate.

- Evaluate and discuss the sources of uncertainty and error, and data limitations (such as temporal and spatial coverage) for each data source.
- Provide estimates or ranges of uncertainty for length and age data as a whole and by area and source.

4. Provide fishery-independent measures of population abundance developed through the terminal year where possible.
    - Evaluate the G-FISHER composite video index for use in the assessment.
    - Consider any changes to the fishery-independent indices comprising the GFISHER index as provided for the previous assessment and evaluate the representativeness through time of the composition data.
    - Evaluate the compositions available. Recommend modifications needed to inform differences in catchability and selectivity of the surveys.
    - Provide appropriate measures of uncertainty for all fishery-independent abundance indices and effort time series considered.
5. Provide commercial catch statistics for both the Eastern and Western Gulf, including both landings and discards in both pounds and number extended through the terminal year. Provide a corresponding working paper for the data and analyses with the following:
    - Evaluate and discuss the adequacy of available data for accurately characterizing landings and discards by fishery sector or gear in pounds whole weight.
    - Provide length and age distributions for both landings and discards, if feasible.
    - Provide estimates of uncertainty around each set of landings and discard estimates.
6. Utilize the new estimates of shrimp fishery effort and bycatch, as appropriate, based on the peer review of such data from SEDAR 87 and subsequent analyses.
7. Document any change in start year from previous assessments
    - Evaluate the existing composition data and recommend whether the data are sufficient to represent the bycatch by the fleet.
8. Document all new methodologies:
    - Address program objectives, methods, coverage, sampling intensity, and other relevant characteristics.
9. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include guidance on sampling intensity and appropriate strata and coverage.
10. Prepare a Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines.

1.3 LIST OF PARTICIPANTS

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1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS

Document #	Title	Authors	Date Submitted
Documents Prepared for the Data Workshop			
SEDAR100-DW-01	Headboat Data for Gray Triggerfish in the Gulf of America	Rob Cheshire	6 August 2025 Updated: 12 August 2025
SEDAR100-DW-02	General Recreational Survey Data for Gray Triggerfish in the Gulf of America	Samantha M. Binion-Rock	15 August 2025
SEDAR100-DW-03	Historical (1955-1980) Recreational Landings for Gulf of America Gray Triggerfish (*Balistes capriscus*) estimated using the FHWAR Census Method	Samantha M. Binion-Rock	14 August 2025
SEDAR100-DW-04	Gulf of America Gray Triggerfish (*Balistes capriscus*) length and age compositions from the recreational fishery	Samantha M. Binion-Rock	12 August 2025 Updated: 10 December 2025
SEDAR100-DW-05	Commercial Landings of Gulf of America Gray Triggerfish (*Balistes capriscus*) from 1949 - 2024	Micki Pawluk and Sarina Atkinson	5 August 2025
SEDAR100-DW-06	CPUE Expansion Estimation for Commercial Discards of Gulf of America Gray Triggerfish	Kevin Thompson, Sarina Atkinson, Gary Decossas	6 August 2025
SEDAR100-DW-07	Gulf of America Gray Triggerfish (*Balistes capriscus*) Length and Age Compositions for the Commercial Handline and Longline Fisheries	Micki Pawluk	7 August 2025 Updated: 20 January 2026
SEDAR100-DW-08	Proxy Discard Estimates of Gray Triggerfish (*Balistes capriscus*) from the US Gulf of America Headboat Fishery	Nuttall, MA	14 August 2025
SEDAR100-DW-09	Standardized Catch per Unit Effort for US Gulf of America Gray Triggerfish (*Balistes capriscus*) from the Southeast Region Headboat Survey	Nuttall, MA	15 August 2025
SEDAR100-DW-10	Social Dimensions of Gray Triggerfish (*Balistis capriscus)* in the Gulf and South Atlantic	David Griffith	7 August 2025

SEDAR100-DW-11	A Summary of Gulf Gray Triggerfish Discard Length Data Collected from At-Sea Observers in For-Hire Fishery Surveys in Florida 2005-2024	Ellie Corbett	8 August 2025
SEDAR100-DW-12	A ratio-based method for calibrating estimates of total landings (numbers and pounds of fish), releases (numbers of fish), and total trips from MRIP-FCAL to SRFS for Gulf Gray Triggerfish (*Balistes capriscus*)	Maria McGirl and Chloe Ramsay	11 August 2025
SEDAR100-DW-13	Length and age compositions of Gulf Gray Triggerfish, *Balistes capriscus*, collected in association with fishery-dependent projects	Maria McGirl, Jessica Carroll, and Bridget Cermak	11 August 2025 Updated: 15 August 2025
SEDAR100-DW-14	A Review of Gray Triggerfish (*Balistes capriscus*) Age-length Data in the Gulf of America, 1999-2024	Ashley Pacicco, Steve Garner, Ryan Nichols	14 August 2025
SEDAR100-DW-15	Standardized catch rates of Gray Triggerfish from the United States Gulf of America commercial handline fishery, 1993-2024	Kevin Thompson and Michaela Pawluk	18 August 2025
SEDAR100-DW-16	Gray Triggerfish Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of America	Adam G. Pollack and David S. Hanisko	15 August 2025 Updated: 18 December 2025
SEDAR100-DW-17	Gulf of America gray triggerfish (*Balistes capriscus*) post-release mortality based on long-term conventual tagging	A. Challen Hyman, Chloe Ramsay, and Thomas K. Frazer	19 August 2025 Updated: 2 September 2025
SEDAR100-DW-18	Indices of abundance for Gulf Gray Triggerfish (*Balistes capriscus*) using data from multiple video surveys	Katherine E. Overly, Heather M. Christiansen, Sean F. Keenan, Theodore S. Switzer, Justin Lewis, Matthew D. Campbell	2 September 2025 Updated: 3 September 2025
SEDAR100-DW-19	Gray Triggerfish (*Balistes capriscus*) indices of relative abundance from	David S. Hanisko, Glenn Zapfe, Adam	3 September 2025

	SEAMAP Fall Plankton Surveys, 1986 to 2023	G. Pollack and Denice M. Drass	
SEDAR100-DW-20	Public comments received via the online comment form during the data process		2 September 2025
SEDAR100-DW-21	Fisherman Feedback: Gray Triggerfish Response Summary	Gulf Council Staff	4 November 2025
SEDAR100-DW-22	Estimation of Gray Triggerfish Bycatch from Gulf of America Shrimp Trawls	Cheston T. Peterson, Carly Daiek, Kyle Dettloff, Steve G. Smith, and Sarina Atkinson	12 December 2025

Reference Documents		
SEDAR100-RD01	Application of three-dimensional acoustic telemetry to assess the effects of rapid recompression on reef fish discard mortality	Erin Collings Bohaboy, Tristan L. Guttridge, Neil Hammerschlag, Maurits P. M. Van Zinnicq Bergmann, and William F. Patterson III
SEDAR100-RD02	Cooperative Research Program Final Report: Estimating Gulf of Mexico Gray Triggerfish Release Mortality and Its Mitigation with Three-Dimensional Acoustic Telemetry	William F. Patterson III, Derek W. Chamberlin, and Miaya Taylor
SEDAR100-RD03	Bomb ^{14}C validates Gray Triggerfish (*Balistes capriscus*) dorsal spine and otolith ageing protocols	Derek W. Chamberlin, Jennifer C. Potts, Walter D. Rogers, Zachary A. Siders, William F. Patterson III
SEDAR100-RD04	Bayesian estimation of von Bertalanffy growth parameters for gray triggerfish, *Balistes capriscus*, incorporating multiple readers and ageing structures	Derek W. Chamberlin, Zachary A. Siders, Jennifer C. Potts, Walter D. Rogers, Miaya A. Taylora, and William F. Patterson, III
SEDAR100-RD05	Low discard survival of gray triggerfish in the southeastern US hook-and-line fishery	Brendan J. Runde, Paul J. Rudershausen, Beverly Sauls, Chloe S. Mikles, Jeffrey A. Buckel
SEDAR100-RD06	Characterization of the U.S. Gulf of Mexico and South Atlantic Penaeid and Rock Shrimp Fisheries Based on Observer Data	Elizabeth Scott-Denton, Pat F. Cryer, Matt R. Duffy, Judith P. Gocke, Mike R. Harrelson, Donna L. Kinsella, James M. Nance, Jeff R. Pulver, Rebecca C. Smith, and Jo A. Williams

2 LIFE HISTORY

2.1 OVERVIEW

The life history working group (LHWG) met to review and discuss all life history data available for gray triggerfish at the SEDAR100 data workshop. New information on age, length, growth, natural mortality, and meristic conversions from data collected since the previous assessment in 2015 (terminal year 2013) was updated and examined to provide recommendations to the stock assessment panel. Data quality was examined with exploratory analyses to evaluate temporal and spatial representativeness. Specifically, the LHWG examined the data to look for issues within the available data types (e.g., length, age, compositions, etc.) as well as periods of low sample size resulting in poor data quality specific to each fleet in either region (East or West) or combined Gulfwide. The LHWG also assessed the impact of a new spine-ageing methodology, implemented for SEDAR100, on length-at-age and subsequent data products. A summary of the data presented, discussed, and recommendations made by the LHWG is presented in this document. Metadata submitted for SEDAR100 (1999-2024) follow the SEDAR Best Practices Template developed in December 2022.

2.1.1 Work Group members and participants in Life History webinars

Lisa Ailloud - NOAA Fisheries, Charleston, SC

Samantha Binion-Rock - NOAA Fisheries, Beaufort, NC

Bridget Cermak- Florida and Wildlife Conservation Commission, St. Petersburg, Florida

Steven Garner - CIMAS in support of NOAA Fisheries, Panama City, FL

Ryan Nichols - NOAA Fisheries, St. Petersburg, FL

Ashley Pacicco - CIMAS in support of NOAA Fisheries, Panama City, FL (Group Lead)

William Patterson III - University of Florida, Gainesville, FL

Michaela Pawluk - NOAA Fisheries, Galveston, TX

2.1.2 Topics Reviewed by the Life History Group

1. Morphometrics
2. Length-at-age data
3. Calendar age assignment
4. Growth
5. Reader Precision/Ageing Error
6. Natural Mortality
7. Length Compositions
8. Age Compositions

9. Reproduction
10. Research Recommendations

2.2 MORPHOMETRICS

All morphometric conversion equations were updated for SEDAR100 (Table 2.13.1) due to the quantity of length and weight data collected since they were last estimated for SEDAR43 (2003-2013). Despite the large increase in data quantity, the estimated regression model parameters were very similar for length-length and length-weight conversions compared to previous estimates. Although all length-length conversion equations were updated, fork length (FL, mm), either observed or predicted, was used for final length. If an observed FL was not recorded, an alternative available length measurement was converted to FL based on the approach used in SEDAR43: 1) observed natural total length, 2) observed maximum total length; or 3) observed standard length. If an observed whole weight (WWt, g) was not recorded, it was converted from final FL (observed or converted) following the morphometric equations updated during SEDAR100 (Table 2.13.1; Figure 2.14.1). A conversion equation from gutted weight to whole weight was not provided in SEDAR43 and was not developed for SEDAR100. Only n = 9 records did not have any final length or weight estimate (see SEDAR100-DW-14).

2.2.1 Recommendations for SEDAR 100

The LHWG recommends using the updated meristic equations developed during SEDAR100 given the length of time since they were last updated and the large increase in sample sizes used to develop the parameter estimates.

2.3 LENGTH-AT-AGE DATA

Life history data submitted for SEDAR100 were provided by both federal (NMFS Panama City) and state agencies (Florida Fish and Wildlife Research Institute (FWRI), the Gulf Fisheries Information Network (GulfFIN), and Dauphin Island Sea Lab/University of South Alabama (USA/DISL), Table 2.13.2). Of the n = 20,544 available samples, n = 19,407 had an age estimate; spines deemed unreadable were not included in this total. NMFS Panama City contributed the majority of age estimates (61.54%) followed by GulfFIN (26.24%). The dataset includes historical data submitted from previous assessments (SEDAR 9, 2006; SEDAR 43, 2015), which included years 1999-2013 in addition to new data to be considered for 2014 to 2024. No samples were collected in 2001. Of the samples with a valid age estimate, n=5,812 samples had unique sampling interviews, belonging to fishery-dependent (FD) (79.64%), fishery-independent (FI) (20.32%), or unknown (0.04%) sources (see SEDAR100-DW-14). All available samples had a value for the state landed category, with n = 4,480 samples having a specific catch location (i.e., latitude and longitude). The state with the highest number of samples

was FL (57.82%), followed by Alabama (15.38%). Not landed (NL) was recorded for 5.78% of the FI samples collected via scientific survey (sampling program= FWRI-FIM; data provider=FWRI). However, these fish were assumed to come from FL as FWRI only samples from state or federal waters off of FL. The eastern Gulf (state landed = FL, AL, MS, and NL [assumed FL]) had a disproportionately higher number of samples (79.4%) compared to the western Gulf (state landed = LA, TX; 20.6%; Figure 2.14.2). Most spine samples were collected from the recreational (REC) fishery (47.95%) followed by the commercial (COM) fishery (31.69%) and those collected by fishery-independent (FI) surveys (20.32%). Very few samples were collected from unknown sources (0.04%). The majority of samples were collected from fish caught with handline (HL) gear (81.69%) followed by trap (TR; 6.45%) or longline (LL; 4.61%) gear (see SEDAR 100-DW-14). Samples collected at the beginning of the time series (1999-2000, 2002) were caught via neuston nets (NEU) deployed during scientific surveys (data provider = DISL/USA, state landed= MS). No samples were collected in 2001. Production ageing began in 2003 at the NMFS Panama City laboratory resulting in dramatic increases in the number of dorsal spines aged per year (Figure 2.14.3). FWRI-FIM and GulfFIN began ageing gray triggerfish spines in 2006 and 2007, respectively.

Dorsal spines were processed following the standard protocol from SEDAR43 and Allman et al. (2018). Edge types varied depending on the data provider, with some noting wide or narrow opaque zones. Otherwise, data providers recorded the edge type as opaque, translucent, or left the category blank. In SEDAR62, all dorsal spine ages were deemed unreliable and excluded from the assessment due to dorsal spine sections significantly underestimating otolith-based ages, specifically for fish aged 5 years and older (Patterson et. al 2019). For SEDAR100, all historical samples (i.e., collected from 1999-2017) originally aged 5 years and older were re-aged. New age data collected from 2018 to 2024 were read using the new dorsal spine ageing method described in Potts et al. (2023). Results from eye lens bomb radiocarbon (^{14}C) analysis validated that the new spine-ageing method (i.e., including compacted bands along the margin in annuli counts for fish age-5+) used in SEDAR100 was comparable to otolith-based age estimates, which are considered more accurate and without bias (Chamberlin et al. 2024).

Gray triggerfish spine age estimates ranged from 0 to 16 years, with the majority of age estimates between 3 and 6 years old (67.47%). A total of 100 samples were older than age-12 and only 1 fish was estimated at age-16. Samples collected via neuston net were collected from floating sargassum mats and all estimated as either age-0 or age-1 fish (n = 66). Fish collected from the COM sector had a mean age (± SD) of 5.65 (± 2.26) years, while fish sampled from the REC fishery had a mean age of 4.92 (± 1.90) years. Sampled fish caught with HL gear were on average 5.00 (± 2.01) years, while sampled fish caught with LL gear had a mean age of 7.04 (± 2.34) years. Overall, length-at-age was highly variable in all year classes from 2003-2024

(Figure 2.14.3). This variability is due in part to natural variability in length-at-age of gray triggerfish but also due to the difficulty in ageing this species because of deposition issues pertaining to compaction of annuli along the margin and the infrequent occurrence of false or paired annuli called "doublets" that do not correspond to a year's worth of otolith deposition.

2.3.1 Recommendations for SEDAR 100

The LHWG recommends that the spine-based age estimates are accepted for use in SEDAR100 as the new age estimates follow the protocol described in Potts et al. (2023) and validated by Chamberlin et al. (2024). This new approach also was accepted for use in SEDAR82 for spine-based age estimates of South Atlantic gray triggerfish.

2.4 CALENDAR AGE ASSIGNMENT

In SEDAR43, gray triggerfish with a capture month from January to June with no visible translucent zones (i.e., age-0) were advanced to calendar age 1. Fish caught from July to December with a final (fork) length ≥160 mm were also advanced to calendar age 1, and fish <160 mm were not advanced (Allman et al. 2019; see SEDAR100-DW-14). The LHWG explored updating the ageing algorithm used for assigning calendar age to reduce mis assignment of young fish to incorrect year classes. Length-frequency histograms by month and calendar-age assignment indicated a large portion of young fish from age-0 to 2 were likely mis assigned using the previous algorithm. Frequency-histograms suggested that fish originally assigned a calendar age of 1 and collected from January through April should have been advanced to calendar age 2. Fish originally assigned a calendar age of 1 and collected from September through December should have been assigned to the previous age class (calendar age 0; Figure 2.14.4). The LHWG identified and investigated two potential sources of error that potentially required adjustment of calendar age assignments:

1. A settlement mark may have been incorrectly identified as a true annulus
2. Incorrect adjustments based on the previous algorithm

To further explore potential settlement mark misidentification, Panama City Lab personnel re-aged dorsal spines for fish with annuli counts of 0 or 1 that were caught from September through December and were < 250 mm FL (n = 134 total; data provider = NMFS Panama City). Trawl-collected, age-0 gray triggerfish showed settlement marks on dorsal spine sections when fish were between 40 and 160-mm FL (Ingram, 2001; SEDAR 9, 2006). The settlement mark can be extremely similar to the first true translucent zone of a dorsal spine annulus in young fish (age-1 and age-2). Fioramonti (2012, Masters Thesis), estimated that the first annulus was 1.5 mm +/- 0.04 mm, and this estimate was used as a guide during visual reinspection by Panama City Lab personnel, which resulted in n = 56 ages being changed from an age-1 to age-0. In response to

the first source of error: Panama City Lab personnel also re-aged samples that appeared as potential outliers in the data for fish with an annuli count of 2 that were caught from April through May with a FL >400 mm (data provider NMFS Panama City), which resulted in n = 29 ages being changed to between 3 and 7 years old. In response to the second source of error, the LHWG discussed whether or not to adjust the ageing algorithm used for SEDAR43. Alternative approaches were discussed, such as using edge type assignments to advance or subtract year classes, which is common practice for many other fishery species. However, because a single annual peak in translucent edge formation was not apparent in the data (Figure 2.14.5), coupled with the fact that edge type was not determined or unreliably determined for many samples aged with the previous ageing protocol, the LHWG deemed edge-type assignments an unreliable solution to adjusting the calendar-age algorithm. Otherwise, annuli count equaled calendar age. Edge type was not used to assign calendar age given the inherent difficulty in assigning edge type, which requires estimating the proportion of total annulus formation. Fractional age was calculated using the established birthdate of July 1, which corresponds to the average peak spawning date of gray triggerfish in the Gulf (Allman et al. 2018; Kelly-Stormer et al. 2017). Each spine was aged independently of fish length and date of capture.

The LHWG also explored the use of ELEFAN with age slicing as an alternative approach to the calendar-age advancement algorithm used in SEDAR43. ELEFAN was used to fit a seasonally-oscillating von Bertalanffy growth function (VBGF) to monthly length-frequency data of fishery independent samples with annuli less than 3. This was done to ensure that the samples were not impacted by regulatory selectivity (i.e., minimum length limits) and focus on the age classes where modal progressions were most obvious. A VBGF model was fit to the data using the function ELEFAN_GA with the R package *TropFishR* using the following settings: 2-cm length bins, moving average = 5, Maxage = 4, Maxiter = 1000, t_anchor (time at length 0) originally estimated then fixed at optimal (0.17, March) for reproducibility. The resulting parameter estimates (Figure 2.14.6) were L_∞=57.06 mm FL, K=0.33yr^{-1}, t_{anchor}= 0.17 years, C = 0.67 (amplitude of growth oscillation where 0 is no seasonal growth and 1 is complete growth cessation during the unfavorable season), and t_s=0.56 (starting point of the growth oscillation as a fraction of the year when the period of slowest growth begins). The group determined that age slicing using ELEFAN was useful for correcting the calendar age of fish with annuli counts of 0 and 1, but not recommended beyond that as modes became less distinct with age. Age slicing (Figure 2.14.7) was applied to the entire dataset of samples with annuli counts of 0 and 1 (both fishery dependent and independent samples) using the growth parameters estimated in the previous step. The slicing was done using the point midway between the lower length bin of calendar age + 1 month and calendar age + 1 year (Figure 2.14.7). Of the 352 samples with annuli count = 0, n = 331 were assigned a calendar age of 0 and n = 21 were assigned a calendar age of 1. Of the 375 samples with annuli count = 1, n=167 were assigned a calendar age of 0, n =

163 a calendar age of 1, n = 25 a calendar age of 2, and n = 20 a calendar age of 3 (Figure 2.14.8).

2.4.1 Recommendations for SEDAR 100

The LHWG recommends that calendar age for samples with annuli counts of 0 or 1 be assigned according to the age slicing algorithm developed using ELEFAN during the data workshop. For all other samples (annuli counts of 2 and up), the annulus count should equal the estimated calendar age.

2.5 GROWTH

Growth (length-at-age) was modeled with von Bertalanffy growth functions (VBGF) estimated in AD Model Builder (Fournier et al., 2012). The length-at-age data used to model growth included all data used in SEDAR43, but with ages for fish 5+ years updated using the new ageing protocol, as well as data from the new data period. Growth models were fit under four different scenarios: 1) sex-specific models; 2) sexes combined; 3) sexes combined but with size-correction for minimum length limits (MLLs) using the updated Diaz method (Diaz et al. 2004); or 4) region-specific models (i.e., East vs West of the MS river outflow) with sexes combined and without size-correction. Although gray triggerfish are known to exhibit sexually dimorphic growth (Kelly-Stormer et al. 2017; Jefferson et al. 2019; Chamberlain et al. 2025), the life-history data submitted for SEDAR100 did not provide sufficient contrast to fit sex-specific growth models (Figure 2.14.9). Likewise, the data did not support modeling growth separately for fish from the eastern or western Gulf (Figure 2.14.10). However, applying the size-correction method to the growth model with sexes combined greatly improved model fit based on visual inspection of residual plots. The parameter estimates for the best-fit VBGF corrected for size-selectivity were L_∞= 468.37 mm FL, K=0.292 yr^{-1}, and t_0=-0.900 years (Figure 2.14.11). Correcting the data for MLLs indicated that selectivity was particularly strong in the COM HL fleet.

2.5.1 Recommendations for SEDAR 100

The LHWG recommended the use of a single set of VBGF parameter estimates (for sexes combined and without regional delineation) to describe gray triggerfish growth in the assessment. The parameter estimates for the best-fit VBGF corrected for size-selectivity were L_∞=468.37 mm FL, K=0.292 yr^{-1}, and t_0=-0.900 years.

2.6 READER PRECISION/AGEING ERROR

The primary age data providers (# of readers; % of total samples aged) for SEDAR100 were NMFS Panama City (two expert readers; 61.54%) and FWRI (one expert reader; 23.12%). Prior

to production ageing, each ageing laboratory reviewed and aged the reference set (n=115 spine thin sections with consensus ages) developed for gray triggerfish to ensure comparable reading methodologies and allow for ageing error estimation. The consensus ages for the reference set were established by expert gray triggerfish readers from the South Atlantic (Jennifer Potts and Walt Rogers) using the protocol described in Potts et al. (2023). Given that gray triggerfish are considered a difficult species to age, an individual with an average percent error (APE) of ≤10% for the reference set was considered acceptable to begin production ageing. Bias plots and estimates of precision were calculated using the *FSA* (Fisheries Stock Analysis) package in R (Ogle et al. 2025). Bland-Altman plots with statistical comparisons (paired t-tests, $\propto$=0.05) of each reader's reference set age estimates indicated there was no significant bias observed for any age class from any of the three readers that provided age data for SEDAR100 (Figure 2.14.12).

Ageing error estimates were provided only for the new data period (2018-2024) and were estimated by fitting a single error model to all three sets of age estimates for the gray triggerfish reference set. Candidate models were fit to mode-predicted ages under several different scenarios to estimate bias and precision using the Northwest Fisheries Science Center's *agingerror* package in R (Punt et al. 2008). Bias models included options for no bias or linear bias. Precision model scenarios included parameters that estimated a 1) constant coefficient of variation (CV), 2) curvilinear SD, 3) curvilinear CV, 4) SD that varied as a linear function of age, or 5) CV that varied as a linear function of age. Consensus age estimates for the reference set were assumed to have imprecision but no bias. Precision parameter estimates were mirrored (i.e., each of the three reader-specific data sets were treated as replicates and modeled together) to produce a single SD-at-age matrix, for input into the stock assessment. A single, generalized SD-at-age matrix is estimated for use in the assessment model because each ageing lab provides estimates for multiple fisheries (i.e., recreational, commercial, or fishery independent) which are confounded among data sets input into the assessment model's data structures. Akaike's information criterion (AIC), its form corrected for small sample size (AICc), and Bayesian information criterion (BIC) along with diagnostic plots of expected values, expected confidence intervals (CI's), and SD were used to select the best fit model to describe ageing error and provided to stock assessment analysts. Ageing error models were not estimated separately for each subregion because there is no evidence to suggest a difference in readability among regions. Although bias was slightly apparent it was not significant in Bland-Altman plots from the FSA package. However, the model that best-fit ageing error data was one that estimated linear bias and curvilinear SD in precision-at-age (Table 2.13.3; Figure 2.14.13).

2.6.1 Recommendations for SEDAR 100

The LHWG recommends including the ageing-error matrix with linear bias and curvilinear SD for describing ageing error in the stock assessment model.

2.7 NATURAL MORTALITY

In SEDAR43, target *M* was estimated using the Hoenig (1983) method, assuming a maximum age (t_{max}) of 15 years, and scaled at age using the Lorenzen (1996) method. The LHWG group discussed two alternative estimators to estimated *M* in SEDAR100: Then et al. (2015), and Hamel and Cope (2022). The Then et al. (2015) estimator is essentially the Hoenig (1983) approach revisited using an updated and larger dataset where $M = 4.899t_{max}^{-0.916}$.

Hamel and Cope (2022) re-evaluated the approach used by Then et al. (2015) and recommended an alternative relationship be used where $M = \frac{5.4}{t_{max}}$. This estimator evaluates Then et al.'s (2015) updated dataset of *M* and maximum age using a more appropriate transformation than was used by Then et al. (2015) (see Hamel and Cope 2022 for more detail on the approach). The LHWG agreed that the Hamel and Cope (2022) estimator was an improvement over the Then et al. (2015) estimator and should be used in SEDAR100.

2.7.1 Recommendations for SEDAR 100

The LHWG recommends continuing to use a maximum age (t_{max}) estimate of 15 years and a minimum/fully selected age of 3 when estimating *M*. The LHWG recommends the Hamel and Cope (2022) equation be used to estimate target *M* (*M*=0.36) and then scale target *M* to age-specific values using the Lorenzen (1996) function (Table 2.13.4 and Figure 2.14.14).

2.8 LENGTH COMPOSITIONS

2.8.1 Commercial

Weighting methodology and final nominal and weighted length compositions for the commercial handline and longline fleets were presented in SEDAR100-DW-07, with preliminary compositions presented in the main paper, and updated final compositions presented in the appendix. The discussion of commercial length compositions at the workshop focused on available sample sizes for a potential 2 area model (East/West) vs. an all-Gulf model, and the potential for splitting longline out as its own fleet vs. proceeding with a single commercial fleet. A minimum sample size of n=30 fish was used to determine suitability of the length compositions. It was also recommended that the samples come from a minimum of n=10 trips to maintain spatial representativeness of samples. However, such a threshold can greatly reduce the amount of data available for use in the assessment, so a 10-trip threshold was used to identify low sample sizes but samples were not excluded if the number fell below that threshold.

When considering a 2-area model, sample sizes for nominal length compositions were sufficient in all years from 1990-2024 for HL samples from the East region, but sample sizes from the HL fleet in the West region were insufficient in some years. For the LL fleet, LL samples from the

East were sufficient to estimate nominal length compositions in roughly half of the years but were insufficient in all years for samples from the West region (for which only a few years had any data). For weighted length compositions, sample sizes for the HL fleet were insufficient for both the East and West regions in several years, while all years had insufficient data to estimate weighted length compositions for the LL fleet in either region. Data suitability for the COM 2-area model is shown in Table 2.13.5.

When considering an all-Gulf model, the HL fleet had sufficient sample sizes for a nominal length composition in all years from 1990-2024, while the LL fleet had sufficient sample sizes to estimate nominal length compositions in approximately half of the years. For weighted length compositions, the HL fleet had sufficient sample sizes in most years, while the LL fleet had insufficient sample sizes in all years. Data suitability for the commercial all-Gulf model is shown in Table 2.13.6.

2.8.2 Recreational

Final nominal and weighted length compositions are presented in Figures A1-A4 of SEDAR100-DW-04. Most of the discussion in the LHWG section focused on evaluating whether the length compositions were suitable for inclusion in the assessment. For the Gulf-wide or East stocks, all years had sufficient sample sizes (nfish ≥30 and ntrip ≥10) to estimate nominal length compositions (Table 2.13.7). For the West stock, there were insufficient sample sizes for most years after 2013. In the mid-1980s to early 2000s, there were sufficient samples to either estimate weighted compositions Gulf-wide, or separately for East and West stocks, however sample sizes were insufficient for the later part of the time series (Table 2.13.7).

2.8.3 Recommendations for SEDAR 100

The LHWG recommended: 1) proceeding with an all-Gulf model due to the limited data available for estimating compositions separately for the East and West in some years; and 2) using weighted length compositions when sufficient data are available and nominal length compositions for years when weighting is not possible. Use of nominal vs. weighted compositions should be compared to evaluate if weighting is having a large impact on compositions.

2.9 AGE COMPOSITION

2.9.1 Commercial

The weighting methodology and final nominal and weighted age compositions are presented in the appendix of SEDAR100-DW-07. For age compositions, the minimum sample size required for suitability was n=10 fish from n=10 trips. However, as with the length compositions, the

number of trips was not used as a hard cutoff due to the potential reduction in data availability. Sample sizes for both a 2-area model (East/West) and an all-Gulf model were considered.

When considering the 2-area model, the HL fleet in the East region had sufficient sample sizes for estimating nominal age compositions in all years from 2003-2024, while data for the HL fleet in the West were sufficient in 2009, and 2011-2024. For the LL East fleet, sample sizes were sufficient for nominal compositions from 2004-2024, with the exception of 2020. For the West LL fleet, sample sizes were insufficient in all years to estimate nominal age compositions. For weighted age compositions, there were sufficient sample sizes for the HL East fleet from 2011-2024, while for the HL fleet in the West had only a few years with sufficient sample sizes. For both the LL fleets in East and West, there were insufficient sample sizes in all years to develop weighted age compositions. Data suitability for the COM 2-area model is shown in Table 2.13.5.

When considering the all-Gulf model, the HL fleet had sufficient sample sizes for nominal age compositions in all years from 2003-2024, and the LL fleet had sufficient sample sizes for nominal age compositions in all years from 2003-2024, except for 2020. For weighted age compositions, the HL fleet had sufficient sample sizes in most years, while the LL fleet had insufficient sample sizes in all years. Data suitability for the COM all-Gulf model is shown in Table 2.13.6.

2.9.2 Recreational

Final nominal and weighted age compositions are presented in Figures A5-A11 in SEDAR100-DW-04. Weighted age bubble plots are also provided in the Recreational Fishery Statistics section of this report. Most of the discussion in the LHWG focused on evaluating whether the age compositions were suitable for inclusion in the assessment. Only 6 years have sufficient sample sizes (nfish ≥10 and ntrip ≥10) to estimate nominal age compositions in the West region while the Gulf-wide and East stocks have sufficient sample sizes for all years (Table 2.13.7). Weighted length compositions are used to produce weighted age compositions. Weighted age compositions were only available to be produced for 5 years in the West, 8 years in the East, and 12 years Gulf-wide because of insufficient sample sizes for weighted length compositions and/or insufficient number of age samples (Table 2.13.7). Sample sizes in the West were low for conditional age-at-length (CAAL) and mean length-at-age in the West, but are sufficient in the East and Gulf-wide (Table 2.13.7).

2.9.3 Recommendations for SEDAR 100

The LHWG recommends comparing nominal and weighted age compositions to evaluate whether the weighting procedure is dramatically influencing age compositions. If weighting is not having a large impact, they recommend using nominal age compositions. If weighting is

having a large impact, consider only using weighted age compositions for the years they are available. The group also recommends using conditional age-at-length (CAAL) where data are sufficient, but recognizes it may not be informative for many fleets because of insufficient contrast across age classes. They also recommend using mean length-at-age (MLAA) to aid in model diagnostics.

2.10 REPRODUCTION

There have been no significant updates to the available maturity or fecundity information when compared to analysis conducted in SEDAR43 (SEDAR, 2015). While 406 reproduction samples were provided by University of Southern Mississippi/Alabama Department of Conservation Natural Resources, the vast majority were outside the months used in reproductive analyses (June-August) conducted during SEDAR43. In addition, no age estimates or batch fecundity estimates were provided.

2.10.1 Recommendations for SEDAR 100

Following recommendations made during SEDAR 74 for Gulf red snapper, the LHWG suggested that the assessment analyst utilize spawning stock biomass as the measure of reproductive potential within the stock assessment model instead of batch fecundity estimates which were used in SEDAR43. The assessment model treats batch fecundity as known and does not take into account uncertainty. The batch fecundity estimates recommended during SEDAR 43 were based on 73 individuals between 26 and 39 cm FL (~2 – 6 years).

2.11 RESEARCH RECOMMENDATIONS

The LHWG drafted the following recommendations:

- Continue refining ageing algorithms for assigning calendar and fractional ages. This includes further research into the use of edge type, which requires that age readers record narrow versus opaque margin codes to get a better understanding of seasonality of annulus formation.
- Consider evaluating maturity-at-age given the ageing issues identified for ages 0-2
- Continue to examine data for region- and sex-specific differences in growth as data accrue over time.
- Continue to recommend that all age-data providers read the gray triggerfish reference set following the Potts et al. (2023) protocol prior to conducting any production ageing.
- Consider exploring epigenetic ageing as a complementary approach to gain insight into sex-specific growth and to potentially improve confidence in age-class assignments.

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2.13 TABLES

Table 2.13.1. Meristic regressions for gray triggerfish (1999-2024) from the Gulf of America. Data is combined from all data sources, both fishery dependent and independent, and includes data without ages if length and/or weight information was provided. Length Type: Max_TL- Maximum total length, FL- Fork length, Nat_TL – Natural total length, SL- Standard length. Weight Type: GWt- Gutted weight when "Condition Type" = "Gutted-head on", WWt- Whole weight. Units: length (mm) and weight (g). Linear and nonlinear regressions were calculated using R (lm and nls functions, respectively).

Conversion	Equation	Statistic	N	Data Range
Max_TL to FL	FL= Max_TL*0.788 + 23.541	r^2 = 0.9591	6,322	Max_ TL: 16-753; FL: 65-617
Nat_TL to FL	FL= Nat_TL*0.792 + 33.477	r^2 = 0.9164	3,710	Nat_TL: 50-718; FL: 78-617
SL to FL	FL= SL*1.144 + 13.531	r^2 = 0.9850	5,015	SL: 51-590 ; FL: 68-617
Max_TL to WWt	$WWt= 2.681*10^{-05} * (Max_TL^{2.884})$	RSE = 274.9	5,123	Max_TL: 16-743; WWt: 10-5,300
Nat_TL to WWt	$WWt= 4.211*10^{-05} * (Nat_TL^{2.827})$	RSE = 275.6	3,654	Nat_TL: 22-718; WWt: 0.251-5,840
FL to WWt	$WWt= 1.450*10^{-05} * (FL^{3.070})$	RSE = 175.4	11,332	FL: 61-617; WWt: 6-5,840
SL to WWt	$WWt= 8.607*10^{-05} * (SL^{2.855})$	RSE = 199.1	4,192	SL: 17-590; WWt: 0.251-5,300
FL to GWt	$GWt= 2.938*10^{-05} * (FL^{2.950})$	RSE = 193.5	2,196	FL: 275- 625; GWt: 454-4,763

Table 2.13.2. Number of gray triggerfish (final) age samples (n =19,407) collected from the Gulf of America from 1999 to 2024 by data provider. Black line indicates the terminal year for SEDAR 43 (i.e., 2013). No age samples were collected during 2001.

YEAR	FWRI	GulfFIN	AGR	BSD	USA/DISL	
1999	0	0	0	0	2	
2000	0	0	0	0	3	
2002	0	0	0	0	60	
2003	0	0	149	0	0	
2004	0	0	167	0	0	
2005	0	0	269	0	0	
2006	11	0	259	0	0	
2007	28	296	206	0	0	
2008	0	191	424	0	0	
2009	0	173	574	0	0	
2010	81	27	331	0	55	
2011	48	191	227	187	66	
2012	91	126	407	298	17	
2013	42	131	495	495	29	
2014	76	7	232	405	26	
2015	125	6	148	775	57	
2016	164	1354	433	664	599	
2017	126	192	57	594	337	
2018	116	691	254	757	0	
2019	30	287	126	803	0	
2020	4	261	109	290	0	
2021	16	347	82	83	0	
2022	116	344	74	491	0	
2023	15	306	280	440	0	
2024	32	162	0	358	0	
Total (n)	1121	5092	5303	6640	1251	19407
%	5.78	26.24	27.33	34.21	6.45	100.00

Table 2.13.3. Estimates of expected age and standard deviation-at-age fit to consensus age estimates from the gray triggerfish reference set using the NWFSC *ageingerror* package in R.

True_Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Expected_age	0.53	1.58	2.64	3.70	4.75	5.81	6.87	7.92	8.98	10.04	11.09	12.15	13.21	14.26
SD	0.394	0.394	0.463	0.529	0.592	0.651	0.707	0.761	0.811	0.859	0.904	0.947	0.988	1.026

Table 2.13.4. Recommended values for age-specific natural mortality (M) for gray triggerfish in the Gulf of America. Target M was calculated using the Cope and Hamel (2022) estimator (M=0.36) then scaled to age-specific values using the Lorenzen (1996) function.

Age	Age-specific M
0	1.374
1	0.775
2	0.589
3	0.500
4	0.450
5	0.419
6	0.398
7	0.384
8	0.375
9	0.368
10	0.363
11	0.359
12	0.356
13	0.354
14	0.353
15	0.352

Table 2.13.5. Final recommendations regarding the suitability of the available length and age data for the Commercial Handline (COM HL) and Commercial Longline (COM LL) fisheries under a 2-area model scenario (East/West). Years in green are considered suitable, red are considered unsuitable, and gray have no available data. Suitability is shown for nominal length compositions, weighted length compositions, nominal age compositions, and weighted age compositions.

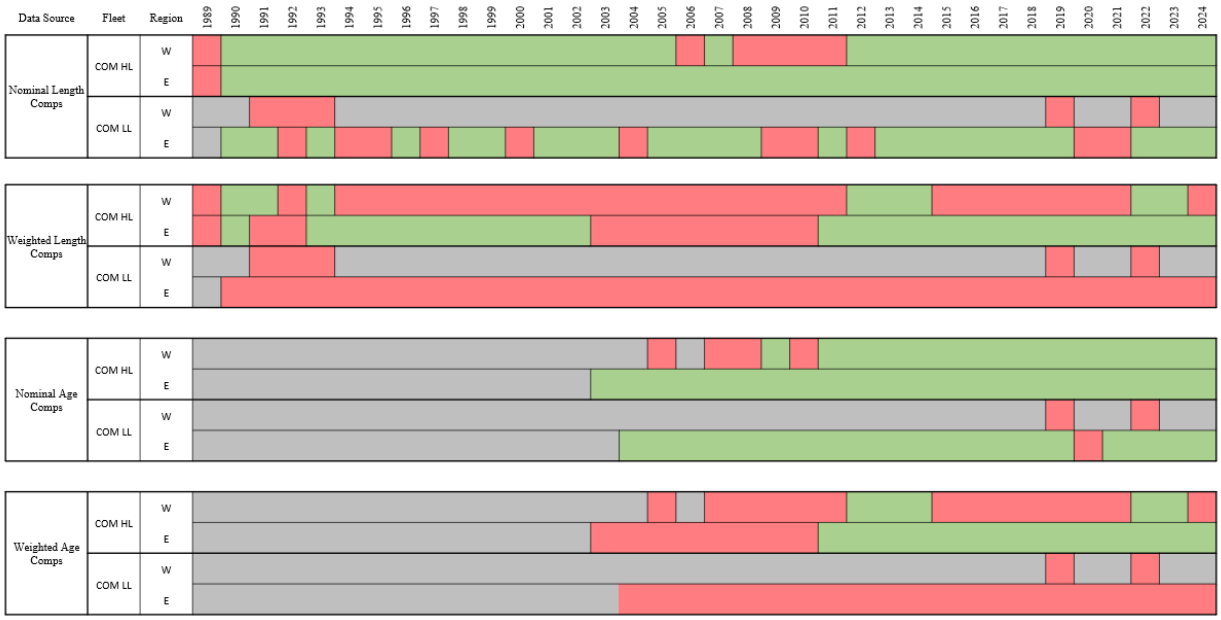


Table 2.13.6. Final recommendations regarding the suitability of the available length and age data for the Commercial Handline and Commercial Longline fisheries for an All Gulf model. Years in green are considered suitable, red are considered unsuitable, yellow is considered suitable on if informative in the model, and gray have no available data. Suitability is shown for nominal length compositions, weighted length compositions, nominal age compositions, and weighted age compositions, and conditional age-at-length (CAAL).

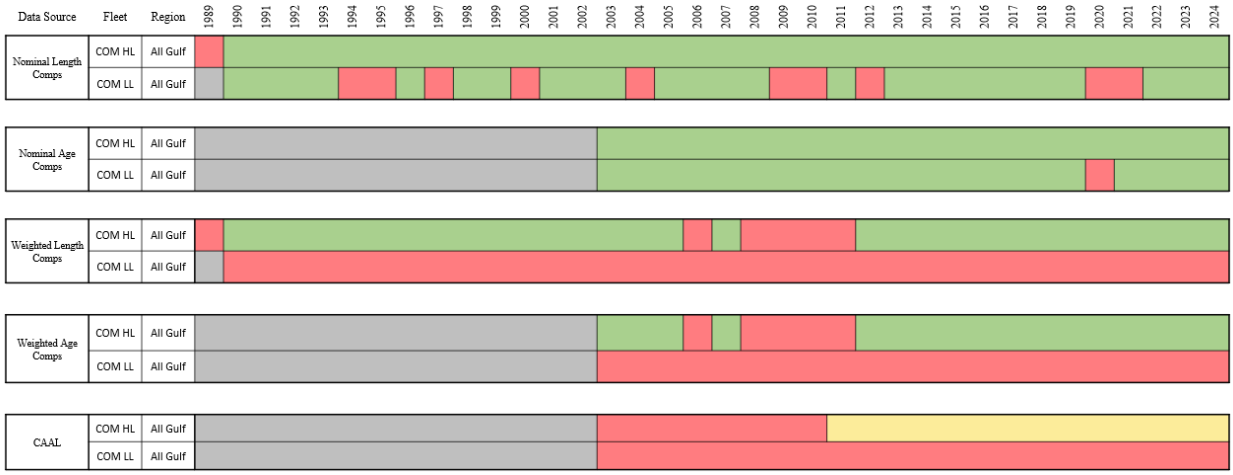
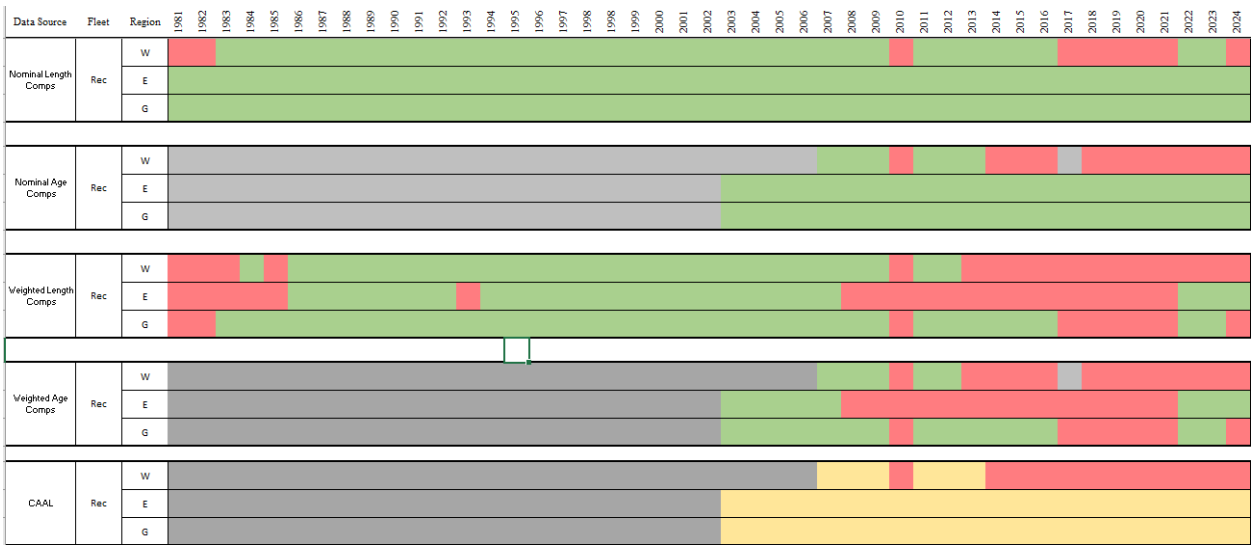


Table 2.13.7. Final recommendations regarding the quality of nominal length and age compositions, weighted length and age compositions, and conditional age-at-length (CAAL) for the recreational fishery for the West (W), East (E), and Gulf-wide (G) stocks. Years in green are deemed sufficient for use in the assessment, yellow are deemed questionable/potentially unreliable for use in assessment, and red are deemed insufficient/unacceptable for use in assessment. Years in gray have no data available.



2.14 FIGURES

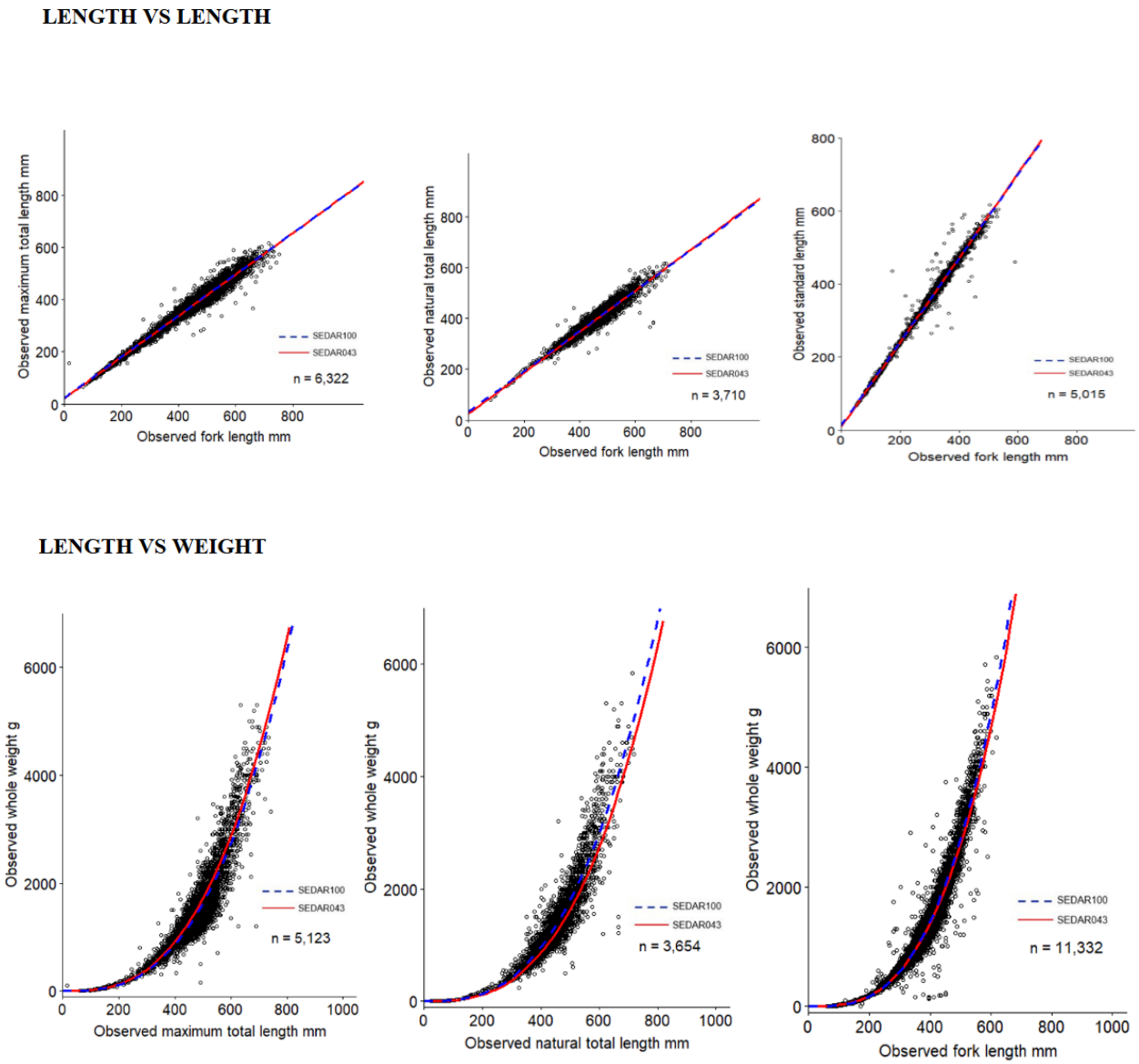


Figure 2.14.1. Scatterplots of observed fork length (FL; mm) versus observed maximum total length (MTL; mm), natural total length (NTL; mm), and standard length (SL; mm), and observed MTL, NTL, and FL versus observed whole weight (g) for SEDAR 43 compared to SEDAR 100 for gray triggerfish data collected from the Gulf of America from 1999-2024.

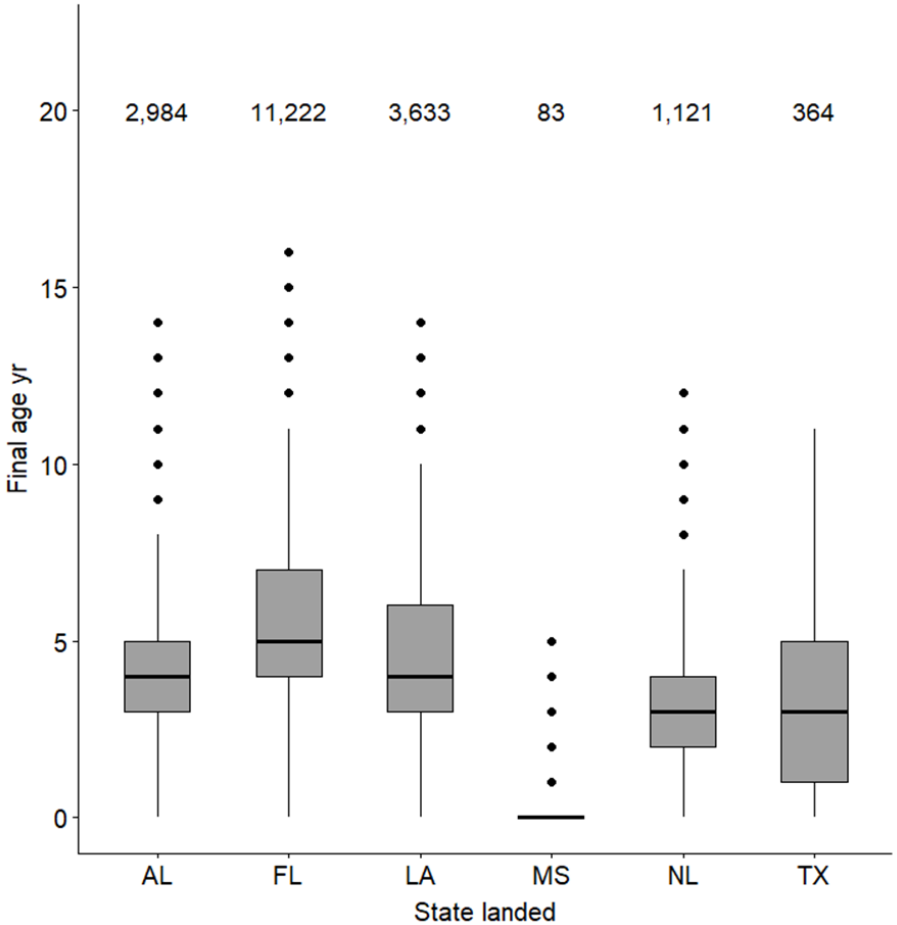


Figure 2.14.2. Boxplot of final age (yr) by state landed (Alabama, AL; Florida, FL; Louisiana, LA; Mississippi, MS; Not Landed, NL; Texas, TX) for gray triggerfish age samples collected from the Gulf of America from 1999 to 2024. No age samples were collected during 2001. Sample numbers are shown along the top of the figure. Boxes indicate the 25th and 75th percentiles, horizontal lines indicate median values, vertical lines indicate the min and max values of the IQR*1.5, and points indicate values outside that range.

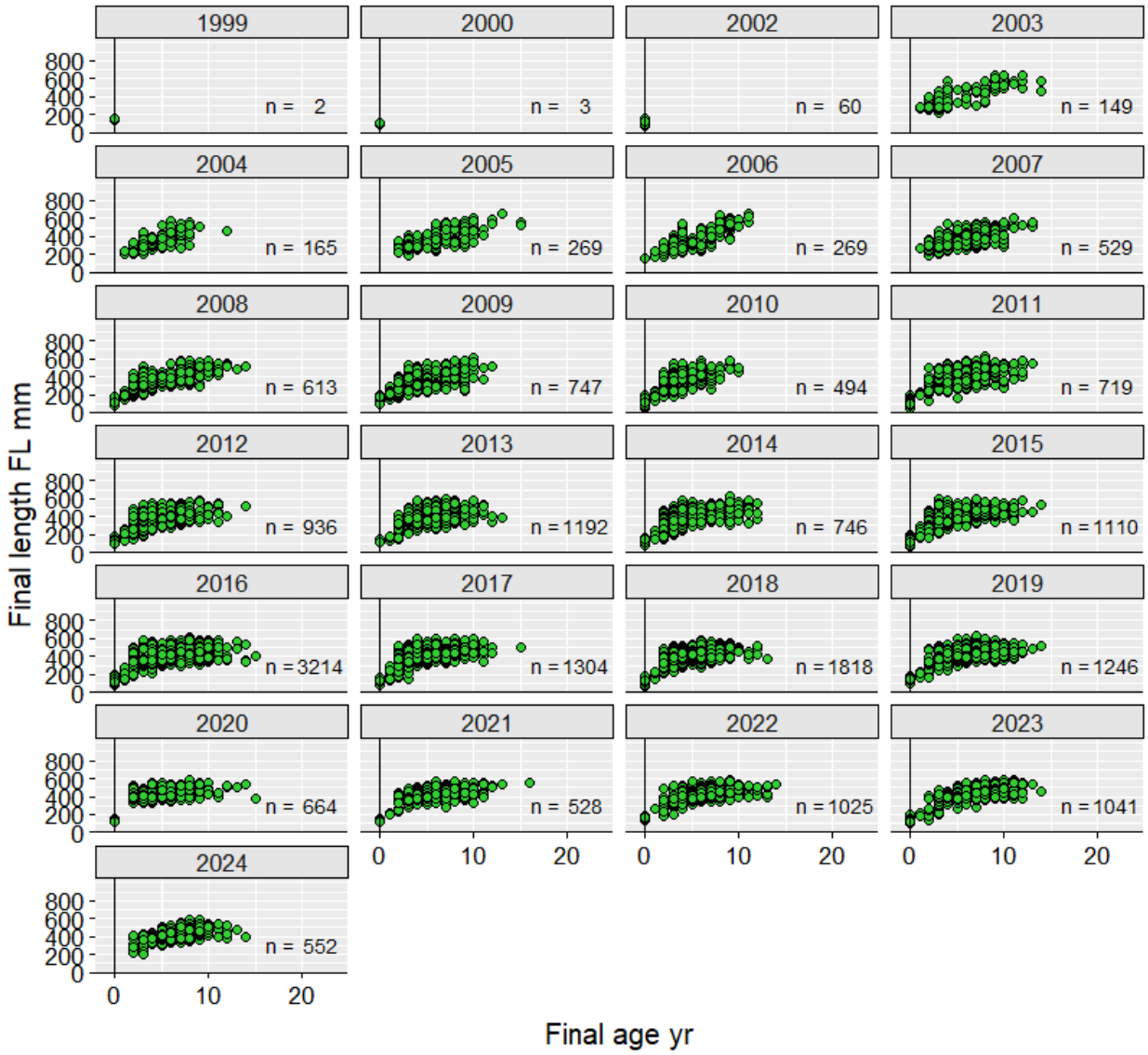


Figure 2.14.3. Scatterplots of final age (yr) at length (FL mm) for gray triggerfish samples collected from the Gulf of America from 1999 to 2024. No age samples were collected from 2001. The number of observations are shown at the bottom right of each panel.

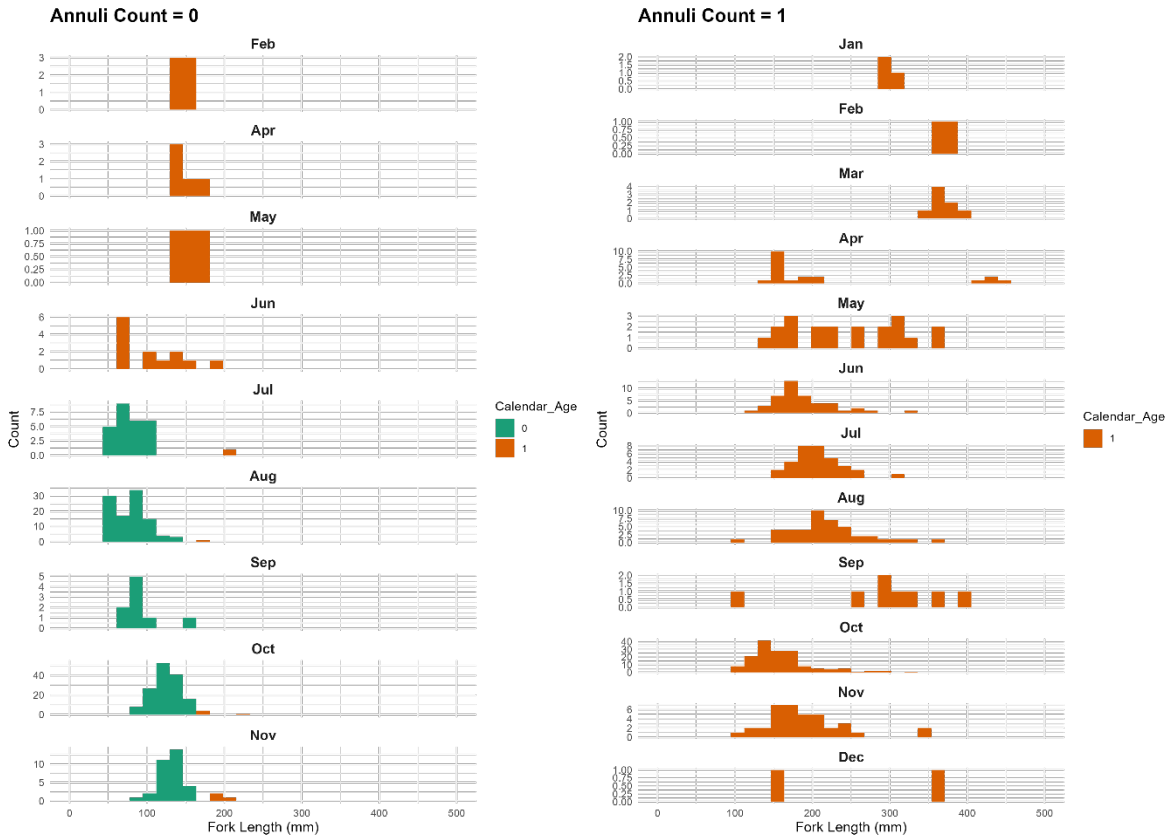


Figure 2.14.4. Monthly histograms of fish size for individuals with an annulus count of zero (left) and one (right). The calendar ages reflect the ages obtained using the SEDAR 43 age adjustment algorithm (fish caught between January and June with no visible translucent zones and fish caught from July to December with FL ≥ 160 mm were advanced by 1 year).

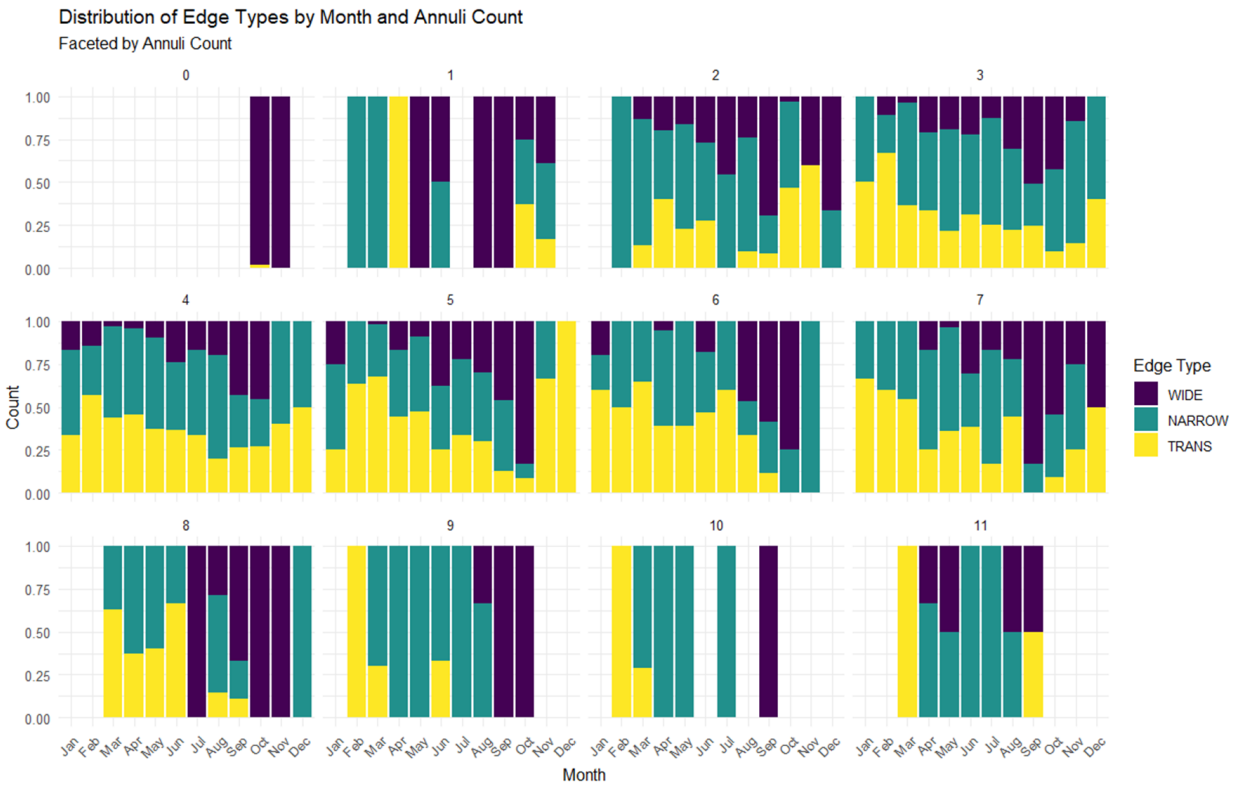


Figure 2.14.5. Edge type assignment by month and annuli count for the samples where month and edge type were recorded (1,987 out of 20,544 samples). The timing of growth band formation remains unclear.

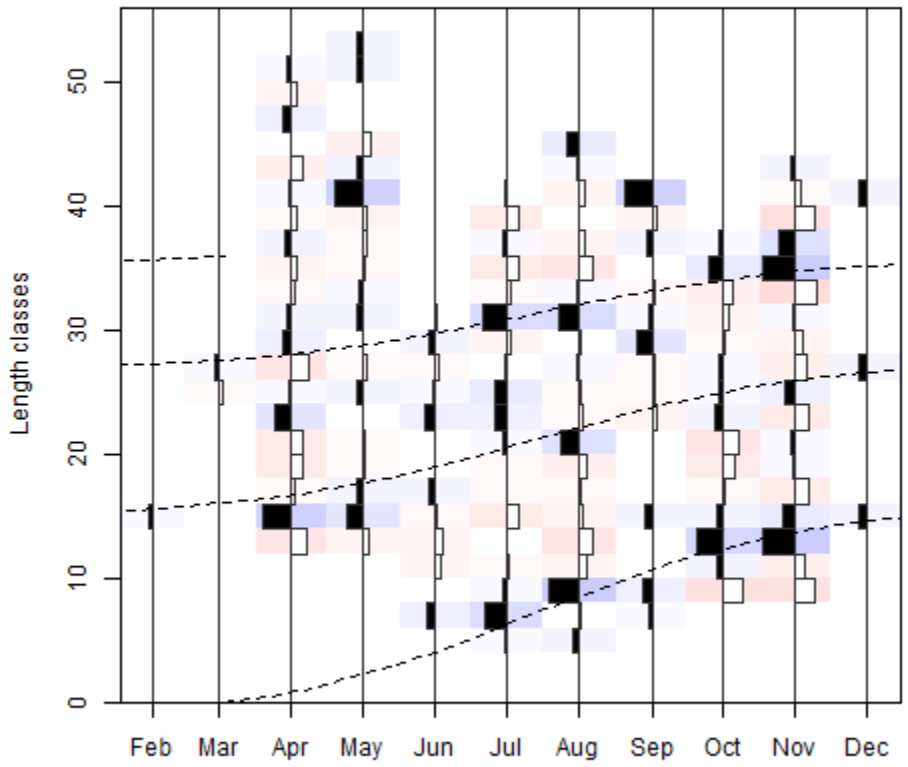


Figure 2.14.6. Monthly length frequency data (histograms) used in fitting the seasonally-oscillating von Bertalanffy growth model (dashed line).

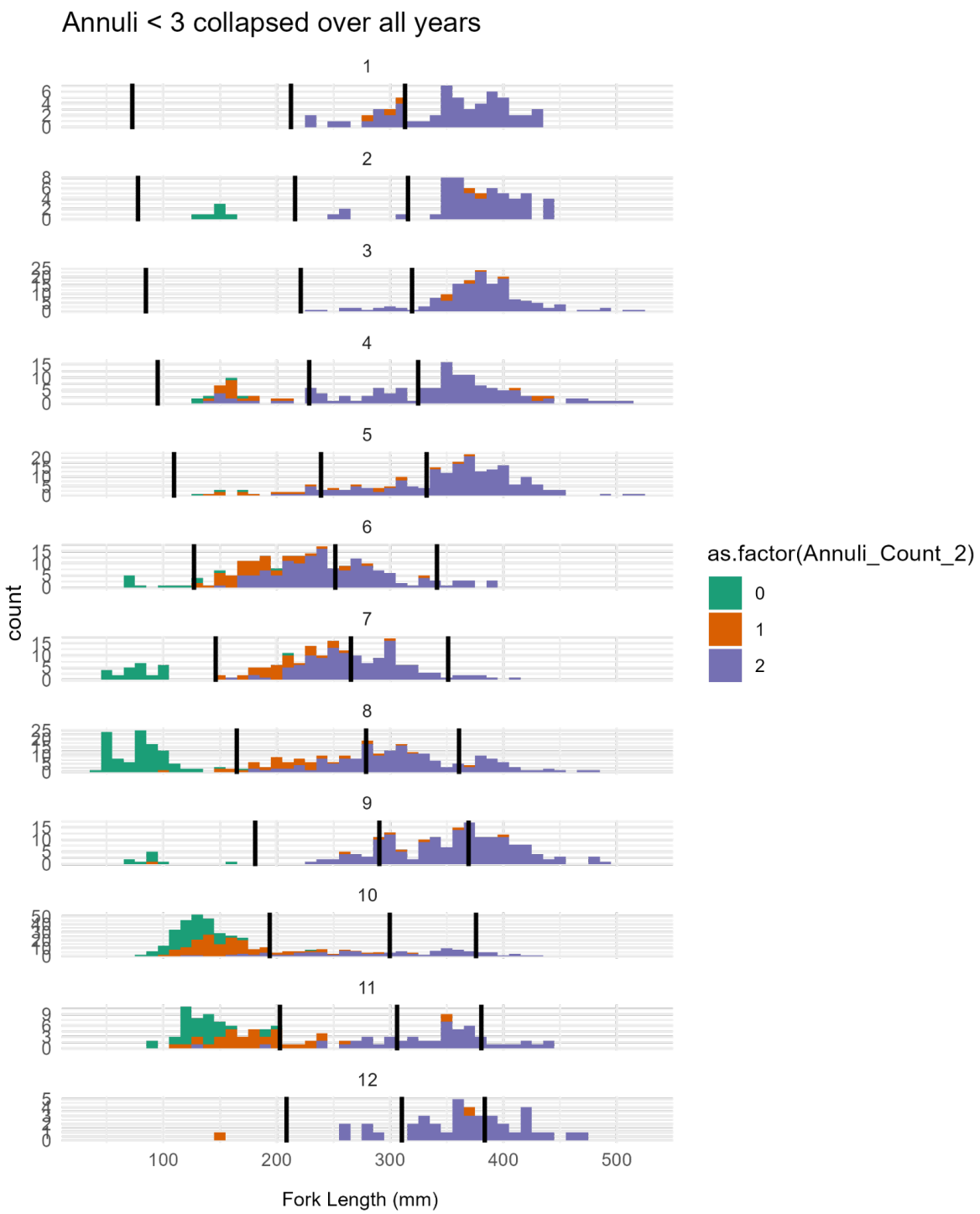


Figure 2.14.7. Location of the age slicing (black vertical lines) against the monthly length frequency data of sample with annuli counts less than 3. Fish with annuli counts of 0 or 1 falling to the left of the first vertical line are assigned a calendar age of 0, fish between the first and second vertical lines a calendar age of 1, etc. Fish with annuli counts of 2 and beyond remained unaltered.

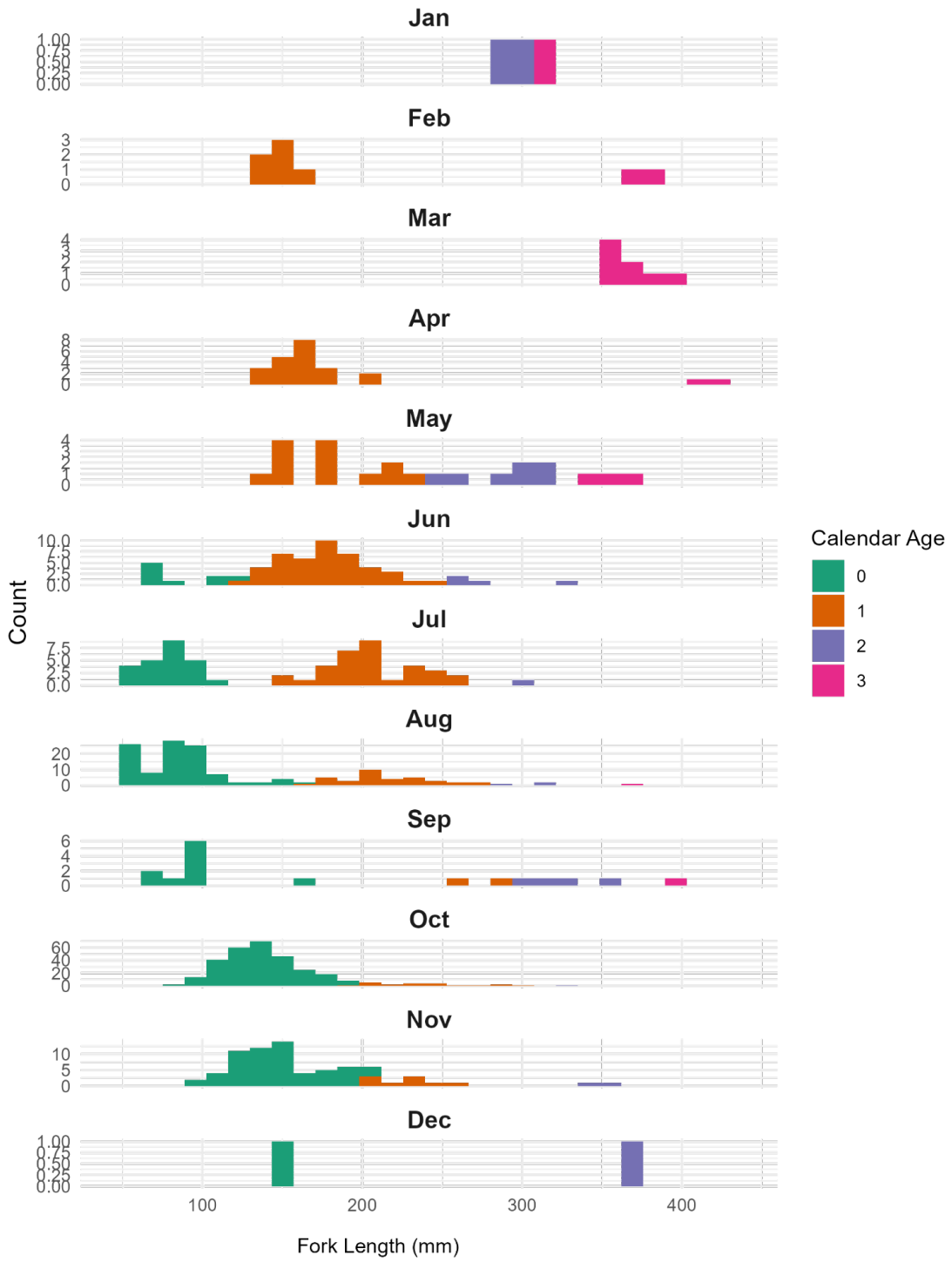


Figure 2.14.8. New calendar age assignments for samples with annuli counts of 0 and 1 using ELEFAN and age slicing.

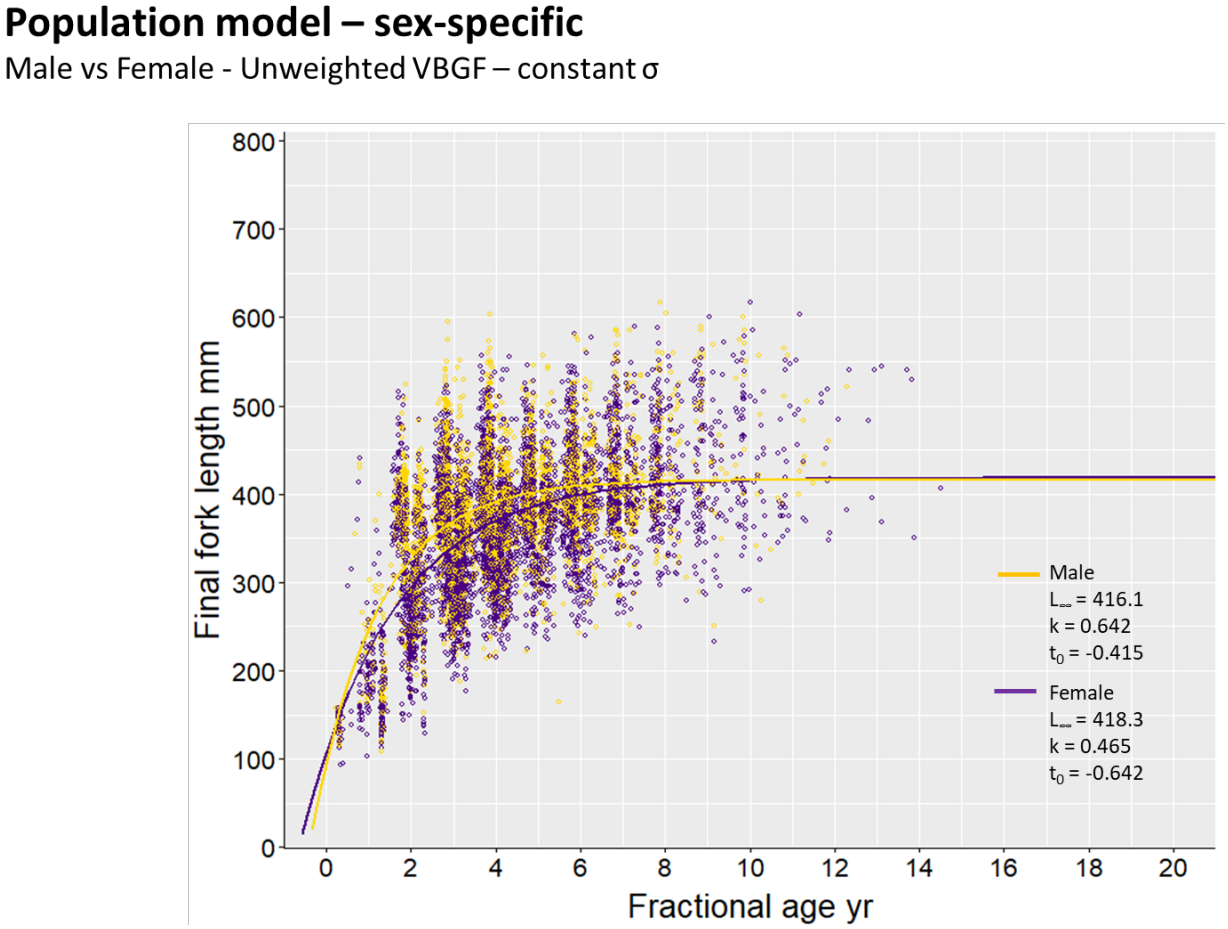


Figure 2.14.9. Von Bertalanffy growth models of gray triggerfish age-at-length (yr, mm) specified by sex. Males are indicated with yellow circles, while females are indicated with purple circles.

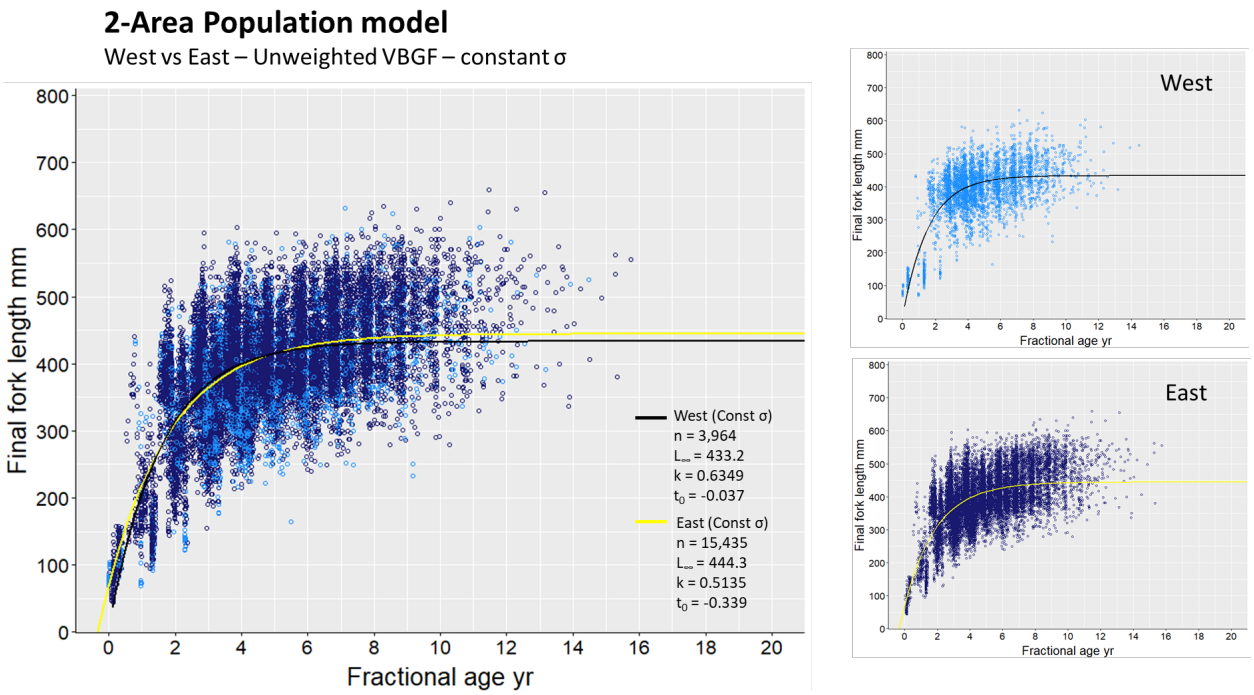


Figure 2.14.10. Von Bertalanffy growth models of gray triggerfish age-at-length (yr, mm) for fish collected from the East vs West Gulf of America (demarcated by the MS river outflow).

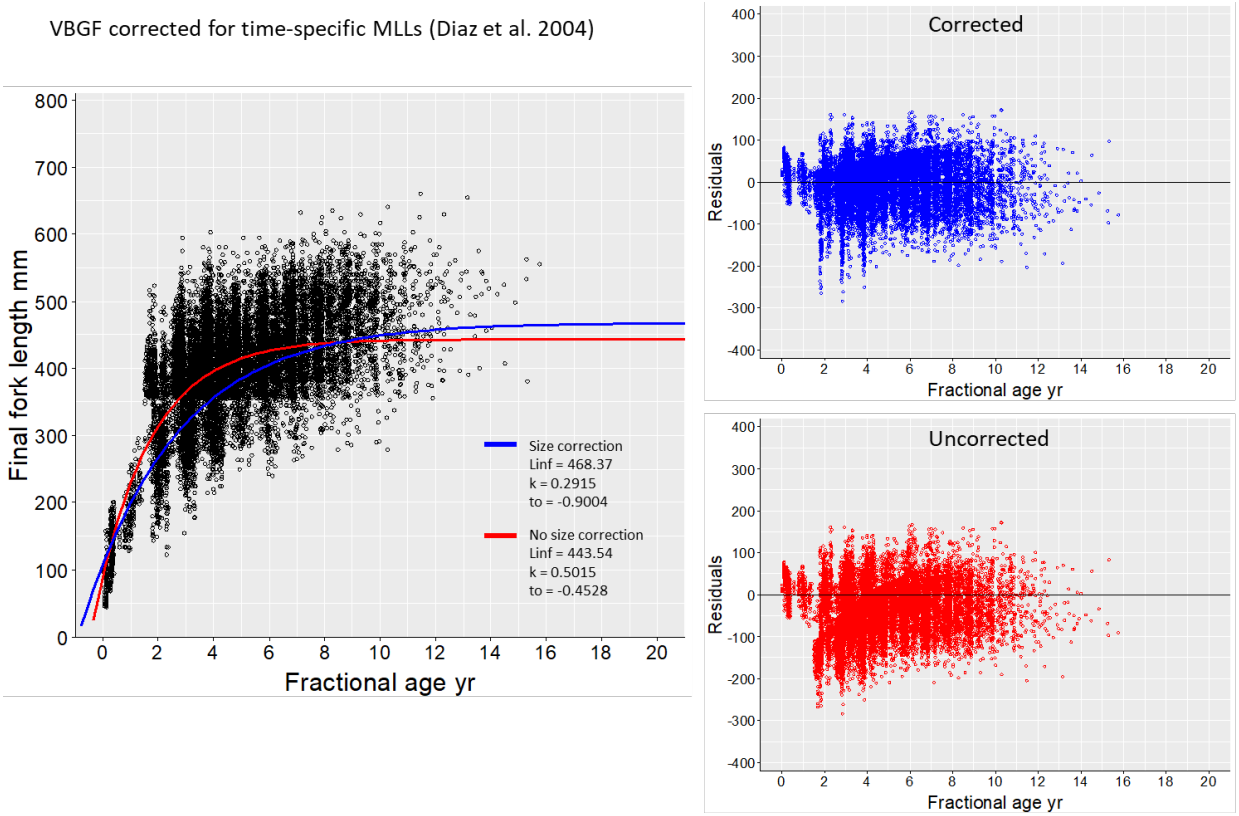


Figure 2.14.11. Von Bertalanffy growth models for gray triggerfish age-at-length (black circles; yr, mm) with lengths uncorrected (red circles, residuals) vs corrected (blue circles, residuals) for truncation due to minimum length limits (i.e., the Diaz method).

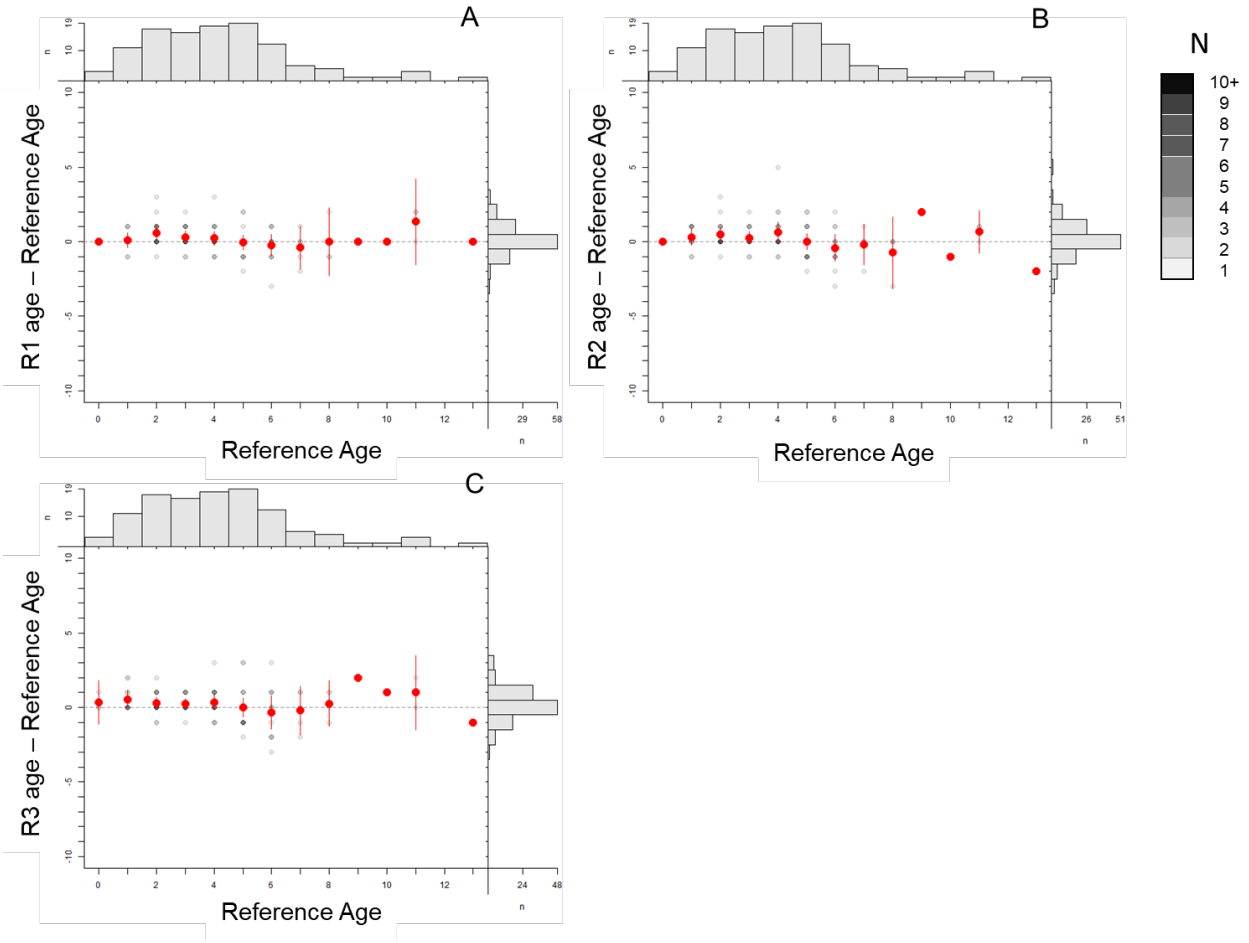


Figure 2.14.12. Bland-Altman plots of reader-specific age estimates vs reference ages for readers from the NMFS Panama City Laboratory (panels A and B) and Florida Fish and Wildlife Research Institute (panel C). Gray-scale circles indicate the number of observations at each point; filled red circles indicate each reader's mean age estimate for each reference age, open red circles indicate means that are significantly different from zero; vertical red lines indicate the standard error of the mean; and gray bars indicate sample sizes for the reference set (top of each plot) and reader-specific age differences (right of each plot).

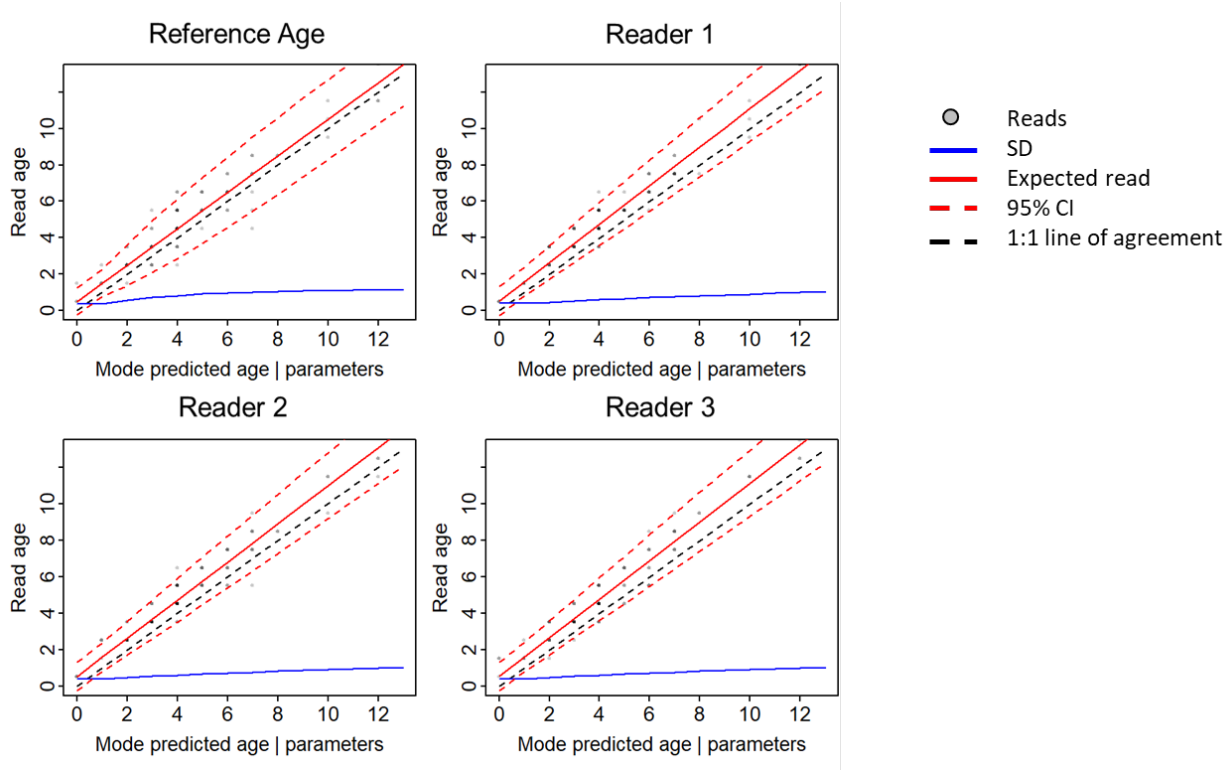


Figure 2.14.13. Output plot indicating ageing error- and bias-at-age estimates from the best-fit model applied to reader-specific age reads of the gray triggerfish reference set. Reader-specific parameters were fixed (i.e., mirrored) to estimate a single set of bias and error parameters for input into the stock assessment.

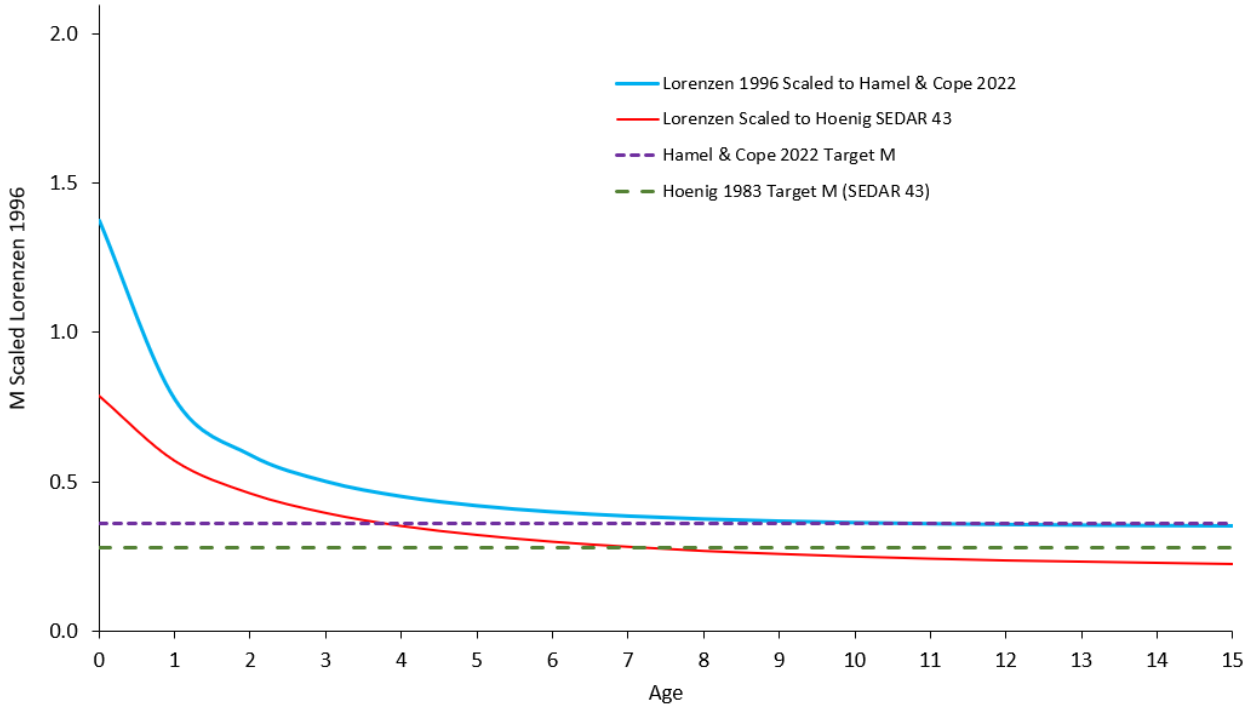


Figure 2.14.14. The recommended age-specific natural mortality (M) vector scaled to the Lorenzen equation (1996) for SEDAR 100 (blue line). The target M based on Hamel & Cope 2022 was 0.36 (dashed purple line). Age-specific M values and Target M used in SEDAR 43 are shown for comparison by the red solid line and the dashed green line, respectively.

3 COMMERCIAL FISHERY STATISTICS

For this data workshop, there was not a Commercial Fisheries Statistics workgroup. The commercial data products discussed at the workshop were shrimp bycatch and shrimp effort (used to derive an index of fleet effort), which were discussed in a combined Indices and Bycatch workgroup, and commercial length and age compositions discussed in the Life History workgroup. For documentation purposes, commercial landings, discards, length and age compositions, and indices are summarized below.

3.1 DATA NOT DISCUSSED AT THE DATA WORKSHOP

Commercial landings and discards were provided for this assessment following decisions adopted during SEDAR 43, SEDAR 62, or through SEDAR best practices. Working papers were provided for these products to thoroughly document the methods and any differences compared to SEDAR 62.

SEDAR100-DW-05: Commercial Landings of Gulf of America Gray Triggerfish (*Balistes capriscus*) from 1949-2024.

SEDAR100-DW-06: CPUE Expansion Estimation for Commercial Discards of Gulf of America Gray Triggerfish.

3.1.1 Commercial Landings

Commercial landings of Gulf Gray Triggerfish were compiled from the Accumulated Landings System (ALS) and state trip ticket programs (STT) following methodology used in SEDAR 43 and SEDAR 62. Landings were provided in whole weight pounds from 1949-2024 by subregion, gear, and year, with subregions being East (Florida - Mississippi) and West (Texas - Louisiana) as shown in Figure 3.10.1. Commercial landings were largely consistent with what was provided in SEDAR 62. Some minor differences were observed between the landings provided in SEDAR 62 and those provided for the current assessment (SEDAR 100), particularly in more recent years, however the landings provided here were consistent with those used for ACL monitoring and therefore considered to be the best available data. Final landings by year, gear, and subregion are summarized in Table 3.9.1, and landings by year and subregion are shown graphically in Figure 3.10.2. Further details regarding the commercial landings are available in the commercial landings working paper, along with recommendations for uncertainty estimates (SEDAR100-DW-05).

3.1.2 Commercial Discards

Commercial discards are estimated for vertical line gear using two different data sources and methods that correspond to differences in management and discard behavior. In 2007, an Individual Fishing Quota (IFQ) was implemented for Red Snapper and this is the same year the SEFSC implemented the Reef Fish Observer Program. For this reason, observer-discard rates were not used to estimate discards prior to IFQ considering this change in management had a significant impact on discard behavior of Red Snapper and other reef fishes caught in the reef fish fishery, such as Gray Triggerfish. Discard estimation from 2007-2024 using observer data followed standard methods presented in SEDAR 62, the previous data/assessment workshop for this species.

Since the SEFSC no longer recommends the use of discard logbook data for estimating discards for SEDAR (Alhale et al. 2024), a hindcast procedure was used to estimate the discards previous to observer coverage using discard rates in the earliest time then applied to logbook-derived effort. The observer method is more reliable because there is a verification step to use observer kept data to re-estimate the landings of Gray Triggerfish. For this assessment, discards were limited to 2000 and after as that was the first year of a size limit in this fishery. Discards were estimated for three overall regions following the TORs of this assessment; East, West, and Gulf-

wide (Table 3.9.2). The commercial discard working paper (SEDAR100-DW-06) documents in three sections the observer method with associated discard length compositions, the discard logbook method, a calibration of discard logbook-derived estimates, as well as comparisons to SEDAR 62. Discards were limited to vertical line gears only with longline being excluded due to near 0 observed catches for this species.

3.2 ISSUES DISCUSSED AT THE DATA WORKSHOP IN THE INDICES AND BYCATCH GROUP

Commercial data issues discussed in the Indices and Bycatch workgroup at the data workshop were limited to shrimp bycatch and included:

- Shrimp effort data
- Shrimp bycatch estimation using SEAMAP data
- Overall estimated shrimp bycatch

3.2.1 Review of Working and Reference Documents

The workgroup considered data and analyses presented from the following documents:

SEDAR100-DW-22: Estimation of Gray Triggerfish Bycatch from Gulf of America Shrimp Trawls

3.2.2 Workgroup Participants

Below are the Indices & Bycatch workgroup participants and their affiliations:

Sarina Atkinson	NMFS
Matthew Campbell	NMFS
Heather Christiansen	FWC
Kyle Dettloff	NMFS
David Hanisko	NMFS
Frank Hernandez	NMFS
Matthew Nuttall	NMFS
Katherine Overly	NMFS
Cheston Peterson	University of Miami/CIMAS (Group Co-lead)
Adam Pollack	NMFS (Group Co-lead)
Ted Switzer	FWC
Kevin Thompson	NMFS
Glenn Zapfe	NMFS

3.3 SHRIMP EFFORT & BYCATCH

3.3.1 Shrimp Effort

Gulf penaeid shrimp effort has non-universal coverage of the fleet. Therefore, trawling effort must be estimated from a sample of the fleet and scaled up to total effort using the landings. There are two sources of data for estimating Gulf penaeid offshore trawling effort. Port agent interviews were used from 1984-2006 and electronic logbook (ELB) positional data were used from 2007-2023. Fleet effort for the observer time period (2007-2023) was estimated using shrimp catch and effort data for a subset of vessels equipped with GPS tracklog (ELB) devices (Smith et al. 2025, Dettloff 2024). Fleet catch of non-target species (discarded as bycatch) was estimated in the second expansion using onboard observer catch and effort data for a subset of vessel trips and the estimated fleet effort (Atkinson et al. 2024 and 2025, Smith et al. 2025). GLM analysis of stratification variables confirmed that season, area, and depth were important variables for partitioning mean and variance of penaeid shrimp and non-target species catch rates. An overview of the data of each source as well as the overall methods are summarized in Atkinson et al. 2025 (SEDAR98-DW-23). Shrimp trawl effort estimates are provided in Table 3.9.3.

3.3.2 Shrimp Bycatch

Because Gray Triggerfish are not mandatorily recorded in the Shrimp Observer program, the bycatch estimation methods used for Red Snapper in SEDAR 98 (Smith et al. 2025) could not be applied directly. Instead, bycatch estimation was applied to proxy species for Gray Triggerfish based on a co-occurrence analysis of SEAMAP data, which were filtered to reflect commercial shrimping grounds and habitat as accurately as possible. Bycatch estimates were then calculated using the same methodology applied to Red Snapper in SEDAR 98 and calibrated based on catch-per-unit-effort (CPUE) ratios of Gray Triggerfish and the proxy species in the filtered SEAMAP dataset. Estimation of Gray Triggerfish shrimp trawl bycatch therefore consisted of three phases: **1)** filtering the SEAMAP data to best represent shrimp habitat; **2)** conducting a stratified co-occurrence analysis of Gray Triggerfish and species tracked by the shrimp observer program to determine proxy species using the filtered SEAMAP data; and **3)** estimation of shrimp bycatch of proxy species using the methods in Smith et al. (2025) and calibration to Gray Triggerfish based on CPUE ratios from the filtered SEAMAP data.

SEAMAP data were subset using a series of filters, described in SEDAR100-DW-22, including intersection of known reef habitat, hard bottom indicator species (e.g. octocorals), overlap with known areas of commercial shrimp effort, and presence of penaeid shrimp catch. A blocked co-occurrence analysis (Mackenzie et al. 2006, Smith et al. 2021) using area-season-depth strata

was applied to the filtered SEAMAP dataset to identify proxy species from the pool of species tracked by the shrimp observer program. The co-occurrence species interaction factor (SIF) was calculated to evaluate the association between Gray Triggerfish and other species in the SEAMAP catch that are also tracked by the shrimp observer program. The co-occurrence analysis used a stratification, or blocking, scheme to allow for spatio-temporal flexibility in species associations and therefore multiple proxy species if necessary. This stratification scheme followed previous work in the Gulf (Smith et al. 2025) by using an Area-Season-Depth stratification consisting of four areas, three seasons, and two depth zones ($\leq$ 10 fathoms and > 10 fathoms). Lane Snapper (*Lutjanus synagris*) and Red Snapper (*L. campechanus*) were chosen as proxy species.

Bycatch estimation was conducted on proxy species following the methods of Smith et al. (2023; 2025). The general approach to estimating bycatch involves two catch rate expansions: one estimating total fleet effort and one estimating total fleet catch/bycatch. Fleet catch of non-target species (discarded as bycatch) was estimated in the second expansion using onboard observer catch and effort data for a subset of vessel trips and the estimated fleet effort (Atkinson et al. 2024, Smith et al. 2025). GLM analysis of stratification variables confirmed that season, area, and depth were important variables for partitioning mean and variance of penaeid shrimp and non-target species catch rates. A hindcasting procedure was developed for estimating bycatch for the pre-observer years 1984-2006 using observer data for 2007-2013 and the improved time series of shrimp landings and effort for 1984-2006. The key assumption was a stable relationship between strata-specific shrimp and proxy species catch rates. The resulting bycatch estimates for 1984-2006 generally tracked changes in shrimp fleet effort, and were less volatile in terms of magnitude compared to the estimates produced for SEDAR 62, which relied on SEAMAP trawl data as a proxy for commercial shrimp trawls (Zhang 2020, SEDAR62-WP-20). To calibrate bycatch estimates of proxy species to Gray Triggerfish, conversion factors were calculated for each stratum based on catch rates of each species in the filtered SEAMAP dataset.

Estimates of Gray Triggerfish bycatch from commercial shrimp trawls for West and East Gulf regions for 1984-2023 are provided in Table 3.9.4 and Figure 3.10.3. Bycatch of Gray Triggerfish was higher in the West Gulf throughout the time series. The shrimp bycatch working paper (SEDAR100-DW-22) details the filtering process of the SEAMAP data, the co-occurrence analysis used to determine proxy species, and bycatch estimation methods.

Decision 1: The workgroup recommends the bycatch estimates from 1984-2023 following the improved methodology used for Red Snapper in SEDAR 98 with Lane Snapper and Red Snapper as proxy species for Gray Triggerfish in SEDAR 100. From workshop discussions with the analysts, the bycatch team suggested using a time-varying conversion factor for calibrating the

estimates of bycatch from proxy species to Gray Triggerfish, which was completed and added to the final calculation.

3.3.3 Shrimp Bycatch Length Composition

Bycatch length compositions were also provided for this assessment. Due to the absence of Gray Triggerfish in the Shrimp Observer data, it was recommended that the filtered SEAMAP data be used as a proxy for discard length compositions. In order to justify this recommendation, Shrimp Observer and filtered SEAMAP Red Snapper length distributions were compared and found to be similar within area-depth-season strata. Therefore, it was assumed that filtered SEAMAP length frequencies for Gray Triggerfish were representative of bycatch length frequencies and calculated based on the estimates of bycatch for both the East/West Gulf regions and Gulf-wide. Length compositions showed that bycatch is focused on sublegal sizes of Gray Triggerfish. The length range was 1.5 to 52.0 cm fork length, with 99.5% of the observations below the minimum legal size of 35.6 cm. Annual length compositions of Gray Triggerfish bycatch were estimated for the entire Gulf region.

3.4 ISSUES DISCUSSED AT THE DATA WORKSHOP IN THE LIFE HISTORY WORKGROUP

Commercial data issues discussed at the data workshop in the life history workgroup include the following topics:

- All Gulf or 2 area model
- Single commercial fleet vs. separate handline and longline fleets
- Adequacy of data for providing nominal and weighted length and age compositions

3.4.1 Review of Working and Reference Documents

The workgroup considered data and analyses presented from the following documents:

SEDAR100-DW-07: Gulf of America Gray Triggerfish (*Balistes capriscus*) Preliminary Length and Age Compositions for the Commercial Handline and Longline Fisheries.

3.4.2 Workgroup Participants

Below are the Life History workgroup participants and their affiliations:

Lisa Ailloud	NMFS
Samantha Binion-Rock	NMFS
Bridget Cermak	FWC
Steven Garner	University of Miami/CIMAS

Ryan Nichols	NMFS
Ashley Pacicco	University of Miami/CIMAS (Group Lead)
William Patterson III	University of Florida, Gainesville, FL
Michaela Pawluk	NMFS

3.5 COMMERCIAL LENGTH AND AGE COMPOSITIONS

Commercial length and age compositions were discussed as part of the life history workgroup. Two main concerns regarding the commercial length and age compositions were 1) whether there was sufficient data to split out longline as its own fleet for modeling, and 2) whether there were sufficient samples for an East/West split in the model. In order to address these concerns, sample sizes for an East/West split, and an All Gulf model were considered for each gear (handline and longline).

Sample sizes were evaluated for adequacy in terms of providing both nominal and weighted compositions. Tables summarizing the data adequacy by year, and gear for an East/West model and an All Gulf model are provided in the Life History report section in Table 2.13.5. Based on the available data, the workgroup recommended that longline be kept a separate fleet from handline as there was a clear difference in size composition between the two gear groups (Figure 3.10.4). Regarding spatial stratification, the workgroup recommended proceeding with an All Gulf model due to extremely limited data in the Western subregion and a lack of evidence for spatial differences in size composition within a given gear group (Figure 3.10.5 - only Handline is shown, as there were limited Longline samples from the Western subregion). Due to limited data for the longline fleet, only nominal age compositions were provided (Figure 3.10.6), while for handline weighted age compositions were provided where possible (Figure 3.10.7). Further details on the construction of the length and age compositions are available in the working paper (SEDAR100-DW-07).

3.6 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

Overall, the Indices and Bycatch workgroup determined the methods for estimating shrimp effort and bycatch from 1984-2023 were appropriate and recommended for use in the assessment model. There was discussion at the workshop of an alternate report detailing shrimp trawl bycatch (Scott-Denton et al. 2012; SEDAR100-RD-06) which included a misleading table which reported Balistidae bycatch to be 0.0%, despite bycatch by weight being non-zero. It was determined this was an error in the presentation of the table in the report, causing some confusion about the validity of these results. The workgroup felt the methods and data were appropriate despite this discussion at the workshop.

The Life History workgroup recommended that the available length and age data were adequate and appropriate for construction of commercial length and age compositions in most years. Two tables are provided in the Life History workgroup report summarizing data adequacy for both nominal and weighted compositions by year and gear (Tables 2.13.5 & 2.13.6). For years when data are insufficient for weighted compositions, nominal compositions are recommended to be used.

3.7 RESEARCH RECOMMENDATIONS

Although the Indices and Bycatch workgroup focused on understanding and evaluating Gray Triggerfish bycatch methods and estimates, the working paper SEDAR100-DW-22 outlines current efforts by SEFSC to improve bycatch estimation in the future. These include:

- Adding Gray Triggerfish to the list of species for which data are currently collected in the Shrimp Observer program.
- Outfitting the commercial shrimp fleet with modern, tamper-proof GPS tracklog devices;
- Applying electronic technologies to enable observers to collect size information on all fish species captured in fish trawls;
- Modifying the allocation of observer sampling effort to better incorporate net configuration and diurnal period;
- The potential for field experiments to improve calibrations of SEAMAP and commercial shrimp trawls.

3.8 LITERATURE CITED

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Zhang, X.. 2020. Shrimp Fishery Bycatch Estimates for Gulf of Mexico Grey Triggerfish, 1972-2017. SEDAR62-WP-20. SEDAR, North Charleston, SC. 29 pp.

3.9 TABLES

Table 3.9.1. Annual calculated Gulf of America Gray Triggerfish landings by gear groupings for each Subregion from 1949 to 2024. Confidential strata have been hidden with an asterisk (*).

Year	East			West		
	Handline+	Longline	Trap	Handline+	Longline	Trap
1949	14,300					
1950	14,700					
1951	28,000					
1952	72,400					
1953	43,600					
1954	39,600					
1955	46,600					
1956	22,800					
1957	17,400					
1958	15,200					
1959	10,300					
1960	11,900					
1961	6,500					
1962	5,600					
1963	3,100			4,200		
1964	15,700			4,300		
1965	17,350			4,300		
1966	8,600			5,200		
1967	12,200			5,200		
1968	8,600			3,900		
1969	14,600			7,700		
1970	15,851			8,200		
1971	30,500			9,900		
1972	47,400			15,200		
1973	40,000			13,200		
1974	40,452			13,100		
1975	62,000			16,000		
1976	69,700			14,800		
1977	50,096			9,290		
1978	48,518		108	10,197		
1979	65,670			31,814	3,919	
1980	64,069	1,406		28,707	2,294	
1981	61,465	3,033		20,636	4,726	
1982	55,317	7,642		26,316	7,398	
1983	40,486	9,102		19,350	4,481	

1984	29,058	8,348		29,396	3,335	*
1985	43,333	11,507		32,230	5,556	
1986	73,392			15,461	8,149	
1987	97,167			27,017	642	
1988	149,656			44,089	2,589	
1989	248,800			60,734	10,543	
1990	325,111	*		77,542	12,515	
1991	266,151	7,995	65,578	91,727	12,892	
1992	313,481	9,349	28,008	105,639	13,679	
1993	283,813	14,777	86,267	175,168	516	*
1994	203,379	18,940	29,645	152,829	484	
1995	179,632	6,442	18,924	130,001	523	
1996	108,475	6,447	21,887	124,244	375	
1997	77,995	10,028	15,807	75,791	993	
1998	86,837	5,531	13,301	70,510	*	
1999	100,374	10,055	14,025	102,446	222	
2000	48,291	5,486	9,320	94,881	284	
2001	87,249	5,991	14,593	67,531	52	
2002	128,461	3,019	17,633	85,800	*	
2003	145,116	7,269	14,034	85,336		
2004	115,943	14,230	12,550	72,801	*	
2005	91,920	6,402	6,627	41,711	*	
2006	49,654	7,539	3,675	31,359	*	
2007	42,162	8,250	*	44,767	*	
2008	34,268	15,331		26,941	*	
2009	52,256	8,636		16,994	*	
2010	43,778	2,749		8,586	*	
2011	89,850	979		13,243	*	
2012	63,497	756		7,784	*	
2013	57,368	1,035		4,638	*	
2014	33,536	4,446		2,703		
2015	38,034	6,751		2,711		
2016	44,509	11,450		3,157	*	
2017	53,232	6,985		2,422	*	
2018	54,210	8,417		2,071		
2019	51,676	9,243		1,571		
2020	47,456	3,857		1,467		
2021	36,445	7,569		940	*	
2022	35,966	8,117		1,197		
2023	45,808	7,543		1,508		
2024	41,875	8,264		1,465		

Table 3.9.2. Commercial discard estimates and standard errors (SE) for the vertical line fishery for the East, West and Gulf-wide in numbers (N) and pounds (lbs).

	Discards (N)			Discards (lbs)		
Year	East	West	Gulf-wide	East	West	Gulf-wide
2000	535	1,034	1,502	646	1,623	2,034
2001	725	950	1,632	875	1,491	2,210
2002	1,031	1,024	2,076	1,244	1,606	2,811
2003	1,138	1,166	2,264	1,374	1,830	3,065
2004	953	1,122	2,039	1,150	1,761	2,761
2005	837	808	1,565	1,010	1,268	2,119
2006	548	507	1,149	662	795	1,556
2007	489	1,002	1,078	590	1,572	1,460
2008	494	736	977	596	1,156	1,323
2009	12,838	2,015	15,977	20,896	3,904	26,692
2010	9,015	1,268	11,642	14,697	2,479	19,451
2011	15,566	1,390	14,944	25,555	2,721	24,966
2012	21,516	4,990	24,285	43,011	13,018	50,042
2013	10,641	1,228	13,827	24,778	3,272	33,180
2014	10,329	934	12,367	24,421	2,490	29,674
2015	9,279	1,049	12,920	21,837	2,795	30,735
2016	11,366	1,257	15,411	26,399	3,350	36,692
2017	10,095	861	13,869	23,185	2,295	33,128
2018	10,012	451	10,380	28,778	1,112	29,470
2019	11,542	381	11,735	33,175	977	33,318
2020	9,773	364	9,866	28,090	872	28,010
2021	9,684	349	9,729	27,834	830	27,621
2022	10,034	361	10,059	28,842	853	28,560
2023	11,316	507	11,630	32,524	1,219	33,019
2024	10,009	526	10,412	28,769	1,247	29,560

Table 3.9.2 continued

	SE (N)			SE (lbs)		
Year	East	West	Gulf-wide	East	West	Gulf-wide
2000	150	819	553	187	1,412	896
2001	204	752	601	253	1,298	974
2002	290	810	764	359	1,398	1,238
2003	320	923	834	397	1,592	1,351
2004	268	888	751	332	1,533	1,216
2005	235	639	576	292	1,103	934
2006	154	401	423	191	692	685
2007	137	793	397	170	1,368	643
2008	139	583	360	172	1,006	583
2009	3,888	1,499	4,619	6,213	2,892	7,501
2010	2,730	943	3,366	4,369	1,837	5,466
2011	4,714	1,034	4,320	7,598	2,016	7,016
2012	4,019	1,691	4,377	7,290	4,829	8,094
2013	1,490	311	1,668	3,803	863	3,940
2014	1,446	236	1,492	3,748	657	3,524
2015	1,299	265	1,558	3,352	737	3,650
2016	1,591	318	1,859	4,052	883	4,358
2017	1,413	218	1,673	3,559	605	3,934
2018	1,784	185	1,768	5,383	437	5,316
2019	2,056	156	1,999	6,205	384	6,010
2020	1,741	149	1,680	5,254	343	5,053
2021	1,725	143	1,657	5,206	326	4,983
2022	1,788	148	1,713	5,395	335	5,152
2023	2,016	208	1,981	6,084	479	5,956
2024	1,783	215	1,773	5,381	490	5,333

Table 3.9.3. Gulf of Mexico trawling effort (in days) by region (East/West) and total with associated CV. CVs were only available for 1984 onward.

Year	East	West	Total	CV
1960	32,332	78,901	111,233	
1961	24,082	55,345	79,427	
1962	28,260	68,219	96,479	
1963	26,846	83,157	110,002	
1964	34,923	84,068	118,991	
1965	31,237	73,990	105,228	
1966	28,562	71,148	99,710	
1967	24,917	91,692	116,609	
1968	32,370	87,436	119,806	
1969	37,798	102,062	139,860	
1970	27,371	90,876	118,247	
1971	27,006	95,168	122,175	
1972	28,737	116,644	145,381	
1973	31,039	104,073	135,111	
1974	33,820	101,592	135,412	
1975	30,509	88,353	118,862	
1976	30,674	112,193	142,867	
1977	33,586	120,224	153,810	
1978	38,657	148,165	186,822	
1979	46,772	148,831	195,603	

1980	26,652	106,763	133,416	
1981	34,121	129,325	163,446	
1982	38,884	121,942	160,826	
1983	47,101	111,336	158,437	
1984	52,691	116,137	168,827	1.4
1985	48,628	125,966	174,594	1.4
1986	54,518	147,191	201,708	1.5
1987	57,929	164,966	222,895	1.4
1988	46,990	144,962	191,953	1.5
1989	55,016	147,450	202,466	1.9
1990	63,417	140,942	204,359	2.3
1991	52,170	148,214	200,384	2.3
1992	52,695	146,284	198,979	2.6
1993	40,552	143,148	183,700	3.3
1994	39,796	105,250	145,046	4.4
1995	36,262	88,145	124,407	2.3
1996	45,704	96,463	142,167	2.3
1997	46,500	117,574	164,074	2.1
1998	63,512	131,623	195,135	2
1999	52,708	138,286	190,994	2.1
2000	39,719	129,580	169,299	1.9
2001	36,998	95,349	132,347	3.3
2002	36,568	112,875	149,444	2.6

2003	30,721	88,406	119,127	2.3
2004	24,279	75,277	99,557	2.3
2005	19,070	60,039	79,109	2.3
2006	16,099	56,197	72,296	2.7
2007	16,921	59,154	76,075	6.9
2008	11,606	50,566	62,172	2.6
2009	13,226	64,080	77,307	2
2010	5,912	44,400	50,312	2.4
2011	9,120	53,520	62,641	1.7
2012	9,232	53,423	62,655	2
2013	11,330	59,275	70,604	7.1
2014	14,087	62,201	76,287	1.3
2015	14,045	61,825	75,871	1.2
2016	12,825	61,443	74,268	1.1
2017	14,180	62,641	76,821	1.1
2018	16,076	55,443	71,519	1
2019	14,066	53,063	67,130	1
2020	18,474	52,164	70,638	1.3
2021	14,814	54,074	68,888	2
2022	12,324	33,293	45,618	2.5
2023	9,161	27,739	36,900	3.2
2024	8,449	27,013	35,462	3.8

Table 3.9.4. Time-series (1984-2023) of annual Gray Triggerfish bycatch estimates and associated standard error (SE) for the West/East subregions and Gulf-wide.

	East		West		Gulf	
Year	Bycatch	SE	Bycatch	SE	Bycatch	SE
1984	348,883	51,039	2,181,785	300,991	602,379	148,033
1985	390,068	54,298	2,397,973	329,808	670,997	178,256
1986	300,785	43,757	2,804,911	391,953	966,090	119,242
1987	430,966	65,524	3,206,838	459,509	540,201	50,701
1988	306,332	55,086	2,875,992	414,721	758,124	77,499
1989	298,776	51,267	2,751,088	385,031	704,027	94,371
1990	327,404	46,174	2,627,805	364,406	484,904	68,151
1991	267,675	42,356	2,714,367	392,295	660,309	55,952
1992	260,878	65,109	2,776,928	395,517	463,600	52,897
1993	275,399	41,411	2,694,047	391,001	437,446	51,893
1994	301,546	46,205	1,909,226	257,363	477,767	53,190
1995	456,167	77,144	1,589,749	223,185	424,302	40,706
1996	472,803	83,880	1,827,673	256,193	387,097	32,528
1997	445,693	93,359	2,218,890	321,520	368,221	31,366
1998	355,665	60,117	1,836,106	257,270	392,766	37,086
1999	249,506	38,249	1,891,162	278,825	257,934	19,562
2000	197,805	27,370	1,791,133	258,747	250,215	26,764
2001	201,124	28,334	1,411,184	219,230	2,530,668	307,430
2002	151,989	23,847	1,637,802	243,661	2,788,041	314,337
2003	139,340	26,969	1,237,157	186,654	3,105,696	349,112
2004	116,536	20,076	1,087,187	160,080	3,637,803	426,309
2005	83,861	14,885	854,585	121,871	3,182,324	427,100
2006	62,639	10,647	779,094	109,951	3,049,864	394,229
2007	140,290	39,430	462,089	114,883	2,955,209	317,663
2008	119,350	37,832	551,647	70,224	2,982,042	348,475
2009	102,596	16,604	863,494	110,293	3,037,806	579,787
2010	54,197	6,727	486,003	66,845	2,969,446	334,731
2011	69,321	9,912	688,803	82,488	2,210,772	274,235

2012	79,113	14,384	624,914	77,892	2,045,915	291,909
2013	35,973	7,615	448,932	67,211	2,300,476	349,643
2014	54,108	5,911	606,201	75,176	2,664,584	454,956
2015	34,799	2,926	428,801	172,639	2,191,771	296,618
2016	29,894	2,481	407,552	177,957	2,140,668	245,028
2017	33,993	2,629	443,774	218,757	1,988,938	202,757
2018	41,274	3,345	383,028	164,065	1,612,308	177,561
2019	36,419	2,818	350,678	126,095	1,789,791	202,955
2020	41,930	3,165	326,291	131,559	1,376,498	193,858
2021	36,414	2,996	356,352	142,460	1,203,723	150,714
2022	25,060	1,813	232,874	79,936	938,446	119,082
2023	22,525	1,907	227,690	102,109	841,732	101,584

3.10 FIGURES

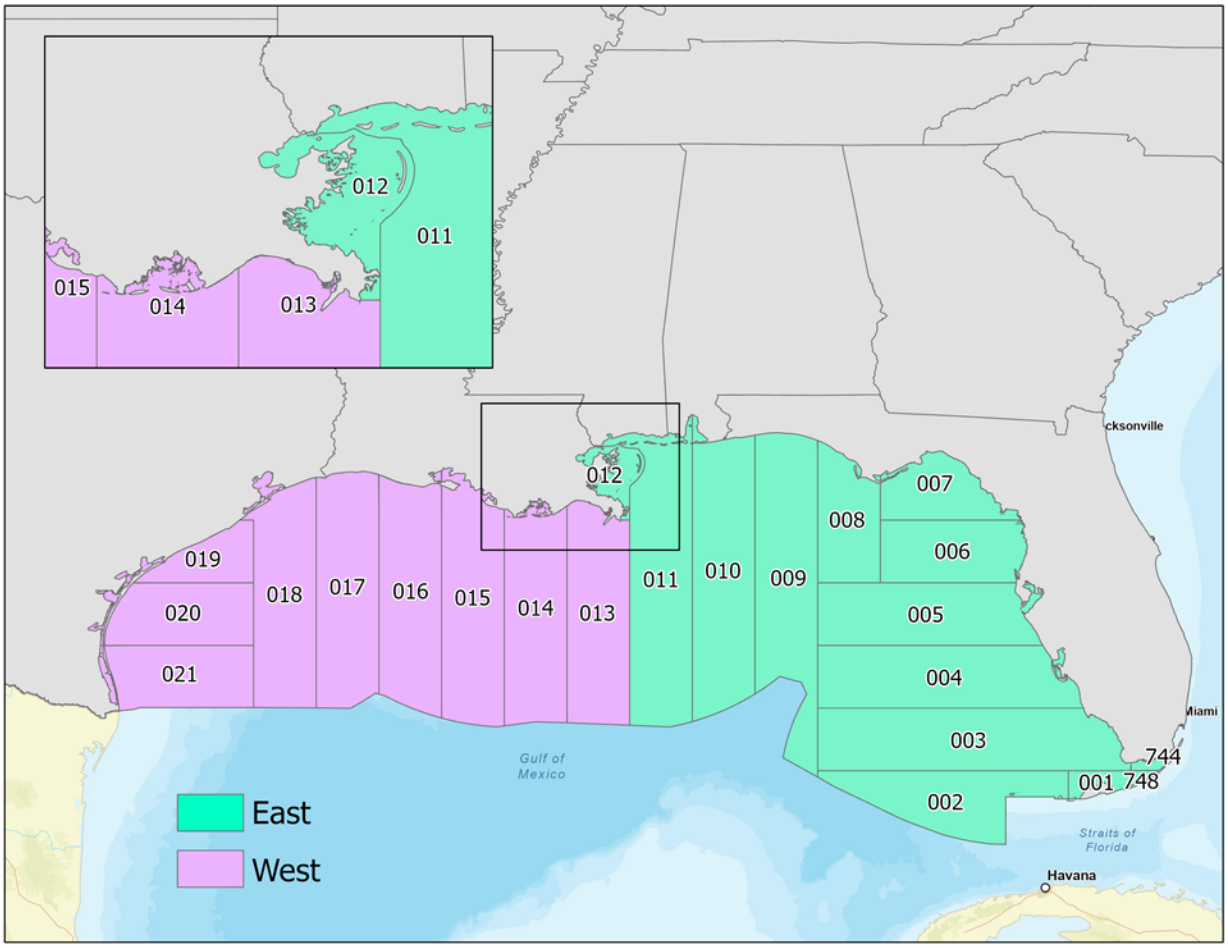


Figure 3.10.1. Gulf of America commercial fishing areas with subregions highlighted.

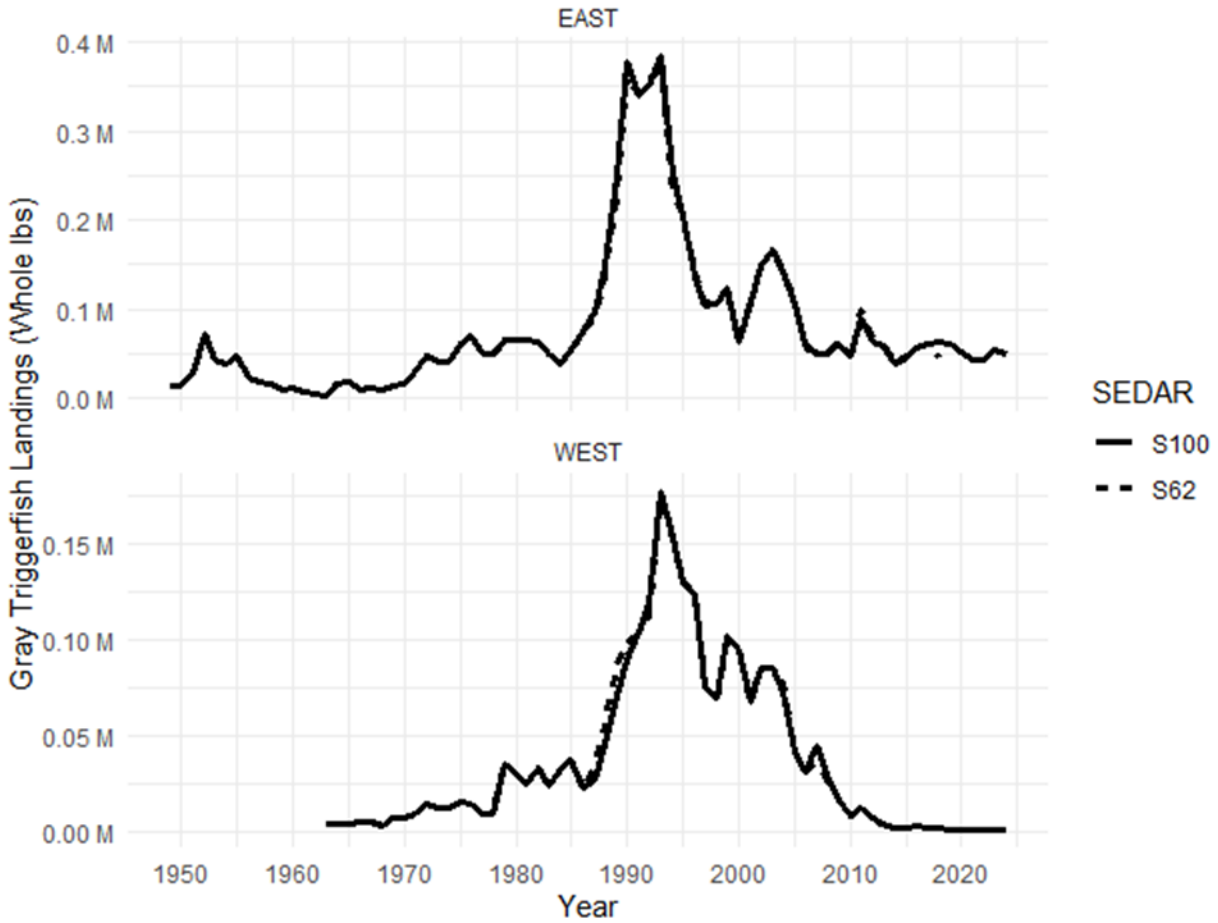


Figure 3.10.2. Annual calculated Gray Triggerfish commercial landings (in whole weight pounds) by subregion for the current SEDAR 100 compared to the previous assessment SEDAR 62 from 1949 - 2024. Confidential landings have been excluded.

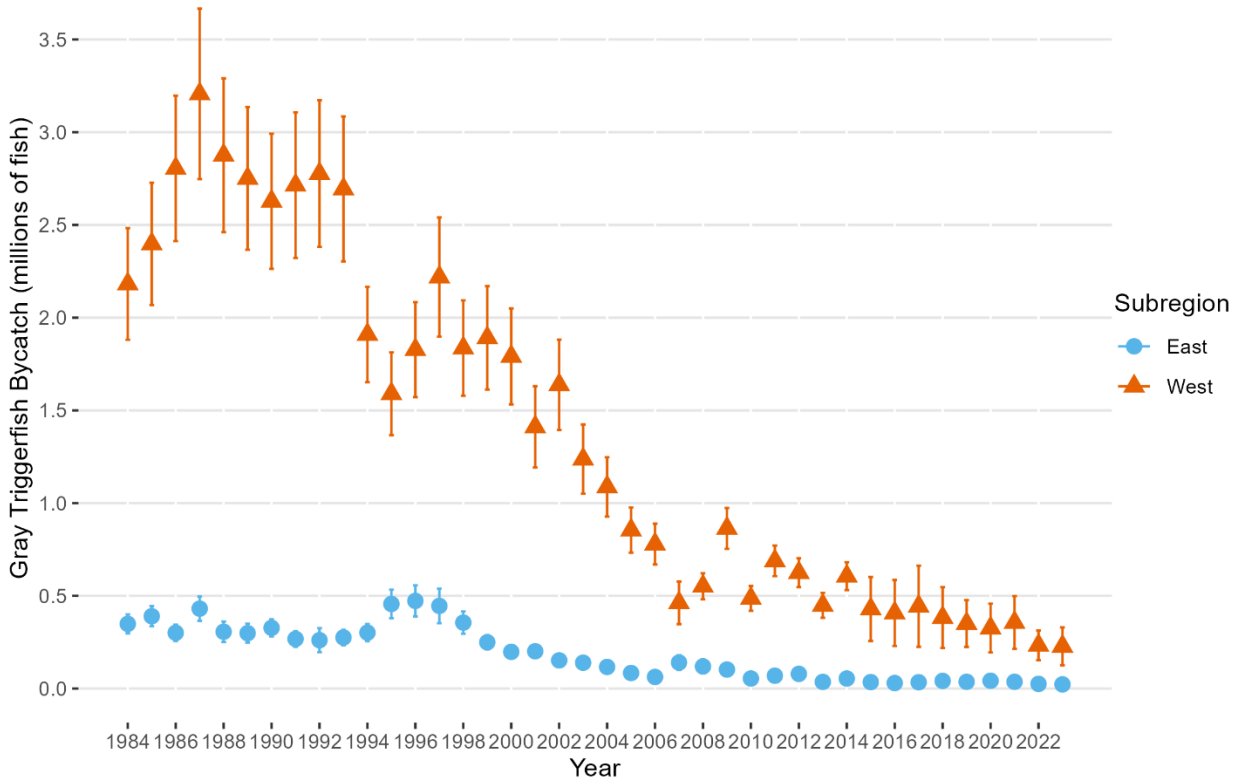


Figure 3.10.3. Gray Triggerfish bycatch time-series (1984-2023) and associated standard errors for West and East Gulf subregions.

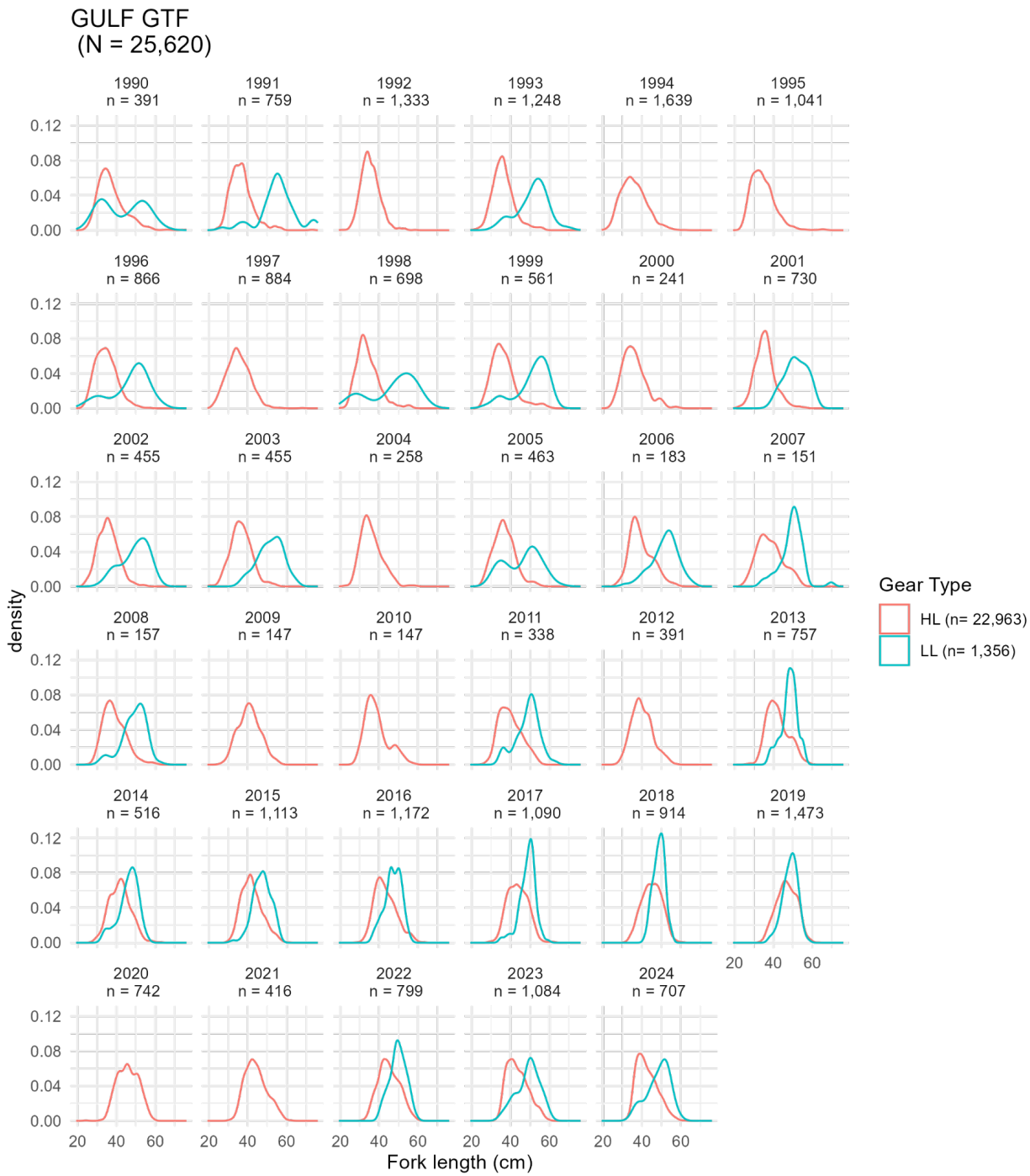


Figure 3.10.4. Annual nominal gulf-wide length compositions for the Gulf Gray Triggerfish commercial handline and longline fisheries.

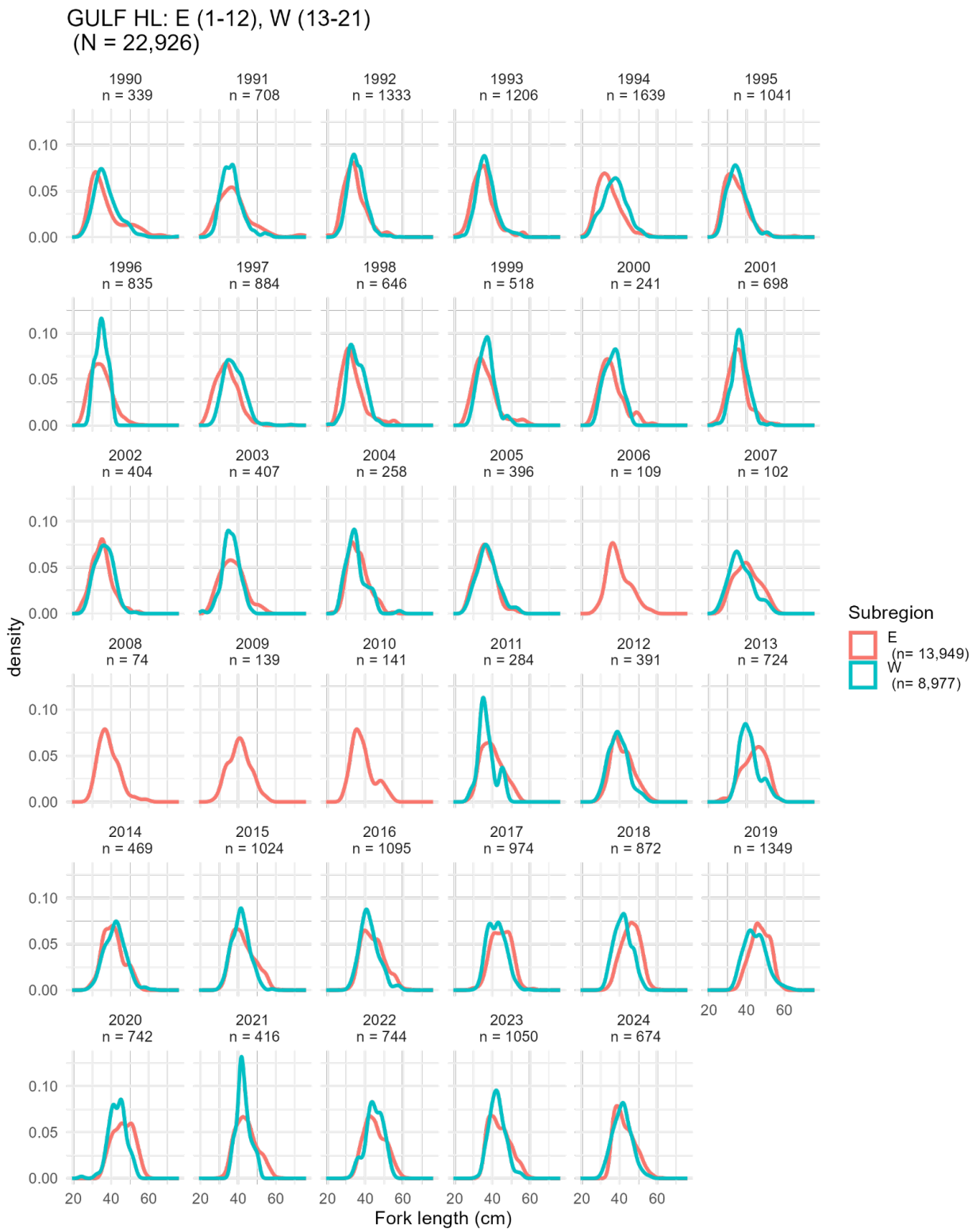


Figure 3.10.5. Annual nominal length compositions for the East and West subregions of the Gulf Gray Triggerfish commercial handline fishery.

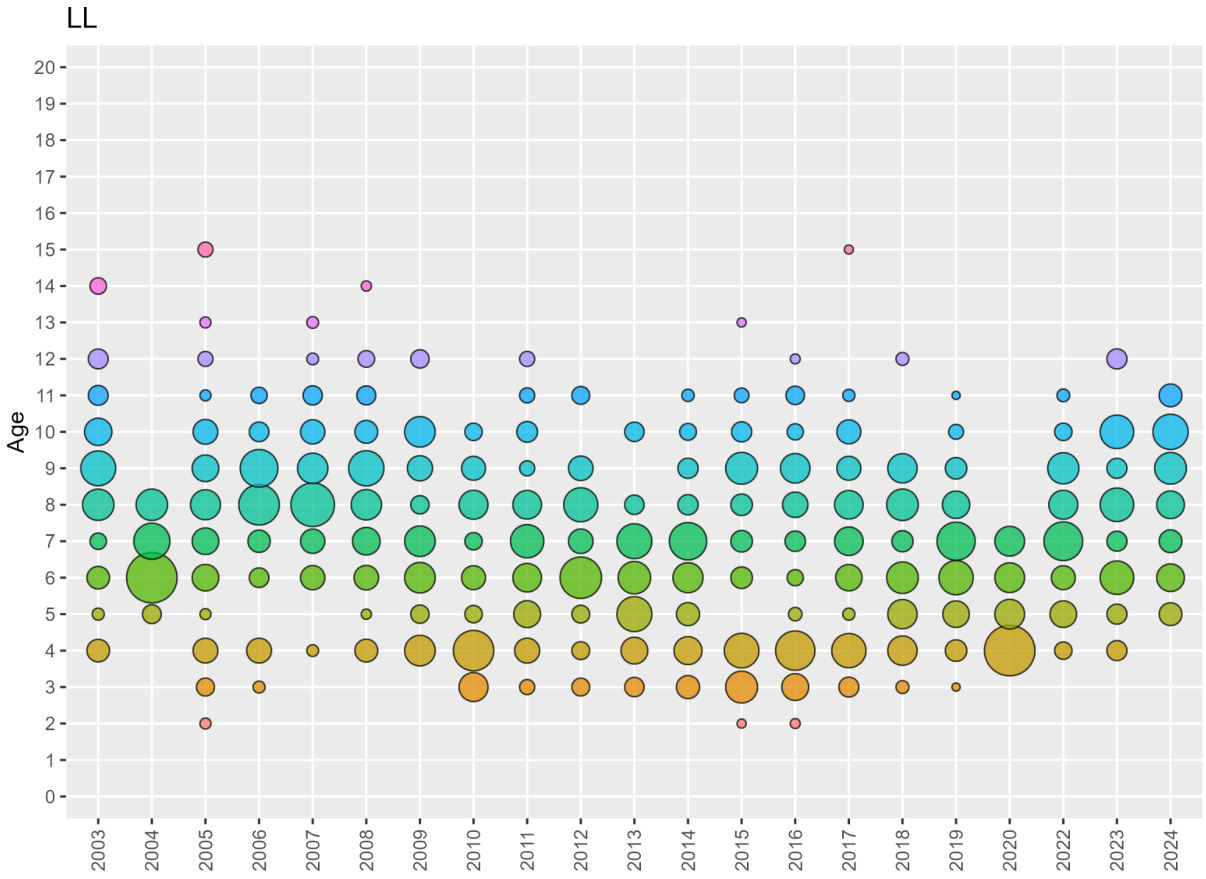


Figure 3.10.6. Final annual nominal age compositions for the Gulf Gray Triggerfish commercial longline fishery. The size of the dots represents the relative proportion at age. Refer to Table 2.13.6 for which years do not meet sample size criteria for inclusion.

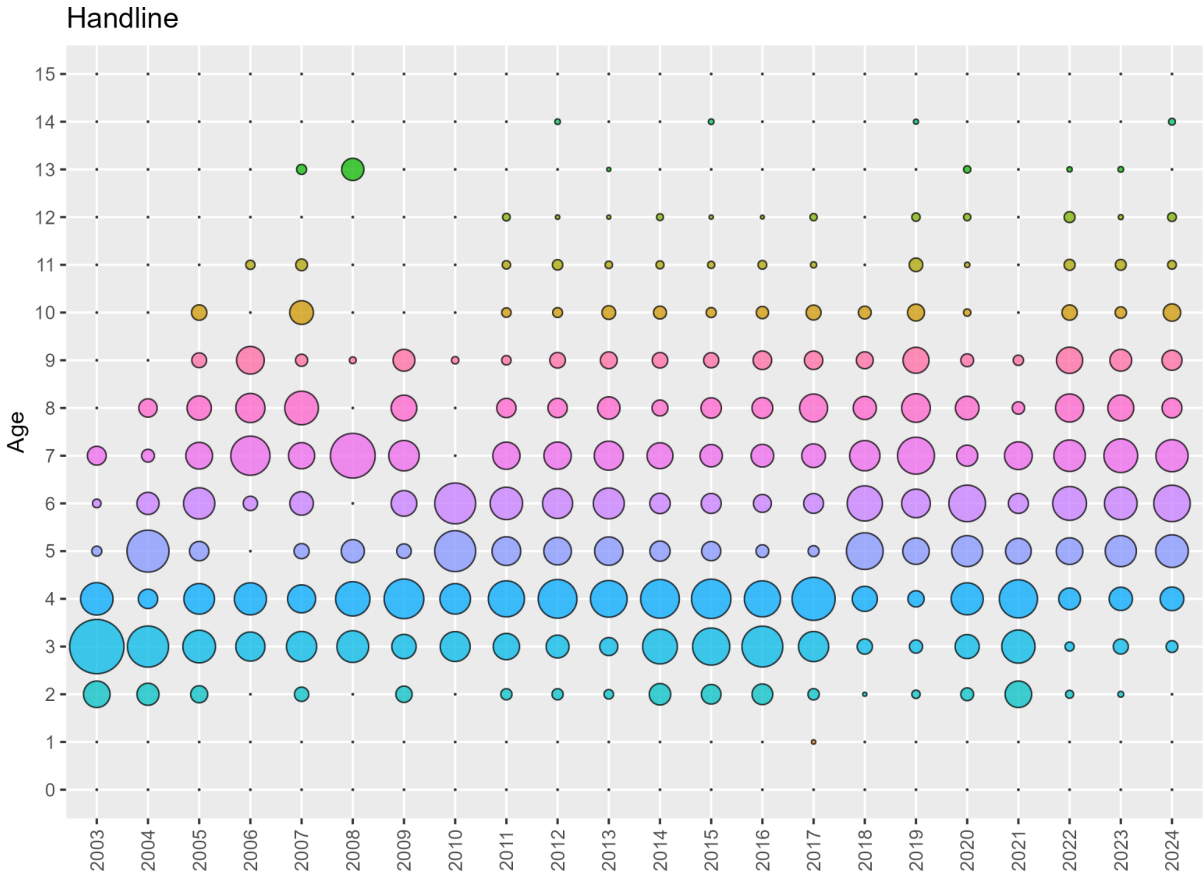


Figure 3.10.7. Final annual weighted age compositions for the Gulf Gray Triggerfish commercial handline fishery. The size of the dots represents the relative proportion at age. Refer to Table 2.13.6 for which years do not meet sample size criteria for inclusion.

4 RECREATIONAL FISHERY STATISTICS

4.1 OVERVIEW

4.1.1 Group Membership

Lead

Matthew Nuttall - National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Sustainable Fisheries Division (SFD)

Members

Abby Carrigan - Florida Fish and Wildlife Conservation Commission (FWCC)
Alicia Paul - FL Charter Fisherman
Challen Hyman - FWCC
David Griffith - Gulf Scientific and Statistical Committee (SSC)
Ellie Corbett - FWCC
Erin Driscoll - FWCC
*Gaitlyn Malone - NMFS SEFSC SFD
Genine McClair – FWCC

Juan Cortes - FWCC
Maria McGirl - FWCC
Mark Tryon - FL Commercial Fisherman
Matthew Nuttall - NMFS SEFSC SFD
Michael Larkin - NMFS SERO
Mike Rowell - AL Charter Fisherman
Olivia Wilms - FWCC
*Rob Cheshire - NMFS SEFSC Fisheries Statistics Division (FSD)
Samantha Binion-Rock - NMFS SEFSC SFD
Sascha Cushner - NMFS SEFSC SFD
Sean Wilms - FWCC
Vivian Matter - NMFS SEFSC SFD

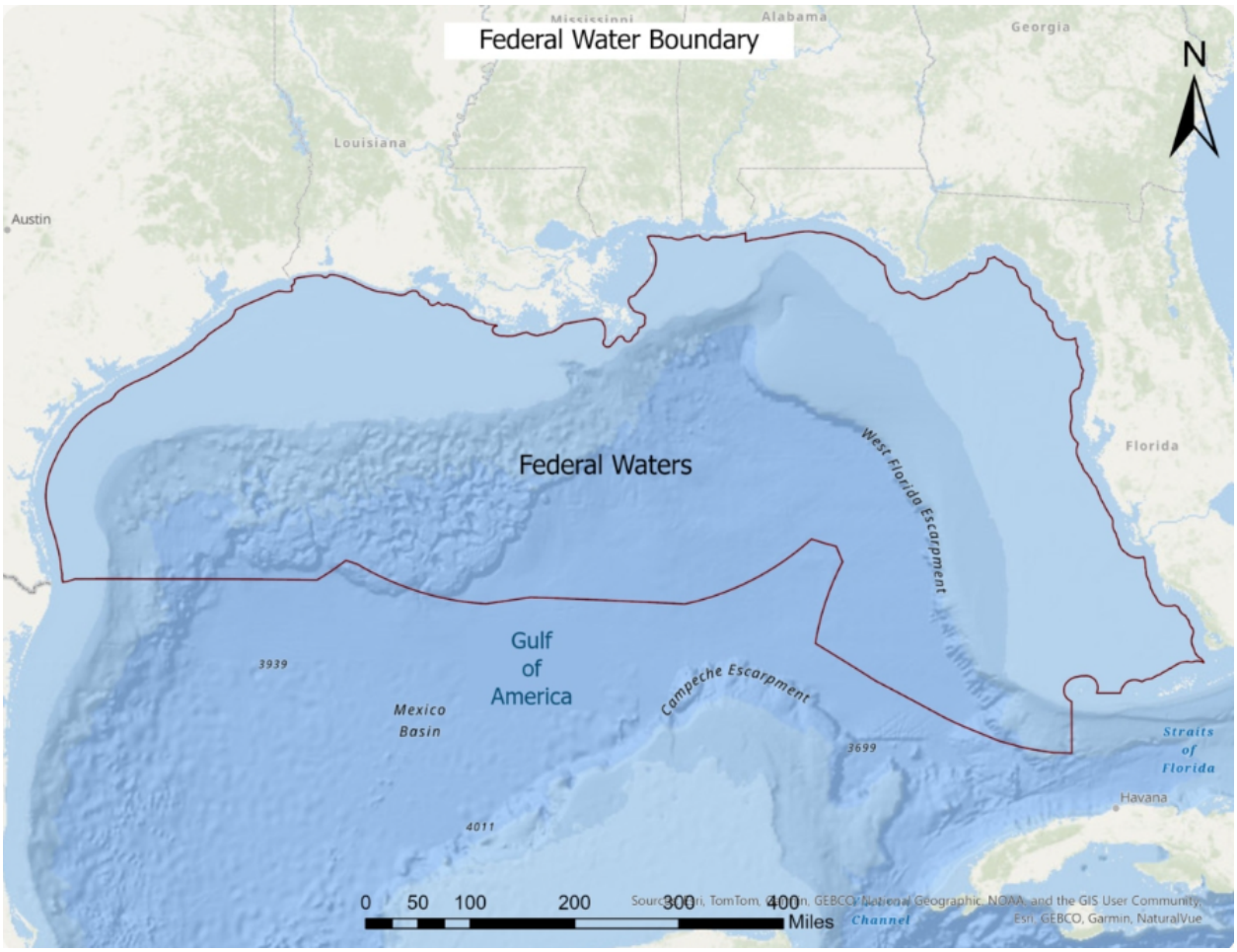
** indicates virtual participation*

4.1.2 Tasks

1. Review fully calibrated MRIP Fishing Effort Survey (FES)/Access Point Angler Intercept Survey (APAIS)/For-Hire Survey (FHS) landings and discard estimates.
2. Allocate MRIP catch estimates from Monroe County to the Gulf of America or South Atlantic.
3. Evaluate MRIP catch estimates by mode of fishing and determine how to incorporate all appropriate modes into the Gray Triggerfish stock assessment.
4. Review calibrations between federal (e.g., MRIP-FES) and state survey estimates.
5. Determine whether MRIP or SRFS estimates should be used to inform Florida Private mode landings and discards.
6. Evaluate usefulness of historical data sources such as the Fishing, Hunting, and Wildlife-Associated Recreation Survey (FHWAR) to generate estimates of landings prior to 1981.

7. Provide input on an appropriate "start year" for the SEDAR 100 Assessment Model.
8. Provide estimates of uncertainty around each set of landings and discard estimates.
9. Review whether SRHS discard estimates (2004+) are reliable for use and determine if there are other sources of data prior to 2004 that could be used as a proxy to estimate headboat discards.
10. Evaluate if the recreational fleet structure should be updated.
11. Provide nominal and weighted length and age distributions for landings, if feasible.
12. Provide nominal and weighted length distributions for discards, if feasible.
13. Evaluate adequacy of available data.
14. Provide research recommendations to improve recreational data.

4.1.3 Gulf of Mexico Fishery Management Council Scamp Group Management Boundaries



4.2 REVIEW OF WORKING PAPERS

Headboat Data for Gray Triggerfish in the US Gulf of America (SEDAR 100-DW-01)

This document provides an overview of the Southeast Region Headboat Survey, the catch estimates of Gray Triggerfish in numbers and weight, the uncertainty associated with these catch estimates, a description of the number of fish measured by the survey, a summary of average

lengths and weights, total effort by headboats in the Gulf of America, and the number of vessels by strata to determine confidentiality. The public version is limited to non-confidential records, but the lead assessment analyst was provided with a confidential version of the working paper to include more detailed information and maps of Gray Triggerfish catch.

General Recreational Survey Data for Gray Triggerfish in the Gulf of America (SEDAR 100-DW-02)

General recreational survey data for Gray Triggerfish from the Marine Recreational Information Program (MRIP), Texas Parks and Wildlife Department (TPWD), and Louisiana Creel Survey (LA Creel) are summarized from 1981 to 2024 for Gulf of America states from Texas to western Florida, excluding the Florida Keys. Estimates from the Charter, Private, Headboat (1981-1985 from Texas to the Florida Keys) fishing modes are presented. These fully calibrated MRIP estimates take into account the change in the Fishing Effort Survey, the redesigned Access Point Angler Intercept Survey, and the For Hire Survey. Tables and figures presented include calibration comparisons, landing and discard estimates, associated CVs, sample sizes, fish sizes, and effort estimates.

Historical Recreational Landings for Gulf of America Gray Triggerfish (Balistes capriscus) estimated using the FHWAR Census Method (SEDAR 100-DW-03)

The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation Survey (FHWAR) is one of the oldest and most comprehensive recreational surveys in the US and was conducted every 5 years between 1955-1985. The FHWAR census method utilizes information from these surveys including U.S. angler population estimates and angling effort estimates from 1955–1985 for the Gulf of America. To obtain historical Gray Triggerfish landings prior to 1981, FHWAR effort estimates in saltwater angler trips (1955-1980) are multiplied by average catch rates from early years (1981-1989) of the MRIP and SRHS data. Interpolation is used to complete the time series.

Gulf of America Gray Triggerfish (Balistes capriscus) length and age compositions from the recreational fishery (SEDAR 100-DW-04)

This working paper describes the data and methodologies used to estimate nominal length and age compositions, conditional age-at-length (CAAL), and mean length-at-age (MLAA) for a combined recreational fleet (i.e., Headboat, Charter, and Private combined) included in the SEDAR 100 Gulf of America Gray Triggerfish Assessment. Changes from SEDAR 62 are also described in this document. Weighting methodologies were discussed during the Data Workshop and an updated working paper was submitted that documents the final nominal and weighted length and age compositions, CAAL, and MLAA for the combined recreational fleet.

Proxy Discard Estimates of Gray Triggerfish (Balistes capriscus) from the US Gulf of America Headboat Fishery (SEDAR 100-DW-08)

Discard data from the Southeast Region Headboat Survey (SRHS) were not routinely collected until 2004, and there are concerns with underreporting during the first few years of data collection (2004-2007). These data are self-reported and not currently validated within the SRHS program. This paper describes the method used and decisions applied in the SRHS (proxy) discards provided in SEDAR 100 for years lacking discard estimates (e.g., 1981-2003) or years with unreliable discard estimates (e.g., 2004-2007) and provides relevant summaries of these proxy discards.

A Summary of Gulf of America Gray Triggerfish Discard Length Data Collected from At-Sea Observers in For-Hire Fishery Surveys in Florida (SEDAR 100-DW-11)

Detailed information on the size and release condition of discarded fish is not collected in traditional dockside surveys of recreational fisheries. At-sea observer surveys provide valuable information on the size and condition of discarded fish, and have been conducted on for-hire vessels in Florida since 2005. At-sea observer surveys have not been consistently funded on both coasts of Florida, which has led to short breaks in the time series in some regions. The majority of these observer trips were conducted on headboat vessels, with charter vessels being surveyed intermittently starting in 2009. This report provides a summary of available information on the size composition, release condition, and disposition of Gray Triggerfish collected by trained observers since 2005 during at-sea surveys on for-hire vessels along the Gulf Coast of Florida.

A ratio-based method for calibrating estimates of total landings (numbers and pounds of fish), releases (numbers of fish), and total trips from MRIP-FCAL to SRFS for Gulf Gray Triggerfish (Balistes capriscus) (SEDAR 100-DW-12)

The Fishery Dependent Monitoring subsection (FDM) of the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) generates private recreational landings, release, and effort estimates for a suite of reef fish in Florida using the State Reef Fish Survey (SRFS). SRFS estimates for Florida Gray Triggerfish (*Balistes capriscus*) from 2016-2024 are provided in this report. Additionally, historical (1981-2015) MRIP-FCAL estimates for Florida have been calibrated into SRFS currency using a peer-reviewed, ratio-based method that has been applied in previous SEDAR stock assessments (e.g. 72, 79, 88, 90, 96), which are also provided.

Length and age compositions of Gulf Gray Triggerfish, Balistes capriscus, collected in association with fishery-dependent projects along Florida's Gulf Coast (SEDAR 100-DW-13)

The Fishery Dependent Monitoring subsection (FDM) of the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) monitors commercial and recreational fishing in marine environments along the Florida coast in association with

several fishery-dependent research and monitoring projects. FDM administers three federal surveys: The Marine Recreational Information Program (MRIP) and the Southeast Region Headboat Survey (SRHS) for the recreational sector, and the Trip Interview Program (TIP) for the commercial sector. Additionally, FDM conducts several unique surveys of recreational anglers that allow for the collection of supplemental biological data. Each fishery-dependent research or monitoring project that contributed age and length data to the Life History Group is detailed in this report.

4.3 RECREATIONAL DATA SOURCES

4.3.1 Marine Recreational Information Program (MRIP)

Introduction

The Marine Recreational Information Program (MRIP), formerly the Marine Recreational Fisheries Statistics Survey (MRFSS), conducted by NOAA Fisheries (NMFS) provides estimates of catch per unit effort, total effort, landings, and discards for six two-month periods (waves) each year. In all states where MRIP samples, MRIP provides estimates for three main recreational fishing modes: shore-based fishing (Shore), private and rental boat fishing (Priv), and for-hire charter and guide fishing (Cbt). MRIP covers all Gulf of America states from western Florida to Mississippi. Louisiana was covered by the survey until 2014 and Texas is not covered to avoid overlap with the TPWD survey (discussed below in 4.3.3). When the survey first began in Wave 2 (Mar/Apr) of 1981, headboats were included in the for-hire mode, but this component has been excluded after 1985 to avoid overlap with the Southeast Region Headboat Survey (SRHS), conducted by the NMFS Beaufort laboratory.

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

combined with estimates of effort to estimate total landings and discards by wave, mode, and area fished (e.g. inland, state, and federal waters).

Catch estimates from the early years of the survey are highly variable with high proportional standard errors (PSE's), and sample sizes in the dockside intercept portion have been increased over time to improve precision of catch estimates. Several quality assurance and quality control improvements were implemented for the intercept surveys in 1990. Prior to 1990, the contractor did not have regional representatives hired to supervise the samplers in any given area. All samplers were hired as independent sub-contractors and communicated directly with the contractor's home office staff. It is more likely that the samplers who worked in the 80's would have varied more in their interpretation of sampling protocols and their ability to identify at least some of the more difficult-to-recognize species. There were a number of other changes made to enhance consistency in sampling protocols and improve error-checking in the Statement of Work for the 1990-1992 contracts. Improvements have continued over the years, but the biggest changes happened during that time (personal communication, NMFS). Catch rate data have improved through increased sample quotas and additional sampling (requested and funded by the states) to the intercept portion of the survey.

Task 1: In order to maintain a consistent time series, charter estimates were calibrated on the Gulf coast prior to 2000 (SEDAR 64-RD-12), and MRIP estimates for private and shore prior to 2018 were calibrated to FES (Papacostas and Foster 2021). CHTS and calibrated FHS charter catch estimates for Gulf of America Gray Triggerfish from 1981 to 1999 are shown in Figure 1 of SEDAR 100-DW-02. Calibrated APAIS and FES estimates for Gulf of America Gray Triggerfish from 1981 to 2024 are shown in Figure 2 of SEDAR 100-DW-02.

Monroe County

MRIP catch from Monroe County is allocated to the official estimates for West Florida. However, they can be estimated separately using domain estimation. The Monroe County domain includes only intercepted trips returning to that county as identified in the intercept survey data. Estimates are then calculated within this domain using standard design-based estimation which incorporates the MRIP design stratification, clustering, and sample weights (SEDAR 68-DW-13). Although Monroe county estimates can be separated from the rest of western Florida using this process, they do not distinguish catch from the Atlantic Ocean and that from the Gulf of America (SEDAR-PW-07).

Task 2: For SEDAR 100, MRIP estimates from Monroe County were allocated to the Atlantic because Gray Triggerfish is a species associated with hard-bottoms and Monroe County catches are most likely from the Atlantic side of the Florida Keys. This recommendation differs from that

applied in SEDAR 9 for Gulf Gray Triggerfish, which included the Florida Keys (SEDAR 9), but is in agreement with Gulf of America (SEDAR 43 and 62) and South Atlantic (SEDAR 32, 41, and 82) Gray Triggerfish assessments thereafter.

Adjustment to Fishing Modes

Task 3a: Between 1981 and 1985, MRIP charter and headboat modes were combined into a single mode for estimation purposes. Since the NMFS Southeast Region Headboat Survey (SRHS) began in the Gulf in 1986, the MRIP combined charter/headboat mode must be split in order to provide estimates of headboat landings in these early years. The MRIP charter/headboat mode (1981-1985) was split by using a ratio of SRHS headboat angler trip estimates to MRIP charterboat angler trip estimates for 1986-1990. In accordance with SEDAR Best Practices, the mean ratio was calculated by state (or state equivalent to match SRHS areas to MRIP states) and then applied to the 1981-1985 estimates to split out the headboat component when needed (SEDAR-PW-07). The MRIP headboat component from this split was used to represent headboat fishing in the Gulf (Louisiana to western Florida) from 1981-1985 and SRHS headboat estimates were used for all years after 1985.

Task 3b: As done in SEDAR 43, shore mode was excluded from MRIP landings and discard estimates. Gray Triggerfish are strongly associated with reefs and hard-bottom and are unlikely to be caught from shore access sites in the Gulf. This is supported by the relatively low contribution of shore catch to general recreational catch. This recommendation is in agreement with decisions made during SEDARs 43 and 62.

Unidentified Triggerfish

Catch estimates of unidentified triggerfish (i.e., leatherjacket family) are present in the MRIP dataset. For SEDAR 100, 100% of unidentified Triggerfish landings and discards were assumed to be Gray Triggerfish. This is consistent with SEDAR 62. For all Triggerfish species (e.g. Gray, Ocean, and Queen), Gray Triggerfish account for almost 100% of all landings and discards, except for a few years in the 1980s (Table 12 in SEDAR 100-DW-02). This is consistent with observations made by commercial and charter fishermen work group members, who reported rarely (~1-2 total occasions spanning many years) catching other Triggerfish species.

Uncertainty

Coefficient of variation (CV) estimates for Marine Recreational Information Program (MRIP) survey catch totals are provided for stock assessments by the Southeast Fisheries Science Center (SEFSC). Variances of total catch-in-number estimates are computed directly from the raw

survey data to obtain CVs appropriate for custom aggregations by year, wave, sub-region, state, and mode using standard survey methods (SEDAR 68-DW-10).

4.3.2 Louisiana Creel Survey (LA Creel)

The Louisiana Department of Wildlife and Fisheries (LDWF) began conducting the Louisiana Creel (LA Creel) survey program on January 1, 2014 to monitor marine recreational fishery catch and effort. The program is designed to sample guided (e.g., charter) and unguided (i.e., combined private/shore) fishing modes and is comprised of three separate surveys: an intercept survey, a private telephone/email survey, and a for-hire telephone/email survey. The dockside/shoreside survey is used to collect data needed to estimate the mean numbers of fish landed by species for each of five different inshore basins and one offshore area. The private telephone/email survey samples from a list of people who possess either a LA fishing license or a LA offshore fishing permit and provided a valid telephone number. The for-hire telephone/email survey samples from a list of Louisiana's registered for-hire captains who provided a valid telephone number. Both telephone/email surveys are conducted weekly. Dockside/shoreside discard information has been collected since 2016 but only for a subset of finfish species which includes Gray Triggerfish.

Calibration to MRIP-FES units

Task 4a: The MRIP and LA Creel surveys were conducted simultaneously in 2015 for benchmarking purposes. A ratio estimator is used to calibrate private mode LA Creel landings and discards in numbers of fish to MRIP FES units. Because the charter fishing frame used by the LA Creel and MRIP surveys are functionally equivalent, charter fishing estimates of the two surveys are assumed equivalent and are not adjusted (SEDAR 98-DW-18). The ratio of the 2015 private mode landings estimates from the LA Creel and MRIP FES surveys (ratio = 3.55) is used to calibrate LA Creel private estimates (2014-2024) to MRIP FES units as the product of the 2015 MRIP/LA Creel landings ratio and the annual LA Creel estimates. Discard and effort estimates between surveys are calibrated using the same ratio as applied to landings. Note that the LA Creel calibration ratios applied to date in SEDAR 100 are considered preliminary and may be revised in the future after MRIP-FES estimates are updated with the new survey design (Gulf Transition Plan 2025).

Uncertainty

Coefficients of variation for annual LA Creel landings and discards estimates are provided by the LDWF. Variances are calculated from the survey data for each week of year, area, and fishing mode and are summed to estimate annual CV's of landings and discards. These variances, in LA Creel units, are then scaled into MRIP-FES units using a Taylor Series expansion that assumes

the MRIP and LA Creel point estimates are independent (i.e., correlation = 0). This is the same approach used to calibrate the TPWD time series into MRIP-FES units, as discussed in section 4.3.3 below.

4.3.3 Texas Parks and Wildlife Department's (TPWD) Marine Sport-Harvest Monitoring Program

The TPWD Coastwide Creel Survey samples fishing trips made by sport-boat anglers fishing in Texas marine waters. Sampling occurs at recreational boat access sites along the Texas coast. Data collected from dockside interviews includes information regarding trip satisfaction, angler county of origin, species sought and landed, geographical area of fish landed, length composition, bait utilized, as well as trip length for sampled boat-trips. Texas Parks and Wildlife began dockside survey methods for recreational anglers in 1974, but only generate recreational catch and effort estimates beginning in May 1983, when methods became largely standardized (SEDAR 70-WP-03). The Coastwide Creel Survey is designed to estimate landings and effort by parsing out seasons based on fishing pressure, for high-use (May 15-November 20) and low-use seasons (November 21-May 14). From there, TPWD disaggregates seasons into waves for all estimates, using the fraction of the total catch for each species from each two-month wave, to make the TPWD time series compatible with the MRIP time series. TPWD surveys private and charterboat fishing trips. While TPWD samples all trips (private, charterboat, ocean, bay/pass), most of the sampled trips are associated with private boats fishing in bay/pass areas, as these trips represent most of the fishing effort in Texas waters. Charterboat trips in ocean waters are the least encountered by the survey. Additional information on the TPWD survey can be found in SEDAR 70-WP-03.

Calibration to MRIP-FES units

Task 4b: The MRIP-FES was implemented in Texas in 2016 (SEDAR 74-RD-110) to compare MRIP-FES effort estimates with the associated effort estimates from the TPWD survey. A ratio estimator was calculated from these two sets of estimates and reviewed during the data workshop for SEDAR 74. This calibration is described in SEDAR 74-DW-10 and may be applied to landings, discards, and effort estimates to calibrate private TPWD estimates into MRIP-FES units. The MRIP-FHS has never been conducted in Texas and so an appropriate TPWD:MRIP calibration for the Texas charter mode is not available.

The Recreational Working Group (RecWG) was tasked with providing a continuous and consistent time series of recreational catch statistics by area for the combined recreational fleet. In accordance with the Terms of Reference, state survey catch estimates were calibrated to a common data unit to be comparable across time and Gulf states. While concerns were raised regarding the current calibration approach in adjusting TPWD private estimates into MRIP FES

units (SEDAR 74-DW-10), the SEDAR 100 RecWG recommended application of this approach in the absence of a better alternative. This decision is in agreement with that from a joint TPWD/SEFSC collaboration that explored potential calibrations between TPWD and MRIP during SEDAR 98, and supported use of the SEDAR 74-DW-10 approach until additional benchmarking becomes feasible (Gulf Transition Plan 2025).

Catch and Uncertainty Estimates

TPWD provides catch estimates by matching high- and low-use seasons (the months included in each) to MRIP waves. Data are summarized by daily angler hours, trips, number of anglers, total catch, length measurement, mean length, and mean weight. These summaries are joined with seasonal and yearly relative pressure to calculate TPWD and NOAA pound estimates. Estimates for trips, anglers, angler hours, total catch, and mean weight incorporate relative pressure from boat ramps. Further breakdown includes estimates by Gulf area, day type, and wave. Overall totals are provided, along with standard errors for effort (angler hours), landings (fish count), and catch per unit effort (fish per angler hour) which are applied as measures of uncertainty. These variances, in TPWD units, are then scaled into MRIP-FES units using a Taylor Series expansion that assumes the MRIP and TPWD point estimates are independent (i.e., correlation = 0). This approach is described in SEDAR 74-DW-10.

4.3.4 Southeast Region Headboat Survey (SRHS)

The Southeast Region Headboat Survey estimates landings and effort for headboats in the South Atlantic and Gulf of America. The SRHS incorporates two components for estimating catch and effort. 1) Information about the size of fish landed is collected by port samplers during dockside sampling, where fish are measured to the nearest mm and weighed to the nearest 0.01 kg. These data are used to generate mean weights for all species by area and month. Port samplers also collect otoliths for aging studies during dockside sampling events. 2) Information about total landings, discards (numbers), and effort (trip duration and number of anglers) are collected via the logbook, a form (electronic since 2013) filled out by vessel personnel for individual trips. These logbooks are summarized by vessel and expanded for known missing trips to generate estimated landings by species, area, and time strata.

The SRHS was started in 1972 but only included vessels from North Carolina and South Carolina. In 1975, the survey was expanded to northeast Florida (Nassau-Indian River counties), followed by Georgia in 1976 and southeast Florida (St. Lucie-Monroe counties) in 1978. In 1986, the survey expanded to include west Florida, Alabama, Louisiana, and Texas. There have been a few changes to the spatial strata definitions within the SRHS over the years. Most

notably, Mississippi was added to the survey in 2010 and Alabama was split from Northwest Florida in 2013.

Texas Headboat Landings (1981-1985)

Landings estimates for Gulf of America headboats between 1981 and 1985 come from the MRFSS/MRIP survey for all states except Texas. As in previous SEDARs, Texas headboat landings for 1981 to 1985 were estimated as a five-year average (1986-1990) from SRHS Texas headboat landings.

Uncertainty

The SRHS is designed to be a census and so reporting compliance and accuracy are the primary components of the uncertainty in landings and discard estimates over time. Headboat activity is monitored by port agents to validate trips. Three proxy estimates of SRHS uncertainty were provided for consideration in the assessment model: (1) unweighted, (2) weighted by landings-in-number, and (3) weighted by landings-in-weight. Unweighted proxy uncertainty estimates (CV) applied the annual proportions of reported to estimated trips by region as a proxy for CV with an additional buffer of 0.05 to prevent the estimate from reaching a zero value:

$$proxyCV = 1 - \frac{n}{N} + 0.05$$

where n is the number of reported trips and N is the number of estimated trips. Weighted proxy CVs were developed to approximate uncertainty by scaling the unweighted CVs with either landings-in-number or weight within each region:

$$proxyCV_i = 1 - \sum_{j=1}^{n} \left[\frac{n_{i,j}}{N_{i,j}} * \frac{L_{i,j}}{L_i} \right] + 0.05$$

where n is the number of reported trips, N is the number of estimated trips, and L is the landings (in number or weight) for year *i* and subregion/region *j*. The weighted proxy CVs by landings-in-number were recommended for use in characterizing SRHS landings and discard uncertainty in the SEDAR 100 assessment model.

4.3.5 For-Hire At-Sea Observer Coverage

At-sea observer sampling is conducted to provide detailed information on the size and release condition (e.g. live, dead) of discarded fish. In Florida, at-sea sampling by FWC, for the headboat and charter boat modes has occurred since 2005 and 2009, respectively, however there have been breaks in coverage (Table 1 in SEDAR 100-DW-11). From 2005-2007, FWC also

included Alabama in their at-sea coverage of headboats. ADNR conducted at-sea observer sampling on headboats from 2017-2019. In 2022, the Return 'Em Right program began in Florida, Alabama, and Mississippi. Return 'Em Right is an ongoing program where at-sea observers sample both headboat and charter trips.

4.3.6 State Reef Fish Survey (SRFS)

In response to the need for more precise estimates of recreational catch for reef fishes, particularly from private boats, the Florida Fish and Wildlife Conservation Commission developed and implemented a new survey that runs side-by-side with the historical Marine Recreational Information Program (MRIP), described in Section 4.3.1. The MRIP is a general survey of all saltwater recreational fishing in both state and federal waters, whereas 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. The SRFS is the result of a decade of development and testing in Florida, in collaboration with independent statistical consultants and NOAA Fisheries scientists. The survey provides year-round, monthly estimates of fishing effort, landings, and discards for a suite of reef fish species commonly targeted by recreational anglers fishing from private boats in Florida. Initially named the Gulf Reef Fish Survey (GRFS), the methodology was implemented in May 2015 and was only conducted on the west coast of Florida, north of Monroe County. In 2018, the survey design and estimation methods were peer-reviewed and subsequently certified by NOAA Fisheries as statistically valid and suitable for use (SRFS Certification Memo and design documentation, available online: https://www.fisheries.noaa.gov/recreational-fishing-data/transitioning-new-recreational-fishingsurvey-designs). The SRFS runs concurrently with the MRIP survey in Florida, which has provided vital statistics on recreational fishing effort and catch in the Gulf of America and Atlantic Ocean off the coast of Florida since 1981. The SRFS and MRIP surveys use independent methods to estimate fishing effort (angler trips). However, catch estimates derived from each method are not completely independent. To estimate catch-per-unit-effort (CPUE), MRIP uses data collected in the Access Point Angler Intercept Survey (APAIS), and SRFS uses a combination of data from the APAIS and supplemental reef fish angler intercepts. Assignments for both intercept surveys are drawn together so that sample weights are compatible (Foster, 2018). SRFS effort is estimated through a mail survey that is used to estimate effort for the suite of reef fish found in Florida, which include Gray Triggerfish. This survey is sent out monthly to 10,000 anglers with the Florida State Reef Fish Angler designation on their Florida saltwater fishing license. This designation is free, but is a required add-on for Florida anglers who intend to or may incidentally catch any of the fish in our reef fish suite. Information on whether anglers targeting or catching this suite of reef fish have the required designation is used as an undercoverage estimate to account for all the anglers who should have been eligible to

receive the mail survey, but did not. Combining dockside intercepts for reef fish collected by APAIS with the supplemental SRFS dockside estimates at offshore angling site to estimate CPUE and large sample sizes for the mail survey allows for the generation of precise estimates of landings and releases for reef fish in the suite.

Consideration of SRFS in SEDAR 100

Task 5: The SEDAR 100 RecWG was tasked with evaluating whether MRIP (SEDAR 100-DW-02) or SRFS estimates (SEDAR 100-DW-12) should be used as a source of landings and discards for the private boat mode in Florida. Responsible for providing a continuous and consistent time series of recreational catch statistics, the Group recommended the use of MRIP-FES estimates for the Florida private boat mode. This decision was largely based on the non-negligible catch coming from private fishing outside of Florida, with catches from Florida comprising 69% and 79% of regional private landings and discards respectively.

4.4 RECREATIONAL LANDINGS

4.4.1 MRIP Landings

Weight Estimation

The Southeast Fisheries Science Center used the MRIP, TPWD, and LA Creel sample data to obtain an average weight by strata using the following hierarchy: species, region, year, state, mode, wave, and area (SEDAR 32-DW-02). The minimum number of weights used at each level of substitution is 15 fish, except for the final species level where the minimum is 1 fish (SEDAR 67-WP-06). Average weights are then multiplied by the landings estimates in numbers to obtain estimates of landings in weight. These estimates are provided in pounds whole weight.

Uncertainties for average weight estimates were calculated from approach #2 in SEDAR 74-DW-12. All observations of fish weight are averaged at the trip level, from which the mean and standard error of these trip-level summaries are calculated at the same strata used in SEFSC weight estimation (e.g., syrsmwa), combined to the year/mode level, and converted to coefficients of variation (CV). These uncertainty estimates for SEFSC average weights are then combined with those for landings-in-number, using the variance product law (Goodman 1960), as an uncertainty estimate for landings-in-weight.

Catch Estimates

Final MRIP landings estimates, in numbers of fish, are shown by year and mode in Table 4.12.1, and associated coefficients of variation by year, region and mode in Tables 3.1-3.3 of SEDAR

100-DW-02 and by year and region in Tables 5.1-5.3 of SEDAR 100-DW-02. Estimates are provided for all Gulf of America states from Louisiana to western Florida, excluding the Florida Keys. Final MRIP landings estimates in pounds whole weight are shown by year and mode in Table 4.12.1, and associated coefficients of variation in Tables 6.1-6.3 of SEDAR 100-DW-02.

4.4.2 LA Creel Landings

Starting in 2014, recreational data for Louisiana are only available from the LA Creel survey. LA Creel landings estimates, calibrated to MRIP-FES units for the private mode, for Louisiana Gray Triggerfish (2014-2024) are provided in Table 4.12.2. These landings-in-number estimates are then multiplied by the corresponding SEFSC average weights to estimate landings-in-weight. Uncertainties for average weight and landings-in-weight are calculated using the same approach described above for MRIP (approach #2 in SEDAR 74-DW-12).

4.4.3 TPWD Landings

TPWD average estimates from 1983 to 1985 (by wave and mode) were used to impute missing estimates for Texas charter and private boat fishing from 1981 until the survey started in May 1983. TPWD Gray Triggerfish landings estimates, calibrated to MRIP-FES units for the private mode (SEDAR 74-DW-10), from 1981 to 2024 are provided in Table 4.12.3. These landings-in-number estimates are then multiplied by the corresponding SEFSC average weights to estimate landings-in-weight. Uncertainties for average weight and landings-in-weight are calculated using the same approach described above for MRIP (approach #2 in SEDAR 74-DW-12).

4.4.4 SRHS Headboat Logbook Landings

Final SRHS landings estimates (in number and weight) for the eastern and western Gulf of America are shown in Tables 2 and 3, respectively, in SEDAR 100-DW-01. CVs are provided for landings estimates in number of fish and can be used as a proxy for uncertainty of estimates in weight. This would assume there is no additional uncertainty from the average weights calculated from the SRHS dockside biological sampling.

The paper headboat logbook forms have changed multiple times throughout the history of the SRHS. The primary changes have been which species are explicitly listed on the forms, although there have always been blank lines to write-in species not listed. Gray Triggerfish has been listed on SRHS logbook forms since the beginning of this survey in the Gulf of America. Electronic reporting started in 2013 and all species were available for selection.

4.4.5 Historic Recreational Landings

Introduction

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

FHWAR Census Method

The 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) presents summary tables of U.S. population estimates, along with estimates of hunting and fishing participation and effort from surveys conducted by the US Fish and Wildlife Service every 5 years from 1955 to 1985 (SEDAR 100-DW-03). This information was used to develop a method for estimating recreational landings prior to 1981. The two key FHWAR survey components that were used in this census method were the estimates of U.S. saltwater anglers and U.S. saltwater days. These estimates are used to calculate the historical effort of Gulf of America saltwater anglers. Landings estimates from modern surveys (e.g., MRIP, SRHS) were used to calculate mean catch rates from 1981-1989 for Gray Triggerfish. The Gray Triggerfish fishery was largely unregulated over these years (e.g., no bag limits, no size restrictions), a characteristic shared with the historical fishery prior to 1981. The nine-year time period is meant to offset the relatively high variability in MRIP catch estimates from the early years of the survey, as described in section 4.3.1. For this calculation, MRIP effort for 1981-wave1 and TPWD effort for 1981-May 1983 were imputed using the best practice approaches described in SEDAR-PW-07. This mean CPUE is applied to the historical FHWAR effort estimates for Gulf of America saltwater anglers to provide estimates of recreational Gray Triggerfish landings prior to 1981.

The final stock ID for Gulf Gray Triggerfish will not be decided until the assessment phase. The lead analyst requested historical recreational landings estimates for two different stock structures. The first treats the entire Gulf as a single stock. The second structure splits the Gulf into West (Texas and Louisiana) and East (Mississippi to west Florida). The mean proportion of landings (MRIP and SRHS) for the West and East was calculated from 1981-1989. The Gulf-wide historical recreational landings estimates were delineated into East and West landings by applying the mean West and East proportions.

Task 6: The SEDAR 100 RecWG reviewed the FHWAR method and preliminary estimates. The Group recommended using the historical estimates calculated using the FHWAR method for the Recreational fleet from 1955-1980. Historical Gray Triggerfish landings estimates in numbers of fish are shown in Table 4.12.4 by region.

Uncertainty

The CV calculated using the FHWAR method for total recreational landings is 0.577, which is the CV of the mean CPUE multiplied by historical FHWAR effort estimates (in saltwater days) and assumed to reflect the uncertainty in historical landings estimates (SEDAR 100-DW-03). The historical FHWAR estimates are believed to be highly uncertain given the limited information available to describe historical recreational fisheries.

Potential Start Year for SEDAR 100 Assessment Model

Task 7: As requested by the assessment analyst, the SEDAR 100 RecWG provided input on an appropriate start year for the Gulf Gray Triggerfish assessment model. Acknowledging the relatively high uncertainty in historical FHWAR estimates, the RecWG highlighted the highly variable trends in recreational landings between 1981-1985, which were part of the time series applied to FHWAR effort estimates to back-calculate historical landings back to 1955. There are also no recreational length or age compositions available over the historical time period, so FHWAR estimates are likely to have a relatively large influence on the model's parameterization of virgin conditions. However, the RecWG also agreed the FHWAR time series constitutes the "best available" representation of historical recreational landings. They were provided and used in past SEDAR stock assessments for Gulf Gray Triggerfish (SEDARs 43 and 62), and their inclusion reduces the chances of a potential one-way trip in the recreational time series, which shows a general decline after the early 1990s. Given these concerns, the RecWG proposed two configurations for the SEDAR 100 stock assessment model:

- Historical Model – to include FHWAR, with potential start years of 1955 or 1945, the latter being a continuity with SEDARs 43 and 62
- Modern Model – to exclude FHWAR, with potential start years of 1981 or 1986

The ultimate choice of which start year is most appropriate is recommended to be left to the SEDAR 100 assessment modeling team, who have access to all available data sources and can better determine whether a model built from unfished conditions or a fished state provides a more defensible representation of the Gulf Gray Triggerfish stock.

4.4.6 Total Recreational Landings

Combined landings estimates from all sources by stock ID region are shown in Table 4.12.4, Figure 4.13.1, and mapped in Figure 4.13.2. Comparisons of landings across stock ID regions for individual modes are shown in Figure 4.13.3, including historical recreational landings estimates

for all modes combined. Overall, landings estimates for Gray Triggerfish showed a general increase into the early 1990s and subsequent decrease thereafter, and with peaks occurring in the early-1990s and mid-2000s. The majority of the recreational landings in the Gulf of America come from the private mode (about 57.4%). The charter mode contributes about 33.6% and the headboat mode makes up the remaining 9.0% of recreational landings. Geographically, most landings come from the East (about 87.4%).

Uncertainty

Task 8a: To provide an associated measure of uncertainty for total recreational landings estimates, coefficients of variation (CVs) are calculated from the sum total of variance across all recreational data sources (i.e., SRHS logbook landings, MRIP landings data, and calibrated TPWD and LA Creel landings data). Details of this approach are outlined in SEDAR 68-DW-31, and are applied to estimates of both landings-in-number and landings-in-weight.

4.5 RECREATIONAL DISCARDS

4.5.1 MRIP Discards

Fish reported to have been discarded alive are not seen by MRIP interviewers and so neither the identity nor the quantities of discarded fish can be verified. The size and weight of discarded fish are also unknown for all modes of fishing. MRIP discard estimates, in numbers of fish, are shown by year and mode in Table 4.12.1, and associated coefficients of variation are shown by year, region, and mode in Tables 4.1-4.3 of SEDAR 100-DW-02 and by year and region in Tables 5.1-5.3 of SEDAR 100-DW-02. Estimates are provided for all Gulf of America states from Louisiana to western Florida, excluding the Florida Keys.

4.5.2 LA Creel Discards

Gray Triggerfish are a target species of the LA Creel survey and so discard estimates for Louisiana Gray Triggerfish are available starting in 2016. Because MRIP discards in Louisiana from 1981 to 2013 are sparse and negligible relative to the Gulf-wide estimates, Louisiana Gray Triggerfish discards in 2014 and 2015 are also considered negligible and were not imputed. This is consistent with the decision for SEDAR 62. Discard estimates for Louisiana Gray Triggerfish are provided in Table 4.12.2, with LA Creel private mode estimates calibrated to MRIP FES units.

4.5.3 TPWD Discards

Self-reported catch is not monitored by the TPWD survey and so discards of Gray Triggerfish from Texas are not estimated by this survey (SEDAR 70-WP-03). As a proxy for recreational

discards from Texas private and charter boat anglers, discard:landings ratios (B2:AB1) are calculated (by year) from Louisiana catch estimates and multiplied by TPWD landings estimates. This is a deviation from the best practice approach of calculating discard:landings ratios that are year *and* mode specific (SEDAR-PW-07). Using the best practice approach, the discard ratios were highly variable and there were two years of imputed Texas discard estimates that were unusually high (Figure 5a in SEDAR 100-DW-02). In an effort to stabilize the applied discard ratios, the RecWG considered applying 1) Louisiana ratios calculated by collapsing mode and 2) mode-specific ratios calculated by collapsing state in a Gulf-wide dataset. The RecWG recommended using the combined mode ratio from LA, which aligns with the combined recreational fleet structure (i.e., charter, headboat, and private combined) applied in previous assessments. The RecWG also expressed concern in calculating discard rates from combined eastern and western data, the latter of which tends to support lower landings. Texas estimates of Gray Triggerfish discards (1981-2024) are provided in Table 4.12.3, including those calibrated to MRIP FES units for the private mode (SEDAR 74-DW-10).

4.5.4 SRHS Headboat Logbook Discards

The SRHS logbook form was modified in 2004 to include a category to collect self-reported discards for each reported trip. This category is described on the form as the number of fish by species released alive and number released dead. Port agents instructed each captain on criteria for determining the condition of discarded fish. A fish is considered "released alive" if it is able to swim away on its own. If the fish floats off or is obviously dead or unable to swim, it is considered "released dead". As of Jan 1, 2013 the SRHS began collecting logbook data electronically. Changes to the trip report were also made at this time, one of which removed the condition category for discards (i.e., released alive vs. released dead) due to difficulties in standardizing these determinations. The form now collects only the total number of fish released, regardless of condition. The SRHS discard data provided for this assessment is in total discards for all years.

As a proxy for SRHS headboat discards of Gulf of America Gray Triggerfish from 1986:2007, the ratio of the mean ratio of SRHS discard:landings (2008-2012) to the mean ratio of MRFSS CH discard:landings (2008-2012) was applied to the yearly MRIP charter boat discard:landings ratio (1986-2007) to estimate the yearly SRHS discard:landings ratio (1986-2007). This ratio was then applied to the SRHS landings (1986-2007) as a proxy for SRHS headboat discards (1986-2007). This method is termed the Super-Ratio approach and is the current SEDAR "Best Practice" method, allowing for changes in both management and year class effects to be incorporated into the proxy discard time series (SEDAR-PW-07). Details of this approach and the associated decision points for SEDAR 100 are described in SEDAR 100-DW-08.

Task 9: The SEDAR 100 RecWG recommended using the Best Practice Super-Ratio proxy method (1986-2007) and the SRHS estimated discards from 2008-2024. Alternative approaches are only considered when the preferred approach fails (SEDAR-PW-07) and given no clear indication of failure, the Super-Ratio approach was chosen for SEDAR 100 (SEDAR 100-DW-08). Final headboat proxy discard estimates are summarized in Table 1 and Figure 2 of SEDAR 100-DW-08.

Uncertainty

Uncertainty proxies for SRHS discards between 2008-2024 by stock ID region and for the entire Gulf of America (Tables 10 and 12 in SEDAR 100-DW-01) are calculated using the same method described for landings. Prior to 2008, uncertainty estimates for SRHS proxy discards are calculated from SRHS estimates of landings, the associated uncertainty for that year, and estimates of the applied discard rate and associated variance. Given proxy discards are calculated as the product of these two terms, the associated variance is approximated using Goodman's Formula for the product of two independent random variables (SEDAR 74-DW-10). Final uncertainty estimates for headboat discards are shown in Figure 2 of SEDAR 100-DW-08.

4.5.5 Total Recreational Discards

Combined discard estimates from all sources by stock ID region are shown in Table 4.12.5, Figure 4.13.4, and mapped in Figure 4.13.5. Comparisons of discards across stock ID regions for individual modes are shown in Figure 4.13.6. Overall, discard estimates for Gray Triggerfish remained low before 2015 and consistently high thereafter, which seemingly coincides with management changes (e.g., short season in 2015, no season in 2017, reduced bag limit in 2018). The majority of the recreational discards in the Gulf of America come from the private mode (about 83.0%). The charter mode contributes about 13.5% and the headboat mode makes up the remaining 3.5% of recreational discards. Geographically, most discards come from the East (about 93.9%).

Uncertainty

Task 8b: Uncertainties for total recreational discards-in-number are calculated using the same approach as that described above for total recreational landings (in Section 4.4.6).

4.6 BIOLOGICAL SAMPLING

4.6.1 Landed Fish

4.6.1.1 MRIP Biological Sampling

The MRIP Access Point Angler Intercept Survey (APAIS) includes the collection of fish lengths from the harvested catch (landed, whole condition). Up to 15 individuals of each landed species per angler interviewed are measured to the nearest mm along a centerline (defined as tip of snout to center of tail along a straight line, not curved over body). For all fish, the centerline is equivalent to fork length. For fish with truncate or rounded tails, centerline length, forked length, and natural total length are considered to be equivalent. Weights are typically collected for the same fish measured, although weights are preferred when time is constrained. Ageing structures and other biological samples are not collected during MRIP assignments because of concerns over the introduction of bias to survey data collection. Information on discarded fish size is not collected during MRIP APAIS sampling.

Summaries of fish size (pounds whole weight) for MRIP-sampled Gray Triggerfish in the Gulf of America by stock ID region and fishing mode (1981-2024) are provided in Tables 7.1-7.3 of SEDAR 100-DW-02. Table 8 in SEDAR 100-DW-02 provides annual summaries for all stock ID regions and fishing modes combined. These summaries include the number of Gray Triggerfish weighed, number of angler trips from which Gray Triggerfish were weighed, and the minimum, average, and maximum weights. The number of Gray Triggerfish sampled for lengths by MRIP are available in Table 1 of SEDAR 100-DW-04.

4.6.1.2 LDWF Biological Sampling

Size, weight, and age structures of recreationally landed Gray Triggerfish have been collected from the LDWF Biological Sampling Program starting in 2014. During the open season for Louisiana Gray Triggerfish, sampling targets for size measurements have been 30 fish per area per mode (charter and private) per week. Sizes are largely measured as maximum total length, with associated weight measurements collected as time permits. Otolith sampling targets are obtained from the federal GulfFIN grants. Summaries of fish size, in pounds whole weight, for LDWF-sampled Gray Triggerfish by mode (2014-2024) are provided in Table 9 of SEDAR 100-DW-02. These summaries include the number of Gray Triggerfish weighed, number of angler trips from which Gray Triggerfish were weighed, and the minimum, average, and maximum weights. The number of Gray Triggerfish sampled for age by LDWF is available in Table 2 of SEDAR 100-DW-04. The number of Gray Triggerfish sampled for lengths by LDWF is available in Table 1 of SEDAR 100-DW-04.

4.6.1.3 TPWD Biological Sampling

Length composition of the catch of Texas sport-boat anglers has been sampled by the TPWD since the high-use season of 1983 (mid-May). Maximum total length is measured by compressing the caudal fin lobes dorsoventrally. Weights of sampled fish are not recorded, but lengths can be converted to weights using length-weight equations (Table 1 in SEDAR 70-WP-

03). The number of Gray Triggerfish sampled for lengths by TPWD is available in Table 1 of SEDAR 100-DW-04.

4.6.1.4 SRHS Biological Sampling

SRHS dockside sampling has been conducted in all Gulf states since 1986, except for Mississippi where sampling started in 2010. Weights are typically collected for the same fish measured during dockside sampling. Biological samples (scales, otoliths, spines, stomachs, and/or gonads) are also collected routinely and processed for aging, diet studies, and maturity studies.

The number of Gray Triggerfish sampled by SRHS for lengths are available in Tables 1 and 2 and the number sampled for age are available in Tables 1 and 3 of SEDAR 100-DW-04. Mean lengths and mean weights by year and stock ID region from biologically sampled Gray Triggerfish in the SRHS are summarized in Tables 20 and 22 of SEDAR 100-DW-01.

4.6.1.5 Length Frequency Distributions of Landings

Length data from the recreational fisheries of the Gulf of America are collected by multiple federal surveys (MRIP 1981-2024, SRHS 1986-2024) and state agencies. Data collected by state agencies (described above and in SEDAR 100-DW-04) are warehoused by the Gulf States Marine Fisheries Commission (GSMFC) in the GulfFIN database (2001-2024).

Length sample sizes from all data sources are shown in Tables 1 and 2 of SEDAR 100-DW-04. Length sample sizes for each potential stock ID (e.g. Gulf, West, East) are provided in Table A1 of SEDAR 100-DW-04.

Task 10a: Nominal length distributions by year and mode are shown in Figure 4.13.7. For most years, the length distributions for Gray Triggerfish sampled from the private, charter, and headboat modes are very similar. There are years where the distributions are different, especially in the early 1980s. These years are typically associated with lower sample sizes and do not appear to be indicative of true differences in length distributions among Gray Triggerfish landed by the different modes. Based on the length distribution of retained Gray Triggerfish, there is not strong evidence to support differences in selectivity among the fishing modes. It is recommended to continue modeling the recreational sector as a combined recreational fleet consisting of the private, charter, and headboat modes, as done in SEDAR 62 and 43.

Task 11a: Nominal (Figures A1-A3 in SEDAR 100-DW-04) and weighted (Figure 4.13.8) length frequencies were generated for recreational landings for each potential stock ID. At the request of the stock assessment analyst, length compositions for SEDAR 100 were generated using 2-cm length bins, with the bin label representing the bin floor. The majority of samples

come from the East stock and the Gulf-wide and East length distributions are very similar for all years. Sample sizes in the West are much lower and the length distribution from the West does not always align with the East and Gulf-wide distributions, especially in years where the sample sizes are the lowest in the 2010s. In the 1990s when sample sizes were higher, there was generally high overlap in the length distributions from the three different stock options. It is not clear if the observed differences are a reflection of lower sample sizes or indicative of true differences in the length distribution of fish from the West stock.

4.6.1.6 Aging Data

Age samples were collected from 13 sampling programs (Tables 1 and 3 in SEDAR 100-DW-04). The largest number of samples are provided through FIN-BIOSTAT. FIN-BIOSTAT sampling began in 2003 and is administered by the Gulf States Marine Fisheries Commission (GSMFC) through GulfFIN. All recreational fishing modes are sampled through FIN-BIOSTAT (Bray, personal communication 2024). FIN-BIOSTAT (n=1,664 from TX-AL) is conducted in every Gulf state, however, in FL it is called RECFIN (n=2,608) from 2003-2018 and RepBio (n=593) from 2018-2024 (Bray and Cermak, personal communication 2023). Descriptions of the various sampling programs are available in SEDAR 100-DW-04 and SEDAR 100-DW-13.

The number of Gray Triggerfish sampled for age from the recreational fishery by year and stock ID region are summarized in Table A3 in SEDAR 100-DW-04. Sample sizes are much higher in the East compared to the West. All years in the East have sufficient sample sizes (n_fish and n_trip ≥ 10) for age compositions, while there were only six years in the early 2000s with sufficient samples for the West.

4.6.1.7 Age Compositions

Task 10b: Nominal age compositions by mode are shown in Figure 4.13.9. The age distributions are fairly similar across the three modes, especially for fish between 1-4 years. It is recommended to continue modeling the recreational sector as a combined recreational fleet consisting of the private, charter, and headboat modes, as done in SEDAR 62 and 43.

Comparisons of nominal and weighted age compositions are shown in Figures A5-A7 of SEDAR 100-DW-04. Weighting had a minimal impact on the age compositions and nominal and weighted age distributions are very similar for all stock scenarios.

Task 11b: Weighted age compositions for all potential stock ID regions are shown in Figure 4.13.10. The age distribution of Gray Triggerfish is more truncated in the West compared to the East. The maximum observed age in the West is 11 years while it is 16 years in the East.

4.6.2 Discards

4.6.2.1 For-Hire At-Sea Observer Biological Sampling

Cooperative headboat and charterboat vessels were randomly selected each month throughout the year in each state. Biologists board selected vessels with permission from the captain and observe anglers as they fish. Data collected for catch include the species, number, final disposition, and size of landed and discarded fish, and that describing effort include the length of the trip and area fished (inland, state, and federal waters). Annual sample sizes of discarded live Gray Triggerfish sampled for length are shown in Table 4.12.6.

4.6.2.2 Length Frequency Distributions of Discards

At-sea observers collected length measurements from 20,470 discarded Gray Triggerfish and 2,565 harvested Gray Triggerfish (Table 4.12.7). Harvested Gray Triggerfish are generally larger than discarded Gray Triggerfish (Figure 4.13.11). The range of harvested Gray Triggerfish constricts in 2009 and this corresponds to a change in the minimum size limit from a 12 inch total length to a 14 inch fork length in 2009. Table 4.12.7 provides the annual number of discarded and harvested Gray Triggerfish measured by at-sea observers for length.

For many assessments (e.g. SEDAR 98, SEDAR 90), the headboat mode is modelled as a separate fleet from the charter and private modes. When headboat is a separate fleet, nominal headboat discard length compositions are weighted by sample weights that correct for under- or over-sampling of a trip duration (e.g. half day, full day) relative to its contribution to the total number of trips of that type conducted across all headboats (SEDAR 100-DW-11) to produce weighted discard length compositions. For SEDAR 100, this approach cannot be used because there is a single recreational fleet and there are discard lengths from both headboat and charter modes. The RecWG discussed two potential weighting options for discard length compositions that use the proportion of discarded Gray Triggerfish. The first option weighted the nominal discard length compositions by mode while the second option weighted them spatially using North (Mississippi - Florida panhandle) and South (Florida peninsula) regions. The Group recommended using the spatial weighting because there were more pronounced spatial differences (Figure 4.13.12) in discard length compositions of fish than there were between modes (Figure 4.13.13).

Task 12: Florida-only discard length compositions for headboat and charter modes are shown in Figures 2 and 4, respectively, in SEDAR 100-DW-11. Final nominal and weighted discard length compositions, using the combined MS, AL, and FL data are shown in Figure 4.13.14. Weighting had minimal impacts on the discard length compositions of Gray Triggerfish from the Recreational fleet.

4.7 RECREATIONAL EFFORT

4.7.1 MRIP Effort

MRIP effort estimates are produced via the Fishing Effort Survey (FES) for private/rental boats and shore mode and the For-Hire Survey (FHS) for charterboat mode. MRIP effort is calculated in units of angler trips, which represents a single day of fishing in the specified mode that does not exceed 24 hours, and is included in the year and mode summaries provided by Table 4.12.1. This table includes MRIP effort estimates for all Gulf of America states from Louisiana to western Florida, excluding the Florida Keys.

4.7.2 LA Creel Effort

Louisiana effort estimates (in angler trips) are provided by LA Creel for years 2014-2024. These estimates are included in Table 4.12.2, which summarizes effort by year and mode and includes the calibration of LA Creel private effort estimates into MRIP-FES units.

4.7.3 TPWD Effort

Texas effort estimates (in angler trips) are provided by TPWD for years 1983-2024. TPWD average estimates from 1983 to 1985 (by wave and mode) were used to impute estimates for Texas charter and private boat fishing from 1981 until the survey started in May 1983**.** These estimates are included in Table 4.12.3, which summarizes effort by year and mode and includes the calibration of TPWD private effort estimates into MRIP-FES units (SEDAR 74-DW-10).

4.7.4 SRHS Effort

Effort data from the SRHS is self-reported by headboat captains as the number of anglers on and the duration of a given trip in their logbooks, which is standardized to "angler days" based on the length of the trip (e.g., 40 anglers on a half-day trip would yield 40 * 0.5 = 20 angler days). Angler days are summed by month for individual vessels. Each month, port agents collect these logbook trip reports and check for accuracy and completeness. Although reporting via the logbooks is mandatory, compliance is not 100% and is variable by location. To account for non-reporting, a correction factor is developed based on sampler observations, angler numbers from office books, and any available information. This information is used to provide estimates of total catch by month and area, along with estimates of effort.

SRHS effort estimates (in angler days) for the eastern and western Gulf of America are provided in Table 16 and Figure 7 of SEDAR 100-DW-01. Estimated headboat angler days have remained relatively stable in the Gulf of America in recent years. Reports from industry staff, captains/owners, and port agents indicated fuel prices, the economy, and fishing restrictions most affected the number of trips and number of passengers, reducing overall fishing effort over the

entire time series. The impact of COVID in 2020 is also reflected in fishing effort, especially in the East.

To standardize recreational fishing effort across the Gulf of America, SRHS effort estimates are also provided in the coarser units of angler trips to match estimates provided by the MRIP, TPWD, and LA Creel surveys. Monthly estimates of angler trips are calculated as the product of the reported number of anglers and ratios for the estimated number of total trips to the reported number of total trips. SRHS effort estimates (in angler trips) for the eastern and western Gulf of America are provided in Tables 17 and Figure 7 of SEDAR 100-DW-01.

4.7.5 Total Recreational Fishing Effort

Combined effort estimates from all sources in angler trips by stock ID region are shown in Table 4.12.8, Figure 4.13.15, and mapped in Figure 4.13.16. Comparisons of effort for the entire Gulf of America for individual modes are shown in Figure 4.13.17. These effort estimates depict all recreational fishing activity in the Gulf of America and are not specific to Gray Triggerfish. Effort estimates have steadily increased between the early 1980s and mid-2000s and have since remained consistently high. The majority of the recreational effort in the Gulf of America comes from the private mode (96.5%) and, geographically, relatively similar amounts of effort are noted in the West and East (43.7% and 56.3% respectively).

4.8 Comments on the Adequacy of Data for Assessment Analyses

Task 13: Regarding the adequacy of available recreational data for SEDAR 100, the Recreational Working Group discussed the following:

- Calibrations to MRIP-FES units for TPWD (1981-2024) and LA Creel (2014-2024) were presented and recommended for use during the Data Workshop.
- Historical landings have a high uncertainty based on data availability and assumptions made in the methodology. Nonetheless, the RecWG considered these historical estimates as the best scientific information available for the historical period (1955-1980) in SEDAR 100.
- Landings, as adjusted, appear to be adequate for the time period covered (1955-2024).
- Since there are no discard estimates from Texas, a proxy discard rate from Louisiana was used to fill this data gap. Similarly, headboat discards prior to 2008 used a proxy discard rate from the charter mode. Discards are self-reported from all data sources. Discards, as adjusted, appear to be adequate for the time period covered (1981-2024).
- Size data appear to adequately represent the landed catch for all modes.
- Discard size data from the headboat and charterboat modes appear to be adequate for describing the size composition of discarded Gray Triggerfish.

4.9 Itemized List of Tasks for Completion following Workshop

- Final recreational catch estimates were completed after the Data Workshop by applying an updated LA Creel calibration factor (Task 4a) and modified approach in imputing TPWD discards (described in Section 4.5.3).
- Final nominal and weighted length and age compositions, conditional age-at-length, and mean length-at-age were completed after the Data Workshop. All analyses are presented in an updated Appendix added to SEDAR 100-DW-04 (completion of Tasks 10 and 11).

4.10 RESEARCH RECOMMENDATIONS

4.10.1 Evaluation and Progress of Research Recommendations from Last Assessment Research Recommendations

Task 13: Research recommendations for the improvement of recreational datasets from SEDAR 43 were evaluated and progress on each item is outlined below:

1. *Evaluate existing methods for deriving historical discard numbers and discard rates and improve methods as appropriate*
   - No information on historical (1955-1980) discard rates were presented for consideration at the SEDAR 100 Data Workshop, so hindcasting of historical discards remains unfeasible.
   - As is now the best practice (SEDAR-PW-07), proxy estimates of SRHS discards (1986-2007) for SEDAR 100 were calculated using the Super-Ratio approach, which differs from the MRIP-charter approach applied in SEDAR 43.
   - Conversely, the best practice approach (SEDAR-PW-07) to impute TPWD discards (1981-2024) resulted in highly variable discard rates, and so a modified approach was applied in SEDAR 100 to stabilize those ratios.

4.10.2 Research Recommendations for SEDAR 100

Task 14: The Recreational Working Group provided the following recommendations to improve recreational data in the Gulf of America:

1. Continued evaluation of LA Creel Calibration Ratios for Gulf Gray Triggerfish
2. Additional MRIP Study in TX to include additional year(s) of benchmarking with TPWD
3. Collection of additional biological samples, particularly from the West
4. Continued funding of at-sea observer programs for tagging and estimation of associated discard mortalities

5. Tagging studies to estimate discard mortalities from recreational fisheries as well as additional sources of mortality, including shrimp trawl bycatch

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4.12 TABLES

Table 4.12.1. Annual landings (AB1), discard (B2), and effort (EFF) estimates for Gulf of America Gray Triggerfish from the MRIP survey. Estimates are provided in numbers of fish and angler trips by mode.

	Cbt			Hbt			Priv			Total		
Year	AB1	B2	EFF	AB1	B2	EFF	AB1	B2	EFF	AB1	B2	EFF
1981	85,258	9,112	418,390	46,432	4,192	199,301	431,749	53,499	11,566,424	563,438	66,803	12,184,115
1982	736,728	16,476	523,703	442,158	4,448	260,912	100,996	197,783	11,539,636	1,279,883	218,707	12,324,251
1983	87,911	7,739	546,272	48,089	4,504	256,493	472,799	790,110	13,790,884	608,798	802,353	14,593,649
1984	76,749	334	515,534	37,736	29	242,211	11,527	207,186	13,385,940	126,012	207,550	14,143,685
1985	74,547	621	558,783	29,631	389	277,516	130,803	210,968	14,380,401	234,982	211,978	15,216,700
1986	451,982	4,320	539,606				64,011	112,747	13,911,468	515,993	117,067	14,451,074
1987	283,043	3,763	552,897				543,971	205,682	13,690,478	827,014	209,446	14,243,375
1988	233,909	1,923	485,592				486,277	175,147	16,173,554	720,187	177,070	16,659,146
1989	375,257	8,955	553,840				914,189	372,400	15,737,950	1,289,446	381,355	16,291,790
1990	895,710	216,342	546,723				717,464	290,254	16,787,633	1,613,174	506,595	17,334,356
1991	1,055,219	17,670	490,070				113,586	132,105	16,489,495	1,168,804	149,775	16,979,565
1992	576,125	20,520	513,244				623,147	230,574	16,957,686	1,199,272	251,094	17,470,930
1993	414,588	41,507	576,894				450,894	279,771	17,380,947	865,482	321,278	17,957,841
1994	456,952	12,042	583,209				278,823	120,700	17,771,476	735,776	132,743	18,354,685
1995	633,920	68,180	693,208				265,412	79,333	18,405,474	899,332	147,513	19,098,682

1996	143,237	31,457	650,088	187,096	212,707	18,383,317	330,333	244,164	19,033,405
1997	152,224	23,822	675,842	199,320	143,274	19,908,220	351,544	167,095	20,584,062
1998	152,418	54,979	656,598	394,671	466,021	21,376,286	547,090	521,000	22,032,884
1999	144,550	21,282	666,626	329,897	282,501	23,454,761	474,447	303,783	24,121,387
2000	83,087	8,147	598,494	280,331	131,876	23,083,653	363,418	140,023	23,682,147
2001	128,291	16,902	622,204	283,327	296,309	25,731,352	411,618	313,211	26,353,556
2002	142,286	17,062	606,183	780,771	683,660	25,015,041	923,058	700,723	25,621,224
2003	144,959	9,885	582,222	980,484	420,015	25,759,681	1,125,443	429,899	26,341,903
2004	191,992	22,708	662,228	784,270	610,291	29,061,390	976,262	632,999	29,723,618
2005	150,953	22,715	579,682	525,209	260,554	28,138,681	676,162	283,269	28,718,363
2006	100,330	10,635	666,576	336,351	234,013	26,013,602	436,681	244,648	26,680,178
2007	81,992	16,857	713,469	314,681	581,304	26,520,209	396,673	598,161	27,233,678
2008	68,659	13,298	665,103	225,331	192,877	28,822,603	293,990	206,175	29,487,706
2009	35,915	65,097	657,134	107,493	232,102	28,052,491	143,408	297,199	28,709,625
2010	30,779	37,761	472,909	255,805	456,281	29,142,688	286,584	494,042	29,615,597
2011	73,557	112,695	595,483	353,819	379,318	29,504,829	427,376	492,014	30,100,312
2012	15,780	63,071	718,252	194,617	587,534	30,808,704	210,397	650,605	31,526,956
2013	30,100	85,685	731,778	282,975	684,105	28,722,437	313,075	769,791	29,454,215
2014	15,421	131,176	592,321	108,214	419,094	20,242,471	123,635	550,270	20,834,792
2015	370	202,416	687,136	50,169	1,545,992	18,925,709	50,540	1,748,408	19,612,845

2016	62,729	358,386	717,394		225,325	1,794,438	20,338,425	288,054	2,152,824	21,055,819
2017	8,967	475,491	719,153		73,824	2,874,019	21,236,945	82,791	3,349,510	21,956,098
2018	45,320	364,917	738,980		137,747	1,629,900	19,666,722	183,067	1,994,816	20,405,702
2019	28,681	295,910	746,964		63,931	1,614,250	17,175,116	92,612	1,910,159	17,922,080
2020	35,939	355,933	828,833		168,557	1,363,499	19,356,174	204,496	1,719,432	20,185,007
2021	44,809	489,124	942,495		60,652	1,872,536	18,336,229	105,461	2,361,660	19,278,724
2022	50,438	305,686	926,284		153,726	2,590,087	20,440,718	204,164	2,895,773	21,367,002
2023	59,791	507,428	912,866		119,115	1,534,110	19,751,275	178,906	2,041,538	20,664,141
2024	35,326	350,522	800,538		158,464	1,723,876	20,747,929	193,791	2,074,398	21,548,467

Table 4.12.2. Annual landings (AB1), discard (B2), and effort (EFF) estimates for Louisiana Gray Triggerfish from the LA Creel survey. Estimates are provided in numbers of fish and angler trips by mode, and those for the private mode are calibrated into MRIP-FES units.

	Cbt			Priv			Total		
Year	AB1	B2	EFF	AB1	B2	EFF	AB1	B2	EFF
2014	43	0	130,622	10,572	0	7,441,673	10,615	0	7,572,295
2015	128	0	159,794	14,275	0	8,043,022	14,403	0	8,202,816
2016	17	92	179,238	10,597	11,033	7,321,861	10,614	11,125	7,501,099
2017	0	0	178,723	1,111	9,003	7,560,183	1,111	9,003	7,738,906
2018	117	31	183,313	7,348	2,077	7,428,797	7,466	2,108	7,612,110
2019	0	456	168,571	1,640	195	6,886,585	1,640	651	7,055,156
2020	5	20	115,424	852	1,246	8,469,878	857	1,266	8,585,302
2021	0	23	163,233	1,157	1,654	6,122,422	1,157	1,677	6,285,655
2022	338	0	162,620	756	774	5,135,536	1,094	774	5,298,156
2023	264	8	177,812	2,545	3,628	5,618,166	2,809	3,636	5,795,978
2024	29	86	151,402	1,892	3,287	5,418,986	1,921	3,373	5,570,388

Table 4.12.3. Annual landings (AB1), discard (B2), and effort (EFF) estimates for Texas Gray Triggerfish from the TPWD survey. Estimates are provided in numbers of fish and angler trips by mode, and those for the private mode are calibrated into MRIP-FES units (SEDAR 74-DW-10).

	Cbt			Priv			Total		
Year	AB1	B2	EFF	AB1	B2	EFF	AB1	B2	EFF
1981	0	0	29,441	7,804	392	7,092,619	7,804	392	7,122,060
1982	0	0	29,441	7,804	4,481	7,092,619	7,804	4,481	7,122,060
1983	0	0	33,666	11,825	13,187	7,091,080	11,825	13,187	7,124,746
1984	0	0	23,029	4,894	14,384	6,553,605	4,894	14,384	6,576,634
1985	0	0	31,627	6,692	44,094	7,633,172	6,692	44,094	7,664,799
1986	0	0	27,050	17,950	1,856	7,370,607	17,950	1,856	7,397,657
1987	74	0	31,084	16,043	0	9,524,327	16,117	0	9,555,411
1988	9	19	28,090	35,214	73,715	9,052,763	35,223	73,734	9,080,853
1989	40	24	42,075	11,629	6,860	7,976,082	11,669	6,884	8,018,157
1990	22	1	35,645	50,745	2,569	7,975,280	50,767	2,570	8,010,925
1991	24	14	47,448	21,514	12,313	7,764,966	21,538	12,327	7,812,414
1992	0	0	49,213	61,677	28,493	8,965,716	61,677	28,493	9,014,929
1993	0	0	54,657	43,007	266,122	9,011,231	43,007	266,122	9,065,888
1994	267	198	90,317	56,609	41,898	9,821,149	56,876	42,096	9,911,466
1995	138	30	74,001	101,000	22,310	9,950,180	101,138	22,341	10,024,181
1996	0	0	75,918	50,168	269	10,192,861	50,168	269	10,268,779
1997	945	450	93,868	42,942	20,441	8,482,200	43,887	20,890	8,576,068
1998	141	129	108,462	62,135	57,064	8,935,940	62,276	57,194	9,044,402
1999	543	249	112,579	24,969	11,430	10,785,527	25,512	11,679	10,898,106
2000	0	0	161,994	69,764	25,307	10,251,717	69,764	25,307	10,413,711
2001	1,519	1,768	141,584	19,019	22,142	8,900,805	20,538	23,911	9,042,389
2002	474	817	136,232	16,010	27,587	8,585,891	16,484	28,403	8,722,123
2003	197	13	117,498	12,850	844	9,400,971	13,047	857	9,518,469
2004	697	271	118,538	33,721	13,109	9,324,533	34,418	13,380	9,443,071
2005	280	271	106,073	44,751	43,351	8,839,997	45,031	43,622	8,946,070
2006	384	62	150,840	59,671	9,668	9,192,171	60,055	9,730	9,343,011
2007	781	527	148,253	28,195	19,034	8,277,571	28,976	19,561	8,425,824

2008	779	159	144,898	38,233	7,828	7,923,028	39,012	7,988	8,067,926
2009	100	719	117,112	14,899	107,097	8,557,970	14,999	107,816	8,675,082
2010	56	0	122,375	3,172	0	8,320,638	3,228	0	8,443,013
2011	32	0	161,208	10,583	0	8,858,407	10,615	0	9,019,615
2012	0	0	220,969	14,735	6,269	8,811,048	14,735	6,269	9,032,017
2013	32	85	142,993	9,722	25,707	9,087,384	9,754	25,792	9,230,377
2014	0	0	138,603	6,790	0	8,913,324	6,790	0	9,051,927
2015	182	0	144,328	10,528	0	8,414,272	10,710	0	8,558,600
2016	0	0	157,452	1,744	1,859	9,955,896	1,744	1,859	10,113,348
2017	0	0	188,501	894	7,241	9,107,944	894	7,241	9,296,445
2018	38	11	298,884	1,875	528	8,476,571	1,913	539	8,775,455
2019	12	13	377,936	2,202	2,435	9,317,226	2,214	2,448	9,695,162
2020	0	0	237,375	1,689	2,558	10,500,343	1,689	2,558	10,737,718
2021	11	16	243,182	796	1,193	8,948,138	807	1,210	9,191,320
2022	0	0	318,026	262	103	9,105,874	262	103	9,423,900
2023	98	103	552,716	5,776	6,065	11,196,487	5,874	6,168	11,749,203
2024	71	128	206,194	534	962	8,110,547	605	1,090	8,316,741

Table 4.12.4. Total recreational landings estimates in numbers (AB1) and pounds (LBS) for Gulf of America Gray Triggerfish combined across all surveys by year and mode. Estimates and their associated coefficients of variation (CV) are provided for recreational landings in numbers of fish (AB1 CV) and in pounds whole weight (LBS CV).

	West				East			
YEAR	AB1	AB1 CV	LBS	LBS CV	AB1	AB1 CV	LBS	LBS CV
1955	44,939	0.58			190,900	0.58		
1956	49,773	0.58			211,434	0.58		
1957	54,607	0.58			231,968	0.58		
1958	59,440	0.58			252,502	0.58		
1959	64,274	0.58			273,036	0.58		
1960	69,108	0.58			293,570	0.58		
1961	71,082	0.58			301,955	0.58		
1962	73,056	0.58			310,339	0.58		
1963	75,029	0.58			318,723	0.58		
1964	77,003	0.58			327,107	0.58		
1965	78,977	0.58			335,492	0.58		
1966	81,605	0.58			346,658	0.58		
1967	84,234	0.58			357,824	0.58		
1968	86,863	0.58			368,991	0.58		
1969	89,491	0.58			380,157	0.58		
1970	92,120	0.58			391,323	0.58		
1971	100,613	0.58			427,403	0.58		
1972	109,107	0.58			463,483	0.58		
1973	117,600	0.58			499,563	0.58		
1974	126,093	0.58			535,643	0.58		

	West				East			
YEAR	AB1	AB1 CV	LBS	LBS CV	AB1	AB1 CV	LBS	LBS CV
1975	134,587	0.58			571,723	0.58		
1976	135,038	0.58			573,640	0.58		
1977	135,489	0.58			575,556	0.58		
1978	135,941	0.58			577,473	0.58		
1979	136,392	0.58			579,390	0.58		
1980	136,843	0.58			581,307	0.58		
1981	87,917	0.50	148,286	0.53	506,603	0.46	1,115,442	0.50
1982	68,712	0.51	83,641	0.52	1,242,253	0.33	3,351,908	0.36
1983	376,569	0.02	1,827,527	0.02	267,332	0.36	623,012	0.38
1984	55,621	0.20	161,395	0.27	98,563	0.49	238,961	0.51
1985	64,316	0.50	292,180	0.81	200,637	0.56	561,834	0.54
1986	45,432	0.18	65,796	0.20	533,553	0.20	1,307,221	0.23
1987	37,961	0.20	56,997	0.19	843,900	0.47	2,326,768	0.49
1988	89,003	0.17	95,049	0.18	734,968	0.27	1,378,942	0.26
1989	133,751	0.52	229,780	0.53	1,247,873	0.20	2,054,995	0.22
1990	241,555	0.32	525,820	0.34	1,553,288	0.18	4,203,634	0.22
1991	112,336	0.18	240,335	0.22	1,167,254	0.26	2,924,127	0.28
1992	156,762	0.10	260,202	0.12	1,214,863	0.17	2,911,565	0.19
1993	98,638	0.12	170,472	0.13	912,823	0.21	2,264,706	0.23
1994	174,934	0.18	348,516	0.19	727,897	0.16	1,598,181	0.23
1995	239,978	0.25	430,965	0.25	858,158	0.25	1,595,306	0.26
1996	99,038	0.14	166,371	0.14	357,986	0.17	668,441	0.23
1997	100,281	0.15	178,695	0.16	358,834	0.14	999,400	0.18
1998	97,801	0.16	171,184	0.26	564,752	0.21	1,197,033	0.22
1999	108,715	0.29	309,872	0.34	432,223	0.12	944,519	0.14
2000	168,122	0.27	404,708	0.29	297,282	0.20	728,359	0.21
2001	59,265	0.44	115,089	0.46	412,946	0.14	792,637	0.15
2002	38,888	0.19	79,279	0.19	954,509	0.24	2,147,548	0.29

	West				East			
YEAR	AB1	AB1 CV	LBS	LBS CV	AB1	AB1 CV	LBS	LBS CV
2003	46,505	0.27	88,370	0.26	1,155,466	0.27	2,292,969	0.38
2004	95,172	0.29	170,620	0.29	971,723	0.18	1,755,471	0.20
2005	63,833	0.08	105,891	0.13	705,630	0.17	1,301,294	0.22
2006	91,584	0.12	140,058	0.23	439,060	0.21	731,634	0.21
2007	61,016	0.20	102,829	0.22	397,383	0.17	717,319	0.19
2008	74,720	0.24	149,062	0.26	280,864	0.19	568,667	0.20
2009	19,900	0.14	32,443	0.25	150,611	0.20	438,450	0.24
2010	3,642	0.05	10,296	0.05	295,622	0.23	901,197	0.26
2011	12,357	0.06	18,302	0.09	442,025	0.19	1,248,379	0.21
2012	29,364	0.33	65,860	0.35	201,690	0.22	645,294	0.25
2013	17,033	0.34	36,613	0.34	315,622	0.36	1,203,388	0.39
2014	17,585	0.06	33,599	0.06	126,417	0.31	394,149	0.33
2015	25,161	0.05	47,959	0.24	51,621	0.48	119,238	0.48
2016	12,728	0.09	40,763	0.19	298,692	0.20	974,112	0.22
2017	2,050	0.09	6,004	0.09	82,792	0.56	209,151	0.55
2018	9,637	0.10	39,036	0.10	198,018	0.37	870,646	0.40
2019	3,930	0.06	10,865	0.06	97,879	0.29	516,021	0.31
2020	2,590	0.05	6,599	0.05	209,663	0.32	998,924	0.35
2021	2,004	0.09	7,598	0.09	110,972	0.25	430,909	0.26
2022	1,421	0.23	4,742	0.25	209,791	0.21	753,356	0.25
2023	8,756	0.04	22,017	0.04	184,273	0.22	666,943	0.24
2024	2,576	0.10	8,203	0.11	198,119	0.20	699,644	0.24

Table 4.12.5. Total recreational discard estimates in numbers (B2) for Gulf of America Gray Triggerfish combined across all surveys by year and mode. Associated coefficients of variation (CV) are also provided.

	West		East	
YEAR	B2	CV	B2	CV
1981	3,439	0.82	63,757	0.61
1982	25,303	0.43	197,885	0.63
1983	392,779	0.00	422,760	0.58
1984	90,191	0.84	131,743	1.00
1985	252,208	0.56	3,865	0.75
1986	3,042	0.32	116,131	0.89
1987	0	0.00	209,715	0.67
1988	99,569	0.18	151,447	0.74
1989	64,217	0.52	324,820	0.28
1990	10,935	0.54	522,657	0.35
1991	46,476	0.70	116,268	0.52
1992	53,131	0.25	228,733	0.21
1993	336,953	0.25	256,192	0.28
1994	87,500	0.28	88,028	0.30
1995	41,559	0.41	132,961	0.35
1996	315	0.15	251,846	0.38
1997	33,822	0.36	159,201	0.32
1998	75,031	0.56	517,465	0.34
1999	46,637	0.33	273,651	0.23
2000	58,818	0.51	108,785	0.40
2001	60,274	0.50	280,973	0.21
2002	51,504	0.28	680,602	0.43
2003	1,937	0.55	431,939	0.46
2004	31,900	0.32	619,486	0.32
2005	50,872	0.11	280,428	0.25
2006	13,085	0.14	243,688	0.31
2007	33,121	0.26	588,983	0.30

	West		East	
YEAR	B2	CV	B2	CV
2008	14,848	0.32	202,691	0.45
2009	135,544	0.19	280,877	0.21
2010	372	0.06	501,614	0.36
2011	531	0.05	507,392	0.24
2012	12,823	0.47	674,278	0.24
2013	43,795	0.36	789,135	0.51
2014	177	0.05	589,924	0.14
2015	272	0.05	1,833,917	0.24
2016	13,247	0.10	2,244,101	0.16
2017	16,371	0.07	3,501,502	0.16
2018	2,759	0.11	2,083,234	0.32
2019	3,234	0.06	1,994,272	0.18
2020	4,049	0.06	1,789,046	0.18
2021	2,899	0.07	2,488,480	0.24
2022	1,811	0.07	3,000,710	0.22
2023	9,904	0.09	2,158,110	0.13
2024	4,464	0.10	2,162,793	0.22

Table 4.12.6. The number of fish and trips, by state, where at-sea observers measured **discarded** Gray Triggerfish for length from the charter and headboat modes.

	Number of Fish						Number of Trips					
	Charter			Headboat			Charter			Headboat		
Year	MS	AL	FL	MS	AL	FL	MS	AL	FL	MS	AL	FL
2005	0	0	0	0	0	10	0	0	0	0	0	10
2006	0	0	0	0	3	10	0	0	0	0	3	10
2007	0	0	0	0	0	11	0	0	0	0	0	11
2009	0	0	159	0	0	52	0	0	20	0	0	20
2010	0	0	201	0	0	115	0	0	38	0	0	34
2011	0	0	540	0	0	249	0	0	59	0	0	52
2012	0	0	435	0	0	292	0	0	57	0	0	50
2013	0	0	432	0	0	212	0	0	57	0	0	40
2015	0	0	983	0	0	738	0	0	94	0	0	103
2016	0	0	1,223	0	0	1,314	0	0	115	0	0	124
2017	0	4	984	0	0	914	0	4	102	0	0	105
2018	0	1	980	0	0	719	0	1	113	0	0	101
2019	0	71	1,590	0	0	1,094	0	19	133	0	0	122
2020	0	0	83	0	0	124	0	0	15	0	0	14
2021	0	0	716	0	0	451	0	0	67	0	0	79
2022	0	99	830	0	129	756	0	27	78	0	11	126
2023	1	275	1,011	0	15	912	1	44	84	0	1	130
2024	0	358	603	0	16	755	0	50	79	0	1	135

Table 4.12.7. The number of fish and trips, in the eastern Gulf of America, where at-sea observers measured harvested and discarded Gray Triggerfish, for length, from charter and headboat modes.

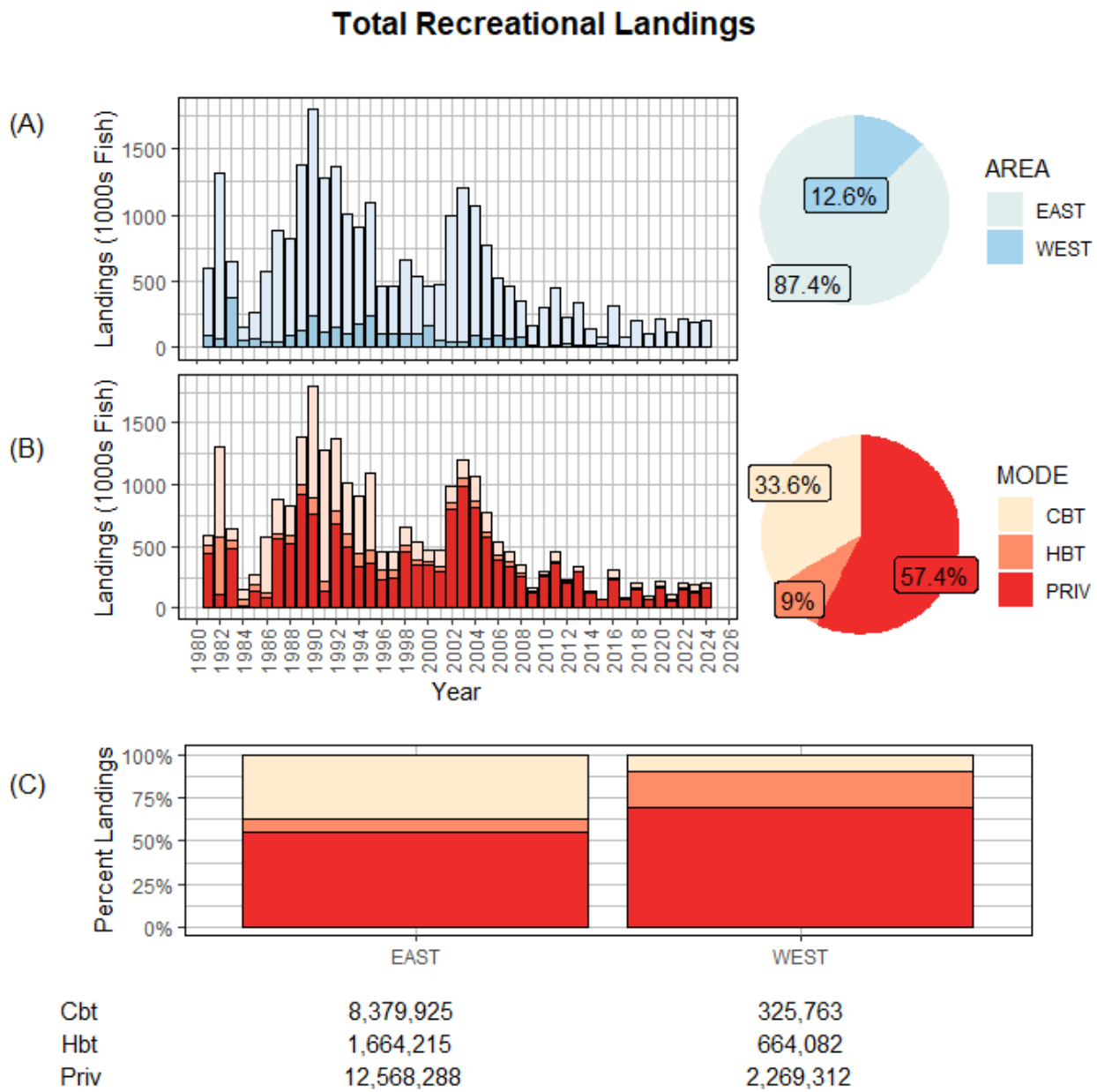
	Charter				Headboat			
	Number of Fish		Number of Trips		Number of Fish		Number of Trips	
Year	Harvest	Discard	Harvest	Discard	Harvest	Discard	Harvest	Discard
2005	0	0	0	0	51	10	51	10
2006	0	0	0	0	68	13	68	13
2007	0	0	0	0	56	11	56	11
2009	38	159	13	20	14	52	8	20
2010	152	201	33	38	32	115	18	34
2011	177	540	52	59	67	249	30	52
2012	62	435	17	57	34	292	15	50
2013	62	432	26	57	21	212	12	40
2015	1	983	1	94	7	738	4	103
2016	123	1,223	30	115	307	1,314	42	124
2017	0	988	0	106	0	914	0	105
2018	105	981	20	114	283	719	25	101
2019	112	1,661	23	152	93	1,094	17	122
2020	0	83	0	15	3	124	2	14
2021	36	716	9	67	14	451	8	79
2022	143	929	33	105	103	885	41	137
2023	100	1,287	40	129	110	927	42	131
2024	96	961	46	129	95	771	42	136

Table 4.12.8. Total recreational fishing effort (in angler trips) for east and west Gulf of America Gray Triggerfish combined across all surveys and modes by year. The combined private-shore mode in the LA Creel survey is allocated as private fishing. MRIP headboat estimates are used for the Gulf of America from 1981-1985, and SRHS from 1986+.

YEAR	East	West
1981	8,807,774	10,570,364
1982	8,789,874	10,728,400
1983	10,856,694	10,933,664
1984	10,660,003	10,132,280
1985	11,695,943	11,257,520
1986	11,342,387	10,836,518
1987	11,243,580	12,906,747
1988	13,746,792	12,352,485
1989	13,184,116	11,484,677
1990	14,010,126	11,710,060
1991	13,510,344	11,600,220
1992	13,798,085	13,031,411
1993	14,176,522	13,209,309
1994	14,638,075	14,018,208
1995	15,295,847	14,191,401
1996	15,003,003	14,636,333
1997	16,342,960	13,117,133
1998	17,739,135	13,664,484
1999	19,324,986	15,913,881
2000	18,489,919	15,904,715
2001	20,987,187	14,680,728
2002	20,615,625	13,987,766
2003	21,268,029	14,868,904
2004	24,965,082	14,477,412
2005	24,447,339	13,457,553
2006	22,294,012	13,977,674
2007	22,519,771	13,469,611
2008	24,285,062	13,485,552

YEAR	East	West
2009	23,016,961	14,632,148
2010	23,601,098	14,666,622
2011	24,288,791	15,112,273
2012	25,927,969	14,932,081
2013	24,089,111	14,888,902
2014	21,091,530	16,680,368
2015	19,872,594	16,821,956
2016	21,324,435	17,672,636
2017	22,221,201	17,091,515
2018	20,666,221	16,443,252
2019	18,171,060	16,805,059
2020	20,369,629	19,375,967
2021	19,545,324	15,563,159
2022	21,604,871	14,801,880
2023	20,874,962	17,609,942
2024	21,736,344	13,943,437

4.13 FIGURES



	EAST	WEST
Cbt	8,379,925	325,763
Hbt	1,664,215	664,082
Priv	12,568,288	2,269,312

Figure 4.13.1. Total recreational landings (AB1) for Gulf of America Gray Triggerfish across all surveys. Landings are provided (A) by area and year in thousands of fish, (B) by mode and year in thousands of fish, and (C) by mode and area in percent numbers of fish.

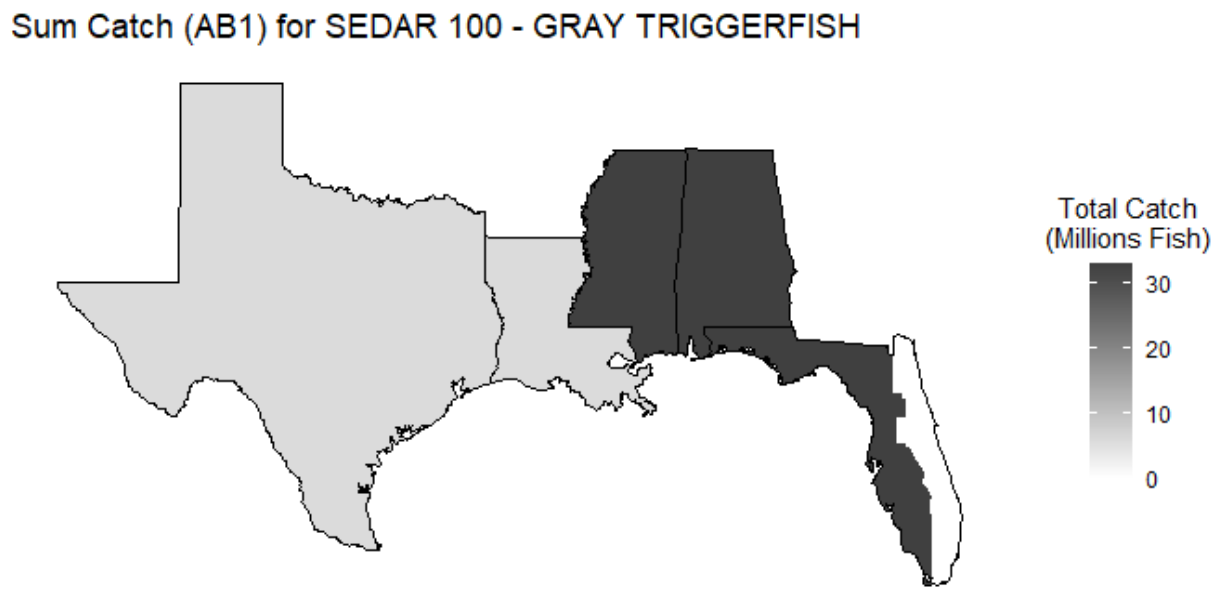


Figure 4.13.2. Distribution of total recreational landings (AB1), in millions of fish, for Gray Triggerfish across the Gulf of America. Estimates are combined across all surveys and years and summarized by region.

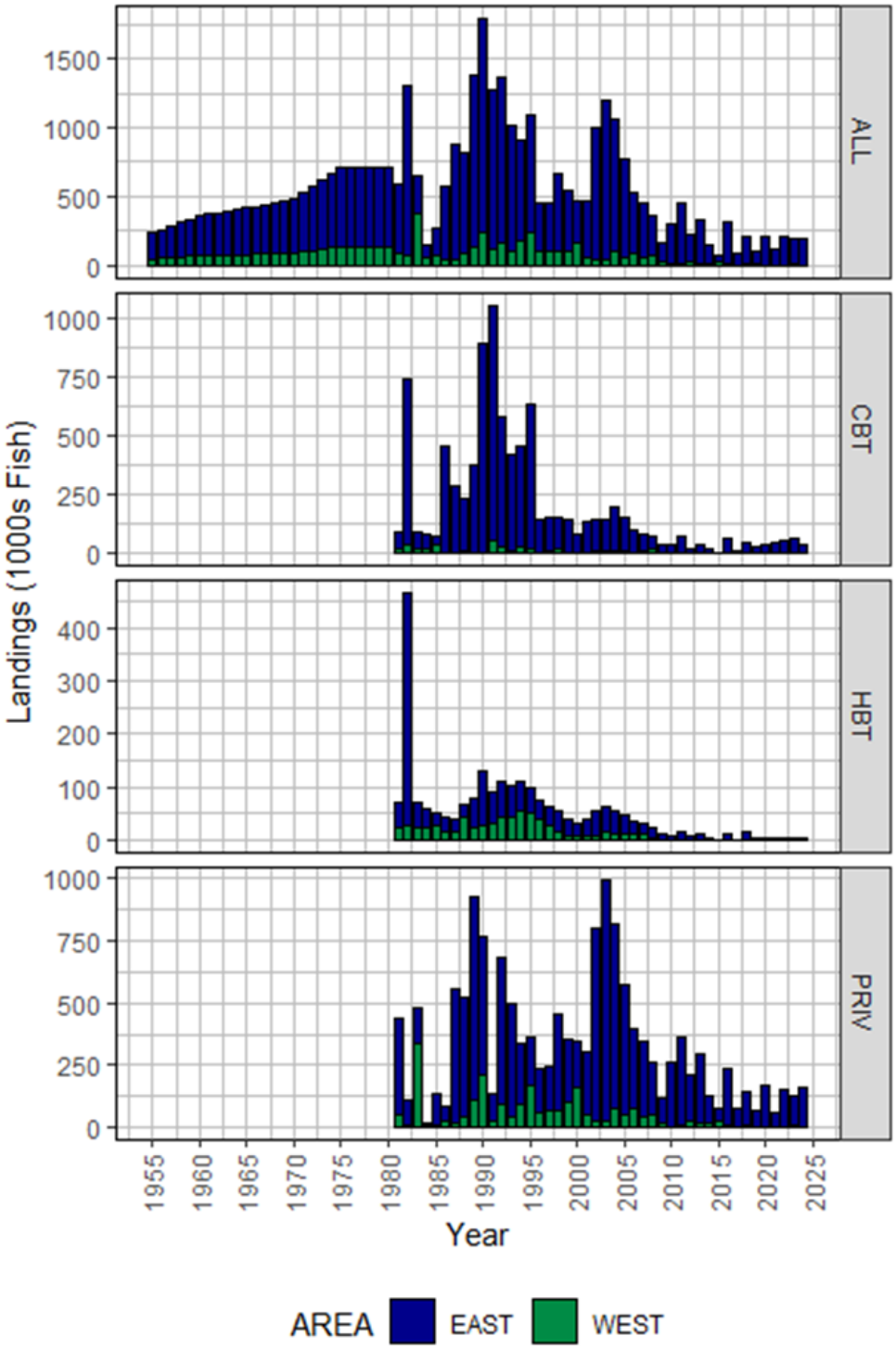
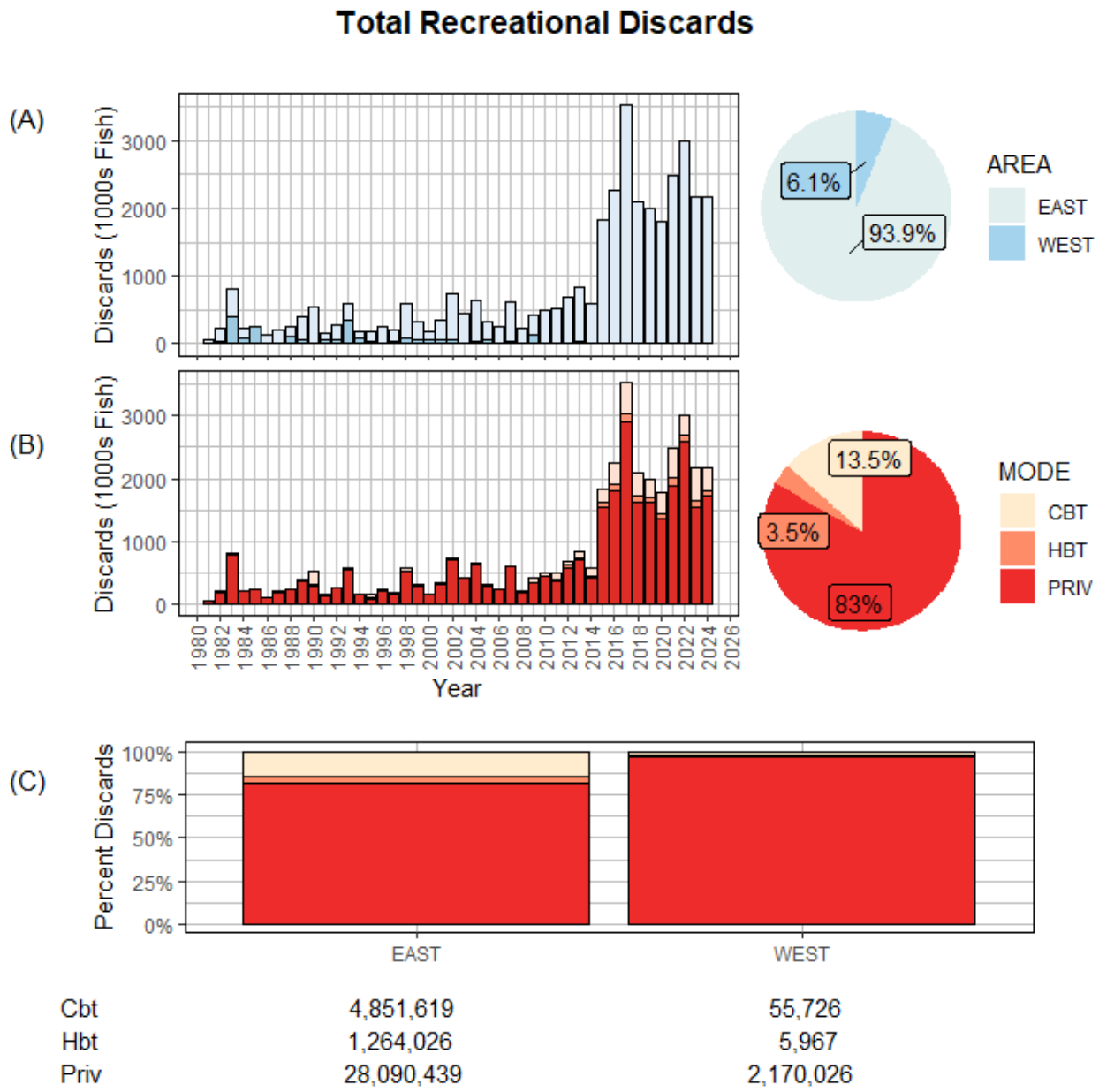


Figure 4.13.3. Recreational landings (AB1) for Gulf of America Gray Triggerfish for each fishing mode. Landings are provided by year and area in thousands of fish. Note that the 'ALL' timeseries includes historical FHWAR estimates (1955-1980) and the sums of mode-specific estimates from other recreational surveys shown in the lower panels (1981+).



	EAST	WEST
Cbt	4,851,619	55,726
Hbt	1,264,026	5,967
Priv	28,090,439	2,170,026

Figure 4.13.4. Total recreational discards (B2) for Gulf of America Gray Triggerfish across all surveys. Discards are provided (A) by area and year in thousands of fish, (B) by mode and year in thousands of fish, and (C) by mode and area in percent numbers of fish.

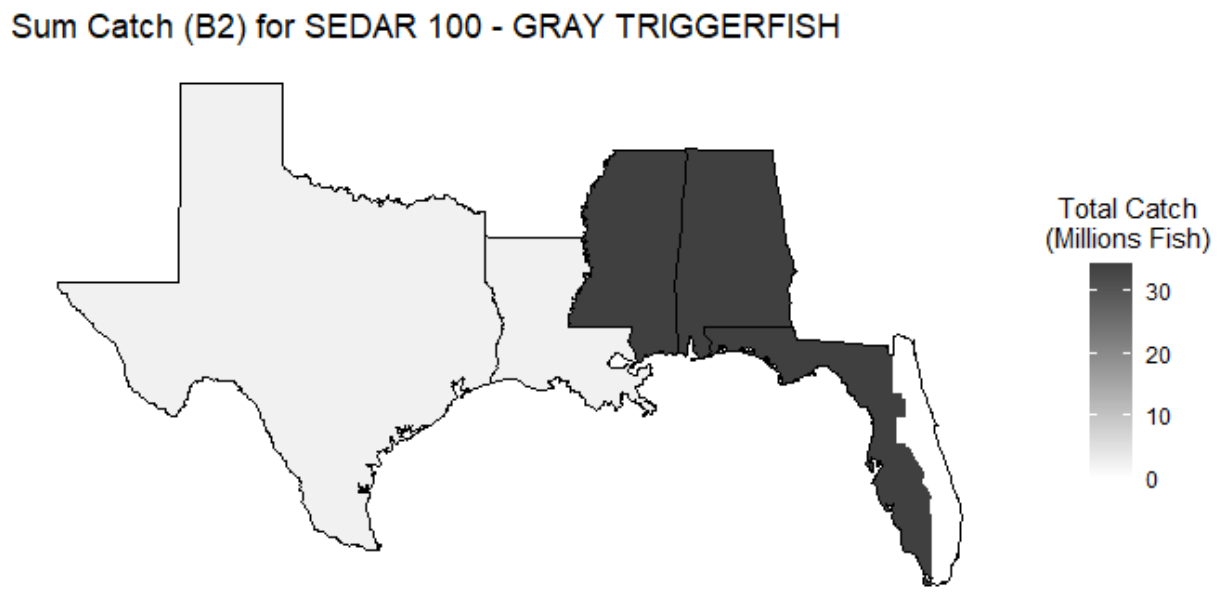


Figure 4.13.5. Distribution of total recreational discards (B2), in millions of fish, for Gray Triggerfish across the Gulf of America. Estimates are combined across all surveys and years and summarized by region.

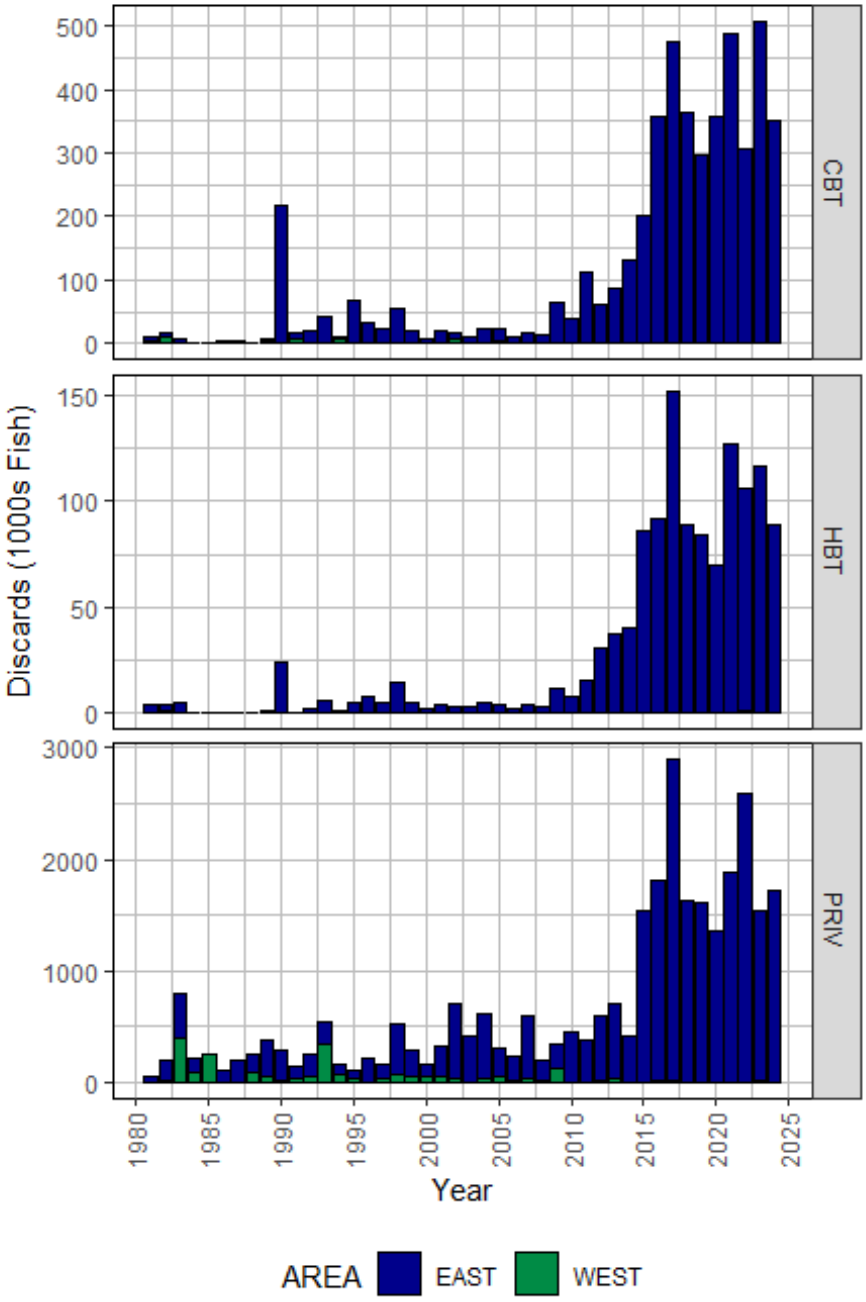


Figure 4.13.6. Recreational discards (B2) for Gulf of America Gray Triggerfish for each fishing mode. Discards are provided by year and area in thousands of fish.

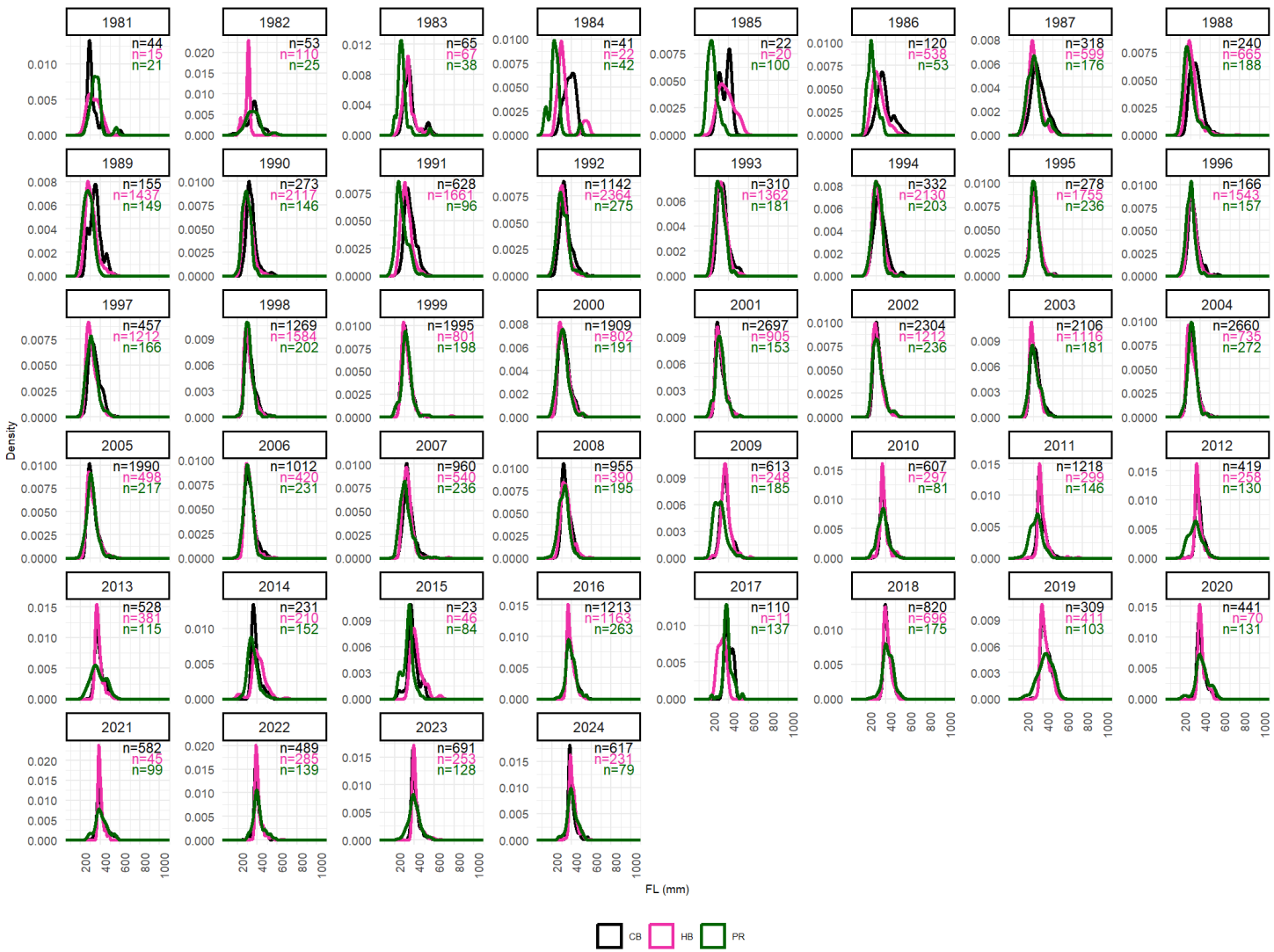


Figure 4.13.7. Nominal length distributions by **mode** (CB= charter, HB = headboat, and PR = private) for Gulf Gray Triggerfish.

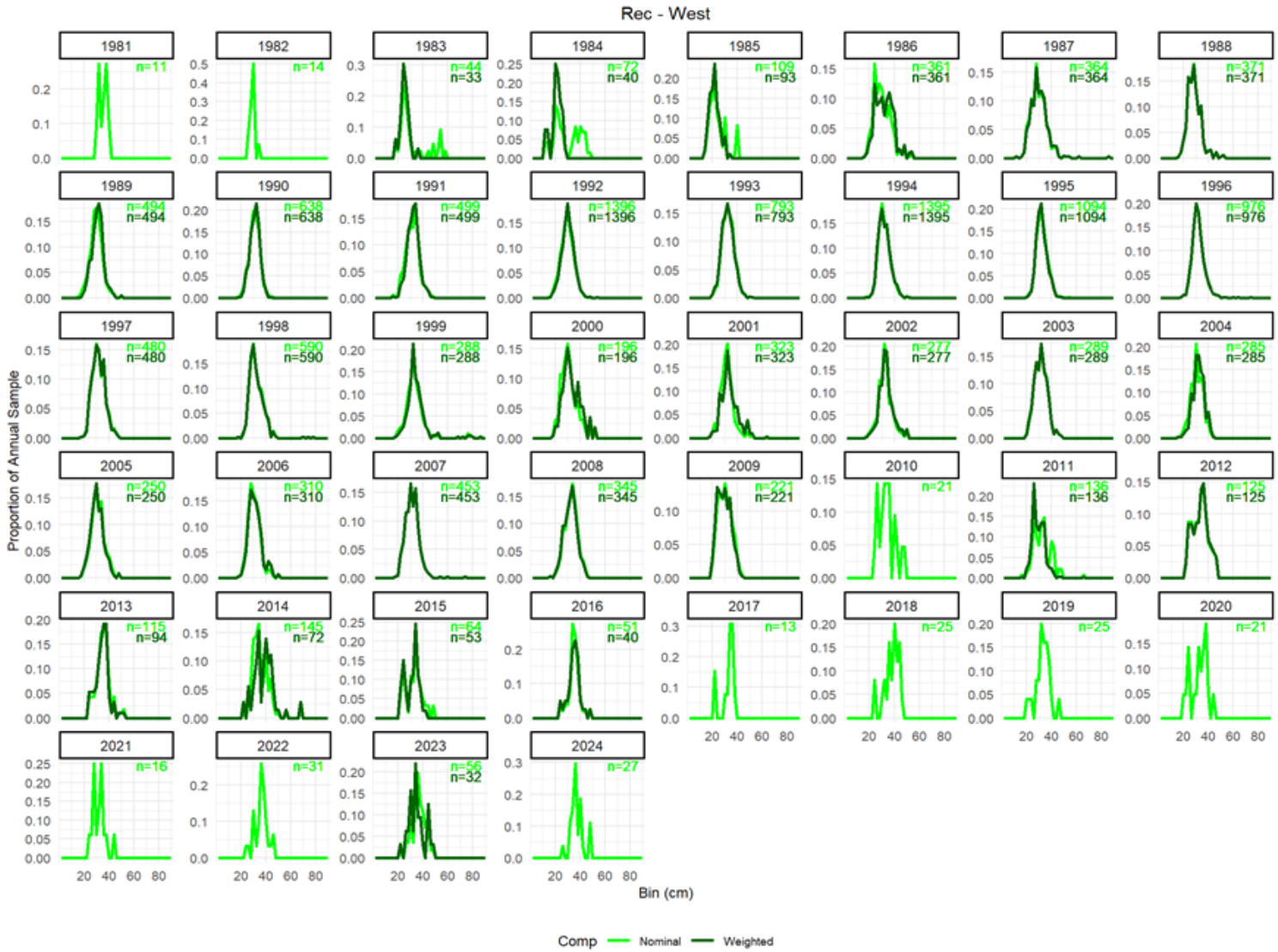


Figure 4.13.8a. Nominal and weighted length distributions for Gulf Gray Triggerfish in the **West** (TX and LA). Refer to Table A2 in SEDAR 100-DW-04 for which years do not meet sample size criteria for inclusion based on weighting.

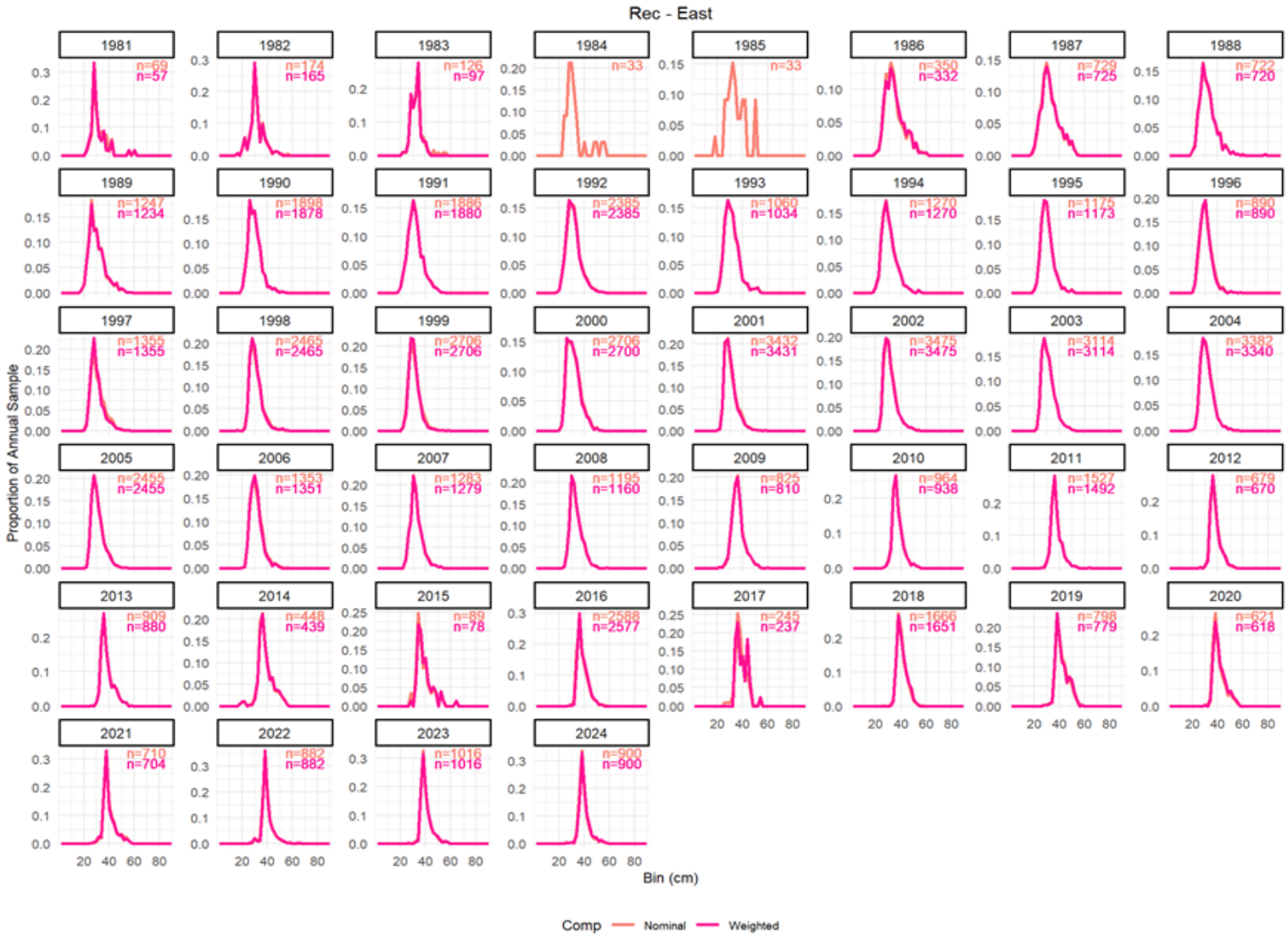


Figure 4.13.8b. Nominal and weighted length distributions for Gulf Gray Triggerfish in the **East** (MS-FL). Refer to Table A2 in SEDAR 100-DW-04 for which years do not meet sample size criteria for inclusion based on weighting.

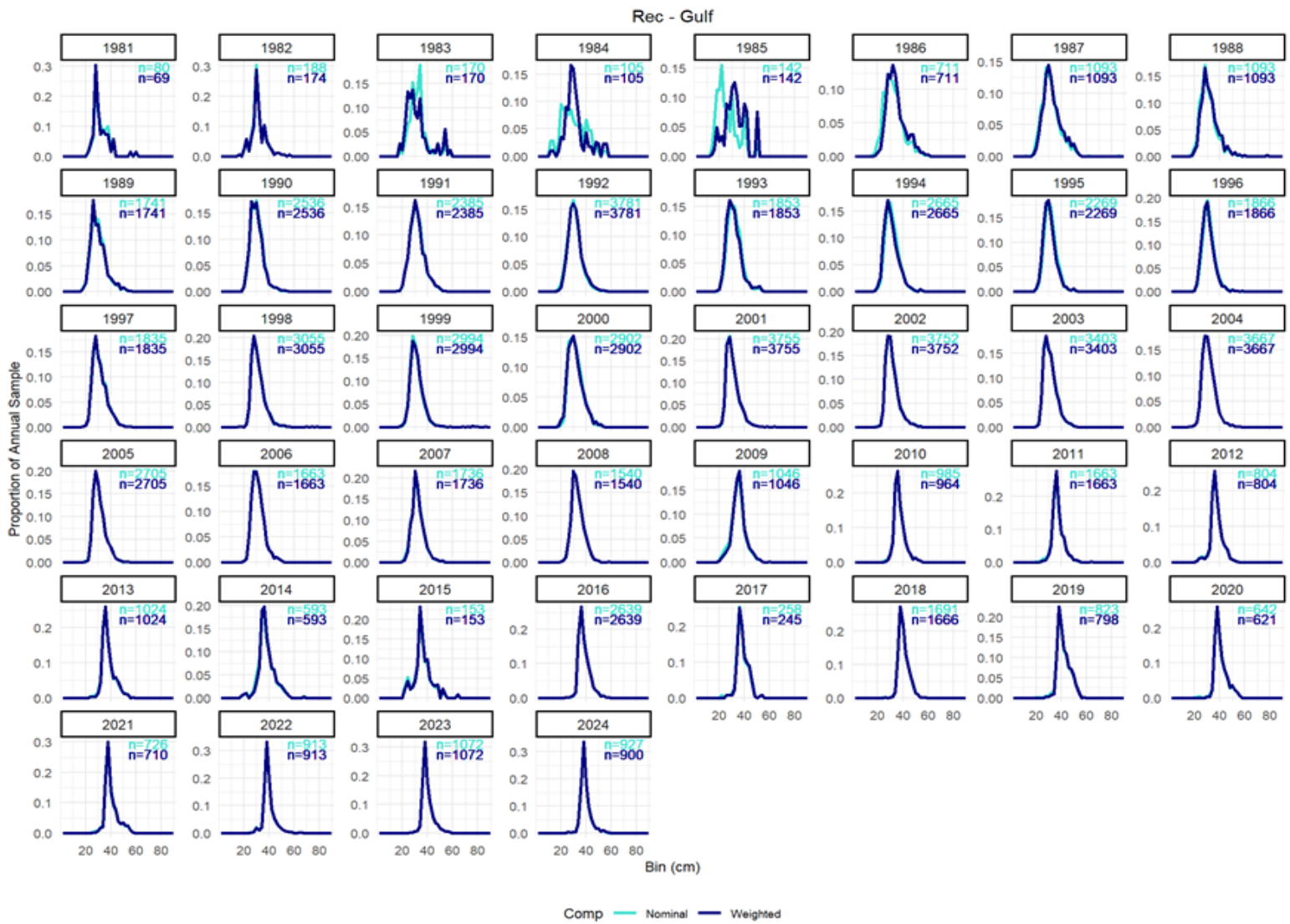


Figure 4.13.8c. Nominal and weighted length distributions for Gulf Gray Triggerfish **Gulf-wide** (TX-FL). Refer to Table A1 in SEDAR 100-DW-04 for which years do not meet sample size criteria for inclusion based on weighting.

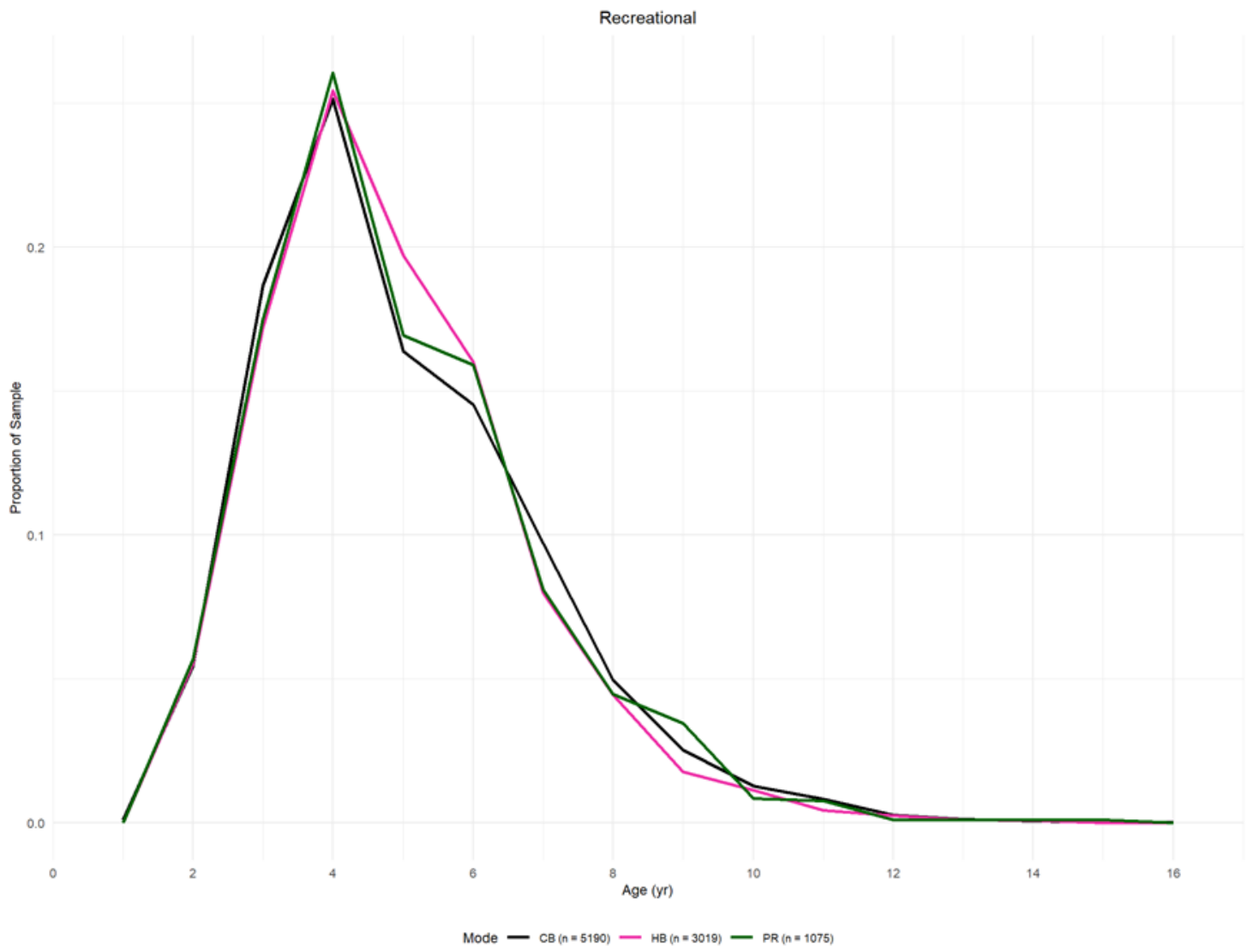


Figure 4.13.9. Nominal age distribution of Gray Triggerfish from the charter (CB), headboat (HB), and private (PR) modes.

Figure 4.13.10a. Weighted age composition for Gulf Gray Triggerfish from the **West** (TX and LA). The weighted length compositions used for weighting did not meet minimum sample size thresholds for years in red.

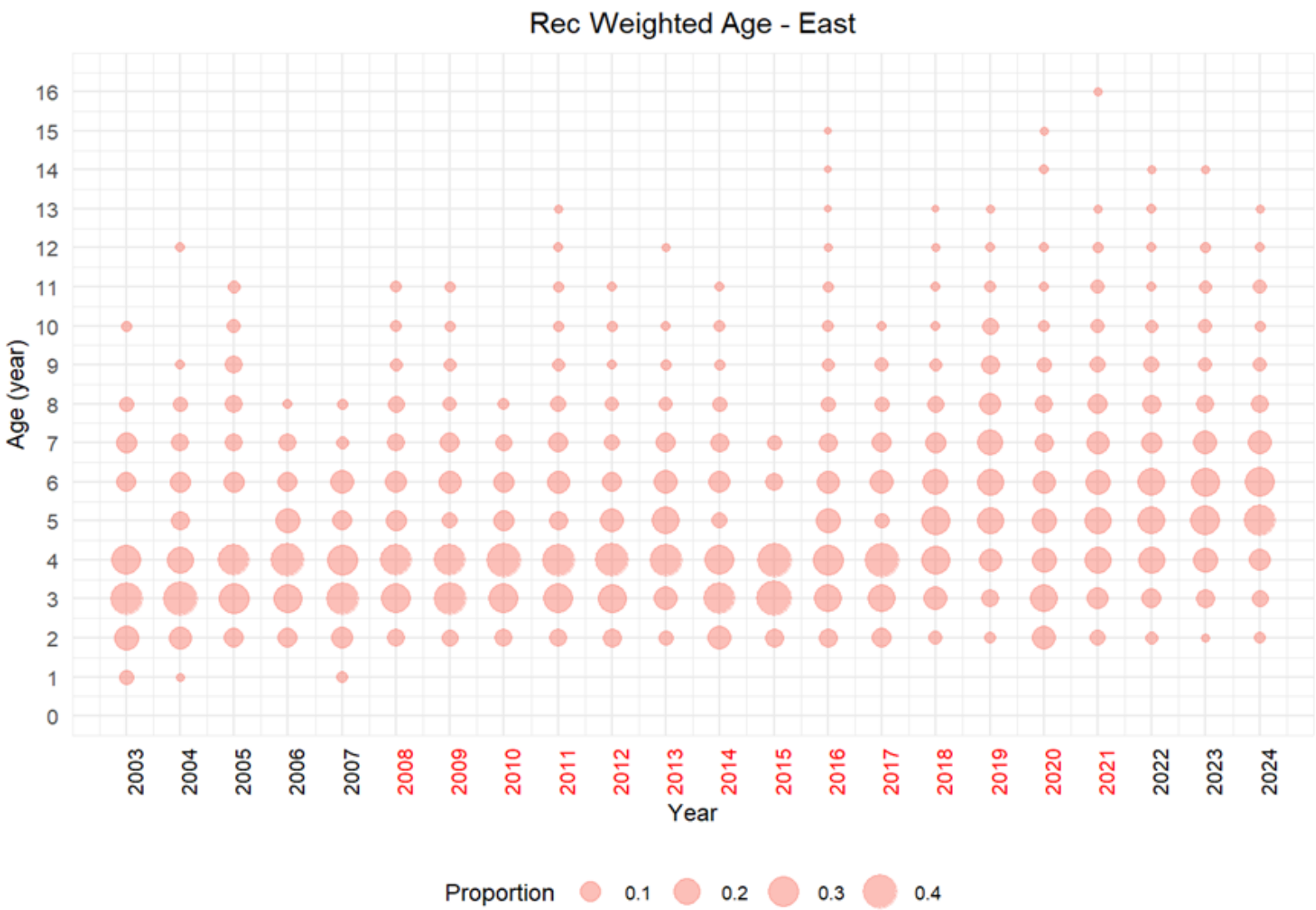


Figure 4.13.10b. Weighted age composition for Gulf Gray Triggerfish from the **East** (MS to FL). The weighted length compositions used for weighting did not meet minimum sample size thresholds for years in red.

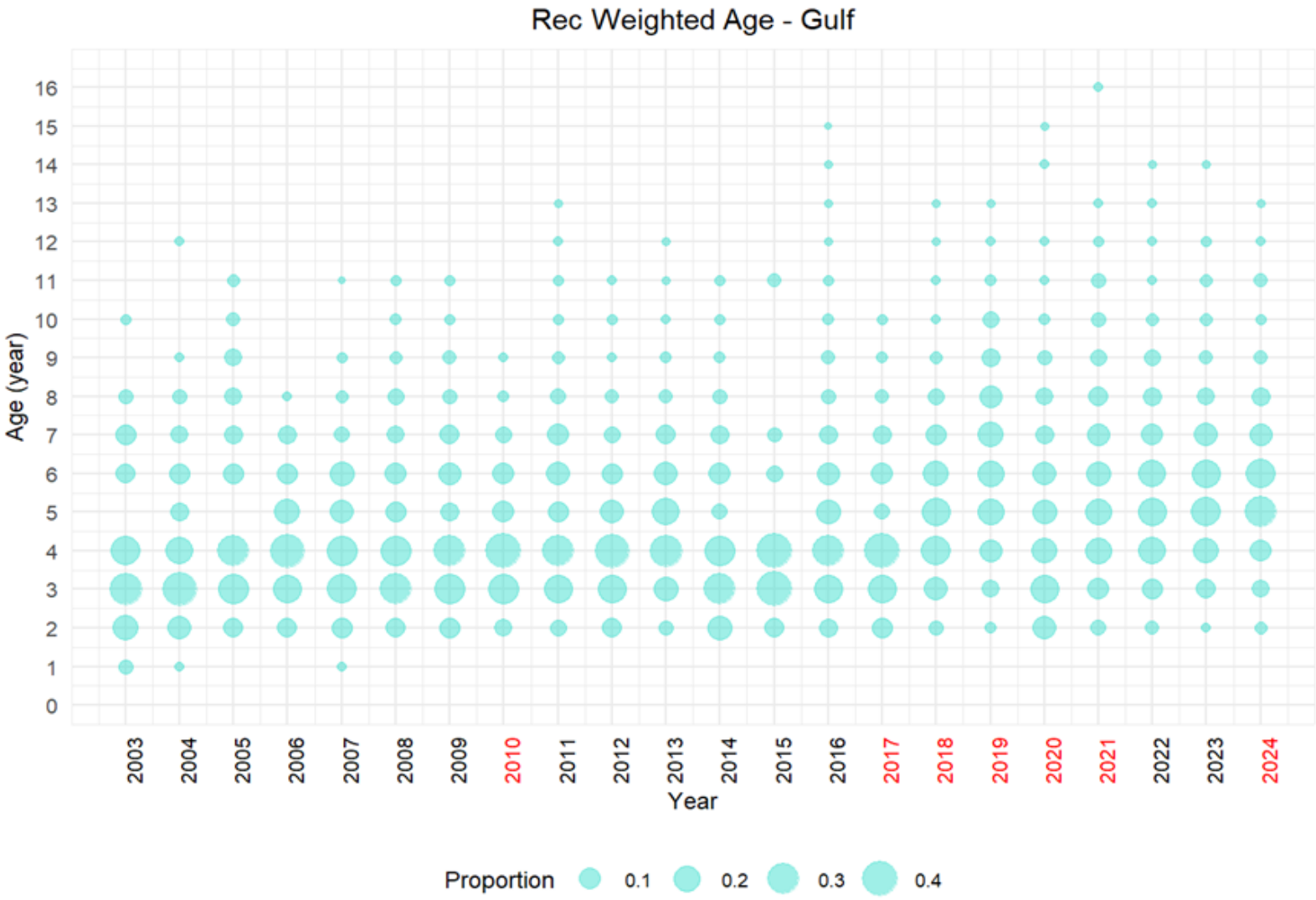


Figure 4.13.10c. Weighted age composition for Gulf Gray Triggerfish **Gulf-wide** (TX-FL). The weighted length compositions used for weighting did not meet minimum sample size thresholds for years in red.

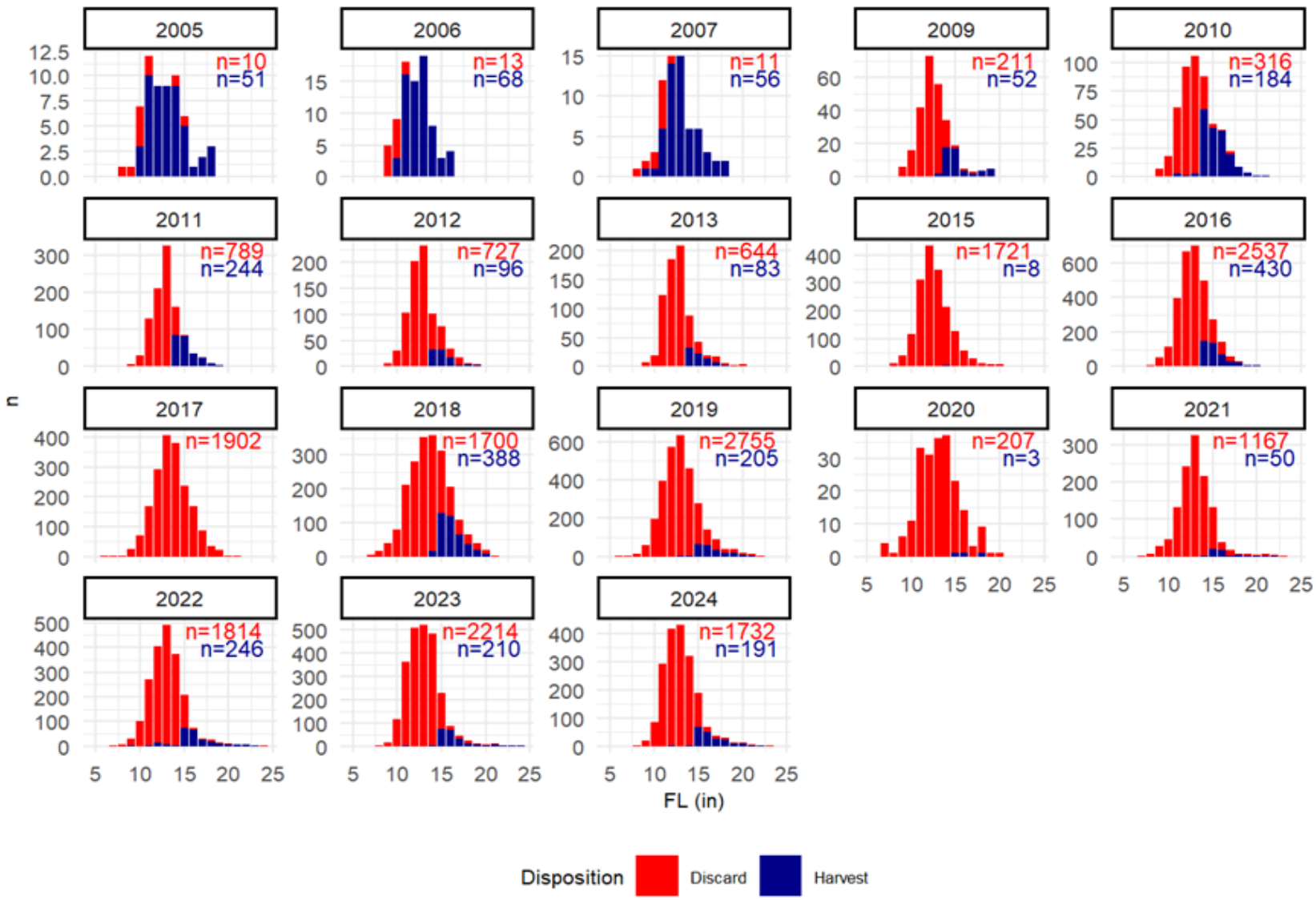


Figure 4.13.11. Length distribution of discarded and harvested Gulf Gray Triggerfish sampled by at-sea observers.

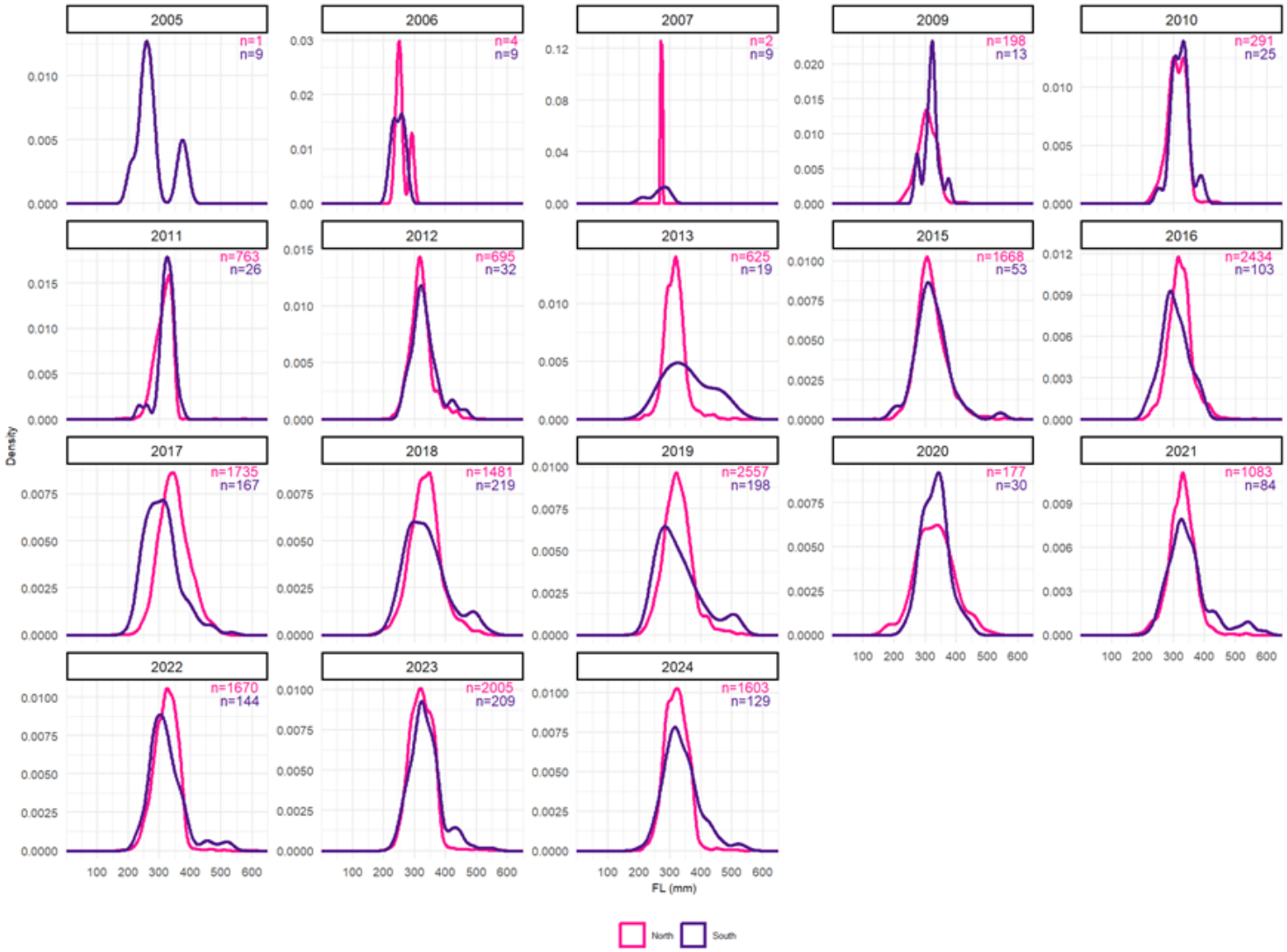


Figure 4.13.12. Comparison of discard length distributions from Gray Triggerfish sampled from the North (MS-FL panhandle) and South (FL peninsula) weighting subregions.

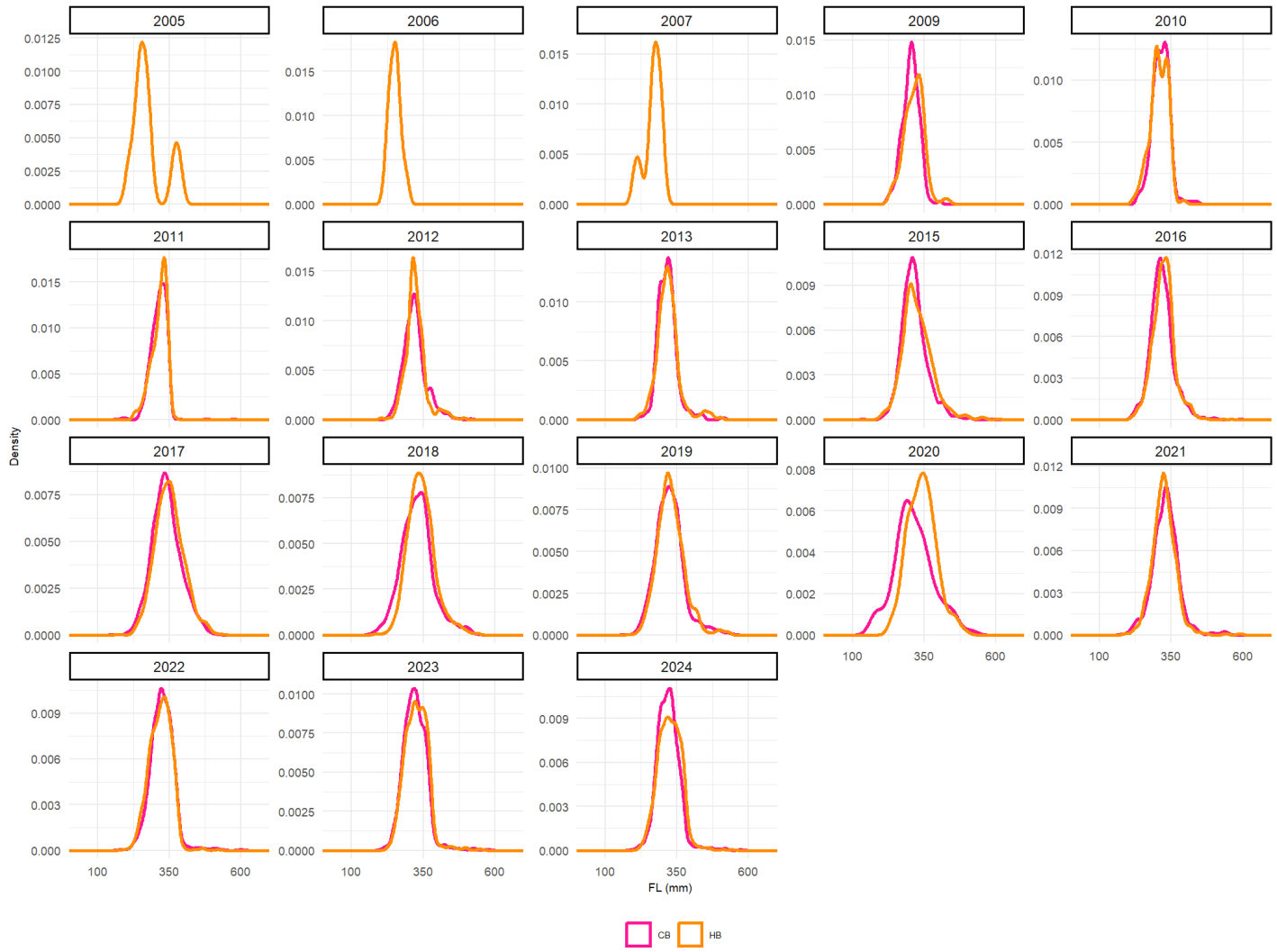


Figure 4.13.13. Discard length distributions by mode (CB = charter, HB = headboat) from Gulf Gray Triggerfish sampled by at-sea observers.

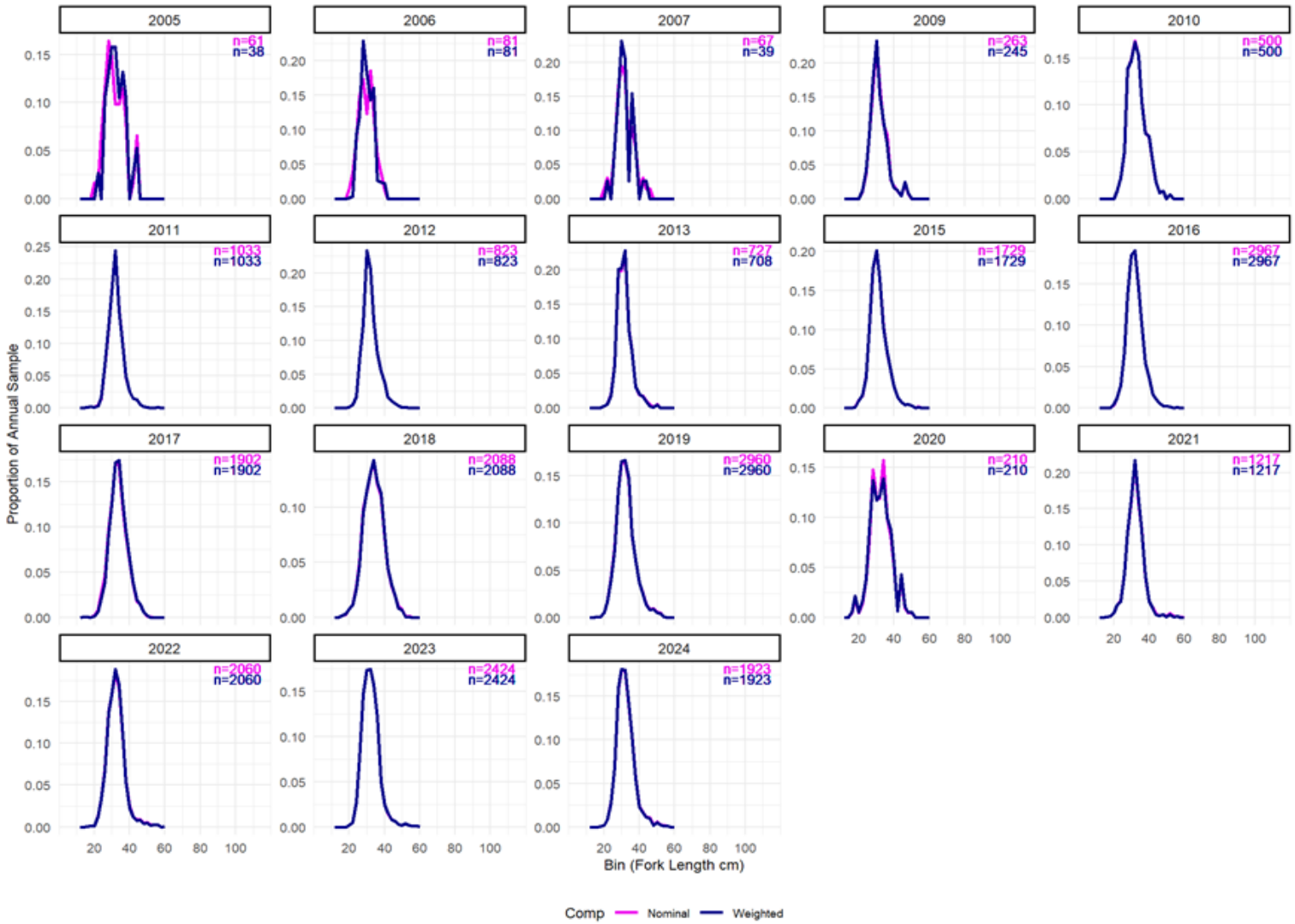
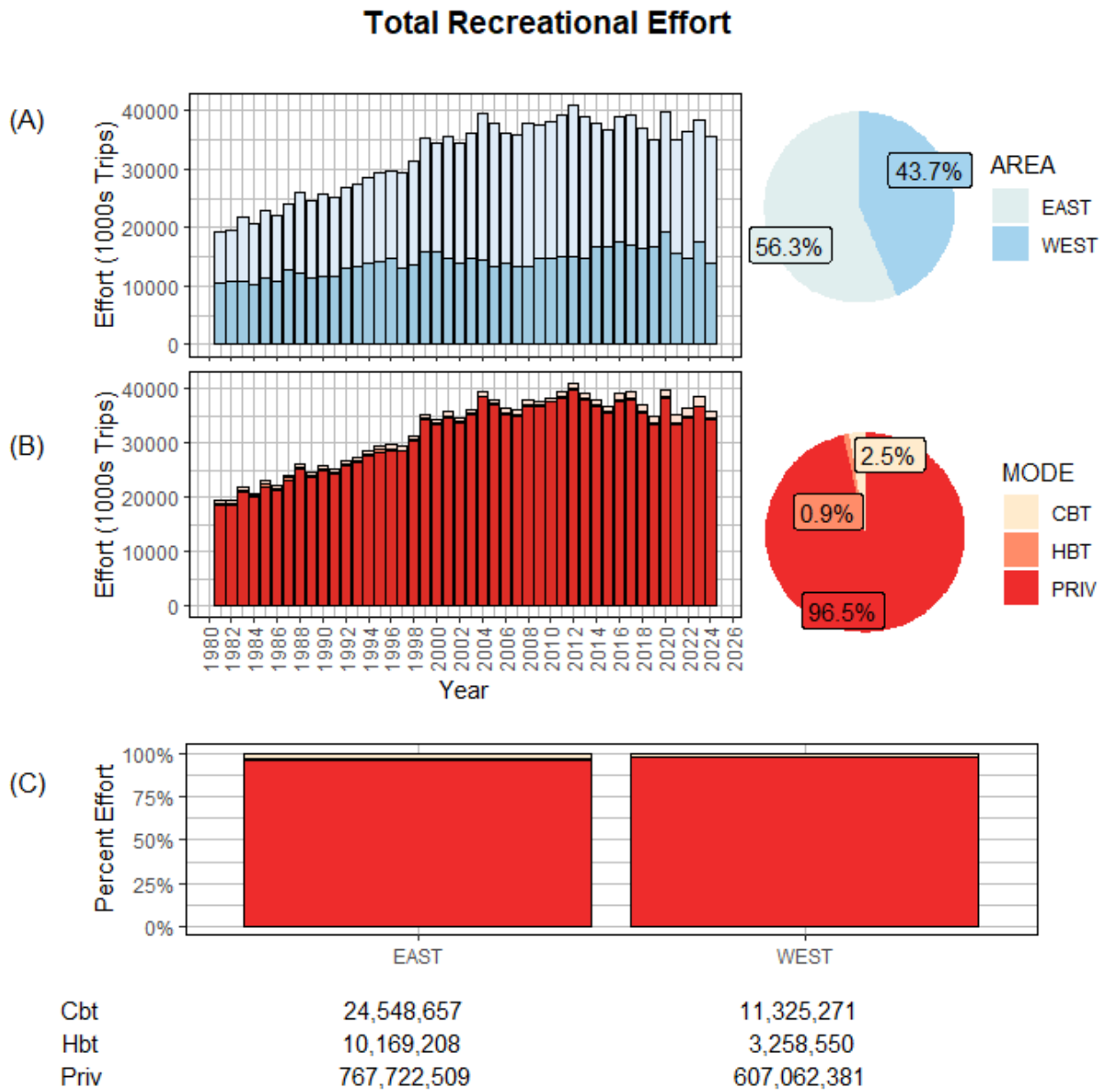


Figure 4.13.14. Nominal and weighted discard length distributions of Gulf Gray Triggerfish (MS-FL) sampled by at-sea observers.



Cbt	24,548,657	11,325,271
Hbt	10,169,208	3,258,550
Priv	767,722,509	607,062,381

Figure 4.13.15. Total recreational effort (angler trips) for Gulf of America Gray Triggerfish across all surveys. Effort is provided (A) by area and year in thousands of trips, (B) by mode and year in thousands of trips, and (C) by mode and area in percent numbers of trips.

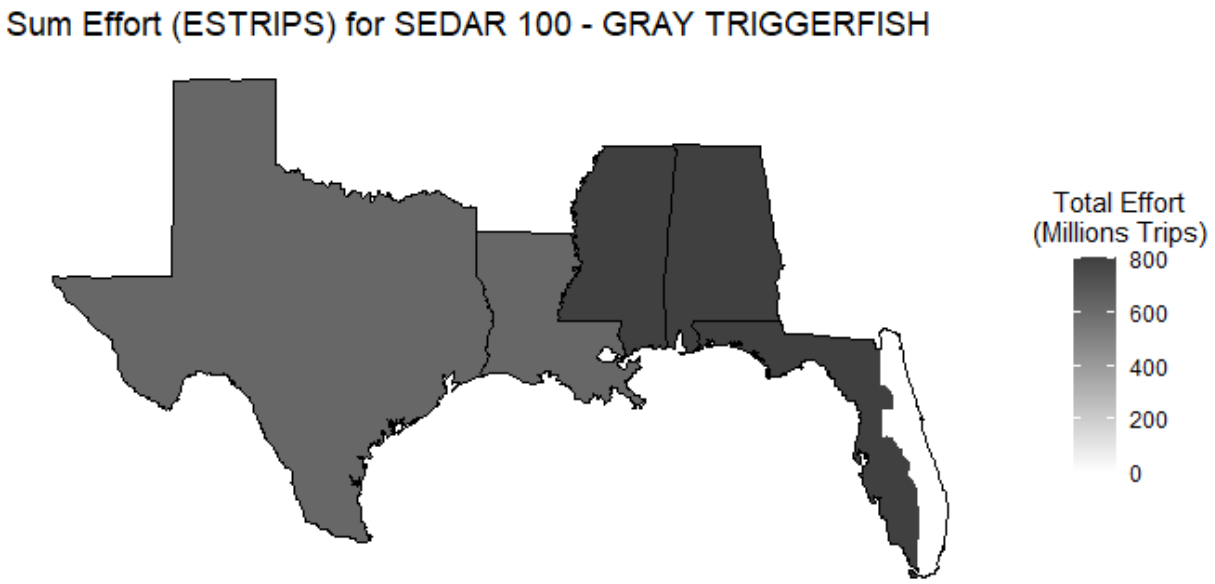


Figure 4.13.16. Distribution of total recreational effort (angler trips), in millions of trips, for Gray Triggerfish across the Gulf of America. Estimates are combined across all surveys and years and summarized by region.

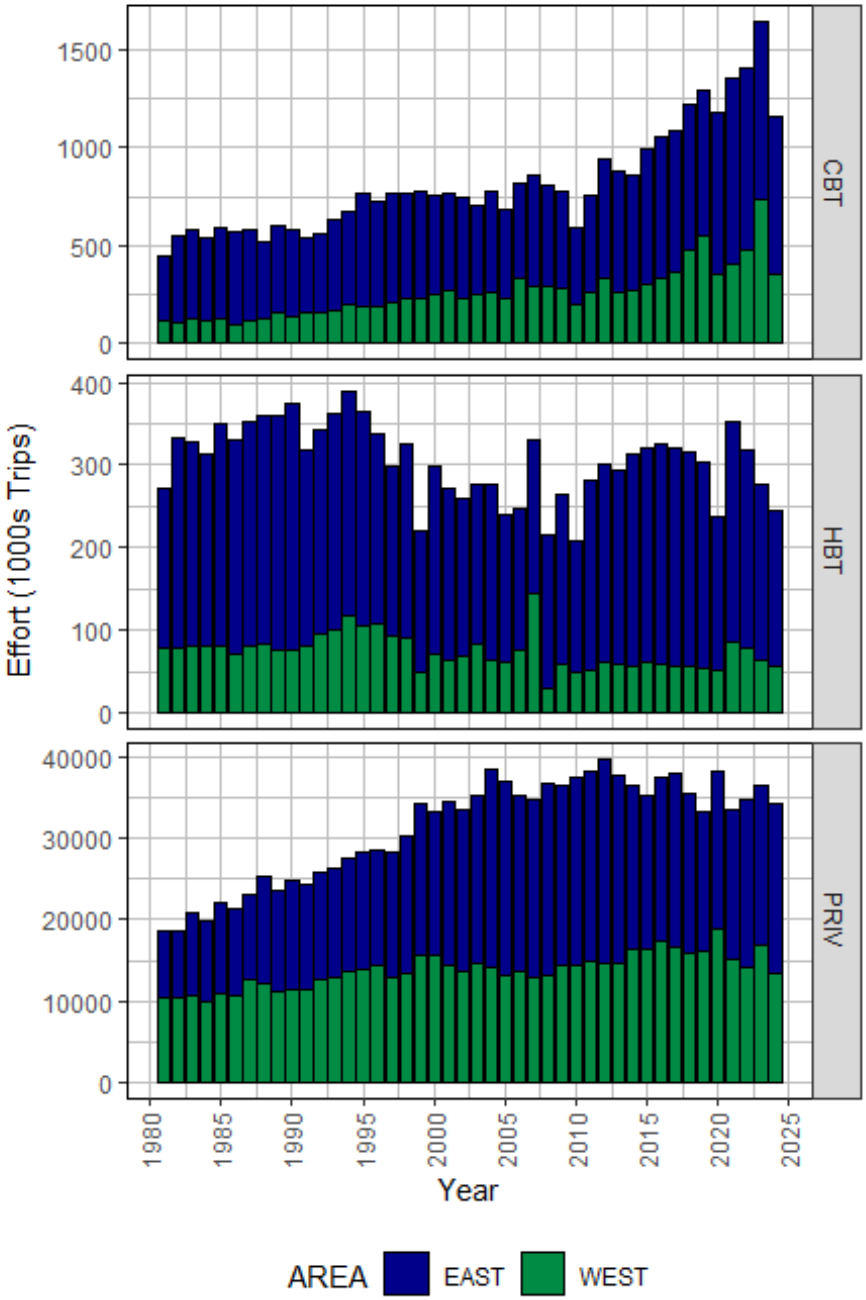


Figure 4.13.17. Recreational effort (angler trips) for Gulf of America Gray Triggerfish for each fishing mode. Effort is provided by year and area in thousands of trips.

5 INDICES OF POPULATION ABUNDANCE

5.1 OVERVIEW

The combined Index and Bycatch Working Group (IBWG) reviewed relative abundance indices and accompanying analyses from six fishery-independent datasets and two fishery-dependent datasets that represented relative abundance trends in the Gulf for gray triggerfish. For this assessment, the IBWG was tasked with making recommendations for two different spatial configurations for the stock assessment model, with one being for a full Gulf-wide stock assessment model and the second being a two-area stock assessment model that would be split into West and East regions.

Full descriptions of the datasets, analytical methods and model diagnostics reviewed by the IBWG can be found in Section 5.2. The IBWG reviewed and evaluated indices independently for the entire Gulf and for each of the two regions (West and East) following the criteria listed in Section 5.3. Relative spatial coverage of "Suitable" and "Suitable and Recommended" indices are included in Figures 5.9.1 and 5.9.2, respectively. Rationalizations for the recommendation or exclusion of an index (Table 5.8.1) are given in the 'Comments on Adequacy for Assessment' in Sections 5.4 (fishery-independent) and 5.5 (fishery-dependent).

For the Gulf-wide model, three fishery-independent and one fishery-dependent indices of abundance are recommended for use in the assessment by the IBWG. Relative abundance and the coefficient of variation on the mean (CV, standard error/mean) for recommended indices Gulf-wide are shown in Table 5.8.2, and overall trends in Figure 5.9.3.

Recommended	Not Recommended
SEAMAP Summer and Fall Groundfish Old (1987 – 2008)	SEAMAP Fall Groundfish Old (1987 – 2007)
SEAMAP Summer and Fall Groundfish New (2009 – 2024)	SEAMAP Fall Groundfish New (2008 – 2024)
SEAMAP / G-FISHER Reef Fish Video (1993 – 2023)	SEAMAP Fall Plankton (1986 – 2023)
Headboat Survey (1986 – 2007)	Commercial Handline (1993 – 2024)

For the West, three fishery-independent and one fishery-dependent indices of abundance are recommended for use in the assessment by the IBWG. Relative abundance and the coefficient of variation on the mean (CV, standard error/mean) for recommended indices in the West are shown in Table 5.8.3, and overall trends in Figure 5.9.4.

Recommended	Not Recommended
SEAMAP Summer and Fall Groundfish Old (1987 – 2008)	SEAMAP Fall Groundfish Old (1987 – 2007)
SEAMAP Summer and Fall Groundfish New (2009 – 2024)	SEAMAP Fall Groundfish New (2008 – 2024)
SEAMAP / G-FISHER Reef Fish Video (1993 – 2023)	SEAMAP Fall Plankton (1986 – 2023)
Headboat Survey (1986 – 2007)	Commercial Handline (1993 – 2024)

For the East, two fishery-independent and one fishery-dependent indices of abundance are recommended for use in the assessment by the IBWG. Relative abundance and the coefficient of variation on the mean (CV, standard error/mean) for recommended indices in the East are shown in Table 5.8.4, and overall trends in Figure 5.9.5.

Recommended	Not Recommended
SEAMAP Summer and Fall Groundfish New (2009 – 2024)	SEAMAP Fall Groundfish New (2008 – 2024)
SEAMAP / G-FISHER Reef Fish Video (1993 – 2023)	SEAMAP Fall Plankton (1986 – 2023)
Headboat Survey (1986 – 2007)	Commercial Handline (1993 – 2024)

5.1.1 Terms of reference

The IBWG was tasked with completing objectives associated from the Data Workshop Terms of Reference (note that the numbering tracks the original Terms of Reference):

4. Provide fishery-independent measures of population abundance developed through the terminal year where possible.

- Evaluate the G-FISHER composite video index for use in the assessment.
- Consider any changes to the fishery-independent indices comprising the GFISHER index as provided for the previous assessment and evaluate the representativeness through time of the composition data.
- Evaluate the compositions available. Recommend modifications needed to inform differences in catchability and selectivity of the surveys.
- Provide appropriate measures of uncertainty for all fishery-independent abundance indices and effort time series considered.

The IBWG was also tasked with examining the follow objective (specific items bolded) from the Assessment Process Terms of Reference:

2. Consider continuity model stratification and data structure and suggest any recommended revisions.

- Re-evaluate whether commercial and recreational fleets should be separated by East and West by reviewing all available data (landings, discards, indices, compositions).
- Provide estimates of uncertainty around each set of landings and discard estimates.
- Review ageing validation and ageing structures studies and consider their appropriateness for inclusion in the assessment model.
    - Update life history data/analyses (e.g., maximum age, growth, mortality, ageing error matrix, reproduction) given revised age data following recent ageing studies as needed.
- **Explore the use of a combined video index from the FWRI, Pascagoula, and Panama City video surveys (e.g., G-FISHER). Recommend modifications needed to inform differences in catchability and selectivity of the surveys.**
- Evaluate the start year and initial Fs used in the assessment model.
- Explore shrimp trawl bycatch magnitude and age-structure, if data are available using new effort and bycatch methodologies (e.g., SEAMAP Summer and Fall Groundfish trawls and shrimp observer data).
- Explore fleet-specific length compositions and **remote sensing data for sargassum coverage as a potential index of recruitment.**
- Consider recent discard mortality studies and analytical results and incorporate updated discard mortality rate(s) as appropriate.

5.1.2 Group membership

Members of the IBWG included: Adam Pollack (co-lead), Cheston Peterson (co-lead), Kate Overly, Kevin Thompson, Matthew Nuttall, Ted Switzer, Heather Christiansen, Kyle Dettloff, Sarina Atkinson, David Hanisko, Matthew Campbell, Frank Hernandez, and Glenn Zapfe.

5.2 REVIEW OF WORKING PAPERS

The IBWG reviewed the following working papers:

SEDAR100-DW-09	-	Standardized Catch per Unit Effort for US Gulf of America Gray Triggerfish (*Balistes capriscus*) from the Southeast Region Headboat Survey
SEDAR100-DW-15	-	Standardized catch rates of Gray Triggerfish from the United States Gulf of America commercial handline fishery, 1993-2024
SEDAR100-DW-16	-	Gray Triggerfish Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of America

SEDAR100-DW-18	-	Indices of abundance for Gulf Gray Triggerfish (*Balistes capriscus*) using data from multiple video surveys
SEDAR100-DW-19	-	Gray Triggerfish (*Balistes capriscus*) indices of relative abundance from SEAMAP Fall Plankton Surveys, 1986 to 2023

5.3 CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATIONS

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

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

After an index was evaluated, it was deemed either Suitable or Not Suitable, following the guidance in the Terms of Reference from SEDAR 74. Once all the indices were evaluated on their own merits and determined to be Suitable or Not Suitable, they entered the second stage of review to determine a recommendation for use in the assessment. Indices were then assigned one of the following categories.

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

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

- Not Suitable (Not Recommended): Based on the criteria listed above, the index did not meet the minimum requirements for being considered for use in the assessment.

5.4 FISHERY-INDEPENDENT INDICES

5.4.1 SEAMAP Groundfish Survey

The NOAA Fisheries Southeast Fisheries Science Center (SEFSC) Population and Ecosystem Monitoring Division Trawl and Plankton Branch and state partners have conducted standardized fall groundfish surveys under the Southeast Area Monitoring and Assessment Program (SEAMAP) in the Gulf of America (GOA) since 1987. SEAMAP is a collaborative effort between federal, state and university programs, designed to collect, manage and distribute

fishery independent data throughout the southeast region. The primary objective of this trawl survey is to collect data on the abundance and distribution of demersal organisms. This survey, which is conducted semi-annually (summer and fall), provides an important source of fisheries independent information on many commercially and recreationally important species throughout the GOA occupying low-relief, sand and mud habitats across the shelf.

Major changes in the SEAMAP sample design occurred between the 2008 summer and fall surveys. The time of day stratification was dropped, tow time was standardized to 30 minutes, and sampling effort was allocated proportionally by each combination of shrimp statistical zone (SSZ) and depth zone spatial area. While the change in sample design occurred in 2008, it is important to note that the state partners did not adopt the new sample design until 2010. Additionally, minor changes to depth zones were made during subsequent years with the current design utilizing two depth zones, which have been consistent since 2013.

In 2008, SEAMAP received supplemental funding that provided the opportunity to conduct experimental bottom trawl surveys on the West Florida Shelf. Based on the success of the experimental trawl surveys by the state of Florida, the surveys were fully expanded in 2010 to include the area from Mobile Bay, AL to Key West, FL. The survey gear consists of a 12.8-m (42 ft) semi-balloon shrimp trawl with a 12.8-m headrope and does not contain a turtle excluder device (TED) or any bycatch reduction devices (BRD).

5.4.1.1 Methods of Estimation

Working Paper Number: SEDAR100-DW-16
Data Type: Fishery Independent
Time Series: 1987 – 2008**,** 2009 – 2024
Sampling Intensity: Table 1 (summer), Tables 2 (fall) in working paper.
Size/Age Data: Predominantly juveniles, see Figures 3 – 5 in working paper for length and age distributions
Data Filtering Techniques: Standard filtering protocols to remove problematic stations.

Standardization: Delta-lognormal following methods outlined by Lo *et al.* (1992)

Submodel Variables

Gulf-wide – SEAMAP Summer and Fall Groundfish (old design, 1987 – 2008)

Binomial submodel: Year, SSZ, Season, Depth
Lognormal submodel: Year, SSZ, Season, Time of Day, Depth

Gulf-wide – SEAMAP Summer and Fall Groundfish (new design, 2009 – 2024)

Binomial submodel: Year, SSZ, Season, Depth

Lognormal submodel: Year, SSZ, Time of Day, Depth

West Gulf – SEAMAP Summer and Fall Groundfish (old design, 1987 – 2008)

Binomial submodel: Year, SSZ, Season, Depth
Lognormal submodel: Year, SSZ, Season, Time of Day, Depth

West Gulf – SEAMAP Summer and Fall Groundfish (new design, 2009 – 2024)

Binomial submodel: Year, SSZ, Season, Depth
Lognormal submodel: Year, SSZ, Time of Day, Depth

East Gulf – SEAMAP Summer and Fall Groundfish (new design, 2009 – 2024)

Binomial submodel: Year, SSZ, Season, Weight of Sponge, Depth
Lognormal submodel: Year, SSZ, Season

Abundance Indices: Addendum Table 1 (Gulf-wide – old design), Addendum Table 2 (Gulf-wide – new design), Addendum Table 3 (West Gulf – old design), Addendum Table 4 (West Gulf– new design), Addendum Table 5 (East Gulf– new design) in SEDAR100-DW-16

5.4.1.2 Comments on Adequacy for Assessment

Initially, only indices from the SEAMAP Fall Groundfish Survey Old Design (1987 – 2008) and SEAMAP Fall Groundfish Survey New Design (2009 – 2024) were presented for use in the assessment following what had been done for previous SEDARs. Both indices represent a long-term fishery-independent survey that has good spatial and temporal coverage. Indices were presented for the Gulf-wide model and for the West for the SEAMAP Fall Groundfish Survey Old Design and for all three regions (East, West, and Gulf-wide) for the SEAMAP Fall Groundfish Survey New Design. However, during the course of the Data Workshop, we examined combining the summer and fall survey data into a single index. Length data were compared and no apparent differences in the distribution were noted, aside from a shift in lengths that would be expected from the fish being older when captured in the fall survey.

Due to the recommendation for combining Summer and Fall survey data, indices from the fall survey were deemed "Suitable and Not Recommended".

The survey coverage across all regions showed broad spatio-temporal sampling, with the entire area being covered in most years. Therefore, the IBWG deemed the summer and fall combined indices for all of the regions "Suitable and Recommended".

5.4.2 SEAMAP/G-FISHER Reef Fish Video Survey- East (EGOA), West (WGOA) and Gulf-wide (GOA)

Historically, three different stationary video surveys were conducted to assess trends in reef fish relative abundance in the Gulf of America (GOA). The NMFS SEAMAP reef fish video survey (SRFV), carried out by NMFS Mississippi Laboratory, has the longest running time series (1993-1997, 2002, and 2004+), followed by the NMFS Panama City lab survey (PC; 2005+), with the most recent survey being the Florida Fish and Wildlife Research Institute video survey (FWRI, starting year 2010). Survey efforts were integrated under a unified design as the Gulf Fishery Independent Survey of Habitat and Ecosystem Resources (G-FISHER) beginning in 2020. Given the surveys use standardized deployment, camera field of view, and fish abundance methods to assess fish abundances on reef or structured habitat, combining indices across datasets allows for the largest possible sample sizes in model fitting and encompassing a greater proportion of the distribution of the stock. Gray Triggerfish, found throughout the GOA, is considered a single stock based on its prolonged, indeterminate larval stage. As requested for this assessment, indices of abundance were provided for the East GOA (EGOA, > -89° longitude), West GOA (WGOA; < -89° longitude), and Gulf-wide GOA (GOA) regions.

5.4.2.1. Methods of Estimation

Working Paper Number: SEDAR100-DW-18
Data Type: Fishery Independent
Time Series: 1993-2023 (All indices; EGOA, WGOA, GOA)
Sampling Intensity: See Table 1 for total number of stations sampled per region per year in SEDAR100-DW-18
Size/Age Data: Data represents juveniles through adult. 10 - 88 cm (EGOA), 16 - 68 cm (WGOA), 10 – 88 cm (GOA). See Figure 19 in SEDAR100-DW-18

Data Filtering Techniques: For all surveys, video reads were excluded if they were unreadable due to low visibility or deployment errors. Data from the SRFV survey collected in 1992 were excluded from the EGOA, WGOA and GOA index calculations because of differences in counting methods in this first year, and no survey data are available for years 1998-2001 and 2003. Additionally, PC survey data from 2005 was excluded because of an incomplete survey. Due to COVID restrictions on field sampling, no data were collected in the WGOA in 2020. As a result, 2020 data were excluded from analysis in the WGOA index. Final sample sizes by region, survey and year can be found in Table 1 and spatial coverage is shown in Figures 1 and 2 in SEDAR100-DW-18. Data were separated into EGOA (zones 2-11) and WGOA (zones 13-21) and GOA (zones 2-21) regions following the Stock ID identified in SEDAR 9, and analyses were completed for each of these regions independently. The same data reduction procedures were applied to the video length data set such that annual size composition vectors were generated solely from stations used to generate standardized indices for each stock.

Standardization: Relative abundance indices were generated using a stepwise approach. First a habitat variable was created that included each of the separate survey individual variables that could be applied to all the data. This was done so final index models can account for changing sampling effort and habitat allocation through time rather than limiting the model to be predicted only by year and survey. We first determined the percentage of sites that occurred on High,

Medium, or Low (H, M, L) proportion positive habitats for each survey and region independently. For this we used a categorical regression tree approach (CART). These subsequent variables were then used in a negative-binomial GLM along with year and survey to predict annual abundances for each region independently.

Submodel Variables:

EGOA CART variables by survey:
SFRV east: *presence/absence of sponge, presence/absence of soft coral, combined maximum relief, latitude, and longitude*
PC: *longitude, general habitat category, and relief*
FWRI: *latitude, longitude, presence/absence of sponge, geoform, depth*
GF east: *latitude, longitude, presence/absence of rock, presence/absence of sponge*

WGOA CART variables by survey:
SFRV west: *depth, latitude, presence/absence of rock, presence/absence of silt/sand/clay*
GF west: *depth*

GOA CART variables by survey:
SFRV east: *presence/absence of sponge, presence/absence of soft coral, combined maximum relief, latitude, and longitude*
SFRV west: *depth, latitude, presence/absence of rock, presence/absence of silt/sand/clay*
PC: *longitude, general habitat category, and relief*
FWRI: *latitude, longitude, presence/absence of sponge, geoform, depth*
GF east: *latitude, longitude, presence/absence of rock, presence/absence of sponge*
GF west: *depth*

Annual Abundance Indices: See Table 8 and Figure 16 for EGOA, Table 9 and Figure 17 for WGOA, and Table 10 and Figure 18 for GOA in SEDAR100-DW-18.

5.4.2.2. Comments on Adequacy for Assessment

All three indices were deemed suitable and recommended by the IBWG at the SEDAR100 Data Workshop in Tampa, FL.

Prior to the G-FISHER survey, previous SEDARs utilized different methods for calculating the abundance indices between multiple reef fish video surveys. SEDAR 62 combined three separate surveys (SRFV, PC, FWRI) to derive estimated annual abundances for the combined EGOA index. This was achieved by fitting a GLM to data using CART-derived habitat groups as a shared variable. This approach predated the formal standardization of the survey universe and design established by G-FISHER. Separately, the WGOA index was derived exclusively from the SRFV dataset, as PC and FWRI did not sample that region at the time. (SRFV also produced standalone EGOA and GOA-wide indices). For all three regions, the SRFV analysis utilized a negative binomial model.

Following SEDAR 62, the G-FISHER survey came online (2020), sampling GOA-wide with a standardized sampling universe, design and methodologies. Additionally, we developed GOA-wide model-weighting methods that allowed us to account for the variation in spatial footprint in the surveys when combining data (current and historical), allowing for a more representative index of regional relative abundance trends. Ultimately, for this assessment we used this updated habitat-based approach to combine relative abundance data for generating annual trends for gray triggerfish (Balistes capriscus) in the EGOA, WGOA, and GOA-wide. This combined approach resulted in low CVs (2021-2024 8-7%). Due to the wide range of the stock being covered in terms of spatial coverage and habitats sampled, the large sample sizes of video sets, and the size range of this species being indexed the combined G-FISHER approach was supported for the EGOA, WGOA, and GOA-wide indices. While we provided all three, the analytical team can use their discretion to determine which index/indices are ultimately included.

Review of the length compositions and survey designs of the independent video surveys did not uncover any obvious differences that would warrant the implementation of time varying selectivity and catchability be applied, and the combined length frequencies across years were similar among surveys (Fig. 19). However, the analytical team can use their discretion to explore time-varying parametrizations if they are determined to be warranted during model development.

5.4.3 SEAMAP Fall Plankton Survey

The Southeast Area Monitoring and Assessment Program (SEAMAP) has supported the collection and analysis of ichthyoplankton samples from fishery-independent resource surveys in the Gulf since 1982 with the goal of producing a long-term database on the early life stages of fishes.

5.4.3.1. Methods of Estimation

Working Paper Number: SEDAR100-DW-19
Data Type: Fishery Independent
Time Series: 1986 to 2023
Sampling Intensity: See Table 4 in SEDAR100-DW-19
Size/Age Data: Intended to index adult spawning stock

Data Filtering Techniques: Preliminary indices of abundance were based on the occurrence and catch per unit effort (CPUE) from SEAMAP Fall Plankton Surveys. Year to year variability in spatial coverage from Fall Plankton Survey data was addressed by limiting observations to samples taken at systematic grid stations that were sampled during at least (~66%) of all years for which there was consistent spatial coverage. Based on this protocol, the core data of the Gulf index includes all samples taken during at least 19 of the 28 years of available data with the years

1992, 1998, 2004, 2005, 2008, 2015, 2017, 2021 and 2023 excluded. Years in which gray triggerfish were not observed were removed prior to the generation of indices.

Standardization: Generalized linear modeling (GLM) methods were used to estimate the proportion of positive occurrence (PPOS) and relative catch per unit effort (CPUE) of larval and juvenile gray triggerfish in neuston nets. PPOS was modeled utilizing a binomial distribution with a logit link. CPUE was estimated by a log linked negative binomial model based on counts of larvae with effort (minutes fished) as an offset. The factors Year, Time of Day (TOD), Region and Depth were examined as possible influences on PPOS and CPUE.

Annual Abundance Indices: See Table 4 for the preliminary PPOS index and Table 5 for the preliminary negative binomial CPUE index in SEDAR100-DW-19.

5.4.3.2. Comments on Adequacy for Assessment

Gray triggerfish indices of CPUE derived from SEAMAP Fall Plankton Surveys have been used as an estimate of adult spawning biomass in previous assessments. Detailed analysis of length composition carried out for SEDAR 62 and SEDAR 100 indicate that gray triggerfish in SEAMAP neuston nets are dominated by older larvae (>5 mm Body Length [BL]) and juvenile stages (>10 mm BL) which account respectively for 12.1% and 78.7% of fish collected in samples. Therefore, CPUE and PPOS indices derived from SEAMAP neuston net samples are primarily composed of juvenile stages (> 10 mm BL) which are much further removed from the larval stages (< 10 mm BL) typically used to reflect trends in adult spawning stock. Larval gray triggerfish at or below 5 mm BL from neuston tows could potentially index spawning stock biomass, but larvae in this size range are rare and only occur in 2% of samples over the time series. Given that gray triggerfish CPUE and PPOS is primarily driven by juvenile fish further removed from the larval stages (< 10 mm BL) typically used to reflect trends in adult spawning stock, the authors of the working paper recommended that the SEAMAP Fall Plankton Survey CPUE and PPOS indices not be included in the assessment as a spawning stock index. This recommendation was discussed and adopted by the IBWG.

Indexing the relative abundance of gray triggerfish from neuston net collections is complicated by their consistent association with floating Sargassum. Examination of gray triggerfish in SEAMAP neuston tows (2006 to 2022) with paired observations of Sargassum catch indicate that older larvae and juveniles co-occur with Sargassum 78% of the time and primarily when Sargassum exceeds 1 liter / 10 min tow. In contrast, larvae at 5 mm BL or less only co-occur with Sargassum 22% of the time and when little (< 1 liter/ 10 min tow) or no Sargassum is observed in the sample. Although, catches of gray triggerfish greater than 5 mm BL are associated with Sargassum catch, a clear relationship with increasing catch of gray triggerfish

and increasing catches of Sargassum was not apparent in our data. However, we did see a pattern of extreme (outliers) gray triggerfish CPUE in samples associated with large catches of Sargassum. Our ability to elucidate the relationship between gray triggerfish and Sargassum CPUE may be limited by the methods used to quantify Sargassum in neuston net tows. Currently, the protocols only record liters of Sargassum taken in the net, but information on the type of Sargassum aggregation, relative density at the surface, at depth and patchiness along or near the neuston tow may be needed to determine a relationship, and account for the seen pattern of extreme observations we see in our data. The use of satellite imagery products is being evaluated to provide a more detailed measurement of Sargassum abundance. This data will be used in future analyses to examine the intricate link between Sargassum abundance and variability of gray triggerfish recruitment in the northern Gulf of America.

At this time, the SEAMAP larval CPUE and PPOS from neuston nets primarily represent an incomplete picture of late-stage larvae and juvenile recruitment to Sargassum habitat. These fish may rely on Sargassum for refuge and transport to suitable benthic habitat for settlement, but major questions regarding these mechanisms are yet unanswered. The IBWG briefly discussed the potential merits of the SEAMAP Fall Plankton Survey CPUE and PPOS indices as an index of recruitment, but ultimately decided that the SEAMAP trawl surveys better represented a more direct recruitment path to the fishery.

5.4.4 Sargassum

As discussed above, indexing the relative abundance of gray triggerfish from neuston net collections is complicated by their consistent association with floating Sargassum. A clear relationship with increasing catch of gray triggerfish and increasing catches of Sargassum was not apparent in our data. The use of satellite imagery products is being evaluated to provide a more detailed measurement of Sargassum abundance. This data will be used in future analyses to examine the intricate link between Sargassum abundance and variability of gray triggerfish recruitment in the northern Gulf of America.

5.5 FISHERY-DEPENDENT INDICES

5.5.1 SRHS Headboat Index

The Southeast Region Headboat Survey (SRHS) collects catch, effort, and biological information from recreational headboats operating throughout the southeast region. First implemented in the Carolinas in 1972, the spatial extent of this survey has since grown, covering the entire South Atlantic by 1978 and the Gulf by 1986. Designed to be a census, SRHS catch records capture the majority of headboat fishing activity across the southeast, with compliance being near 100 percent since permits became tied to reporting requirements in 2008. These catch records are

from industry-reported logbooks, which were submitted via paper forms until 2013 when the survey switched to electronic reporting.

5.5.1.1. Methods of Estimation

Working Paper Number: SEDAR100-DW-09
Data Type: Fishery Dependent
Time Series: 1986-2007

Sampling Intensity: The SRHS Working Paper (SEDAR100-DW-01) summarizes the number of headboats actively fishing (Tables 5-7) and their total fishing effort (Tables 14-17, Figure 7)

Size/Age Data: The SRHS Working Paper (SEDAR 100-DW-01) summarizes the lengths and weights of those landed fish sampled by SRHS port samplers (Tables 20-23, Figures 8-9)

Data Filtering Techniques: Standard filtering protocols to remove vessels with infrequent participation in the fishery, trips that reported six or fewer anglers, and trips with suspected data errors. Trips conducted during the closed season for Gulf Gray Triggerfish were also excluded.

SRHS logbook records after 2007 were excluded following perceived effects of management regulations on Gray Triggerfish catch rates (e.g., circle hook mandate, size and bag limits, spatial and seasonal fishery closures). Trip selection was conducted using the guild approach, which retained trips that were positive for those reef fish species believed well-sampled by the SRHS program.

Standardization: delta-lognormal

Submodel Variables

East:
Binomial: Year + Area + Year*Area
Positive Observations: Year + Area + Season + Year*Area

West:
Binomial: Year + Trip Duration + Day/Night + Year*Trip Duration
Positive Observations: Year + Season + Red Snapper Season

Gulf:
Binomial: Year + Area + Year*Area
Positive Observations: Year + Area + Season + Year*Area

Annual Abundance Indices: Table 2 (East), Table 4 (West), and Table 6 (Gulf)

5.5.1.2. Comments on Adequacy for Assessment

The IBWG found the provided SRHS Headboat Indices "Suitable and Recommended" for all regions. These indices provide one of the longest time series (1986+) and have widespread spatial coverage compared to other regional indices. It covers a time period over which fishery-independent indices are generally not available, and was truncated to account for the potential effects of management, including regulations aimed at Gray Triggerfish but also other reef fish that may interact with Gray Triggerfish.

5.5.2 Commercial Vertical Line

This index uses landings data from the Coastal Fisheries Logbook Program (CFLP) to characterize population trends of Gray Triggerfish as represented by the commercial vertical line (handline and electric reel) fishery. This index was used in both SEDAR 43 and 62 and the methods presented here are generally similar to those analyses. However, notable improvements were made to the subsetting routine for the Stephens MacCall procedure, the subsequent spatial zones used in the index, and the final model form which are more reflective of current best practices for indices produced with this dataset.

5.5.2.1. Methods of Estimation

Working Paper Number: SEDAR100-DW-15
Data Type: Fishery Dependent
Time Series: 1993-2024
Sampling Intensity: Between 614-1,982 trips (N) per year
Size/Age Data: Reflective of the commercial landings from handline

Data Filtering Techniques: Initial filtering was for East and West where, due to proportion positive catch of Gray Triggerfish, the East was defined by SEAMAP zones 5-12 and West included zones 13-20 (Table 1 in SEDAR 100-DW-15). Data were then further filtered for trips with incomplete information and for extreme outliers (99th percentile). Stephens MacCall was then used to subset to trips that are considered reflective of Gray Triggerfish habitat using other species associations. Species found positively and negatively associated with Gray Triggerfish in this assessment were generally in line with the previous indices provided in SEDAR 43 and 62.

Standardization: Delta models were used with a binomial component and a positive CPUE component with a gamma distribution for East, West and Gulf-wide.

> **Submodel Variables** Backwards selection with AIC evaluation was used and all three models had all possible variables in the final model for both the binomial and positive catch components. Variables included were:
>
> YEAR – Year was necessarily included, as standardized catch rates by year are the desired outcome. Years modeled were 1993-2024
> **SEASON – Season included four levels: (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec)**

AREA – The SEAMAP zone as a factor with the East including zones 5-12, and the West with zones 13-20 (8 levels each)

DAYS AT SEA – Days at sea (sea days) were pooled into four levels as quartiles of the data for the respective dataset (East, West, or Gulf-wide)

CREW SIZE – Crew size was included as a factor with levels from 1-6 (min to max value)

HOOK HOURS – Trip total hook hours as a four-level factor pooled into quartiles of the data for the respective dataset (East, West, or Gulf-wide)

Annual Abundance Indices: SEDAR100-DW-15 Tables 2-4.

5.5.2.2. Comments on Adequacy for Assessment

This index was deemed suitable based on the time series, segment of the population represented in both length composition and spatial extent, and modeling methodology. However, it was not recommended for use in the assessment. The changing management through time of this species in regards to trip limits, size limits, and reduced season duration make this fishery dependent time series difficult to decouple from these impacts on fishery behavior. Furthermore, it was deemed duplicative in terms of length composition and habitats sampled as the independent, G-FISHER survey which was recommended for use in this assessment.

5.6 RESEARCH RECOMMENDATIONS

- Evaluate potential red tide impacts
- Explore incorporating artificial reef / platform data from G-FISHER (short time series)
- Understanding the connection between sargassum habitat and abundance / life history of gray triggerfish
    - Daily aging of sub-age 0 gray triggerfish
    - Is sargassum obligate?

5.7 LITERATURE CITED

Lo, N.C.H., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Canadian Journal of Fisheries and Aquatic Science 49: 2515-2526.

5.8 TABLES

Table 5.8.1. Breakdown of the fishery independent (top) and fishery dependent (bottom) surveys considered for use in the assessment along with their final determination. (S/R – Suitable and Recommended, S/NR – Suitable and Not Recommended, * - recommended with the understanding that the survey is spatially limited in the eastern gulf)

Fishery Independent Surveys	Gulf-wide	West	East
SEAMAP Fall Groundfish (1987 - 2007)	S/NR	S/NR	
SEAMAP Fall Groundfish (2008 - 2024)	S/NR	S/NR	S/NR
SEAMAP/G-FISHER Reef Fish Video (1993 - 2023)	S/R	S/R	S/R
SEAMAP Fall Plankton (1986 - 2023)	S/NR	S/NR	S/NR
SEAMAP Summer + Fall Groundfish (2009 - 2024)	S/R	S/R	S/R
SEAMAP Summer + Fall Groundfish (1987 - 2008)	S/R*	S/R	

Fishery Dependent Surveys	Gulf-wide	West	East
Commercial Handline (1993 - 2024)	S/NR	S/NR	S/NR
Headboat (1986 - 2007)	S/R	S/R	S/R

Table 5.8.2. Relative abundance (Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of Gulf of America indices recommended for consideration in the assessment.

Year	SEAMAP Summer + Fall Groundfish - Old		SEAMAP Summer + Fall Groundfish - New		SEAMAP / G-FISHER		Headboat	
	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV
1986							0.87078	0.28836
1987	0.56835	0.19422					0.725005	0.29970
1988	0.4953	0.18968					0.87672	0.28776
1989	0.94459	0.16063					1.30915	0.27191
1990	0.45549	0.19061					2.047945	0.23935
1991	2.12051	0.12036					1.470091	0.24176
1992	0.27423	0.20794					1.480927	0.24418
1993	1.38049	0.14471			0.414269	0.19035	1.244823	0.24951
1994	1.45428	0.12897			0.933006	0.48495	1.27111	0.26385
1995	0.91974	0.15517			0.467131	0.30182	1.047011	0.29284
1996	0.65535	0.1858			0.375482	0.15845	1.122074	0.29087
1997	0.56956	0.17321			1.5776	0.20402	1.06009	0.28747
1998	0.10533	0.32013					0.941592	0.27705
1999	1.23651	0.13952					0.999605	0.26817
2000	1.96108	0.12436					0.542469	0.29785
2001	2.97053	0.13786					0.448137	0.30606
2002	0.94186	0.15086			0.900191	0.69144	0.623839	0.30017
2003	0.49846	0.18469					0.731692	0.29248
2004	0.50154	0.16484			0.652346	0.35212	0.797104	0.27902
2005	0.83504	0.15025			0.627868	0.21874	1.021499	0.26247
2006	1.38013	0.15047			1.200054	0.17882	0.642355	0.28554
2007	0.77025	0.16508			1.044374	0.19354	0.725984	0.28789
2008	0.96138	0.12369			1.085496	0.15869		
2009			0.61897	0.11589	1.48863	0.13915		
2010			0.70009	0.14607	0.741284	0.16141		
2011			0.90649	0.13997	0.840483	0.15283		
2012			1.21177	0.12073	0.688465	0.15174		
2013			0.64263	0.17613	0.568017	0.13420		
2014			0.93016	0.12766	0.666497	0.10558		
2015			1.26452	0.10983	0.858797	0.09649		
2016			0.47892	0.17682	1.266416	0.06667		
2017			0.75718	0.13612	1.072754	0.07404		
2018			0.98507	0.12388	1.041269	0.08434		
2019			1.14612	0.13527	0.905208	0.07928		
2020			0.78121	0.20421	1.556289	0.15459		
2021			1.3194	0.12839	1.653959	0.10195		
2022			1.86293	0.12511	1.74845	0.09047		
2023			1.72429	0.11596	1.625666	0.08137		
2024			0.67024	0.16309				

Table 5.8.3. Relative abundance (Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of west Gulf of America indices recommended for consideration in the assessment.

Year	SEAMAP Summer + Fall Groundfish - Old		SEAMAP Summer + Fall Groundfish - New		SEAMAP / G-FISHER		Headboat	
	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV
1986							0.683745	0.23507
1987	0.56304	0.19792					0.812996	0.21658
1988	0.45253	0.20054					1.087124	0.19699
1989	0.95888	0.16346					1.050667	0.21867
1990	0.47975	0.19439					1.589953	0.17919
1991	2.119	0.12341					2.52238	0.15202
1992	0.26502	0.21294					1.807058	0.16429
1993	1.36879	0.15369			0.149586	0.625	1.681793	0.17305
1994	1.41369	0.13303			1.459932	0.812	1.582176	0.17579
1995	0.96362	0.15656			0.194915	0.638	1.164559	0.18289
1996	0.55524	0.19615			0.33414	0.24	1.338432	0.19055
1997	0.59367	0.17437			3.192575	0.271	0.816146	0.21127
1998	0.11264	0.33014					0.640204	0.21981
1999	1.28985	0.14009					0.452752	0.26216
2000	1.93435	0.12721					0.215218	0.26512
2001	3.1296	0.14041					0.316262	0.23869
2002	0.96754	0.15502			1.764596	0.96	0.470578	0.21605
2003	0.46774	0.20036					0.673872	0.19449
2004	0.49796	0.1731			1.247655	0.495	0.749522	0.18561
2005	0.80951	0.15419			1.06584	0.335	0.785661	0.17293
2006	1.35775	0.15563			0.911536	0.563	0.660336	0.17953
2007	0.78665	0.16702			0.988967	0.405	0.898565	0.17474
2008	0.91316	0.1275			1.283476	0.331		
2009			0.30954	0.18981	0.568642	0.353		
2010			0.54099	0.22447	1.261437	0.396		
2011			0.87263	0.18966	1.774749	0.326		
2012			1.58582	0.16013	1.786139	0.271		
2013			0.4783	0.27617	0.99117	0.279		
2014			0.68605	0.20383	0.826124	0.291		
2015			1.31314	0.16091	0.327755	0.586		
2016			0.2088	0.3106	0.732415	0.307		
2017			0.67187	0.20299	1.170404	0.229		
2018			0.92783	0.18334	0.726635	0.218		
2019			0.86136	0.22143	0.241806	0.328		
2020			0.80129	0.27829				
2021			1.45306	0.16381	0.728675	0.22		
2022			2.76839	0.17071	0.544817	0.228		
2023			2.22968	0.15389	0.726014	0.22		
2024			0.29125	0.31778				

Table 5.8.4. Relative abundance (Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of east Gulf of America indices recommended for consideration in the assessment.

Year	SEAMAP Summer + Fall Groundfish - Old		SEAMAP Summer + Fall Groundfish - New		SEAMAP / G-FISHER		Headboat	
	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV
1986							0.92459	0.38094
1987							0.655596	0.43189
1988							0.757932	0.41019
1989							1.330944	0.36396
1990							2.332684	0.30268
1991							1.362103	0.31348
1992							1.418992	0.31090
1993					0.768665	0.198	1.076832	0.33190
1994					0.923364	0.234	1.132578	0.35826
1995					0.961285	0.322	0.962184	0.41655
1996					0.651515	0.2	0.969531	0.41463
1997					0.831543	0.176	1.030454	0.40226
1998							1.025469	0.35667
1999							1.215352	0.32928
2000							0.650139	0.38151
2001							0.446371	0.40803
2002					0.538689	0.198	0.659246	0.38689
2003							0.734911	0.38879
2004					0.432993	0.225	0.818797	0.36721
2005					0.551896	0.181	1.156903	0.33669
2006					1.555499	0.164	0.630368	0.38627
2007					1.386453	0.212	0.708025	0.38449
2008					1.105631	0.166		
2009			1.26805	0.13895	2.132814	0.139		
2010			1.00236	0.18506	0.681176	0.143		
2011			0.97905	0.2075	0.66574	0.12		
2012			0.85167	0.18818	0.471503	0.131		
2013			0.89383	0.21944	0.461266	0.135		
2014			1.2116	0.15712	0.661946	0.106		
2015			1.2081	0.14859	1.136682	0.096		
2016			0.90836	0.20037	1.433038	0.07		
2017			0.78901	0.17841	1.089281	0.081		
2018			0.94298	0.16406	1.196008	0.108		
2019			1.39336	0.16137	1.052933	0.083		
2020			0.6052	0.30197	1.296986	0.111		
2021			0.95653	0.21544	1.255586	0.081		
2022			1.02324	0.18347	1.410275	0.071		
2023			1.02242	0.17948	1.347235	0.068		
2024			0.94424	0.17638				

5.9 FIGURES

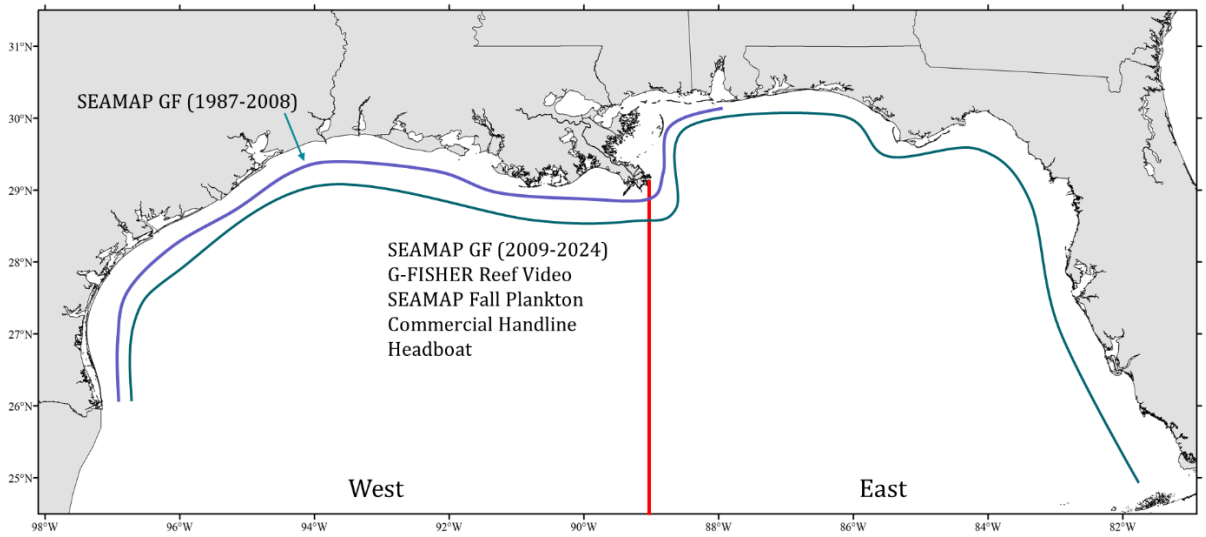


Figure 5.9.1. Relative spatial extent of indices found to be suitable for further review. Red line represents the boundary between the regions as defined in SEDAR43.

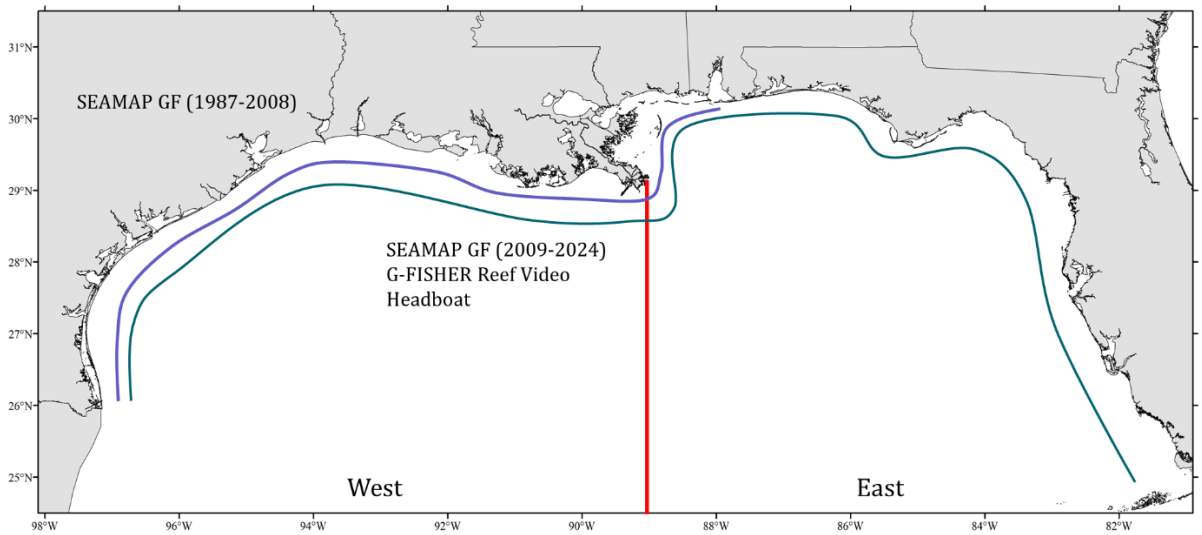


Figure 5.9.2. Relative spatial extent of indices found to be "Suitable and Recommended" for use in the assessment. Red line represents the boundary between the regions as defined in SEDAR43.

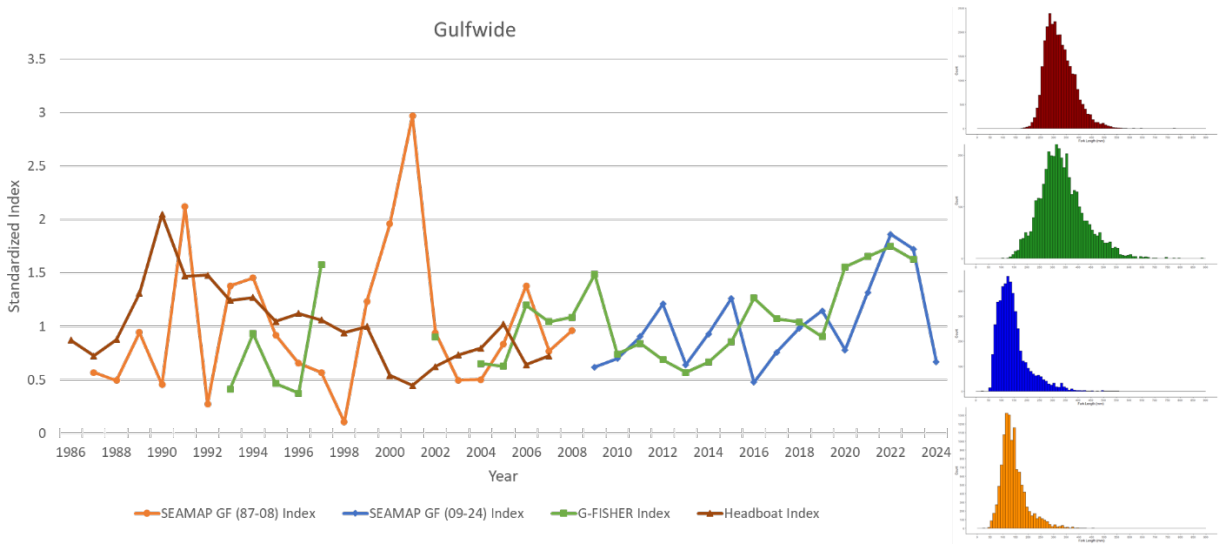


Figure 5.9.3. Recommended relative abundance indices for the Gulf of America, scaled to a mean of one for each time series. Length distribution of gray triggerfish for each time series is displayed in the corresponding color. Note the x-axis on the length distribution is from 0 to 900 mm, with 50 mm breaks.

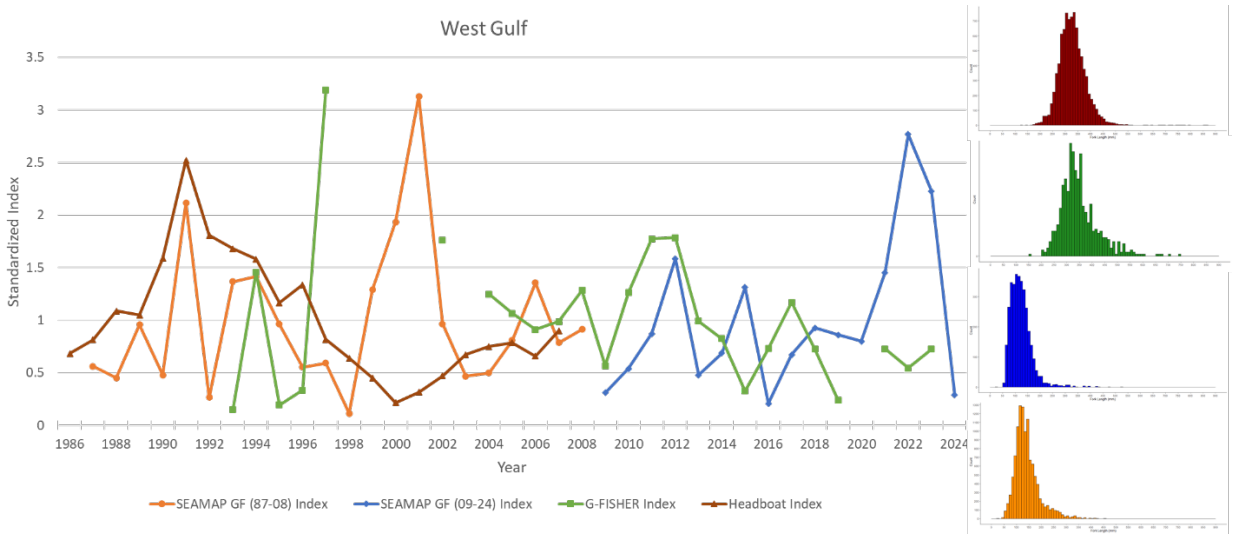


Figure 5.9.4. Recommended relative abundance indices for the western Gulf of America, scaled to a mean of one for each time series. Length distribution of gray triggerfish for each time series is displayed in the corresponding color. Note the x-axis on the length distribution is from 0 to 900 mm, with 50 mm breaks.

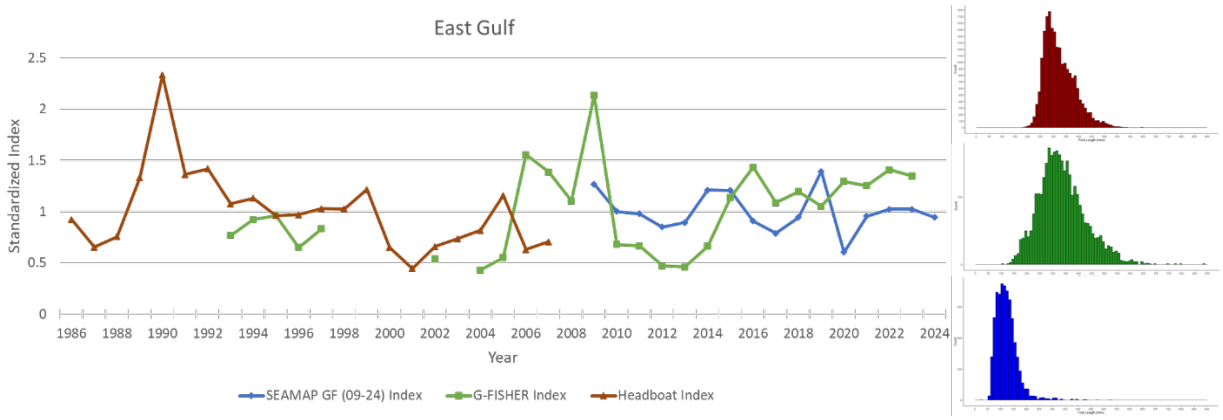


Figure 5.9.5. Recommended relative abundance indices for the eastern Gulf of America, scaled to a mean of one for each time series. Length distribution of gray triggerfish for each time series is displayed in the corresponding color. Note the x-axis on the length distribution is from 0 to 900 mm, with 50 mm breaks.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 100

Gulf Gray Triggerfish

SECTION III: Assessment Report

July 2026

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

NOTE: Modifications to the model configuration reported in this report were made during the Review Workshop held August 11-14, 2026. For complete results reflecting those changes, please see Section VI -Addenda to the Assessment Report.

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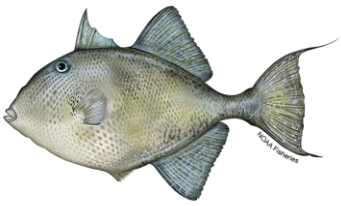

SEDAR 100 Gulf of America Gray Triggerfish Stock Assessment

Gulf Fisheries Branch
Sustainable Fisheries Division
NOAA Fisheries - Southeast Fisheries Science Center

July 2026

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1. Introduction

This document summarizes the Southeast Data Assessment and Review (SEDAR) 100 Gulf of America (Gulf) Gray Triggerfish (*Balistes capriscus*) Assessment as implemented in the Stock Synthesis (version 3.30.21.00) modeling framework (Methot and Wetzel 2013). The last completed assessment for Gulf Gray Triggerfish was the SEDAR 43 Standard Assessment with data through 2013 (SEDAR 2015).

Where practicable, the SEDAR 100 Assessment Process (AP) Model used the same data sets as the SEDAR 43 Standard Model with time series updated through 2024. However, notable changes include:

- revised age data from new ageing protocols and updated growth, natural mortality, and ageing error estimates
- switched to modeling maturity as a function of length rather than age given ageing issues
- updated the time series of commercial landings by reviewing the SEDAR 43 methodology (assumptions and decisions) and making improvements where warranted
- updated the time series of commercial discards using the catch-per-unit-effort (CPUE)-expansion approach used since SEDAR 61 in Gulf stock assessments
- updated the time series of recreational landings and discards from the National Marine Fisheries Service's (NMFS) Marine Recreational Fisheries Statistics Survey (MRFSS) estimates to the Marine Recreational Information Program Fishing Effort Survey (MRIP-FES)-based estimates and using fully-calibrated Texas Parks and Wildlife Department and Louisiana Creel Survey estimates
- incorporated more error in landings and discard estimates to better reflect uncertainties in removals
- updated discard mortality estimates based on recent research
- updated time series of shrimp effort and shrimp bycatch estimates
- re-evaluated indices of relative abundance for inclusion in the assessment
- separated the Southeast Area Monitoring and Assessment Program (SEAMAP) Trawl Survey into two time periods based on differing survey designs and included length compositions
- standardized the relative abundance and length compositions of the Combined Video Survey to account for differences in habitat and survey footprints of the three surveys
- fitted to all available length composition data (discards, landings, and surveys) and used weighted length compositions where possible
- inputted conditional age-at-length compositions for fishing fleets to enable the internal estimation of growth within Stock Synthesis
- re-evaluated recruitment parameters including steepness and *SigmaR* and fixed them at 0.99 and 0.6, respectively
- applied a Dirichlet-Multinomial internal re-weighting approach to age and length compositions

These changes reflect improvements in data inputs and parameterization compared with SEDAR 43. A more comprehensive description of these changes is detailed in subsequent sections of the

assessment report. Assessment methods, results, model diagnostics, stock status determination criteria and projections are also provided through this report.

1.1. Workshop Time and Place

The SEDAR 100 Assessment was developed internally by the Southeast Fisheries Science Center (SEFSC). No SEDAR-led meetings were conducted during this stage. The Assessment Process included internal meetings between January and May to review modeling modifications from SEDAR 43 and make recommendations towards a base model.

1.2. Terms of Reference

Assessment Process Terms of Reference

1. Evaluate and document the following specific changes in input data or deviations from the previous assessment model.

2. Consider continuity model stratification and data structure and suggest any recommended revisions.

    a. Re-evaluate whether commercial and recreational fleets should be separated by East and West by reviewing all available data (landings, discards, indices, compositions).
    b. Provide estimates of uncertainty around each set of landings and discard estimates.
    c. Review ageing validation and ageing structures studies and consider their appropriateness for inclusion in the assessment model.
        i. Update life history data/analyses (e.g., maximum age, growth, mortality, ageing error matrix, reproduction) given revised age data following recent ageing studies as needed
    d. Explore the use of a combined video index from the FWRI, Pascagoula, and Panama City video surveys (e.g., G-FISHER). Recommend modifications needed to inform differences in catchability and selectivity of the surveys.
    e. Evaluate the start year and initial Fs used in the assessment model.
    f. Explore shrimp trawl bycatch magnitude and age-structure, if data are available using new effort and bycatch methodologies (e.g., SEAMAP Summer and Fall Groundfish trawls and shrimp observer data).
    g. Explore fleet-specific length compositions and remote sensing data for sargassum coverage as a potential index of recruitment.
    h. Consider recent discard mortality studies and analytical results and incorporate updated discard mortality rate(s) as appropriate.

3. Document any revisions or corrections made to the input data sets and provide updated input data tables. Provide commercial and recreational landings and discards in numbers and weight (pounds). Describe the fraction of catch by fleet that is discarded.

4. Generate model parameter estimates and their variances, estimates of model uncertainties, and estimates of stock status and management benchmarks. In addition to

the base model, conduct sensitivity analysis to address uncertainty in data inputs and model configuration and consider runs that represent plausible, alternate hypotheses about key parameters.

a. Use the following status determination criteria (SDC):
   i. MSY proxy = yield at F_{MSY} or proxy ($F_{30\%SPR}$, Amendment 48)
   ii. Provide model outputs using alternative MSY proxies as justified by the life history and data available for the stock
   iii. If overfished, MSY proxy = $F_{Rebuild}$
   iv. MSST = $0.5*SSB_{MSY}$ (Amendment 44)
   v. MFMT = F_{MSY} and $F_{Rebuild}$ (if overfished)
   vi. OY = 90% of MSY or proxy (Amendment 48)
   vii. If different SDC are recommended, provide outputs for both the current and recommended SDC.
b. 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.
c. Provide yield and spawning stock biomass streams for the overfishing limit and acceptable biological catch in pounds:
   i. Annually for five years
   ii. Under a "constant catch" scenario for both three and five years
   iii. For the equilibrium yield at F_{MSY}, when estimable

5. Develop a stock assessment report to address these Terms of Reference and fully document the input data and results of the stock assessment model.

1.3. Documents Prepared for the Assessment Process

Document #	Title	Authors	Date Submitted
Documents Prepared for the Assessment Process			
SEDAR100-AP-01	Gray Triggerfish Post-Release Mortality (SEDAR 100)	S100 Ad Hoc Discard Mortality Working Group	23-Apr-26

2. Data Review and Update

A variety of data sources were used in the SEDAR 100 Assessment following the SEDAR 43 Standard Assessment (terminal year of 2013) and the attempted but never completed SEDAR 62 Standard Assessment (terminal year of 2017). Where practicable, the SEDAR 100 AP Model used the same data sets as the SEDAR 43 Standard Model with an updated time series though

2024. However, given the length of time since the last completed assessment (SEDAR 43), there were a number of new or revised data sets provided for consideration including:

1. Updated morphometric conversions
2. Revised age estimates based on improved ageing procedures for reading and advancing age estimates
3. Updated growth curve and natural mortality estimates
4. An ageing error matrix accompanying the revised age data
5. Commercial landings and discard estimates
6. National Marine Fisheries Service's (NMFS) Marine Recreational Information Program Fishing Effort Survey (MRIP-FES) catch and discard time series along with fully calibrated Texas Parks and Wildlife Department and Louisiana Creel Survey estimates
7. Annual estimates of uncertainty accompanying landings and discard estimates
8. Updated estimates of shrimp effort, shrimp bycatch, and proxy bycatch length compositions
9. Commercial and recreational length compositions weighted by landings where possible
10. Commercial and recreational conditional age-at-length compositions
11. Mean length-at-age of Gray Triggerfish landed by each fleet (for checking model predictions only, the model is not fitting to these data inputs)
12. Updated discard mortality estimates based on recent research
13. Separated the Southeast Area Monitoring and Assessment Program (SEAMAP) Trawl Survey into two time periods based on differing survey design and included length compositions
14. Standardized the relative abundance and length compositions of the Combined Video Survey to account for differences in habitat and spatial footprints of the three video surveys

These new data series were considered because they had not previously been available for the SEDAR 43 Standard Assessment or represented improved data inputs for use in the SEDAR 100 Assessment. The data utilized in the SEDAR 100 AP Model are summarized below and illustrated in **Figure 1** along with their corresponding temporal scale. Comprehensive descriptions of individual data components are provided within each subsection below.

1. Life history
    a. Morphometrics
    b. Age and growth
    c. Natural mortality
    d. Maturity
    e. Fecundity
2. Discard mortality rates (based on numbers of fish)
    a. Recreational
    b. Commercial Vertical Line
3. Landings
    a. Recreational: 1945-2024 (1,000s of fish)

   b. Commercial Vertical Line: 1945-2024 (metric tons whole weight)
   c. Commercial Longline: 1979-2024 (metric tons whole weight)
4. Mean weight (kg, whole weight) of landings
   a. Recreational: 1981-2024
5. Shrimp Effort
   a. Shrimp Effort: 1945-2024
6. Discards
   a. Recreational: 1981-2024 (1,000s of fish)
   b. Commercial Vertical Line: 2000-2024 (1,000s of fish)
   c. Shrimp Bycatch: median value of 1947-2023 assumed representative for 1946-2023 (1,000s of fish)
7. Length composition of landings (2 to 74 cm Fork Length (cm FL), 2 cm FL bins)
   a. Recreational: 1981-2024
   b. Commercial Vertical Line: 1990-2024
   c. Commercial Longline: 1990-2024
8. Length composition of discards (2 to 74 cm FL, 2 cm FL bins)
   a. Recreational: 2009-2024 (Florida, Alabama, and Mississippi At-Sea Observer Programs)
   b. Commercial Vertical Line: 2010-2024 (NMFS Reef Fish Observer Program)
   c. Shrimp Bycatch: 1984-2023 (Proxy based on SEAMAP Trawl Survey)
9. Conditional age-at-length of landings (1-year age bins, plus group ages 10 and older)
   a. Recreational: 2003-2024
   b. Commercial Vertical Line: 2003-2024
   c. Commercial Longline: 2003-2022
10. Mean length-at-age of landings
   a. Recreational: 2003-2024
   b. Commercial Vertical Line: 2003-2024
   c. Commercial Longline: 2003-2022
11. Abundance indices
   a. Fishery-independent:
      i. SEAMAP Trawl Early Survey: 1987-2008
      ii. SEAMAP Trawl Late Survey: 2009-2024
      iii. Combined Video Survey: 1993-2024
   b. Fishery-dependent:
      i. Recreational (Southeast Region Headboat Survey, SRHS) CPUE: 1986-2007
12. Length composition of surveys (2 to 74 cm FL, 2 cm FL bins)
   a. SEAMAP Trawl Early Survey: 1987-2008
   b. SEAMAP Trawl Late Survey: 2009-2024
   c. Combined Video Survey: 1996-2024

A summary listing of all data sets included in the assessment, along with any revisions to the contact information for who provided the analysis, has been compiled below. This will be the source of data information for the next assessment.

Data Type	Contributing Organization	Data Providers	Contact Information
Life History			
Raw length data	GulfFIN	Gregg Bray	Gregg.Bray@gsmfc.org
Raw age and length data	GulfFIN	Gregg Bray	Gregg.Bray@gsmfc.org
Raw age and length data	FWRI	Justin Lewis	Justin.Lewis@MyFWC.com
Raw age and length data	MSU	Amanda Jargowsky	aej279@msstate.edu
Raw age, length, reproduction data	SEFSC	Ashley Pacicco	ashley.pacicco@noaa.gov
Raw reproduction data	USM	Nancy Brown Peterson	nancy.brown-peterson@usm.edu
Compiled age, length, and reproduction data	SEFSC	Ashley Pacicco	ashley.pacicco@noaa.gov
Natural mortality estimate	SEFSC	Ashley Pacicco	ashley.pacicco@noaa.gov
Growth curves	SEFSC	Ashley Pacicco Steve Garner	ashley.pacicco@noaa.gov steven.garner@noaa.gov
Morphometric conversions	SEFSC	Ashley Pacicco	ashley.pacicco@noaa.gov
Ageing error matrix	SEFSC	Steve Garner	steven.garner@noaa.gov
Fishery-Dependent			
Raw commercial size data (sample size)	SEFSC	Larry Beerkircher	lawrence.r.beerkircher@noaa.gov
Raw commercial size data	SEFSC	Larry Beerkircher	lawrence.r.beerkircher@noaa.gov
Raw recreational size data	SEFSC	Samantha Binion-Rock	samantha.binion-rock@noaa.gov
Raw recreational size data - SE Region Headboat Survey	SEFSC	Rob Cheshire	rob.cheshire@noaa.gov

Data Type	Contributing Organization	Data Providers	Contact Information
Fishery-Dependent			
Raw commercial logbook catch and effort	SEFSC	Sydney Alhale	sydney.alhale@noaa.gov
Raw commercial discard logbook data	SEFSC	Sydney Alhale	sydney.alhale@noaa.gov
Raw commercial observer program data	SEFSC	Gary Decossas	gary.decossas@noaa.gov
Raw recreational discard size data	FWRI	Ellie Corbett	Ellie.Corbett@MyFWC.com
Raw recreational discard size data	SEFSC	Matt Nuttall	matthew.nuttall@noaa.gov
Raw recreational discard size data	ADCNR	John Mareska	John.Mareska@dcnr.alabama.gov
Commercial mean weights	SEFSC	Michaela Pawluk	michaela.pawluk@noaa.gov
Commercial landings	SEFSC	Sarina Atkinson Michaela Pawluk	sarina.atkinson@noaa.gov michaela.pawluk@noaa.gov
Commercial length compositions	SEFSC	Michaela Pawluk	michaela.pawluk@noaa.gov
Commercial age compositions	SEFSC	Michaela Pawluk	michaela.pawluk@noaa.gov
Commercial mean length at age	SEFSC	Michaela Pawluk	michaela.pawluk@noaa.gov
Commercial conditional age-at-length	SEFSC	Michaela Pawluk	michaela.pawluk@noaa.gov
Recreational catch (landings + discards) estimates and effort estimates	SEFSC	Samantha Binion-Rock	samantha.binion-rock@noaa.gov
Recreational private mode estimates (MRIP-FCAL to SRFS calibrations & SRFS catch estimates)	FWRI	Maria McGirl	Maria.McGirl@MyFWC.com
SE Region Headboat Survey catch and effort	SEFSC	Rob Cheshire	rob.cheshire@noaa.gov

Data Type	Contributing Organization	Data Providers	Contact Information
Fishery-Dependent			
Headboat discards prior to SRHS	SEFSC	Matt Nuttall	matthew.nuttall@noaa.gov
Compiled recreational catch (landings + discards) estimates	SEFSC	Matt Nuttall Samantha Binion-Rock	matthew.nuttall@noaa.gov samantha.binion-rock@noaa.gov
Recreational historical landings estimates	SEFSC	Samantha Binion-Rock	samantha.binion-rock@noaa.gov
Recreational length compositions	SEFSC	Samantha Binion-Rock	samantha.binion-rock@noaa.gov
Recreational age compositions	SEFSC	Samantha Binion-Rock	samantha.binion-rock@noaa.gov
Recreational mean length at age	SEFSC	Samantha Binion-Rock	samantha.binion-rock@noaa.gov
Recreational conditional age-at-length	SEFSC	Samantha Binion-Rock	samantha.binion-rock@noaa.gov
Recreational discard length compositions - Florida only	FWRI	Ellie Corbett	Ellie.Corbett@MyFWC.com
Recreational discard length compositions - MS to FL	SEFSC	Samantha Binion-Rock	samantha.binion-rock@noaa.gov
Commercial discards estimates	SEFSC	Sarina Atkinson Kevin Thompson	sarina.atkinson@noaa.gov kevin.thompson@noaa.gov
Commercial discard length compositions	SEFSC	Sarina Atkinson Kevin Thompson	sarina.atkinson@noaa.gov kevin.thompson@noaa.gov
Shrimp effort	SEFSC	Kyle Dettloff	kyle.dettloff@noaa.gov
Shrimp bycatch estimates and length compositions	SEFSC	Steve Smith Cheston Peterson	steven.smith@noaa.gov cheston.peterson@noaa.gov
Headboat index (East, West, Gulf-wide)	SEFSC	Matt Nuttall	matthew.nuttall@noaa.gov
Commercial vertical line index (East, West, Gulf-wide)	SEFSC	Kevin Thompson	kevin.thompson@noaa.gov

Data Type	Contributing Organization	Data Providers	Contact Information
Fishery-Independent			
G-FISHER index	SEFSC	Kate Overly	katherine.overly@noaa.gov
G-FISHER length compositions	SEFSC	Kate Overly	katherine.overly@noaa.gov
SEAMAP Summer-Fall Trawl Survey index	SEFSC	Adam Pollack	adam.pollack@noaa.gov
SEAMAP Summer-Fall Trawl Survey age compositions	SEFSC	Adam Pollack	adam.pollack@noaa.gov
SEAMAP Summer-Fall Trawl Survey length compositions	SEFSC	Adam Pollack	adam.pollack@noaa.gov

2.1. Stock Structure and Management Unit

No new literature was identified during SEDAR 100; therefore, the stock definition was unchanged from previous assessments. Gray Triggerfish has been considered a single unit stock throughout the Gulf because of their prolonged and indeterminate pelagic phase and the potential of wide dispersal (SEDAR 2006). The management unit for Gulf Gray Triggerfish extends from the United States (US)–Mexico border in the West through the northern Gulf and west of the Dry Tortugas and the Florida Keys (north of US Highway 1).

2.2. Life History Parameters

Life history data used in the assessment included length-weight and length-length relationships, age and growth, natural mortality, maturity, and fecundity. Some of the life history data were input to the assessment model as fixed values, while other life history parameters were estimated. Sex ratio at birth was assumed to be 1:1 as in SEDAR 43.

2.2.1. Morphometric and Conversion Factors

Morphometric conversion factors developed during the SEDAR 43 Standard Assessment were updated during the SEDAR 100 Assessment because of the large increase in sample sizes for analyses. The relationship between whole weight (wwt; in kilograms) and fork length (FL; in centimeters) for both sexes combined was used as a fixed model input (**Table 1**, **Figure 2A**). The total length (TL) to FL conversion was used to convert the minimum size limit in 1999 for input into the model retention functions (**Section 3.1.8**).

2.2.2. Age and Growth

Age data for SEDAR 100 were collected between 2003 and 2024 by federal and state sampling programs and submitted by the Panama City Laboratory of the SEFSC, the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI; SEDAR100-DW13), the Gulf States Marine Fisheries Commission Fisheries Information Network (GulfFIN), and Dauphin Island Sea Lab/University of South Alabama (detailed in SEDAR100-DW14). Age data from the commercial and recreational fisheries were input into the assessment (**Sections 2.3.9-2.3.10**).

While preparing for the SEDAR 100 Assessment, major improvements to ageing procedures were made following recent research on Gray Triggerfish ageing. Specifically, previous methods for ageing spines led to age estimates biased low because of the difficulty in distinguishing translucent zones near the edge of the spines. Potts et al. (2023) developed a protocol which increased magnification on spines and led to less biased age estimates, results of which were later validated by Chamberlain et al. (2024 [SEDAR100-RD03]). The increased magnification revealed the presence of compacted growth zones near the margin of the dorsal spine sections of age-5 or older specimens; therefore, for SEDAR 100, all Gray Triggerfish aged 5 or older were re-aged using the updated protocol. While these updates led to a greatly improved age data set for consideration, there remains considerable variability in size-at-age. For example, a 40 cm FL Gray Triggerfish can range anywhere from 2 to 15 years old (**Figure 3**).

The SEDAR 100 Life History Working Group uncovered an issue at the Data Workshop with how age assignments were being adjusted based on the settlement mark and a previously defined algorithm (Allman et al. 2019 [SEDAR62-WP09]). These issues were alleviated partly by the primary reader re-ageing all fish with annuli counts of 0 or 1 that were caught from September through December and were < 25 cm FL, along with outlier fish with an annuli count of 2 that were caught from April through May with a FL > 40 cm. In addition, the Life History Working Group developed an age slicing algorithm using Electronic Length Frequency Analysis (ELEFAN) to assign calendar age for samples with annuli counts of 0 or 1, however, this approach was not recommended beyond age 1 as modes became less distinct with age (**Figure 2.14.7 in Data Workshop Report**). Gray Triggerfish with two annuli counts re-aged by the primary reader ranged from 3 to 7 years old, further highlighting the difficulty in ageing, which remains a key uncertainty for this species.

Growth was modeled using a single size-modified von Bertalanffy growth curve for both sexes combined (**Table 2**, **Figure 2B**). The SEDAR 100 Data Workshop recommended a constant coefficient of variation (CV)-at-age (CV = 0.14). Growth curves were estimated by sex to evaluate whether the SEDAR 100 data supported sexually-dimorphic growth, however no notable differences were detected (**Section 2.5 of Data Workshop Report**). This finding differs from previous studies (summarized in Jefferson et al. 2019 [SEDAR62-RD01]; Chamberlain et al. 2025 [SEDAR100-RD04]), although many of the older studies referenced likely suffered from biased age estimates obtained using the old spine ageing protocol.

To account for uncertainty in the ageing process (e.g., due to different readers; SEDAR100-DW14), standard deviations (SD)-at-age were calculated and used as a measure of ageing error in the assessment model. Ageing error estimates were estimated by fitting a single error model to all three sets of age estimates for the reference set. The best fit model based on Akaike's

Information Criterion (AIC) values estimated linear bias and assumed a curvilinear SD (**Section 2.6 in Data Workshop Report**). Uncertainty in age estimates increased with age (**Table 3**), with wider distributions of observed ages evident for older Gray Triggerfish (**Figure 4**).

2.2.3. Natural Mortality

As in SEDAR 43, natural mortality (*M*) was modeled using a Lorenzen function, i.e. a size-dependent mortality schedule (Lorenzen 2000; Lorenzen et al. 2022) in which the instantaneous mortality rate-at-age is inversely proportional to length-at-age (**Table 4**, **Figure 2C**). Parameters required for this approach include the age at full recruitment to the fishery, a target *M* point estimate for the species representing the cumulative mortality rate over the range of exploited ages, and growth curve parameter estimates.

Following review of the updated age data, the SEDAR 100 Life History Working Group maintained the maximum age (*tmax*) of 15 years used in SEDAR 43. An updated point estimate for *M* was derived using the *M* estimator developed by Hamel and Cope (2022):

$$M = 5.4/tmax$$

This study evaluated Then et al.'s (2015) updated data set of *M* and maximum age with a more appropriate transformation than was used by Then et al. (2015) (see Hamel and Cope 2022 for more detail on the approach). Applying the Hamel and Cope (2022) estimator using a maximum age of 15 years yielded an updated *M* point estimate of 0.36, an increase from the SEDAR 43 estimate of 0.28 based on Hoenig (1983).

2.2.4. Maturity

Maturity parameters developed during the SEDAR 43 Standard Assessment were not updated during the SEDAR 100 Assessment because no new analyses were conducted. While new reproduction data from Alabama waters spanning 2016 through 2019 (N = 406) were submitted by the University of Southern Mississippi/Alabama Department of Conservation and Natural Resources, the majority of data were collected outside of the time period used in SEDAR 43 analyses (June through August) and no age estimates were provided. Previously, SEDAR 43 recommended modeling maturity as a function of age (Fitzhugh et al. 2015 [SEDAR43-WP03]). However, given the ageing concerns particularly for ages 1-2 discussed in **Section 2.2.2** and also noted in SEDAR100-DW20, maturity was modeled as a function of length for SEDAR 100 using the values provided for SEDAR 43. The slope was estimated at -0.232 and the length at 50% maturity was predicted around 15.26 cm FL (**Figure 2D**). The first age mature was 2 years based on SEDAR 43 (Fitzhugh et al. 2015 [SEDAR43-WP03]), although this should be revisited given changes to the age estimates.

2.2.5. Fecundity

Fecundity parameters used during the SEDAR 43 Standard Assessment (i.e., $eggs = aLength^b$; Lang and Fitzhugh 2015 [SEDAR62-RD05]) were not updated during the SEDAR 100 Assessment because no new data were provided. However, given concerns over the limited fecundity data from SEDAR 43 (N = 73 spanning an incomplete size range of 26 to 39 cm FL) combined with the lack of uncertainty accounted for in the relationship within the assessment

model, SEDAR 100 used female-only spawning stock biomass (SSB) as a measure of reproductive potential (i.e., SSB equivalent to female body weight, **Figure 2E**).

2.2.6. Discard Mortality

Discard mortality estimates were updated from those recommended for the SEDAR 43 Standard Assessment (5% with 10% as a sensitivity) based on a synthesis of recent studies and analyses (SEDAR100-AP01). The discard mortality rate for the Recreational fleet was 40%, which was obtained from a synthesis of current discard mortality research from tagging and acoustic telemetry studies (Runde et al. 2019 [SEDAR100-RD05], Bohaboy et al. 2020 [SEDAR100-RD01], Patterson et al. 2020 [SEDAR100-RD02]) and a Bayesian discrete-time survival analysis by Hyman et al. (SEDAR100-DW17; but updated in Hyman et al. 2026). Additional discard mortality estimates of 26% and 60% were recommended for sensitivity runs by the Ad-Hoc Discard Mortality Working Group, with these values representing the lower and upper bounds based on the studies reviewed (SEDAR100-AP01). Given the lack of data to evaluate discard mortality for the Commercial Vertical Line fleet, discard mortality was assumed similar between the Recreational and Commercial Vertical Line fleets because of similar fishing practices.

2.3. Fishery-Dependent Data

2.3.1. Commercial Landings

Commercial landings data (1945-2024) used in the assessment are presented in **Table 5** and **Figure 5**. Commercial landings for Gray Triggerfish were constructed using data housed in NOAA's SEFSC's Accumulated Landings System (ALS) and from state trip ticket programs when available: Texas 2014+, Louisiana 2000+, Mississippi 2015+, Alabama 2002+, and Florida 1986+ (**Table 6**). The earliest year with commercial landings data was 1949 (SEDAR100-DW05), and therefore estimates prior to 1948 were interpolated down to an assumed start in 1945 following SEDAR 43 (**Table 5**). For the assessment, commercial landings were partitioned into two fleets that represent the two main commercial harvesting gears: (1) Vertical Line or Handline and (2) Longline (**Section 3.1.6**). For SEDAR 100, landings by trap and other gears (~6% overall) were lumped into the Commercial Vertical Line fleet.

Commercial landings have been predominantly by vertical line gears, which increased considerably throughout the late 1980s and peaked in 1993 (**Figure 5**). Comparatively, Longline landings have remained relatively low, with the exception of a small peak in 1990.

Commercial landings were reported in pounds wwt and converted to metric tons for input into the assessment model. Uncertainty estimates for landings were not provided during the SEDAR 43 Standard Assessment, which fit the landings as known (log-scale standard error (SE) of 0.05). Uncertainty estimates based on expert opinion were developed during the SEDAR 68 Gulf Scamp Grouper Research Track Assessment by state (**Table 6**; SEDAR 2021). Since Gray Triggerfish are caught across the Gulf, state-specific error estimates were multiplied by state landings to produce a weighted-error estimate for annual landings by fleet (**Table 5**). These error estimates included more uncertainty for the earlier years of the time series (**Table 5**).

Although numerous updates and improvements to methodology have been made between SEDAR 100 and SEDAR 43, the commercial landings estimates were very similar since 1963. Historical landings estimates revealed the largest difference (>10%; **Table 7**), primarily because

SEDAR 43 interpolated commercial landings from 1945 to 1962 whereas commercial landings estimates were provided for SEDAR 100 beginning in 1949. SEDAR 100 showed a notable increase in landings in the early 1950s.

2.3.2. Recreational Landings

Recreational landings data (1945-2024) used in the assessment are presented in **Table 8**. Recreational landings of Gray Triggerfish were estimated using fully calibrated estimates from the Marine Recreational Information Program (MRIP) using the Fishing Effort Survey (FES) and the redesigned Access Point Angler Intercept Survey (APAIS; SEDAR100-DW02), Texas Parks and Wildlife Department estimates calibrated to MRIP-FES units (SEDAR100-DW02), Louisiana Creel Survey estimates calibrated to MRIP-FES units (SEDAR100-DW02), and the Southeast Region Headboat Survey (SRHS; SEDAR100-DW01). While estimates from the Florida State Reef Fish Survey (SRFS) were reviewed during the Data Workshop (SEDAR100-DW12), their inclusion was ultimately not recommended because landings were more spread throughout the Gulf.

Historical recreational landings (1955-1980) were estimated using the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) approach (SEDAR100-DW03), whereas the estimates prior to 1955 were interpolated down to an assumed start in 1945 following SEDAR 43 (**Table 8**). For the assessment, recreational landings were included for a single fleet encompassing charter, private and headboat modes (**Section 3.1.6**). Following SEDAR 43, the shore mode was excluded because it comprised <1% of overall recreational landings and estimates tend to be very sporadic and highly uncertain.

Recreational landings were substantially higher than commercial landings throughout the time series (**Figure 5**). Recreational landings peaked in the early 1990s and also exhibited smaller peaks in the early 1980s and mid-2000s, before declining to relatively lower values in the most recent years.

The large differences between SEDAR 100 and SEDAR 43 recreational landings estimates are expected, primarily because SEDAR 100 used estimates from the MRIP-FES survey which are much larger than previous estimates provided for SEDAR 43 (**Table 9**). In addition, SEDAR 100 included Texas and Louisiana recreational estimates which were calibrated to MRIP-FES units.

Recreational landings data were also provided in wwt (**Table 10**). Weight estimates were developed by the SEFSC and used the MRIP (Matter and Nuttall 2020 [SEDAR68-DW13]) sample data to obtain a mean weight of landed Gray Triggerfish by strata using the following hierarchy (from coarsest to finest): species, region, year, state, mode, wave, and area (Matter and Rios 2013). Mean weight of landed Gray Triggerfish was then multiplied by the landings estimates in numbers to obtain estimates of landings in weight (SEDAR100-DW02). Fishery managers use these landings estimates in weights for Annual Catch Limit (ACL) monitoring.

Recreational landings in 1,000s of fish were input into the assessment model (**Table 8**; **Figure 5**). Numbers were ultimately preferred as the input (as opposed to weights) because they are the native units of data collection by the MRIP program (and other state sampling programs). Uncertainty estimates (CV) were provided for the Recreational fleet, averaging 0.25 and ranging from 0.12 in 1999 to 0.55 in 2017 (SEDAR100-DW02). Only one year (2017) had a landings CV estimate that exceeded 0.5 (**Section 3.4.7**).

Along with recreational landings in numbers, the mean weight (in kilograms) of Gray Triggerfish landed by the Recreational fleet was also included in the assessment model (**Table 11**). The mean weight was obtained by dividing the estimates of recreational landings in weights by the recreational landings in numbers to get an average size (**Table 11**). The SE was calculated from trip-level summaries of raw weight data (mean(weight) by vessel) to account for any correlation in fish sizes sampled from the same intercept (SEDAR100-DW02). Accompanying uncertainty estimates (CV) for mean weight of Gray Triggerfish landed by the Recreational fleet averaged 0.13 (range: 0.06-0.34; **Table 11**). Inclusion of this data source allows a comparison between the expected mean weight by the assessment model and the mean weight of Gray Triggerfish landed by the Recreational fleet.

2.3.3. Commercial Discards

Commercial discards (2000-2024) for the Vertical Line fleet used in the assessment are presented in **Table 12**. The commercial discards were estimated using CPUE from the NMFS Reef Fish Observer Program and total fishing effort from the NMFS Commercial Reef Logbook Program (SEDAR100-DW06). Estimates begin in 2000 because it was assumed that discards were negligible prior to the implementation of a federal size limit of 12 inches TL in 1999 (SEDAR100-DW06). A full description of the CPUE-expansion estimation procedure is given in SEDAR100-DW06. Overall, discards by the Vertical Line fleet accounted for a very variable proportion of the total catch (kept + discards), with substantially larger discards since 2009 due to increased regulations (SEDAR100-DW06). No discard estimates were provided for the Commercial Longline fleet.

Compared to recreational discards and shrimp bycatch, commercial discards are very minor (**Figure 6**). The discard estimates reported in numbers were input into the assessment as 1,000s of fish. This input was preferred to the approach used in SEDAR 43, which input discards as a fraction using a fixed error of 0.2 and modeled three time blocks to account for various fishing regulations. Annual estimates were input along with their corresponding log-scale SEs which averaged 0.25 (range: 0.12-0.37; **Table 12**). A discard mortality rate of 40% was used for the Vertical Line fleet (**Section 2.2.6**).

2.3.4. Recreational Discards

Recreational discards (1981-2024) used in the assessment are presented in **Table 13**. The recreational discards were estimated using fully calibrated estimates from MRIP using FES and the redesigned Access Point Angler Intercept Survey (APAIS; SEDAR100-DW02), Texas Parks and Wildlife Department estimates calibrated to MRIP-FES units (SEDAR100-DW02), Louisiana Creel Survey estimates calibrated to MRIP-FES units (SEDAR100-DW02), SRHS estimates (SEDAR100-DW01), and proxy headboat discard estimates (1986-2007) using the Super-Ratio approach (SEDAR100-DW08).

Recreational discard estimates have increased substantially in recent years (**Figure 6**), primarily due to increased regulations. The discard estimates reported in numbers were input into the assessment as 1,000s of fish with corresponding log-scale SEs which averaged 0.31 (range: 0.13-0.75; **Table 13**). The years 1981-1987 had CV estimates that exceeded 0.5 (**Section 3.4.7**). A discard mortality rate of 40% was used for the Recreational fleet (**Section 2.2.6**).

2.3.5. Shrimp Bycatch Discards

A technical review of the shrimp bycatch input data sources, data processing procedures, and estimation methods used in prior Gulf assessments, including SEDAR 43, concluded that the previous methodology was no longer appropriate for estimating bycatch in the shrimp trawl fishery. As a result, a new approach to estimating bycatch was developed by the SEFSC. This methodology was first applied to SEDAR 98 Gulf Red Snapper (*Lutjanus campechanus*) and successfully passed a Center for Independent Experts (CIE) technical review (Smith et al. 2025 [SEDAR98-DW25]). Unfortunately, this approach was not feasible for Gray Triggerfish because they were not consistently recorded within the Shrimp Observer Program since mandatory reporting began in 2007. Gray Triggerfish was not on the list of 22 species for which data were to be recorded during "Evaluation Protocol" observer trips. Gray Triggerfish have been documented to occur in shrimp bycatch (SEDAR100-DW22), although the magnitude of bycatch has been uncertain given how reporting issues in the observer data may have biased previous results (Scott-Denton et al. 2012 [SEDAR100-RD06]).

For Gray Triggerfish, a stop-gap approach was applied in the interim to develop estimates of shrimp bycatch for use in the SEDAR 100 Assessment. Bycatch estimation was applied to proxy species for Gray Triggerfish based on a co-occurrence analysis of SEAMAP trawl data, which were filtered to reflect commercial shrimping grounds/habitat as accurately as possible. The proxy species chosen were Lane Snapper (*Lutjanus synagris*) and Red Snapper depending upon the strata examined. Annual bycatch estimates (1984-2023) were then calculated using the same methodology applied to Red Snapper in SEDAR 98 and calibrated based on catch-per-unit-effort (CPUE) ratios of Gray Triggerfish and the proxy species in the filtered SEAMAP trawl data set. Additional details on the data filtering process applied to the SEAMAP trawl data set, determining co-occurring species for use as a proxy, and the methodology are discussed in SEDAR100-DW22.

Estimates of Gray Triggerfish caught by shrimp trawlers from 1984 to 2023 were made available during SEDAR 100 using the approach discussed above (**Table 14**). Estimates of shrimp bycatch prior to 1984 were based on two different methods. For 1960 through 1983, the relative trend in shrimp effort (**Table 15**; **Figure 7**) was used to back-calculate shrimp bycatch estimates, assuming that the trend in effort would reflect the trend in bycatch estimates. For 1947-1959, a simple interpolation was used which gradually reduced the estimated bycatch to a starting value of 26,000 fish in 1947 (assumed start based on first year of data from SEDAR 43).

Shrimp bycatch estimates increased until reaching a peak in 1987, and have declined substantially in recent years (**Table 14**; **Figure 6**) due to economic challenges facing the fishery (Liese et al. 2026).

Shrimp bycatch estimates between SEDAR 100 and SEDAR 43 differed considerably, with far less inter-annual variability observed in the SEDAR 100 estimates (**Figure 8**). Estimates provided for SEDAR 43 began in 1972, with prior values back-calculated using an unverified approach. Overall, shrimp bycatch estimates for SEDAR 100 were considerably lower, peaking around 3.6 million fish compared to over 12 million fish estimated for SEDAR 43 (**Figure 8**).

Because of the large uncertainty in the annual estimates of shrimp bycatch, the bycatch discards were input as a single super-period, where the median value for all available years (1947-2023)

of 1,612,310 was assumed representative for the time period 1946-2023. The log-scale SE for the mean discard numbers was set to 0.121 which was the estimated SE for 1984. The median bycatch estimate was then scaled annually by a time series of shrimp effort (**Table 15**; **Figure 7**), which was scaled to a mean of 1 for input into the assessment model.

2.3.6. Commercial Size Composition

Annual length compositions were combined into 2-cm Fork Length interval bins (2 to 74 cm FL). For each commercial fleet, length data of landed or retained Gray Triggerfish from the commercial trip intercept program (TIP) and GulfFIN were aggregated into two major sub-regions (East and West) and weighted based on the distribution of landings estimates between sub-regions. For years where weighting was not possible, nominal compositions were used (Vertical Line: 2006, 2008-2011; Longline: all years). A detailed description of the revised methodology, data filtering, results and data limitations for developing compositions are discussed in SEDAR100-DW07. Length data from the NMFS Reef Fish Observer Program were used to characterize the length compositions from commercial discards (SEDAR100-DW06). Annual discards-at-length were computed by multiplying the relative proportion at a length bin and annual estimates of total discards.

Overall, length compositions of Gray Triggerfish landed and discarded by the Commercial Vertical Line fleet peaked around 36 and 32 cm FL, respectively (**Figure 9**). Annual Commercial Vertical Line length compositions of Gray Triggerfish landed (1990-2024) are presented in **Figure 10** along with input sample sizes which averaged 106 trips (range: 22-244). Annual Commercial Vertical Line length compositions of Gray Triggerfish discarded (2010-2024) are presented in **Figure 11** along with sample sizes in number of trips which averaged 30 trips (range: 10-96).

Overall, length compositions of Gray Triggerfish landed by the Commercial Longline fleet peaked around 50 cm FL (**Figure 9**). Annual Commercial Longline length compositions of Gray Triggerfish landed (1990-2024) are presented in **Figure 12**. Input sample sizes averaged 25 trips (range: 10-46).

Annual length compositions were input into the assessment model along with input sample sizes reflective of the number of trips (≥ 10). Year-fleet combinations with less than 10 trips sampled were excluded from the assessment model (Vertical Line landings: 1989; Vertical Line discards: 2007-2009, 2020; Longline landings: 1992, 1994-1995, 1997, 2000, 2004, 2009-2010, 2012, 2020-2021).

SEDAR 43 did not include length compositions as a data input into the assessment model. For SEDAR 43, length compositions of landings were used in conjunction with an age-length key to develop annual age compositions for input into the assessment model. Given the concerns discussed previously in **Section 2.2.2** regarding the age data for Gray Triggerfish, as well as to address an explicit Term of Reference for SEDAR 100, length compositions of both landed and discarded Gray Triggerfish were input directly into the SEDAR 100 AP Model.

2.3.7. Recreational Size Composition

Annual length compositions were combined into 2-cm Fork Length interval bins (2 to 74 cm FL). For the Recreational fleet, length data of landed Gray Triggerfish were obtained from MRIP

(formerly MRFSS), Texas Parks and Wildlife Department, SRHS and GulfFIN. Length data were aggregated into two major sub-regions (East and West) and weighted based on the distribution of landings estimates between sub-regions. For years where weighting was not possible, nominal compositions were used (1981-1982, 2010, 2017-2021, 2024). A detailed description of the revised methodology, data filtering, results and data limitations for developing compositions are discussed in SEDAR100-DW04. Length composition samples provided by Florida's FWRI At-Sea Observer Program (SEDAR100-DW11), Alabama's At-Sea Observer Program, and Mississippi's At-Sea Observer Program were used for characterizing the discards for the Recreational fleet (**Section 4.6.2 in Data Workshop Report**). Length data were aggregated into two major sub-regions (North [Mississippi - Florida panhandle] and South [Florida peninsula]) and weighted based on the distribution of discard estimates between sub-regions. While the SEDAR 100 Recreational Working Group explored additional weighting schemes (e.g., by mode), they recommended using the spatial weighting because there were more pronounced spatial differences in discard length compositions than among modes (**Section 4.6.2 of Data Workshop Report**).

Overall, length compositions of Gray Triggerfish landed and discarded by the Recreational fleet peaked at 30 (smaller peak at 36) and around 32 cm FL, respectively (**Figure 9**). Annual Recreational length compositions of Gray Triggerfish landed (1981-2024) are presented in **Figure 13** along with input sample sizes which averaged 463 trips (range: 30-802). Annual Recreational length compositions of Gray Triggerfish discarded (2009-2024) are presented in **Figure 14** along with sample sizes in number of trips which averaged 164 trips (range: 29-274).

Annual length compositions were input into the assessment model along with input sample sizes reflective of the number of trips (≥ 10).

2.3.8. Shrimp Discards Size Composition

Annual length compositions were combined into 2-cm Fork Length interval bins (2 to 74 cm FL). For the Shrimp Bycatch fleet, length data of discarded Gray Triggerfish were assumed representative of the distribution obtained from the filtered SEAMAP trawl length frequencies and calculated based on the estimates of bycatch. A detailed description of these proxy compositions is provided in SEDAR100-DW22.

Overall, length compositions of Gray Triggerfish discarded by the Shrimp Bycatch fleet peaked around 10 cm FL (**Figure 9**). Annual length compositions of Gray Triggerfish in the shrimp bycatch (1984-2023) are presented in **Figure 15**. The number of trips was not available, and therefore the input sample sizes were set to 1.

Annual length compositions were input into the model but were excluded from model fitting because they served as proxies and were obtained from the SEAMAP Trawl Survey, which was modeled separately (**Section 2.4.1**).

2.3.9. Commercial Age Composition

Conditional age-at-length compositions of Gray Triggerfish landed by the Commercial Vertical Line and Commercial Longline fleets were developed and ultimately used in the assessment model (**Figures 16-17**). Age observations were assumed to be conditional on length and input as conditional-age-at-length data with sample sizes specified as the number of fish (SEDAR100-

DW07). For SEDAR 100, this data input was selected over age composition because using conditional age-at-length avoids double use of fish for both age and length compositions, especially when age compositions are weighted by length compositions (as presented in SEDAR100-DW07). This approach was used because the Trip Interview Sampling program measures lengths from all randomly selected fish (randomly selected from each market size category where necessary; Saari and Beerkircher 2014). This linkage allows more detailed information on the size-age relationship to be incorporated into the growth model fitting process and improves estimates of variance of size-at-age (Methot et al. 2023). A mean length-at-age vector for each year and fleet was included in the model for comparison between the expected length-at-age by the assessment model and the observed length-at-age.

SEDAR 43 did not include actual age compositions as a data input within the stock assessment model and instead input age compositions that were obtained from length compositions in conjunction with an age-length key. For SEDAR 100, the conditional age-at-length approach was used to include the best available information available (i.e., maximizing the use of weighted length compositions) while also incorporating the age data in the most appropriate manner given the concerns discussed in **Section 2.2.2**. Uncertainty in the age data remains an issue, as no strong cohorts are evident in the age compositions (SEDAR100-DW07), likely due to the highly variable and weak relationship between length and age (**Figure 3**).

Year-fleet combinations with less than 30 fish per year were excluded from the assessment model (Vertical Line landings: 2004, 2006-2008, 2010; Longline landings: 2004, 2009-2010, 2012, 2020, 2023-2024). For the Commercial Vertical Line fleet, input sample sizes averaged 21 Gray Triggerfish and ranged from 1 to 120, with 30% of observations having fewer than 5 Gray Triggerfish. For the Commercial Longline fleet, input sample sizes averaged 5 Gray Triggerfish and ranged from 1 to 27, with 58% of observations having fewer than 5 Gray Triggerfish.

2.3.10. Recreational Age Composition

Conditional age-at-length compositions of Gray Triggerfish landed by the Recreational fleet were developed and ultimately used in the assessment model (**Figure 18**). Age observations were assumed to be conditional on length and input as conditional-age-at-length data with sample sizes specified as the number of fish (SEDAR100-DW04). Year-fleet combinations with less than 30 fish per year were excluded from the assessment model (2015). Input sample sizes averaged 30 Gray Triggerfish and ranged from 1 to 453, with 33% of observations having fewer than 5 Gray Triggerfish. A mean length-at-age vector for each year was included in the model for comparison between the expected length-at-age by the assessment model and the observed length-at-age. The same uncertainties and lack of cohorts are observed in the recreational age data (SEDAR100-DW04).

2.3.11. Commercial Catch-Per-Unit-Effort Indices of Abundance

While the Commercial Vertical Line CPUE index from the NMFS Commercial Reef Logbook Program data was used in past assessments and developed for SEDAR 100 (SEDAR100-DW15), the Index and Bycatch Working Group did not recommend its inclusion for SEDAR 100. This decision was largely based on the numerous management regulations, particularly in the more recent years, which likely results in the index not being reflective of trends in the population (**Section 5.5.2 of the Data Workshop Report**).

2.3.12. Recreational Catch-Per-Unit-Effort Indices of Abundance

The Recreational CPUE index, obtained from the SRHS, was recommended during the SEDAR 100 Assessment for use in the assessment (SEDAR100-DW09) because of its long and consistent time series and large spatial coverage (**Figure 19**). However, the index was truncated in 2007 due to the implementation of regulations such as circle hooks in 2008 (GMFMC 2007) and other recreational regulations thereafter (e.g., size limits and bag limits). Annual CVs were converted to log-scale SEs (**Section 3.2**) and are presented in **Table 16**. Recreational CPUE increased rapidly from 1987-1990, reaching its highest value in 1990 before gradually declining until its lowest value in 2001. CPUE increased until 2005 and then declined (**Figure 19**).

An analysis by Fitzpatrick and Williams (2022) conducted on Atlantic Gray Triggerfish concluded: "changing regulations, changing targeting, advances in fishing technology, and changing environmental conditions through time" render the proportionality between stock abundance and MRIP CPUE assumption invalid. For these reasons, the MRIP index was not considered for inclusion in the SEDAR 100 assessment.

2.4. Fishery-Independent Surveys

2.4.1. SEAMAP Groundfish Trawl Survey

Standardized trawl surveys have been conducted in the Gulf since 1972 and continued under the Southeast Area Monitoring and Assessment Program (SEAMAP) in 1982 and 1987 for the summer and fall, respectively. The primary objective of this trawl survey conducted semi-annually is to collect data on the abundance and distribution of demersal organisms in the Gulf. Prior to 2009, the summer survey did not sample from Mobile Bay, Alabama eastward to Florida. Full survey details can be found in Nichols (2004).

The recommendation from SEDAR 43 was to include one abundance index derived from the SEAMAP Groundfish Trawl Survey for fall only, because of the assumption that Gray Triggerfish caught in fall were most likely age-0 fish. However, following current best practices the time series was split when the survey design was changed in 2008 and two indices were produced for Gray Triggerfish (SEDAR100-DW16). The first index (SEAMAP Trawl Early Survey) spans the time period from 1987-2008 covering the northwestern and central Gulf and the second index (SEAMAP Trawl Late Survey) from 2009-2024 covers the entire Gulf. Additionally, after exploring length and age compositions (N = 519 from 2008-2024; **Figure 20**) of Gray Triggerfish caught in both seasons, which was not available for review during SEDAR 43, considerable overlap in length distributions was evident as well as Gray Triggerfish older than age-0 (SEDAR100-DW16). As a result, the Index and Bycatch Working Group recommended combining summer and fall data for index and composition development for SEDAR 100. A detailed description of the data, limitations, methodology and results can be found in SEDAR100-DW16.

The standardized indices for the SEAMAP Trawl Early Survey and SEAMAP Trawl Late Survey are summarized in **Table 16** and **Figure 19**. Annual CVs were converted to log-scale SEs (**Section 3.2**) and are presented in **Table 16**. Relative abundance during the SEAMAP Trawl Early Survey was highly variable throughout the time series, with the highest and lowest values separated by three years (**Figure 19**). Relative abundance during the SEAMAP Trawl Late

Survey also showed considerable interannual variability, along with a trend of relatively high CPUE occurring roughly every 2-4 years, with the highest values observed in 2022-2023 (**Figure 19**).

Length compositions of Gray Triggerfish peaked around 12 cm FL for both the SEAMAP Trawl Early Survey and the SEAMAP Trawl Late Survey, with very few (<4%) Gray Triggerfish observed larger than 30 cm FL (**Figure 21**). Survey length compositions of Gray Triggerfish for the SEAMAP Trawl Early Survey (1987-2008) and SEAMAP Trawl Late Survey (2009-2024) are presented in **Figures 22-23**. Input sample sizes for the SEAMAP Trawl Early Survey averaged 81 stations (range: 15-159) and for the SEAMAP Trawl Late Survey averaged 94 stations (range: 42-140), respectively.

Annual length compositions were input into the assessment model along with input sample sizes reflective of the number of stations (≥ 10).

2.4.2. Video Survey

The Combined Video Survey used in SEDAR 43 represented three independent stationary video surveys that have historically been conducted in the Gulf to derive fishery-independent abundance estimates of reef fish stocks. The longest running survey was the SEAMAP Reef Fish Video Survey initiated by the NMFS Mississippi Laboratory in 1992 (e.g., Campbell et al. 2018 [SEDAR62-WP02]), followed in 2006 by the NMFS Panama City Laboratory (PC) Survey (e.g., Overly and Gardner 2019 [SEDAR62-WP06]), and finally Florida's FWRI Video Survey, which started in 2010. This survey has recently been updated to integrate the three surveys into a unified design beginning in 2020. This updated survey program is known as G-FISHER (Gulf Fishery Independent Survey of Habitat and Ecosystem Resources; Switzer et al. 2023). A habitat-area weighting approach was used to develop both the index of relative abundance and the annual length compositions. This approach accounts for both differences in habitat classes sampled by each survey and the overall survey footprints (Thompson et al. 2022). A full description of this updated survey can be found in SEDAR100-DW18.

The standardized index for the Combined Video Survey is summarized in **Table 16** and **Figure 19**. Annual CVs were converted to log-scale SEs (**Section 3.2**) and are presented in **Table 16**. Relative abundance varied throughout the time series, with the lowest values at the beginning of the time series and relatively higher abundance during 1998, 2006-2009 and 2020-2023 (**Figure 19**).

Overall, length compositions of Gray Triggerfish encountered by the Combined Video Survey peaked around 32 cm FL (**Figure 21**). Input sample sizes averaged 108 stations (range: 21-279), and annual length compositions generally covered a wide size range and were very jagged throughout the time period (**Figure 24**).

2.4.3. SEAMAP Fall Larval Survey

The SEAMAP Fall Ichthyoplankton/Larval Survey was previously used as an index of spawning stock biomass in SEDAR 43. During SEDAR 100, additional data including the lengths of Gray Triggerfish encountered by the survey revealed that the majority of Gray Triggerfish were juveniles (~78%) and not larvae as previously thought (SEDAR100-DW19). As a result, the Index and Bycatch Working Group recommended that the SEAMAP Fall Larval Survey not be

used as a larval index for spawning stock biomass. While the Index and Bycatch Working Group also discussed treating this survey as an index of juveniles for consideration in the assessment, this would be redundant of the SEAMAP Groundfish Trawl survey which samples juvenile Gray Triggerfish once they have settled and recruited to the population. Further, the Index and Bycatch Working Group voiced concerns that an index of relative abundance derived from neuston nets primarily represent the recruitment of juvenile fishes to Sargassum habitat, and not necessarily the recruitment of juveniles to the Gray Triggerfish population.

2.5. Environmental Considerations

2.5.1. Sargassum

SEAMAP ichthyoplankton surveys began to consistently document and quantify the amount of Sargassum collected in neuston samples starting in 2006 (SEDAR100-DW19). Examination of these data revealed that the proportion of positive occurrence and CPUE of Gray Triggerfish were found to be greatly dependent on the occurrence of Sargassum. However, a clear pattern of increasing Gray Triggerfish CPUE with increasing Sargassum CPUE for fish greater than 5 mm body length was not apparent in the available data.

Sargassum has been hypothesized to be an important nursery habitat for Gulf fishes such as Gray Triggerfish (Wells and Rooker 2004). After hatching, Gray Triggerfish may choose to inhabit structure in surface waters until suitable demersal habitat is found, and may be pelagic from a few weeks to several months (Simmons and Szedlmayer 2011 [SEDAR62-RD10]). Gray Triggerfish associate with Sargassum spp. patches and other flotsam during their pelagic phase. A NOAA Restore Science Program project was funded from 2017-2022 which set out to explore the link between Sargassum and juvenile life stages of fishes (i.e., recruitment). The project used field surveys, remote sensing, and modeling approaches to evaluate the nursery function and fisheries importance of Sargassum. One output of the project was the development of Sargassum Abundance Indices at multiple temporal and spatial scales using time series of vessel-based and remote sensing observations of Sargassum.

For SEDAR 100, no indices of Sargassum were submitted for consideration. The indices discussed above are limited in utility because they do not span a large enough spatial domain to capture Gulf-wide trends in Sargassum distribution or abundance. In addition, estimates of uncertainty are not available at this time. Current Sargassum data collection protocols in the SEAMAP Larval Survey only record liters of Sargassum taken in the net and do not collect information on the type of Sargassum aggregation, relative density at the surface, at depth and patchiness along or near the neuston tow. The use of satellite imagery products is being examined to provide a more detailed measurement of Sargassum abundance.

2.5.2. Red Tide

No evidence of red tide mortality was presented during the SEDAR 100 Assessment for Gray Triggerfish. A review of the literature highlighted no mention of Gray Triggerfish in red tide fish kills (Driggers et al. 2016) or as potential species vulnerable to red tides according to local ecological knowledge interviews (Blake et al. 2022) or fishermen feedback (SEDAR100-DW21). Gray Triggerfish were reported in fish kills observed after the 1971 red tide, but Smith (1975) noted that Gray Triggerfish survived in greater numbers and hypothesized that was because they

are not restricted to the bottom waters and can move out of affected areas. Red tide mortality for Gray Triggerfish was estimated by the West Florida Shelf Ecospace model (Vilas et al. 2023 via the Shiny app) but the results were uncertain and would require additional vetting of Gray Triggerfish data inputs and Ecospace model predictions. Collectively, this information suggests that red tides likely do not have a major impact on the Gray Triggerfish population.

2.5.3. Deepwater Horizon Oil Spill

Negative effects of the Deepwater Horizon oil spill have been hypothesized on marine resources due to the vast amount of oil spilled and the subsequent use of oil dispersant into the affected areas, and this concern was noted for Gray Triggerfish in SEDAR100-DW10. Monitoring of reef fish communities in the region pre- and post-Deepwater Horizon found no significant difference in the occurrence or density of Gray Triggerfish, although the density estimates were quite variable (Lewis et al. 2020). Murawski et al. (2018) only collected two Gray Triggerfish in their offshore longline surveys conducted for 2011-2017.

3. Stock Assessment Model Configuration and Methods

3.1. Stock Synthesis Model Configuration

The assessment model used was Stock Synthesis, version 3.30.21.00. Descriptions of algorithms and options are available in the User's Manual (Methot et al. 2023), the NOAA Fisheries Toolbox website (*http://nft.nefsc.noaa.gov/*), and Methot and Wetzel (2013). Stock Synthesis is a widely used integrated statistical catch-at-age model that has been tested for stock assessments in the United States, particularly on the West Coast and in the Southeast, and also throughout the world (see Dichmont et al. 2016 for review). Statistical catch-at-age models consist of three closely linked modules: the population dynamics module, an observation module, and a likelihood function. Input biological parameters (**Section 2.2**) are used to propagate abundance and biomass forward from initial conditions (population dynamics model) and Stock Synthesis develops expected data sets based on estimates of fishing mortality (*F*), selectivity, and catchability (the observation model). The observed and expected data are compared (the likelihood module) to determine best fit parameter estimates using a statistical maximum likelihood framework (detailed in Methot and Wetzel [2013]). Because many inputs are correlated, the concept behind Stock Synthesis is that processes should be modeled together, which helps to ensure that uncertainties in the input data are properly accounted for in the assessment.

The Stock Synthesis modeling framework provides estimates for key derived quantities including: time series of recruitment (units: 1,000s of age-0 recruits), abundance (units: 1,000s of fish), biomass (units: metric tons), SSB (units for Gray Triggerfish: SSB in metric tons), and exploitation or harvest rate (*F*; units for Gray Triggerfish: total biomass killed all ages / total biomass age 1+). The r4ss software (Taylor et al. 2021) was utilized extensively to develop various graphics for model outputs and was also used to summarize various output files and perform diagnostic runs. The ss3diags software (Carvalho et al. 2021) was also used to perform additional diagnostics.

3.1.1. Initial Conditions

The assessment begins in 1945 and has a terminal year of 2024. While minor removals of Gray Triggerfish are assumed to have occurred in the Gulf prior to 1945, the stock was assumed to be at or close to virgin fishing conditions in 1945. The start year of 1945 was supported by the SEDAR 43 Assessment Panel, but a re-evaluation of this decision was requested during SEDAR 100. Therefore, we considered various start years for this assessment:

Year	Pros	Cons
1945	- Consistent with previous assessment	- High uncertainty in historical estimates (recreational 1955-1980, commercial 1949-1986) and no shrimp information before 1960
	- Starts at virgin conditions	- Need to back-calculate landings and shrimp bycatch using interpolation back to start
1963	- No landings interpolation needed	- Still high uncertainty in historical landings (recreational 1963-1980 and commercial 1963-1986)
	- Shrimp effort started in 1960	- Need to scale back shrimp bycatch estimates for 1963-1983 (using trend in effort)
		- Starts in fished conditions, need to approximate initial conditions
1981	- No landings interpolation needed	- Still high uncertainty in recreational removals (1981-1985) and commercial landings (1981-1985)
	- More confidence in available data	- Need to scale back shrimp bycatch estimates for 1981-1983 (using trend in effort)
		- Starts in fished conditions, need to approximate initial conditions
1986	- No landings interpolation needed	- Missing contrast in the data, basically a one-way trip
	- Most confidence in available data	- Starts in fished conditions, need to approximate initial conditions

Ultimately, a start year of 1945 was maintained for the SEDAR 100 AP Model for the following reasons. First, beginning an assessment during fished conditions makes a strong assumption about the starting depletion level of the stock, which is further complicated due to the need to specify initial conditions for the Shrimp Bycatch fleet. Second, initializing the assessment model in the 1980s leads to a one-way trip and limited contrast in the data. Extensive sensitivity

explorations were conducted for different start years which revealed minimal differences in recent population trajectories where stock status is determined (**Section 4.8.7**).

3.1.2. Temporal Structure

The Gray Triggerfish population was modeled from age-0 (Stock Synthesis starts at age-0; Methot et al. 2023) through age-15, with data bins spanning age-0 through age-10+, with the last age representing a plus group. The population was modeled through the maximum age of 15 years, however the vast majority of data available were for ages 10 or younger (98.7%). Settlement was specified as July 1st to coincide with peak spawning (Allman et al. 2018; Kelly-Stormer et al. 2017). Data collection and fishing activities were assumed relatively continuous throughout the year; therefore, inclusion of a seasonal component to the removals was not deemed necessary. The fishing season was assumed to be continuous and homogeneously distributed throughout the year.

3.1.3. Spatial Structure

A single area model was implemented where recruits are assumed to homogeneously settle across the Gulf.

During SEDAR 43, a fleets-as-areas approach was used which separated fishing fleets and all of their associated data inputs (landings, discards, CPUE indices, and compositions) into East and West. The East encompassed NMFS statistical grids 1-12 whereas the West encompassed NMFS statistical grids 13-21 (SEDAR100-DW05). This fleets-as-areas approach has been used since SEDAR 9 (terminal year of 2004) to account for regional differences in fishing pressure and fishery selectivity. While fleets-as-areas were initially included to match model structure from SEDAR 43, this decision was re-evaluated during SEDAR 100 along with whether to develop a true two-area model. Shrimp bycatch and fishery-independent surveys were not split and were considered Gulf-wide as in previous assessments.

After examining all data submitted for SEDAR 100, no strong support was found for maintaining the fleets-as-areas approach. No large differences in length or age compositions were noted between East and West (SEDAR100-DW04, SEDAR100-DW07), suggesting that selectivities of the fleets remained similar between regions. The vast majority of data came from the East including recreational landings (91%) and discards (96%), recreational landings length (81%) and age (95%) samples, recreational discard length samples (100%), commercial landings (72%) and discards (85%), and commercial length samples of landings (63%) and discards (93%). Exceptions where data primarily came from the West included commercial landings age samples (67%) and shrimp effort (75%) and bycatch estimates (93%). Composition data were particularly limiting in the West, leading to a vast majority of years not recommended for inclusion in the assessment if data remained split by region based on sample size cutoffs not implemented during SEDAR 43 (**Sections 2.8-2.9 in Data Workshop Report**).

SEDAR 100 also re-evaluated whether data supported separating the stock into East and West populations. SEDAR 100 found no differences in growth between East and West (**Section 2.5 in the Data Workshop Report**) and therefore the stock was modeled as a single unit stock throughout the Gulf. In addition, no estimates of movement between regions were available to parameterize movement within a two-area model. Gray Triggerfish exhibit high site fidelity

based on tagging studies (Ingram and Patterson 2001; Herbig and Szedlmayer 2016 [SEDAR62-RD08]).

3.1.4. Life History

A fixed length-weight relationship was used to convert body length (cm FL) to body weight (kg wwt; **Table 1, Figure 2A**). Stock Synthesis moves fish among age classes and length bins on January 1st of each modeled year starting from birth at age-0. Because the 'true' birth date often does not occur on January 1st, with peak spawning occurring around July 1st (Allman et al. 2018; Kelly-Stormer et al. 2017), settlement was specified as July 1st, which allowed Stock Synthesis to internally convert between input calendar ages and real age when estimating growth and natural mortality-at-age (both in terms of real age).

Growth within Stock Synthesis was modeled with a three parameter von Bertalanffy equation: (1) L_{Amin} (cm FL), the mean size at A_{min} (growth age for L_{Amin}; age-0.5 for Gray Triggerfish); (2) L_{Amax} (cm FL), the mean size at maximum aged Gray Triggerfish; and (3) K (year^{-1}), the growth coefficient. In Stock Synthesis, when fish recruit at the real age of 0.0 they have a body size equal to the lower limit of the first population bin (2 cm FL for Gray Triggerfish). Fish then grow linearly until they reach a real age equal to the input value of A_{min} and have a size equal to L_{Amin}. As they age further, they grow according to the von Bertalanffy growth equation (**Figure 2B**). L_{Amax} was specified as equivalent to $L\infty$. Two additional parameters are used to describe the variability in size-at-age and represent the CV in length-at-age at A_{min} (age-0.5) and A_{max} (age-15). For intermediate ages, a linear interpolation of the CV on mean size-at-age is used.

The von Bertalanffy growth model parameters (L_{Amin}, L_{Amax} [i.e., $L\infty$], and K) and the variance parameters CV_{Amin} and CV_{Amax} were re-estimated internally to Stock Synthesis using length and conditional age-at-length compositions. Starting values were obtained from the SEDAR 100 Assessment Data Workshop recommendations (**Table 2**). We explored using these values as priors, however the $L\infty$ estimate of 46 cm FL seemed low compared to the available age-length data (**Figure 3**). Given this in combination with the concerns over the age data (**Section 2.2.2**), we allowed Stock Synthesis to freely estimate all five growth parameters internally. Ultimately, the variance parameters CV_{Amin} (0.437) and CV_{Amax} (0.124) were fixed at the model estimated values to reduce the number of moderate correlations (> 0.7) between model parameters when all five growth parameters were estimated freely.

The natural mortality rate (M) was assumed constant over time but decreasing with age. Target M was set at the Hamel and Cope (2022) point estimate of 0.36 per year (based on a maximum age of 15) and scaled internally using the Lorenzen function over the range of fully recruited ages (3-15 years) to derive an age-specific vector of M (**Table 4, Figure 2C**).

The assessment model was set-up with both sexes combined. Immature females transitioned to mature females based on a fixed logistic function of length (**Figure 2D**) for the reasons discussed in **Section 2.2.4**. Reproductive potential was defined in terms of female-only SSB (i.e., SSB equivalent to body weight; **Figure 2E**) for the reasons discussed in **Section 2.2.5**.

3.1.5. Recruitment Dynamics

A Beverton-Holt stock-recruit function was used to parameterize the relationship between spawning output and resulting recruitment of age-0 fish. The stock-recruit function (representing

the arithmetic mean stock-recruit levels) requires three parameters: (1) steepness characterizes the initial slope of the ascending limb (i.e., the fraction of virgin recruits produced at 20% of the equilibrium spawning biomass); (2) the virgin recruitment (R_0, estimated in log space; ln(R_0)) represents the asymptote or virgin recruitment levels; and (3) the variance or recruitment variability term (*SigmaR*) which is the SD of the log of recruitment (it both penalizes deviations from the stock-recruit curve and defines the offset between the arithmetic mean stock-recruit curve and the expected geometric mean from which the deviations are calculated).

The SEDAR 43 Standard Model estimated steepness (0.459), *SigmaR* (0.358), and ln(R_0). These decisions were re-evaluated during SEDAR 100, and ultimately steepness was fixed at 0.99 and *SigmaR* was fixed at 0.6. Fixing steepness at 0.99 is a computational convenience to estimate average recruitment rather than those from a stock-recruit curve; it does not imply perfect compensation in the population. This decision was made because of concerns over the model's ability to estimate steepness (0.422; **Section 4.8.7**). The likelihood profile did appear to show a minimum (**Section 4.8.2**), but data conflicts were persistent. The SEDAR 43 Standard Model also estimated a low steepness of 0.459, and the likelihood profile suggested that the parameter was poorly estimated as values between 0.4-0.45 and 0.6-0.65 were approximately within 2 likelihood units. The SEDAR 9 Assessment Process panel concluded that using the median value of 0.8 from a meta-analysis was appropriate after failing to find evidence that steepness was estimable. A value of 0.97 for Gray Triggerfish was recommended from the FishLife R package, which was used during SEDAR 68 to develop a biologically plausible value for steepness (SEDAR 2021). FishLife synthesizes life history data and produces estimates of life history inputs (such as steepness) based on available studies of the target species and congeners (Thorson et al. 2017a) and was strongly recommended by the CIE reviewers of that assessment as a best practice if steepness cannot be estimated. *SigmaR* was re-evaluated and fixed at 0.6 after reviewing diagnostics such as the likelihood profile which showed the parameter was poorly estimated (**Section 4.8.2**). This value of *SigmaR* is commonly used as a fixed input in other stock assessments to reflect an acceptable level of variability in recruitment.

Annual deviations from the stock-recruit function were estimated in Stock Synthesis as a vector of deviations forced to sum to zero and assuming a lognormal error structure. During model building, the constraint of forcing the deviations to sum to zero was explored by applying a slightly different stock recruitment function methodology. However, this method has not been previously applied in the Gulf and more research is needed to understand the effects on the model results. A lognormal bias adjustment factor was applied to recruitment estimates as recommended by Methot et al. (2023).

For the SEDAR 100 AP Model, main period (i.e., data rich, when representative length or age composition data are available) recruitment deviations spanned 1981-2024. No recruitment deviations were estimated in the early period (i.e., pre-1981) because their estimation led to highly uncertain parameters (CV > 1), suggesting little information was available in the early composition data to inform the earlier age structure. Full bias adjustment was used only from 1998 to 2022. Bias adjustment was phased in linearly, from no bias adjustment prior to 1937 (note the model starts in 1945) to full bias adjustment in 1998. Bias adjustment was phased out in 2022, decreasing from full bias adjustment to no bias adjustment by 2024. The years selected for full bias adjustment were estimated following the methods of Methot and Taylor (2011).

3.1.6. Fleet Structure and Surveys

Four fishing fleets were modeled and had associated length and/or conditional age-at-length compositions. The fleets were: Recreational (Rec_1; includes charter, private, and headboat modes), Commercial Vertical Line (ComVL_2; vertical line + trap + other gears), Commercial Longline (ComLL_3), and Shrimp Bycatch (Shrimp_Bycatch_4). Fleet structure was re-evaluated during SEDAR 100 and recommended based on the availability of length and age composition data, comparisons of length distributions among gears (commercial) or modes (recreational), and resulting sample sizes. A single recreational fleet was maintained because no large differences in selectivity were evident, as length and age compositions were very similar among modes (SEDAR100-DW04, SEDAR100-DW13). The Commercial Longline fleet was treated separately from the other commercial gears because it selected for much larger and older Gray Triggerfish (SEDAR100-DW07).

One fishery-dependent CPUE index was included in the SEDAR 100 AP Model: Recreational CPUE derived from the SRHS (Recreational (SRHS) CPUE; HB_Surv_5; units: numbers per angler hour). CPUE was treated as an index of abundance where the observed standardized CPUE time series was assumed to reflect annual variation in population trajectories. The CPUE index was of landings only, and the selectivity was assumed identical to the Recreational fleet.

Three fishery-independent surveys were modeled and had associated length compositions. The surveys were: SEAMAP Trawl Early Survey (1987-2008; TrawlEarly_6, units: fish per trawl hour), SEAMAP Trawl Late Survey (2009-2024; TrawlLate_7, units: fish per trawl hour), and Combined Video Survey (Video_8, units: MaxN). For each survey, the length composition was fit directly based on the estimated length-based selectivity functions (**Section 3.1.7.1**).

The Shrimp Bycatch fleet was modeled as a bycatch-only fishery with the catch driven by an effort time series and fitted to the median estimate of Gray Triggerfish bycatch (1,612,310 fish with a CV of 0.121) using the “super-period” feature in Stock Synthesis. No age/length data were available directly for that fleet, but proxy length compositions were provided alongside the shrimp bycatch estimates (SEDAR100-DW22). These length compositions were included as a check on model predicted length compositions (i.e., they were not fit to within the assessment model). Selectivity was mirrored to that of the SEAMAP Trawl Early Survey due to similarities in gear and area fished. Discards from the Shrimp Bycatch fleet were included in the search for Maximum Sustainable Yield (MSY).

3.1.7. Selectivity

Selectivity represents the probability of capture by age or length for a given fleet or survey and represents the net result of multiple interrelated factors (e.g., gear type, targeting, and availability of fish due to spatial and temporal constraints). Stock Synthesis allows users to specify length-based selectivity, age-based selectivity, or both. The final selectivity curve governing each fleet/survey reflects the additive effect of both age- and length- based processes.

For SEDAR 100, length-based selectivity was estimated given the inclusion and reliance on length composition data (discards, landings, and surveys) because of concerns over the reliability of age data (**Section 2.2.2**). In addition, most of the factors that affect selectivity (hook size, fishing location, fishing method) operate largely upon size or length rather than on fish age. This

deviates from SEDAR 43 where age-based selectivity was used because that model only fit to age compositions (derived using age-length keys and length compositions).

Selectivity patterns were assumed to be constant over time for the Shrimp Bycatch fleet and SEAMAP trawl surveys. Time-varying selectivity was used for the Combined Video Survey to capture differences during three time blocks corresponding to the introduction of additional sampling programs: 2006-2009 for Panama City, 2010-2019 for FWRI, and 2020-2024 for G-FISHER. The Gulf Gray Triggerfish fishery has experienced changes in management regulations over time such as size limits, commercial trip limits and recreational bag limits (**Figure 25**) along with reduced open season lengths for both commercial and recreational fisheries since 2012 (**Figure 26**). Time-varying selectivity was used for the directed fishing fleets to account for the mandatory implementation of circle hooks in 2008 which may have altered selectivity patterns in the reef fish fishery. By comparing hook and line catches with ROV sampling, Garner et al. (2017 [SEDAR62-RD02]) found that peak selectivity shifted about 8 cm smaller using circle hooks. This parameterization for each fleet led to improved model fits to the composition data. In addition to allowing for time-varying selectivity, changes due to management regulations were also accounted for in the assessment model using time-varying retention patterns (**Section 3.1.8**) and by modeling discards explicitly (**Section 3.1.10**).

3.1.7.1. Length-based Selectivity

Length-based selectivity patterns were specified for each fleet and survey and were characterized as one of two functional forms:

1. a two-parameter logistic function - a logistic curve implies that fish below a certain size range are not vulnerable, but then gradually increase in vulnerability with increasing size until all fish are fully vulnerable (asymptotic selectivity curve). Two parameters describe logistic selectivity: (1) the length at 50% selectivity, and (2) the difference between the length at 95% selectivity and the length at 50% selectivity.

2. the six-parameter double normal function - the double normal has the feature that it allows for domed or logistic selectivity and is a combination of two normal distributions; the first describes the ascending limb, while the second describes the descending limb. A line segment joins the maximum selectivity of the two functions. However, the double normal functional form can be more unstable than other selectivity functions due to the increased number of parameters. When robust length or age compositions are available with sufficient numbers of larger or older fish, it may be appropriate to freely estimate all parameters (especially the descending limb). If that is not the case, certain parameters can be fixed to improve model stability as long as fixing the parameter does not largely influence the point estimates of the remaining selectivity parameters. Unless strong evidence exists for domed selectivity, it is generally advisable to use the logistic function.

In the SEDAR 100 AP Model, length-based selectivity patterns were defined for each fleet/survey: 1) Recreational (double normal), 2) Commercial Vertical Line (logistic), 3) Commercial Longline (logistic), 4) SEAMAP Trawl Early Survey (double normal, mirrored to Shrimp Bycatch), 5) SEAMAP Trawl Late Survey (double normal), and 6) Combined Video Survey (double normal). Selectivity for the Recreational (SRHS) CPUE was mirrored to the

Recreational fleet and selectivity for the Shrimp Bycatch fleet was mirrored to the SEAMAP Trawl Early Survey given similarity in gear and geographical coverage.

Double normal selectivity was implemented for the Recreational fleet because it could be limited by maximum depth fished and previous research supported dome-shaped selectivity for recreational gears (Garner et al. 2017 [SEDAR62-RD02]). Time-varying parameters estimated included the peak, descending width, and the end logit parameters for the 2008-2024 time block (the estimated top-logit and ascending width parameters did not differ if allowed to be time-varying). All parameters were freely estimated with the exception of the starting logit parameter which was fixed and allowed Stock Synthesis to decay the small fish selectivity according to the ascending width parameter. The model was not sensitive to the starting logit parameter over a range of values.

Logistic selectivity was modeled for both the Commercial Vertical Line and Commercial Longline fleets. Initial explorations estimated dome-shaped selectivity, however model fits did not differ substantially from the simpler 2-parameter logistic curve. Time-varying parameters estimated for each fleet included the inflection and 95% width parameters for the 2008-2024 time block. All parameters were freely estimated.

Dome-shaped selectivity was modeled for both the SEAMAP Trawl Early Survey/Shrimp Bycatch fleet and the SEAMAP Trawl Late Survey which trawl at the shallowest depths inhabited by Gray Triggerfish and occasionally captures large Gray Triggerfish. All selectivity parameters were freely estimated for each survey. This represents a departure from SEDAR 43 which assumed that only age-0 Gray Triggerfish were selected.

Dome-shaped selectivity was modeled for the Combined Video Survey after model explorations identified this pattern as the best fitting to the length composition data (compared to logistic and cubic splines). Time-varying parameters estimated included the peak for the 2006-2009, 2010-2019, and 2020-2024 time blocks. The base peak parameter was fixed at the model estimate because it was well estimated but highly correlated with the time-varying peak estimates. The starting logit parameter was fixed at the model estimate (-14.9, near the lower bound) and the ending logit parameter was fixed at the upper bound. The model was not sensitive to either logit parameter over a range of values. The implementation of time-varying selectivity led to much improved fits to the index of relative abundance for the Combined Video Survey, particularly in the last few years.

3.1.7.2. Age-based Selectivity

Age-based selectivity was not specified for any of the fleets or surveys.

3.1.8. Retention

Discard estimates and associated length compositions were provided for the Recreational and Commercial Vertical Line fleets and were generally assumed to be regulatory discards (**Figure 25**). However, discard estimates for the Recreational fleet started in 1981, which was prior to the implementation of management regulations. Gray Triggerfish are not typically a targeted species (SEDAR100-DW10; SEDAR100-DW20) and are notoriously difficult to clean/filet (SEDAR100-DW10) and may have been discarded historically due to reduced desirability. The

SEDAR 82 Atlantic Gray Triggerfish Assessment identified an increase in desirability of Gray Triggerfish over time (SEDAR 2024), which may also pertain to the Gulf.

Time-varying retention functions are commonly used in Gulf stock assessments to allow for varying discards at size due to regulations. For Gray Triggerfish, time blocks were based on changes in the minimum size limits, commercial trip and recreational bag limits, and reduced open seasons (**Figures 25-26**). For each fleet, the retention function was specified as a logistic function consisting of four parameters: (1) the inflection point, (2) the slope, (3) the asymptote, and (4) the male offset inflection (not applicable to this model and assumed to be zero).

All time-varying inflection point and slope parameters were estimated freely in the model. The base inflection point and slope parameters for each fleet were fixed at the model estimate, and the model was not sensitive to these parameters over a range of values. Both the base asymptote and time-varying asymptote parameters for each fleet were estimated freely within the model, with discarding prior to 2011 assumed due to lower desirability and discarding from 2012-2024 assumed due to regulations (i.e., reduced open seasons, commercial trip limits, and recreational bag limits).

The parameters for the time varying retention blocks for the Commercial Vertical Line fleet were treated as:

Time Block	Inflection	Slope	Asymptote
pre-1999	Fixed at model estimate	Fixed at model estimate	Estimated (due to low desirability)
1999-2007	Estimated; initially started at size limit of 12 inches TL	Estimated	
2008-2011	Estimated; initially started at size limit of 14 inches FL	Estimated	
2012-2024			Estimated (due to regulations)

The parameters for the time varying retention blocks for the Recreational fleet were treated as:

Time Block	Inflection	Slope	Asymptote
pre-1999	Fixed at model estimate	Fixed at model estimate	Estimated (due to low desirability)
1999-2007	Estimated; initially started at size limit of 12 inches TL	Estimated	
2008-2011	Estimated; initially started at size limit of 14 inches FL	Estimated	
2012-2017			Estimated (due to regulations)
2018-2024	Estimated; initially started at size limit of 15 inches FL	Estimated	

3.1.9. Landings and Compositions

Landings by fleet and associated length and conditional age-at-length compositions were estimated using fleet-specific continuous fishing mortality rates and length-specific selectivity curves following Baranov's catch equation. Fishing mortality was estimated using either the Stock Synthesis developer recommended fleet-specific continuous/hybrid approach (F method 4) or the *F* as a parameter approach (F method 2). Estimation of *F* in the latter approach is influenced by all data in the model, with the retained catch and discard catch having the greatest influence depending on the SE for these observations. The former approach allows some fleets to remain in hybrid where *F* is a tuned factor where the tuning is based on the retained catch for each fishing fleet.

The commercial landings were assumed the most representative and reliable data source in the model, especially over the most recent time period, because this information was collected in the form of a census as opposed to being collected as part of a survey. The commercial landings were assumed to have a lognormal error structure, with annual log-scale SEs obtained from regionally weighted estimates (**Section 2.3.1**). The recreational landings were less precise than the commercial landings, as evident by larger CVs (**Section 2.3.2**; **Table 8**). This allowed Stock Synthesis more freedom to deviate from the observed recreational landings. All CVs were converted to a log-scale SE (see **Section 3.2**). While the actual log-scale SEs that accompanied the recreational landings were initially used in model development, and have been considered in a sensitivity analysis (**Section 3.4.7**), any log-scale SE that exceeded 0.25 was capped at 0.25 in the SEDAR 100 AP Model (1945-1985, 1987, 2013-2015, and 2017-2020).

A new feature available for fitting composition data in Stock Synthesis is the Dirichlet-Multinomial which differs from the standard multinomial in that it includes an estimable parameter (theta) which scales the input sample size (Thorson et al. 2017b; Methot et al. 2023).

The Dirichlet-Multinomial is self-weighting, which avoids the potential for subjectivity as when the Francis re-weighting procedure is applied (Francis 2011). This approach also allows for observed zeros in the data, and the effective sample sizes calculated are directly interpretable. The Dirichlet-Multinomial uses the input sample sizes directly, adjusted by an estimated variance inflation factor, which adjusts the overall weight of data for each fleet relative to one another based on model fit to reduce the potential for particular data sources to have a disproportionate effect on total model fit. The more positive the inflation factor, the more weight the data carry in the likelihood. The Dirichlet-Multinomial is considered an improved practice and recommended for use by the Stock Synthesis model developers. A normal prior was used on the Dirichlet-Multinomial parameters of 0 (SD = 1.813), which is recommended to counteract the effect of the logistic transformation between the Dirichlet-Multinomial parameter and the data weighting (Methot et al. 2023).

For SEDAR 100, the length and/or conditional age-at-length composition data for each fleet/survey were assumed to follow a Dirichlet-Multinomial error structure where input sample sizes were number of trips for commercial and recreational length composition data, number of fish for conditional age-at-length data and number of stations for fishery-independent surveys. Number of trips or stations were used instead of number of fish for length compositions because it was thought to better reflect relative effective sample size in each year, as samples are rarely truly random or independent (Hulson et al. 2012).

3.1.10. Discards and Associated Length Compositions

Discard data for the Recreational and Commercial Vertical Line fleets were directly fit in the model using size-based retention functions, and a lognormal error structure was assumed. The model estimated total discards based on the selectivity and retention functions, then calculated dead discards based on the discard mortality rate of 40% assumed for each fleet (**Section 2.2.6**). For the Shrimp Bycatch fleet, a lognormal error structure was assumed and all fish selected for were assumed dead. Length compositions of discards for the Recreational and Commercial Vertical Line fleets were input specifying annual sample sizes as number of trips and using the Dirichlet Multinomial approach for weighting.

3.1.11. Indices

The indices are assumed to have a lognormal error structure. For all indices of relative abundance, input CVs were those obtained through index standardization. The CVs provided by the index standardization were converted to log-scale SEs required for input to Stock Synthesis for lognormal error structures (**Section 3.2**). The fishery-dependent Recreational (SRHS) CPUE index had a much larger mean log-scale SE (0.27) compared to the SEAMAP Trawl Early Survey (0.17), SEAMAP Trawl Late Survey (0.14), and Combined Video Survey (0.17). While error estimates were provided for part of the shrimp effort time series (1984-2024; **Table 15**), the Shrimp Effort Index was assumed to have a log-scale SE of 0.2 throughout the time series to allow the assessment model to deviate if supported by other data streams.

3.2. Goodness of Fit and Assumed Error Structure

A maximum likelihood approach was used to assess goodness of model fit to each of the data sources (e.g., catch, indices, compositions, etc.). For each separate data set, an assumed error

distribution and an associated likelihood component was specified, the value of which was determined by the difference in observed and expected values along with the assumed variance of the error distribution. The total likelihood was the sum of each individual component. A nonlinear iterative search algorithm was used to minimize the total negative log-likelihood across the multidimensional parameter space to determine the parameter values that provide the best fit to the data. With this type of integrated modeling approach, data weighting (i.e., the variance associated with each data set) can affect model results, particularly if the various data sets indicate differing population trends.

Where lognormal error structures were used, annual CVs associated with each of the data sources were converted to log-scale SEs where necessary using the approximation: $log_e(SE) = \sqrt{\left(log_e(1 + CV^2)\right)}$ provided in Methot et al. (2023).

Weak penalty functions were implemented to keep parameter estimates from hitting their bounds (Methot et al. 2023). Parameter bounds were set to be relatively wide and were unlikely to truncate the search algorithm.

Uncertainty in parameter estimates was quantified by computing asymptotic SEs for each parameter. Asymptotic SEs are calculated by inverting the Hessian matrix (i.e., the matrix of second derivatives) after the model fitting process (Methot and Wetzel, 2013). Asymptotic SEs provide a minimum estimate of uncertainty in parameter values.

3.3. Estimated Parameters

In total, 305 parameters were estimated for the SEDAR 100 AP Model, of which 268 were active parameters (**Tables 17 and A1**). These parameters include: the three von Bertalanffy growth parameters (L_{Amin}, L_{Amax} [i.e., $L\infty$] and K), one stock-recruit relationship parameter ($\ln(R_0)$), the stock-recruit deviations for the data-rich time period (1981-2024), year specific (1945-2024) F for the Recreational and Shrimp Bycatch fleets, catchability parameters for each index, extra SD parameters for each index of relative abundance, length-based selectivity parameters for each fleet and survey, length-based retention parameters for the Recreational and Commercial Vertical Line fleets, and 6 parameters informing the Dirichlet-Multinomial length and conditional age-at-length composition weightings.

3.4. Model Diagnostics

3.4.1. Residual Analysis

The main approach used to address model fit and performance was residual analysis of model fit to each of the data sets (e.g., catch, indices, length/age compositions). Any temporal trends in model residuals (or trends with age or length for composition data) can be indicative of model misspecification and poor performance. It is not expected that any model will perfectly fit any of the observed data sets, but ideally, residuals will be randomly distributed and conform to the assumed error structure for that data source. Any extreme patterns of positive or negative residuals are indicative of poor model performance and potential unaccounted for process or observation error.

3.4.2. Correlation Analysis

High correlation between parameters can lead to flat likelihood response surfaces and poor model stability. By performing a correlation analysis, modeling assumptions that lead to inadequate model parameterizations can be highlighted. Because of the highly parameterized nature of stock assessment models, it is expected that some parameters will always be correlated (e.g., stock-recruit parameters or growth parameters). However, a large number of extremely correlated parameters warrant reconsideration of modeling assumptions and parameterization. A correlation analysis was carried out and correlations with an absolute value greater than 0.7 were reported.

3.4.3. Likelihood Profiles

Likelihood profiles are used to examine the change in negative log-likelihood for each data source in order to address the stability of a given parameter estimate, and to see how each individual data source influences the estimate. The analysis is performed by holding the given parameter at a constant value and rerunning the model. This is repeated for a range of reasonable parameter values. Ideally, the graph of negative log-likelihood values against parameter values will give a well-defined minimum, indicating that data sources agree. When a given parameter is not well estimated, the profile plot may show conflicting signals across the data sources. The resulting total likelihood surface will often be flat, indicating that multiple parameter values are equally likely given the data. In such instances, the model assumptions need to be reconsidered.

Typically, profiling is carried out for a few key parameters, particularly those defining the stock-recruit relationship. Profiles were carried out for the five growth parameters (L_{Amin}, L_{Amax} [i.e., $L\infty$], K, CV_{Amin}, and CV_{Amax}), ln(R_0), *SigmaR*, and steepness.

3.4.4. Jitter Analysis

Jitter analysis is a relatively simple method that can be used to assess model stability and to determine whether a global as opposed to a local minimum has been found by the search algorithm. The premise is that all of the starting values are randomly altered (or ‘jittered’) by an input constant value and the model is rerun from the new starting values. If the resulting population trajectories across a number of runs converge to the same final solution, it can be reasonably assumed that a global minimum has been obtained. This process is not fault-proof and no guarantee can ever be made that the ‘true’ solution has been found or that the model does not contain misspecification. However, if the jitter analysis results are consistent, it provides additional support that the model is performing well and has come to a stable, global solution.

For this assessment, a jitter value of 0.1 (10%) was applied to the starting values and 100 runs were completed.

3.4.5. Retrospective Analysis

Retrospective analysis evaluates the consistency of terminal year model estimates as it sequentially removes a year of data at a time and reruns the model. Mohn’s Rho can be used to determine retrospective bias, with values between -0.15 to 0.2 considered acceptable for longer-lived species and values outside that range indicate of an undesirable retrospective pattern (Mohn 1999; Hurtado-Ferro et al. 2015; Carvalho et al. 2021). If the resulting estimates of derived

quantities such as SSB or recruitment differ significantly, particularly if there is serial over- (+ Mohn's Rho) or underestimation (- Mohn's Rho) of any important quantities, it can indicate that the model has some unidentified process error, and requires reassessing model assumptions. It is expected that removing data will lead to slight differences between the new terminal year estimates and the updated estimates for that year in the model with the full data. Oftentimes additional data, especially compositional data, will improve estimates in years prior to the new terminal year, because the information on cohort strength becomes more reliable. Therefore, slight differences are expected between model runs as more years of data are peeled away. Ideally, the difference in estimates will be slight and more or less randomly distributed above and below the estimates from the model with the complete data sets.

A five-year retrospective analysis was carried out. Retrospective forecasts were also evaluated to determine consistency between forward projections and subsequent updates with newly available data added one year at a time (Carvalho et al. 2021).

3.4.6. Additional Diagnostics

Additional diagnostics using the R package 'SS3Diags' are presented following the recommendations of Carvalho et al. (2021). Joint residual plots were used to assess goodness of model fit by identifying conflicting time series and auto-correlation of residual patterns via a Loess smoother (Winker et al. 2018; Carvalho et al. 2021). Undesirably high root mean squared error (RMSE) were values which exceeded 30%. Model misspecification was evaluated by exploring patterns in residuals of indices and compositions using a runs test, which indicates the presence of nonrandom variation (Carvalho et al. 2021). In addition, outlier data points were identified via the 3-sigma limit, where any points beyond this limit would be unlikely given random process error in the observed residual distribution (Carvalho et al. 2021).

Prediction skill of the model was tested using the hindcasting cross-validation approach of Kell et al. (2021). The mean absolute scaled error (MASE; Hyndman and Koehler 2006) was calculated for a 5-year period for each data input where available. The mean absolute scaled error scales the mean absolute error of forecasts (i.e., prediction residuals) to the mean absolute error of a naïve in-sample prediction (Carvalho et al. 2021). A skilled model would improve the model forecast compared to the baseline (i.e., random walk), with a mean absolute scaled error value of 0.5 indicative of a forecast being twice as accurate as the baseline and values >1 indicative of average model forecasts worse than the baseline (Carvalho et al. 2021; Kell et al. 2021).

3.4.7. SEDAR 100 AP Model Sensitivity Runs

Sensitivity runs were conducted with the SEDAR 100 AP Model to investigate critical uncertainty in data and reactivity to modeling assumptions. An exhaustive evaluation of model uncertainty was not carried out, but the aspects of model uncertainty judged to be the most important for model performance and accuracy were investigated.

Only the most important sensitivity runs are presented below, but many additional exploratory runs were also implemented. The order in which they are presented is not intended to reflect their importance; each run included here provided important information for developing or evaluating the base case model and alternate states of nature. Focus of the sensitivity runs was on

population trajectories, improvements in fit and important parameter estimates (e.g., recruitment).

Recreational removals - Recreational removals (i.e., landings and discards) remain a key area of uncertainty for Gulf fish stocks. To evaluate the sensitivity of results to alternative data streams or uncertainty estimates, we conducted five sensitivity runs:

1. *Replaced uncertain recreational landings estimates*. Replaced any yearly landings estimates that have a CV>=0.5 with the average of the two neighboring years following MRIP guidance. This was done solely for 2017 where the point estimate of 84,842 fish was replaced with an estimated 174,416 fish.

2. *Excluded uncertain recreational discard estimates*. Excluded recreational discard estimates for 1981-1987 where CVs exceeded 0.5 given the inability to replace these values with neighboring year estimates.

3. *Reduced recreational removals by 40%*. Assumed that recreational removals were 40% lower than provided to mimic the MRIP-FES pilot study results (Andrews 2022). Preliminary results from the pilot study suggested that the MRIP-FES overestimated private effort by 30-40%, which translates into overestimates of removals.

4. *Used actual error estimates for recreational landings*. Implemented the log-scale SEs converted from CVs provided for recreational landings (**Table 8**).

5. *Used log-scale SE of 0.05 for recreational landings*. Treated the recreational landings as known, as was done during SEDAR 43.

Discard mortality rate - Discard mortality remains an active area of research for Gray Triggerfish, with more recent studies suggesting higher values than used in previous assessments or supported by fishermen (SEDAR100-DW10). To evaluate the sensitivity of results to alternative values, we conducted two sensitivity runs:

1. *26% for all fleets*. Used alternative value recommended by the ad-hoc Discard Mortality Working Group, which is based on the lower limit of the range identified in the literature review and corroborated by the Bayesian analysis (SEDAR100-AP01).

2. *60% for all fleets*. Used alternative value recommended by the ad-hoc Discard Mortality Working Group, which is based on the upper limit of the range identified in the literature review and corroborated by the Bayesian Analysis (SEDAR100-AP01).

Shrimp Bycatch - The estimation of bycatch in the shrimp fishery is difficult to determine given the lack of coverage of Gray Triggerfish in the Shrimp Observer Program through 2024. To evaluate the influence of these removals on model results, we conducted three sensitivity runs:

1. *Excluded shrimp bycatch*. Assumed shrimp bycatch is zero, although this is not supported by the available data which identify Gray Triggerfish in the bycatch (see Appendix 1 in

SEDAR100-DW22 and Scott-Denton et al. 2012 [SEDAR100-RD06]).

2. *Reduced shrimp bycatch estimates by 50%*. Assumed shrimp bycatch is half what has been estimated.

3. *Fit to the median shrimp bycatch estimate for only 1984-2023 (1,290,110) using the super-period approach*. Avoided fitting to the back-calculated or interpolated shrimp bycatch estimates.

Growth - The use of platoons mimics the effect of size selectivity on the distribution of size-at-age fish surviving the fishery. To evaluate the influence of size-dependent survivorship on model results, we conducted two sensitivity runs:

1. *Three platoons*. Assumed three platoons that follow a normal approximation.

2. *Five platoons*. Assumed five platoons that follow a normal approximation.

Steepness - Steepness is generally one of the most uncertain parameters estimated in a stock assessment model and is a critical quantity to stock assessment. To evaluate sensitivity of results to this parameter, we conducted one sensitivity run:

1. *Freely estimate steepness without a prior*. Steepness was estimated without a prior as in SEDAR 43.

Estimation of *F* and uncertainty estimates - Enabled estimation of annual *F* for each fleet for compatibility with the SEFSC's projection approach that maintains fleet allocations throughout the projection period (**Section 6**). To evaluate the influence of these specifications on model results, we conducted one sensitivity run:

1. *Annual Fs for each fleet using uncertainty*. Estimated annual Fs for all fishing fleets and used the uncertainty estimates provided.

Age-Structured Production Model (ASPM) - This simpler model is used as a diagnostic to detect misspecification of key systems-modeled processes that control the shape of the production function (Carvalho et al. 2017). To evaluate sensitivity of results to alternative model structures, we conducted two sensitivity runs:

1. *ASPM without recruitment deviations*. Evaluated whether the net effect between surplus production and observed catches alone could explain trends in the indices of abundance.

2. *ASPM with recruitment deviations*. Evaluated if composition data are needed to estimate the variability in recruitment (Minte-Vera et al., 2017).

Combining Landings and Dead Discards - A simpler approach to characterizing removals is to add dead discards to landings, which removes the need to parameterize length-based retention and explicitly model discards. To evaluate the sensitivity of results to this alternative model structure, we conducted one sensitivity run:

1. *Lumped dead discards with landings*. Added dead discards to the landings estimates for the Recreational and Commercial Vertical Line fleets and assumed that selectivities were identical for discarded and landed fish. For the Recreational fleet, the total number of discards (**Table 13**) was multiplied by the discard mortality rate of 40% and then added to the landings estimates. For the Commercial Vertical Line fleet, the total weight of discards (**Table 11 in SEDAR100-DW06**) was multiplied by the discard mortality rate of 40% and then added to the landings estimates.

Start Year - Historical data are particularly uncertain, but it can be equally as challenging to start the model in a fished condition because of the need to specify initial depletion at the start of the model. Typically, initial equilibrium catches are set equal to the average landings from the first 5 years for each fleet, from which a set of initial *F*s is estimated. This approach is not feasible for shrimp bycatch, which requires a more complex approach because initial conditions are defined based on an initial *F*. Following an approach first used during SEDAR 81 Gulf Spanish Mackerel (*Scomberomorus maculatus*) (SEDAR 2023), a search for optimal initial equilibrium catches was done by taking the following steps:

a. Each fleet's initial equilibrium catches were set to the mean landings over the first five years of the time series and initial equilibrium *F* for the Shrimp Bycatch fleet was set to 0.084 for 1963 and 0.129 for 1981. These estimates were based on the 1958-1962 and 1977-1981 averages obtained from the SEDAR 100 AP Model estimates.

b. Each initial catch (+ the Shrimp Bycatch initial *F*) was multiplied by a series of scalars ranging from 0.1 to 4.9 in 0.2 increments (i.e. where 0.1 would cut the equilibrium catches by 90% and 1.9 would nearly double them) and the model was re-run.

c. A likelihood profile of each model run was plotted to determine the most likely scalar (i.e. lowest negative log likelihood) given the information present in the model.

To evaluate the influence of starting in a later year on model results, while also accounting for the potential complications of specifying initial conditions as described above, we conducted two sensitivity runs:

1. *Start in 1963*. Started model in 1963 in a fished condition and used a prior on Shrimp Bycatch initial *F* of 0.084 as described above. Starting in 1963 corresponds to the start of commercial landings data and removes some uncertainty and the need to interpolate landings data.

2. *Start in 1981*. Started model in 1981 in a fished condition and used a prior on Shrimp Bycatch initial *F* of 0.129 as described above. Starting in 1981 corresponds to the start of the recreational data, and removes a lot of the uncertainty and need to back-calculate or interpolate data streams.

Jackknife of indices of abundance - The goal of these sensitivity runs was to determine if any single index of abundance was having undue influence on the model and causing tension with other data in terms of estimating parameters. The approach can be especially useful for

identifying indices that may be giving conflicting abundance trend signals compared to the other indices. If removing a data set leads to dramatically different results, it suggests that the data set should be reexamined to determine if the sampling procedures are consistent and appropriate (e.g., an index may only be sampling a sub-unit of the stock and resulting abundance signals may only reflect a local sub-population and not the trend in the entire stock). Each index was removed and the model rerun. Other data sets (i.e., landings and compositional data) were deemed fundamentally necessary to stabilize the assessment and therefore their exclusion was not included in the jack-knife analysis (i.e., a full jackknife was not conducted).

4. Stock Assessment Model - Results

4.1. Estimated Parameters

Most parameter estimates and variances were reasonably well estimated (i.e., CV < 1) for the SEDAR 100 AP Model (**Tables 17 and A1**). Of the 268 active parameters, 20 exhibited CVs above 1 and were poorly estimated, including 15 (of 44) recruitment deviations, the top logit parameter of the Recreational fleet and the SEAMAP Trawl Early Survey/Shrimp Bycatch fleet selectivity curves, the parameters defining the top logit and descending limb of the Combined Video Survey selectivity curve, and the asymptote of the 2012-2024 Recreational fleet retention curve. No parameters were estimated near bounds.

Figure 27 shows parameter distribution plots along with starting values and priors.

The Dirichlet-Multinomial parameters for the Recreational and Commercial Vertical Line/Commercial Longline length compositions were estimated >5 (i.e. a weight of >99% through inverse logit transformation), indicating no need for down-weighting the input sample sizes for these fleets. Four of the Dirichlet-Multinomial parameters were estimated below 5:

- Recreational conditional age-at-length compositions (62%)
- Commercial Vertical Line/Commercial Longline conditional age-at-length compositions (62%)
- SEAMAP Trawl Early Survey/SEAMAP Trawl Late Survey length compositions (46%)
- Combined Video Survey length compositions (40%)

4.2. Fishing Mortality

The exploitation rate (*F*; total biomass killed all ages / total biomass age 1+) for the entire stock is provided in **Table 18** and **Figure 28** and by fleet is provided in **Table 19** and **Figure 29**. Given the substantial differences in data inputs, particularly the recreational removals and the shrimp bycatch estimates, the magnitude of annual *F* estimated overall and by fleet were very different compared to the estimates from the SEDAR 43 Standard Model (**Table 18**; **Figures 28-29**).

F for the stock increased gradually until 1979, declined to a low in 1984 for the recent time period (1981-2024), increased to the largest estimate in 1993, and was highly variable thereafter (**Figure 28**). With the exception of the second highest estimate in 2013, *F* trended downward since 1993. Since 1945, *F* for the stock has averaged around 0.173, and ranged between 0.0002

in 1945 to 0.44 in 1993 (**Figure 28**). More recently since 1981, *F* for the stock has averaged around 0.237 (range: 0.094-0.44). For this recent time period, *F* remained above the recent (1981-2024) time series mean in most years between 1987 and 2013, but has since declined to below mean values. The terminal year (2024) *F* for the entire stock was 0.21, which is slightly below the recent time series mean.

For SEDAR 100, *F* was primarily driven by the Recreational fleet throughout the time series, which contrasts the dominance of exploitation by the Shrimp Bycatch fleet in SEDAR 43 (**Table 19**; **Figure 29**). *F* for the Recreational fleet was largest on average (0.12; recent mean of 0.17) and has varied considerably throughout the time series, ranging from 0.0001 in 1945 to 0.384 in 2013. After peaking in 2013, *F* dropped considerably in 2014 and 2015, and has generally remained above the time series mean in recent years (**Figure 29**). The Shrimp Bycatch fleet exhibited the next highest exploitation on average (0.043; recent mean of 0.049), which peaked in the late 1980s and again in the late 1990s and has remained well below the time series mean since 2004 (**Figure 29**). Both the Commercial Vertical Line and Commercial Longline fleets exhibited much lower *F*s (average of 0.01 and 0.001, respectively), with exploitation peaking in the early 1990s for both fleets (**Figure 29**). The Commercial Vertical Line fleet exhibited variable levels of exploitation throughout the time series, with higher levels during the 1990s and 2000s, and declining to relatively stable estimates since 2014 (**Figure 29**). *F*s for the Commercial Longline fleet remained consistently low since this deep-water fishery began in the late 1970s (Prytherch 1983), with the exception of a slight peak in 1990. The terminal year (2024) *F*s for the Recreational, Commercial Vertical Line, Commercial Longline, and Shrimp Bycatch fleets were 0.192, 0.004, 0.0007, and 0.013, respectively (**Table 19**).

4.3. Selectivity

Selectivity parameter estimates and associated uncertainty are listed in **Table 17** with the Label prefix "Size". Most selectivity parameters appeared well estimated (CV < 1; **Table 17**), with the exception of the top logit parameter defining the Recreational fleet and SEAMAP Trawl Early Survey/Shrimp Bycatch fleet selectivity curves, and the parameters defining the top logit and descending limb of the Combined Video Survey selectivity curve. Since length-based selectivity was not used in the SEDAR 43 Standard Model, no comparisons can be made.

Gray Triggerfish were fully selected (> 95%) for at larger sizes for the Commercial Longline fleet compared to the Commercial Vertical Line and Recreational fleets (**Figure 30**). The Commercial Longline fleet reached 50% selection around 48 cm FL, with full selection by 54 cm FL (**Figure 30**). In contrast, the Commercial Vertical Line fleet reached 50% selection around 38 cm FL, with full selection by 48 cm FL (**Figure 30**). The Recreational selectivity curve was estimated as dome-shaped and reached 50% selection around 30 cm FL, with full selection by 34 cm FL before declining and leveling off at 29.9% around 46 cm FL or larger (**Figure 30**).

The derived age-based selectivity patterns illustrate that the Recreational fleet selects for younger fish, with the Recreational fleet generally selecting Gray Triggerfish 6-9 years (selectivity > 50%; **Figure 31**). In contrast, the Commercial Vertical Line and Commercial Longline fleets generally select for Gray Triggerfish 8+ years and 14+ years, respectively. None of the directed fleets reached full selectivity (i.e., 95%). Selectivity for the Commercial Vertical Line and Commercial Longline fleets peaked at 91.5% for age-15 and 62.9% for age-15, respectively

(**Figure 31**). Selectivity for the Recreational fleet peaked at 54.2% for age-7 and then declined slightly for older ages (**Figure 31**).

Shifts in selectivity patterns assumed due to regulations such as the implementation of circle hooks in 2008 were evident for all three directed fleets (**Figure 32**). The selectivity curves for both the Recreational and Commercial Vertical Line fleets shifted towards larger fish in the 2008-2024 time period. For the 1945-2007 time block, the Commercial Vertical Line fleet reached 50% selection around 30 cm FL, with full selection by 36 cm FL (**Figure 32**). The Recreational selectivity curve for the 1945-2007 time block was slightly less domed, and reached 50% selection around 24 cm FL, with full selection by 28 cm FL before declining and leveling off at 42% around 50 cm FL or larger (**Figure 32**). In contrast, the selectivity curve for the Commercial Longline fleet shifted towards smaller fish in the 2008-2024 time period. For the 1945-2007 time block, the Commercial Longline fleet reached 50% selection around 56 cm FL, with full selection by 66 cm FL (**Figure 32**).

The SEAMAP Trawl Early Survey/Shrimp Bycatch fleet selectivity curve was estimated as dome-shaped and reached 50% selection for Gray Triggerfish around 8 cm FL, with selectivity leveling off at 39.5% around 22 cm FL or larger (**Figure 30**). This translated into maximum selection of 65.7 by age-1, with selection declining with age until leveling off around 39.5 by age-12 (**Figure 31**). The SEAMAP Trawl Late Survey also selected for smaller Gray Triggerfish (6 cm FL), with selectivity leveling off at 57.8% for Gray Triggerfish around 22 cm FL or larger (**Figure 30**). This also translated into maximum selection for age-1 of 76%, which then declined with age until leveling off around 57.8% by age-7 (**Figure 31**).

The Combined Video Survey selected for larger Gray Triggerfish and reached 50% selection around 44 cm FL, with full selection by 54 cm FL (**Figure 30**). This translated into selection (>50%) by age-10 and then increased to a max of 75.8% by age 15 (**Figure 31**). Shifts in selectivity were included to account for differences in the surveys, and estimated selectivity curves revealed differences among time periods. Selectivity curves were similar between the 1993-2005 and 2010-2019 time periods, where selectivity reached 50% selection around 46 cm FL, with full selection by 58 cm FL (**Figure 32**). Selectivity curves were similar between the 2006-2009 and 2020-2024 time blocks, where both shifted towards smaller Gray Triggerfish where selectivity reached 50% selection around 42 cm FL, with full selection by 54 cm FL (**Figure 32**).

4.4. Retention

Retention parameter estimates and associated uncertainty are listed in **Table 17** with the Label prefix “Retain”. Most retention parameters appeared well estimated (CV < 1; **Table 17**), with the exception of the asymptote for the 2012-2024 Recreational fleet retention curve.

Fleet-specific terminal year (2024) selectivity, retention, discard mortality (constant at 40%) and fraction of fish kept, dead and discarded for the Recreational fleet are shown in **Figure 33**. Retention curves changed considerably with management regulations, as they shifted towards larger fish with increasing size limits (**Figure 34**). The majority of Gray Triggerfish encountered were retained in the early period (1945-2011), whereas the 2012-2024 retention curve only reached an asymptote of 46.7% retention due to more strict management regulations (**Figures 25-26**).

Fleet-specific terminal year (2024) selectivity, retention, discard mortality (constant at 40%) and fraction of fish kept, dead and discarded for the Commercial Vertical Line fleet are shown in **Figure 35**. Changes in retention patterns were largely due to changes in size limits, as retention curves shifted towards larger fish with increasing size limits (**Figure 36**). Almost all Gray Triggerfish encountered were retained in the early period (1945-2011), whereas the 2012-2024 retention curve only reached an asymptote of 82.9% retention due to more strict management regulations (**Figures 25-26**).

Fleet-specific terminal year (2024) selectivity, retention, discard mortality (constant at 100%) and fraction of fish dead and discarded for the Shrimp Bycatch fleet are shown in **Figure 37**. All Gray Triggerfish selected for were discarded dead.

4.5. Recruitment

As noted in **Section 3.1.5**, steepness was fixed at 0.99 and *SigmaR* was fixed at 0.6 which differs from SEDAR 43 where both were estimated. The corresponding Beverton-Holt stock recruit relationship is shown in **Figure 38**. The SEDAR 100 AP Model estimated an ln(R_0) at 11.469 (0.004) (**Table 17**), which equates to 95.74 million age-0s.

Estimated annual recruitment of age-0s from 1945 to 2024 are provided in **Table 20** and shown in comparison to SEDAR 43 in **Figures 38-39**. The highest recruitments estimated by the SEDAR 100 AP Model occurred during 1981 (219.29 million age-0s), 1987 (185.73 million age-0s), 2013 (173.09 million age-0s), 2017 (168.77 million age-0s), and 1988 (148.57 million age-0s). Between 1981 and 2024 (when recruitment deviations were estimated), estimated recruitment averaged 90.06 million age-0s and was lowest in 2023 at 30.07 million age-0s (**Figures 38-39**). Estimated recruits were very variable throughout the 1980s and 1990s, were relatively low during the early 2000s, and highly variable since the mid 2010s (**Figure 39**). Estimated recruitment for the last 10 years averaged 99.89 million age-0s, which was about 10% higher than the 1981-2024 mean. Recruitment trajectories were very different than those estimated in SEDAR 43 due to the combination of changes to input data and model settings for recruitment (**Figure 39**).

Recruitment deviations were much more variable for the SEDAR 100 AP Model and were fairly randomly distributed with a few noticeable trends of negative deviations (1982-1984, 2000-2006) and positive deviations (2011-2014, 2017-2019). Recruitment deviations were characterized by a period of higher than average recruitment in recent years, although the confidence intervals for some years were very large and overlapped with 0 (**Figure 40**). Recruitment deviations were generally well estimated (CV < 1) in the SEDAR 100 AP Model with the exceptions of 1982, 1985-1986, 1993, 1996, 2000-2001, 2007, 2009, 2015-2016, 2019-2021, and 2024 (**Table 17**). The asymptotic SEs for recruitment deviations averaged 0.2 between 1981 and 2024, and ranged from 0.08 in 2013 to 0.58 in 2024 (**Figure 41**). Variability in recruitment was much higher in the SEDAR 100 AP Model because *SigmaR* was fixed at 0.6 whereas it was estimated at 0.358 in the SEDAR 43 Standard Model. The estimated (and applied) recruitment bias adjustment ramp is shown in **Figure 42**.

4.6. Biomass and Abundance Trajectories

The estimated annual total biomass (metric tons), exploitable biomass (ages 1+, metric tons), SSB (metric tons), SSB ratio (SSB/SSB_0 where SSB_0 is virgin or unfished SSB) and exploitable abundance (ages 1+) from 1945 to 2024 are provided in **Table 20**. Total biomass averaged 5,883 metric tons, and ranged from 2,810 metric tons in 2006 to 9,967 metric tons in 1945. Total biomass declined gradually, reached the lowest value in the mid 2000s, and has since increased to levels similar to the early 1980s (**Figure 43**). The magnitude of estimated total biomass differed considerably from SEDAR 43, particularly in the earliest years (**Figure 43**). Exploitable (ages 1+) biomass and numbers averaged 5,681 metric tons and 37.89 million, respectively. Exploitable biomass was lowest in 2007 at 2,660 metric tons whereas exploitable numbers were lowest in 2006 at 20.02 million. Exploitable biomass peaked at 9,758 metric tons in 1945 whereas exploitable numbers were highest in 1982 at 67.89 million (**Table 20**). SSB averaged 4,846 metric tons and ranged from 2,096 metric tons in 2008 to 8,817 metric tons in 1945 (**Table 20**). A comparison of SSB in terms of magnitude was not possible between assessments because SEDAR 43 used the number of eggs and not metric tons as used in SEDAR 100.

The SSB ratio averaged 0.55, and ranged from 0.24 in 2007-2008 to 1 in 1945 (**Table 20**). The estimated SSB ratio declined gradually throughout the first half of the time series, increased slightly in the early 1980s, declined to its lowest level at 24% in 2008, and has since increased to 55% in 2024 (**Table 20**; **Figure 43**). The SSB ratio from SEDAR 43 showed a similar declining trend over time, but reached its lowest value in 2013 (**Figure 43**).

The mean age of Gray Triggerfish generally remained around 0.5 year throughout the time series for the SEDAR 100 AP Model, which is younger than observed for the SEDAR 43 Standard Model (**Figure 44**). The most abundant age class was age-0 in all years. At virgin conditions, age-0 and age-10+ Gray Triggerfish dominated in numbers and biomass, respectively (**Figure 45**).

4.7. Model Fit and Residual Analysis

4.7.1. Landings

Given the large log-scale SEs assigned to the Recreational landings (up to 0.25), differences were observed between input and expected landings in numbers (**Table 21**, **Figure 46**). The model expected lower Recreational landings in the 1970s and throughout some of the 1980s and 1990s, whereas the model expected considerably higher landings in 1998 and around 2007 (**Figure 46**). The landings for the Commercial Vertical Line and Commercial Longline fleets were fit almost exactly as these fleets generally had relatively small log-scale SEs, especially since 1986 (**Tables 22-23**, **Figure 46**; see **Section 3.4.7** for sensitivity run using these uncertainty estimates). The overwhelming majority of landings came from the Recreational fleet (**Figure 47**).

The majority of years showed good agreement between expected and observed mean body weight of the Recreational landings, with the exception of 1983-1985, 1990-1991, 1997, and 2000 where the expected values fell outside the confidence intervals (**Figure 48**). The mean weight landed over time by the Recreational fleet averaged 2.2 pounds wwt and ranged from 1.6 pounds wwt in 1990 to 3.7 pounds wwt since 2023 (**Table 21**).

The mean weight landed over time by the Commercial Vertical Line fleet averaged 3.2 pounds wwt and ranged from 2.4 pounds wwt in 1990 and 1995 to 4.5 pounds wwt since 2022 (**Table 22**). The Commercial Longline fleet retained larger Gray Triggerfish, with the mean weight landed over time averaging 6.6 pounds wwt and ranging from 5.9 pounds wwt in 2015-2017 to 7.5 pounds wwt in 1988 (**Table 23**).

4.7.2. Discards

Since 2009, the majority of discards have come from the Recreational fleet (**Figure 49**). Throughout almost all years of the time series, the Recreational fleet was responsible for the majority of total catch (landings + all discards; **Figure 50**) and total removals (landings + dead discards; **Figure 51**). The discard fraction increased considerably for the Recreational and Commercial Vertical Line fleets in 2013 (**Figure 52**) due to regulations (**Figures 25-26**), which was not evident in SEDAR 43 because of its terminal year of 2013.

For the Recreational fleet, discard estimates were provided beginning in 1981 (**Figure 53**). Because of how retention was parameterized, the assessment model expected small (relative to those in 1981+) amounts of discards prior to 1981 (mean: 131,737; **Table 24**). The model generally fit well to the discard observations, with only a few years showing predictions falling beyond the confidence limits of the data. The model expected an especially high discard estimate in 2013, which corresponded with reductions in season length and the implementation of a Gray Triggerfish bag limit (**Figures 25-26**). Compared to landings, dead discards in terms of biomass and numbers accounted for far less removals (mean: 17% of biomass, 26% of numbers; **Figure 54**). However, dead discards have made up the majority of removals since 2009 (**Figure 54**). Expected total discards averaged 0.51 million (0.21 million dead) and 0.74 million pounds wwt (0.3 million pounds wwt dead), and peaked at 3.08 million (1.23 million dead) and 5.36 million pounds wwt (2.14 million pounds wwt dead) in 2013. The mean weight of Gray Triggerfish discarded over time by the Recreational fleet averaged 1 pound wwt and ranged from 0.7 pounds wwt in 1999-2007 to 1.9 pounds wwt in 2022-2023 (**Table 24**).

For the Commercial Vertical Line fleet, discard estimates were provided beginning in 2000 (**Figure 55**). The assessment model expected very small amounts of discards from 1945-1999 (mean: 198; **Table 25**). The model fit the discard observations well as all values remained within the confidence limits of the data. Compared to landings, dead discards in terms of biomass and numbers accounted for far less removals (mean: 4% of biomass, 6% of numbers; **Figure 56**), although they did make up a larger proportion since 2009 (**Figure 56**). Expected total discards averaged 2,914 Gray Triggerfish (1,165 dead) and 6,450 pounds wwt (2,580 pounds wwt dead), and peaked at 19,345 Gray Triggerfish (7,738 dead) in 2011 and 46,604 pounds wwt (18,642 pounds wwt dead) in 2012. The mean weight of Gray Triggerfish discarded over time by the Commercial Vertical Line fleet averaged 0.9 pounds wwt and ranged from 0.4 pounds wwt throughout some of the 1980s and 1990s to 2.7 pounds wwt in 2022-2023 (**Table 25**).

4.7.3. Shrimp Bycatch

Overall, the expected discards by the Shrimp Bycatch fleet were much smaller in SEDAR 100 compared to SEDAR 43 (**Figure 49**), and were smaller than recreational removals in nearly all years (**Figure 51**). The model estimated a lower median bycatch value (1,420,330), but this estimate remained within the confidence intervals of the input value of 1,612,310 (**Figure 57**).

Expected shrimp bycatch averaged 1.4 million and 0.49 million pounds wwt, and peaked at 3.77 million and 0.96 million pounds wwt in 1989. The mean weight discarded over time by the Shrimp Bycatch fleet averaged 0.4 pounds wwt and ranged from 0.2 pounds wwt in 1982, 1988, and 2013-2014 to 0.6 pounds wwt in 1985 (**Table 26**).

4.7.4. Indices

Observed and expected shrimp effort are provided in **Table 27** and **Figure 58**. Observed and expected values were nearly identical (RMSE = 0.027), with the exception of the late 1970s and early 1980s where the model slightly underestimated effort.

Observed and expected indices of relative abundance are provided in **Tables 28-29** and **Figures 59-62**.

The model fit best to the Combined Video Survey index (RMSE = 0.294, extra SD parameter = 0.117; **Table 17**) where expected relative abundance generally tracked observed abundance (**Figure 62**). Relative abundance was expected to remained below average until around 2016 and has increased well above the average since 2020. The implementation of time-varying selectivity for this survey substantially improved model fit for this index (RMSE = 0.406 without), specifically by enabling the index to fit the trend from 2006-2009 and since 2020. This index exhibited a relatively moderate correlation of 0.55 with the expected SSB.

The model fit for the Recreational (SRHS) CPUE index was variable (RMSE = 0.323, extra SD parameter = 0.074; **Table 17**), as it fit better during the earlier part of the time series. This index exhibited the second highest correlation of 0.4 with the expected SSB. Expected relative abundance matched the increasing trend in the late 1980s, peaked in 1990 along with the observed index, and then remained around the time series mean until 2005 where it increased slightly then declined (**Figure 59**).

The poorest fits were evident for the SEAMAP Trawl Early Survey index (RMSE = 0.694, extra SD parameter = 0.414; **Table 17**) and the SEAMAP Trawl Late Survey index (RMSE = 0.371, extra SD parameter = 0.231; **Table 17**). The SEAMAP Trawl Early Survey index was highly variable and uncertain. The expected index did not track the observed trends well, as the expected index peaked in the late 1980s whereas the observed index was highest in 2001 (**Figure 60**). The SEAMAP Trawl Late Survey index was much less variable, but the model still fit poorly and did not track the trends in the observed index well, with the expected index peaking in 2014 but the observed index peaking in 2022 (**Figure 61**). Both indices were poorly correlated with the expected SSB (Trawl Early = -0.14; Trawl Late = 0.33), although this is expected given that both indices primarily track juveniles and not adults.

4.7.5. Fishery Length Compositions

Aggregated across years, the expected length compositions were generally similar to the observed compositions for most fleets and data types (**Figure 63**). Fits to retained length compositions were often better than to discarded length compositions, although sample sizes were notably smaller for discard length compositions (discussed below).

Annual fits to retained length compositions for the Recreational fleet were generally good, with expected and observed peaks corresponding in many years (**Figure 64**). Some early years

exhibited small sample sizes and therefore jagged compositions differing from the expected compositions. The Pearson residuals were very variable (min = -7.32, max = 64.14), with clear patterns evident such as underpredicting smaller Gray Triggerfish (large positive residuals) in the early 1980s and since 2009 and underpredicting the largest Gray Triggerfish around 2000 (**Figure 64**). While sample sizes were relatively small for the discard compositions, resulting in poor fits in some years such as 2020, Pearson residuals did not show any concerning magnitudes (min = -2.99, max = 4.91) or patterns (**Figure 65**). When estimated, the Dirichlet parameter for recreational length compositions exceeded 5 (**Table 17**) and did not result in very different sample sizes from the inputs, suggested that input sample sizes were appropriate.

Annual fits to retained length compositions for the Commercial Vertical Line fleet were variable, but in general expected and observed peaks corresponded in many years (**Figure 66**). Poorer fits were noted for years which exhibited smaller sample sizes and therefore jagged compositions differing from the expected compositions, such as the early 1990s and 2006-2012. The Pearson residuals were relatively large (min = -2.61, max = 29.71) and patterns were evident. The model underpredicted larger Gray Triggerfish in the early 1990s, Gray Triggerfish around 34 cm FL in the 2010s, and Gray Triggerfish around 50 cm FL in the late 2010s. Given limited sample sizes in most years, the agreement between expected and observed discard compositions was poor (**Figure 67**), but residuals did not reveal any concerning magnitudes (min = -2.72, max = 5.81) or strong patterns. When estimated, the Dirichlet parameter for commercial length compositions exceeded 5 (**Table 17**) and did not result in very different sample sizes from the inputs, suggested that input sample sizes were appropriate.

Annual fits to retained length compositions for the Commercial Longline fleet showed more variability due to data quality and quantity, with many years showing poor correspondence and jagged compositions (**Figure 68**). The Pearson residuals were relatively small (min = -1.34, max = 6.39) and did not show any strong patterns. While the overall fit showed a slight mismatch in the peak of the expected distribution, the overall aggregated fit was adequate (**Figure 63**).

Although the model did not fit directly to the proxy length compositions for the Shrimp Bycatch fleet, overall there was good agreement between the expected and observed compositions in most years (**Figure 69**). The Pearson residuals were relatively small (min = -0.22, max = 0.92), but did show some pattern from 2014 onward where the model underpredicted Gray Triggerfish around 6 cm FL.

4.7.6. Survey Length Compositions

Aggregated across years, the expected length compositions were generally similar to the observed compositions for the surveys (**Figure 70**).

Annual fits to length compositions for the SEAMAP Trawl Early Survey showed more variability in quality and very variable sample sizes among years (**Figure 71**). Some years showed considerably more spread in the observed compositions such as 1990, 1998, and 2006. The Pearson residuals were relatively small (min = -2.09, max = 9.58) and did not show any strong patterns. The estimated Dirichlet parameter of -0.18 for the trawl surveys led to lower sample sizes compared to the inputs (DM adjusted mean = 37 fish, range: 7-73). Even though the overall fit showed a slight mismatch in the expected distribution for larger fish ~ 30 cm FL, the overall aggregated fit was adequate (**Figure 70**).

Annual fits to length compositions for the SEAMAP Trawl Late Survey also showed high variability in the underlying data and sample sizes across years (**Figure 72**). As observed above, some years showed considerably more spread in the observed compositions such as 2016, 2020, and 2024. The Pearson residuals were relatively small (min = -2.64, max = 9.7) and did not show any strong patterns. The estimated Dirichlet parameter of -0.18 for the trawl surveys led to lower sample sizes compared to the inputs (DM adjusted mean = 43 fish, range: 20-64).

Annual fits to length compositions for the Combined Video Survey were quite variable with many years exhibiting a jagged distribution (**Figure 73**). While most years showed considerable spread in the observed compositions (e.g., 20-60 cm FL), in general the model tended to fit the composition well. The Pearson residuals were relatively small (min = -2.18, max = 13.44) and did not show any strong patterns. The estimated Dirichlet parameter of -0.39 for the video survey led to lower sample sizes compared to the inputs (DM adjusted mean = 44 fish, range: 9-113). The expected distribution was slightly shifted towards larger fish, but overall the aggregated fit was adequate (**Figure 70**).

4.7.7. Fishery Age Compositions

The model fits to the conditional age-at-length for the Recreational fleet are shown in **Figure 74**. The Pearson residuals were relatively small (min = -2.85, max = 18.44) and occasionally showed some clusters such as underpredicting smaller and older Gray Triggerfish in 2009. The estimated Dirichlet parameter of 0.47 for the recreational age data resulted in lower sample sizes (DM adjusted mean = 19 fish, range: 1-279). Differences in observed and expected mean age were variable for the Recreational fleet, with expected mean age ranging between 3.75 and 5.5 years and the observed mean age varying between 3.5 and 6 years (**Figure 75**). The expected mean age generally increased throughout the time series and remained within the 95% confidence intervals for about half of the years. Most years revealed good agreement between observed and expected mean length-at-age, with some years displaying fairly variable observed mean length-at-age due to lower sample sizes (**Figure 76**).

The model fits to the conditional age-at-length for the Commercial Vertical Line fleet are shown in **Figure 77**. The Pearson residuals were relatively small (min = -3.8, max = 11.34) and sometimes revealed patterns such as overpredicting age-5 and age-6 Gray Triggerfish across lengths in 2014-2017 and 2019. The estimated Dirichlet parameter of 0.5 for the commercial age data resulted in lower sample sizes (DM adjusted mean = 14 fish, range: 1-75). Differences in observed and expected mean age were variable for the Commercial Vertical Line fleet, with expected mean age ranging between 4 and 6 years and the observed mean age varying between 3.5 and 7 years (**Figure 78**). The expected mean age generally increased throughout the time series, and while the expected mean age followed the same trend as the observed mean age, many of the expected values fell outside 95% confidence intervals. Most years revealed good agreement between observed and expected mean length-at-age, with some years displaying fairly variable observed mean length-at-age due to lower sample sizes (**Figure 79**).

The model fits to the conditional age-at-length for the Commercial Longline fleet are shown in **Figure 80**. The Pearson residuals were relatively small (min = -1.88, max = 8.01) and did not show any strong patterns. The estimated Dirichlet parameter of 0.5 for the commercial age data resulted in lower sample sizes (DM adjusted mean = 3 fish, range: 1-17). Differences in observed and expected mean age were variable for the Commercial Longline fleet, with expected mean

age ranging between 5.75 and 7 years and the observed mean age varying between 6 and 8.25 years (**Figure 81**). The expected mean age gradually decreased from 2006 to 2016 and increased thereafter, and generally has remained within the 95% confidence intervals for about half of the years. Most years revealed good agreement between observed and expected mean length-at-age, with some years displaying fairly variable observed mean length-at-age due to lower sample sizes (**Figure 82**).

4.8. Model Diagnostics

4.8.1. Correlation Analysis

Given the highly parameterized nature of the SEDAR 100 AP Model, some parameters were mildly correlated (correlation coefficient > 70%) but no combinations displayed a strong correlation (> 95%; **Table 30**). Moderate correlations occurred between some time-varying retention parameters for each fleet, some selectivity parameters for fleets and surveys, and the von Bertalanffy growth parameters. Correlation between many of these parameters is not surprising, especially for the selectivity parameters, because the parameters of selectivity functions are inherently correlated (i.e., as the value of one parameter changes the other value will compensate). The same can be said for the von Bertalanffy growth parameters, which are by their very nature correlated.

4.8.2. Likelihood Profiles

The total likelihood component from the ln(R_0) likelihood profile indicates that the global solution for this parameter is approximately 11.45 (**Figure 83**), with the SEDAR 100 AP Model estimating ln(R_0) at 11.469 (**Table 17**). Conflicts were evident, particularly between the length composition data and indices which favored lower values around 11.25 and the mean weight of recreational landings and the age data which supported higher values around 12.

The total likelihood component from the *SigmaR* likelihood profile indicates that the global solution for this parameter is approximately 0.8 (**Figure 84**). However, values between 0.48 and 0.8 remained within 2 negative log-likelihood units, suggesting this parameter was not well estimated. *SigmaR* was fixed in the SEDAR 100 AP Model at 0.6 (see **Section 3.1.5**). Recruitment supported lower values than the total minimum, whereas most other data inputs supported higher values around 0.8.

The total likelihood component from the steepness likelihood profile (not using a prior) supported a minimum around 0.43 (**Figure 85**), but values between 0.39-0.41 and 0.45-0.47 remained within 2 negative log-likelihood units. Conflicts were evident, particularly between the mean weight of recreational landings and age data which favored lower values around 0.31, the discard data which supported higher values around 0.51, and recruitment which favored 0.59.

The total likelihood component from the L_{Amin} growth parameter indicates that the global solution for this parameter is approximately 8 cm FL (**Figure 86**), with the SEDAR 100 AP Model estimate of 8.353 cm FL (**Table 17**). Other values which remained within 2 negative log-likelihood units included 9 cm FL. The data sources were generally in close agreement (~8 cm FL) with the exception of catch which favored around 5 cm FL.

The total likelihood component from the L_{Amax} [i.e., $L\infty$] growth parameter indicates that the global solution for this parameter is approximately 54 cm FL (**Figure 87**), with the SEDAR 100 AP Model estimate of 53.804 cm FL (**Table 17**). Other values which remained within 2 negative log-likelihood units included 53 and 55 cm FL. Conflicts were evident, as the catch, indices, and age data supported lower values between 49-52 and mean weight of recreational landings and discard data supported higher values around 57 and 60 cm FL, respectively.

The total likelihood component from the *K* growth parameter indicates that the global solution for this parameter is approximately 0.15 (**Figure 88**), with the SEDAR 100 AP Model estimate of 0.153 (**Table 17**). Other values which remained within 2 negative log-likelihood units included 0.14-0.145 and 0.155-0.165. While the catch data and recruitment supported higher values around 0.2, the discard data supported lower values around 0.1.

The total likelihood component from the CV_{Amin} growth parameter indicates that the global solution for this parameter is approximately 0.44 (**Figure 89**), with the SEDAR 100 AP Model estimate of 0.437 (**Table 17**). Other values which remained within 2 negative log-likelihood units included 0.42-0.43 and 0.45-0.46. The indices, mean weight of recreational landings, length data and recruitment supported lower values around 0.25.

The total likelihood component from the CV_{Amax} growth parameter indicates that the global solution for this parameter is approximately 0.12 (**Figure 90**), with the SEDAR 100 AP Model estimate of 0.124 (**Table 17**). Other values which remained within 2 negative log-likelihood units included 0.1-0.11 and 0.13-0.15. The indices and recruitment supported lower values around 0.05 whereas the catch and discard data favored higher values around 0.2.

4.8.3. Jitter Analysis

No jitter runs demonstrated a lower negative log-likelihood solution than the SEDAR 100 AP Model, and 42% and 90% of runs converged to the same likelihood solution or within 25 negative log-likelihood units, respectively (**Figure 91**). For the remaining runs for the SEDAR 100 AP Model, given that the total negative log-likelihood values were much higher than that of the SEDAR 100 AP Model, it is probable that non-optimal solutions were found (i.e., the model search was stuck in local minima). However, the recruitment parameter estimates (**Figure 92**) and the estimates of SSB, recruitment, and *F* were fairly consistent across runs (**Figure 93**). Given these results, the jitter analysis indicates that the SEDAR 100 AP Model is relatively stable and reached the global solution.

4.8.4. Retrospective Analysis

Mohn's Rho, which measures the severity of retrospective patterns, was equal to -0.07 and -0.005 for the SSB and *F* time series (**Table 31**), respectively, which are within the acceptable range (-0.15 to +0.20; see Hurtado-Ferro et al. (2015)). For comparison, the SEDAR 43 Standard Model revealed retrospective patterns with Mohn's Rho for SSB of 0.383 (forecast bias = 0.437) but not for *F* of -0.112 (forecast bias = 3.005). As the last few years of data are peeled off, the model estimates of SSB and *F* in each successive terminal year do not change by a large margin and generally remain within the confidence intervals (**Figure 94**). Differences were noted for SSB and *F* where Mohn's Rho fell outside the acceptable range for a terminal year of 2020 and 2019, respectively (**Table 31**). While recent trends remained relatively similar, it is important to highlight that the early trajectories for SSB and *F* did differ (i.e., fell outside the confidence

intervals) for terminal years of 2022, 2020, and 2019. These models estimated considerably lower ln(R_0) values (**Figure 95**) and more closely tracked recent trends in relative abundance for the SEAMAP Trawl Late Survey.

Annual recruitment estimates varied considerably as more years of data are peeled off, and estimates were extremely high and very uncertain for a terminal year of 2022, 2020, and 2019, leading to an unacceptable Mohn's Rho of 6.5. This uncertainty in recruitment is expected because the model is missing key composition data inputs that capture those cohorts (**Figure 96**). A retrospective pattern for age-0 recruits was also noted in SEDAR 43 (Mohn's Rho = 1.16). This volatile behavior in estimated recruitment likely led to the poor forecast bias in *F* (**Table 31**; **Figure 94**). These issues with recruitment appear to be exacerbated by the Shrimp Bycatch fleet, as the sensitivity run with shrimp bycatch excluded (**Section 4.8.7**) led to much lower but still undesirable Mohn's Rho for recruitment (0.59) and forecast bias in *F* (0.27).

4.8.5. Additional Diagnostics

The SEDAR 100 AP Model displayed acceptable RMSE (<30%) for the joint residuals for mean length data sources, conditional age-at-length, but not for the indices (**Table 32**). Residuals revealed some conflict for each data source (evident by colored vertical lines in opposite directions) and trends in the residuals (evident by Loess smoothed line; **Figure 97**). The SEDAR 43 Standard Model revealed similarly poor diagnostics for the indices, where seven of the eight indices of relative abundance exhibited a RMSE above 30%.

Runs test results revealed evidence of non-randomly distributed residuals for the Recreational (SRHS) CPUE, SEAMAP Trawl Early Survey, and Combined Video Survey indices of abundance, Commercial Vertical Line conditional age-at-length, and Recreational, Commercial Vertical Line, and SEAMAP Trawl Early Survey length compositions (**Table 33**; **Figure 98**). Outliers (evident by red points) were identified in the residuals for the Recreational (SRHS) CPUE and Combined Video Survey indices of abundance, conditional age-at-length for the commercial fleets, and residuals for length compositions for all fleets and surveys except the SEAMAP Trawl Late Survey (**Figure 98**). The SEDAR 43 Standard Model revealed similarly poor diagnostics for the indices, where five of the eight indices of relative abundance failed the runs test.

Superior prediction skill (<1) was not evident in any of the indices of relative abundance (**Figure 99**), but was observed for mean length for the commercial fleets and SEAMAP Trawl Late Survey (**Figure 100**; **Table 34**). Of the eight indices of relative abundance included in the SEDAR 43 Standard Model, only two (commercial East CPUE and commercial West CPUE) revealed good prediction skill.

4.8.6. Bridging Analysis

The general flow of model building runs that led to the SEDAR 100 AP Model is shown in **Tables 35-36**. Changes in estimated quantities starting from the SEDAR 43 Standard Model are shown in **Figures 101-104**.

Model building occurred in phases, starting with converting the original SEDAR 43 Standard Model (Step 1) from Stock Synthesis version 3.24 to 3.30 (Step 2). Model results were identical (**Tables 35-36**). Step 3 involved updating all data streams with the exception of the composition

data (i.e., SEDAR 43 age compositions remained through 2013) and maintaining the model structure of the SEDAR 43 Standard Model ("Continuity" model). Additional years of data shifted SSB and recruitment estimates higher since the 1980s and SSB increased to virgin conditions by 2023 (**Figure 101**). Steepness bounded at 1 in the "Continuity" model (**Table 36**). Changes in data streams (e.g., inclusion or exclusion of indices) and the lack of composition data updates likely drove these differences.

Step 4 served as an updated "Continuity Model" which incorporated the best available age data by adding in the nominal age compositions, the ageing error matrix, Dirichlet-Multinomial parameters for the composition data, and also incorporating the SEAMAP Trawl Late Survey which was not split during SEDAR 43. Recruitment deviation estimation was also adjusted to begin in 1993 to better match the availability of the age data (which began in 2003). This model had poor convergence and bounding issues (**Table 35**), exhibited much larger estimates of *SigmaR* and ln(R_0) (**Table 36**), and showed substantially more uncertainty in SSB, SSB ratio, and recruitment (**Figure 101**), with the ending SSB ratio exceeding 1 (i.e., SSB in 2024 > SSB_0; **Table 36**).

Step 5 switched to a length-focused model which fit to all available length compositions (of discards, landings, and surveys), used length-based selectivity for fleets and the Combined Video Survey, used Dirichlet-Multinomial parameters for composition data, and added in the SEAMAP Trawl Late Survey. This intermediate model served as a "Revamped Continuity Model for SEDAR 43" given the uncertainties in the ageing data that are now known (**Section 2.2.2**), and was presented to the Gulf Council's Scientific and Statistical Committee meeting in February 2026. This model also had poor convergence and bounding issues (**Table 35**), with steepness bounding at 1 (**Table 36**). Largely due to the inclusion of length composition data, this change led to very different recruitment estimates, a lower ln(R_0) (**Table 36**), and consistently lower estimates of virgin and annual SSB (**Figure 101**). Estimates of *F* were consistently larger for this model, particularly in the 1990s, and SSB ratio increased to 73% in 2024 (**Figure 101**).

Step 6 updated natural mortality, which led to a slight reduction in NLL (**Table 35**) and an upward shift in annual SSB ratio and lower *F* estimates since 1960 (**Figure 102**). Step 7 updated the growth parameters and fixed them at the Data Workshop recommended values, which reduced the NLL by ~1,700 units and led to 10 fewer parameters with CV > 1 (**Table 35**). Steepness was estimated much lower at 0.36 (**Table 36**) and the fits to the length compositions and nominal age compositions were greatly improved. Updating the growth parameters shifted virgin and annual SSB and recruitment estimates much higher from 1945 to around 1980, which led to noticeably lower SSB ratios since the 1990s (**Figure 102**). The trend in recruitment differed considerably since 1981 and *F* was much lower throughout the time series.

Step 8 updated morphometrics, switched maturity to length-based, switched fecundity from eggs to SSB in metric tons, and implemented length-based selectivity for the SEAMAP Trawl Early Survey (mirrored by the SEAMAP Trawl Late Survey and Shrimp Bycatch fleet). The model results were identical for the life history changes, with the exception of the raw SSB which switched units during this step (**Figure 102**). Modeling length-based selectivity for the SEAMAP Trawl Early Survey/SEAMAP Trawl Late Survey/Shrimp Bycatch fleet greatly improved the fits to their length compositions, shifted SSB higher throughout the time series, and led to slightly higher historical *F* until 1980 (**Figure 102**). Recruitment estimates prior to 1980 were consistently higher, but have remained similar since 1980 (**Figure 102**). Step 9 updated the

discard mortality rate to 40% for the Recreational and Commercial Vertical Line fleets, which led to similar key model parameter estimates (**Table 36**) and relatively higher SSB ratios, recruitment, and *F* estimates, which were more pronounced over the last 10 years.

Step 10 implemented a number of changes to retention parameters, such as estimating the inflection points and allowing the width parameters and asymptote parameters to also be time-varying in addition to the inflection point. These changes reduced the NLL by about 1,400 units at the expense of more parameters (**Table 35**) and reduced ln(R_0) (**Table 36**), but fits to compositions and discards were noticeably improved. Annual estimates of SSB, recruitment and *F* generally remained within the confidence limits of Step 9 (**Figure 102**). Step 11 replaced the nominal age compositions for fishing fleets with conditional age-at-length, which led to a slightly lower *SigmaR* value (**Table 36**) but did not result in large changes to time series of SSB, recruitment or *F* (**Figure 102**).

Step 12 estimated all five growth parameters, with priors for L_{Amin}, L_{Amax} [i.e., $L\infty$], and *K* based on the Data Workshop recommendations. This change led to improved fits to the length compositions for most fleets and surveys, reduced the NLL by about 900 units (**Table 35**), and resulted in higher and more variable recruitment estimates and slightly lower SSB estimates (**Figure 102**). Step 13 separated out the Commercial Longline fleet from the Commercial Vertical Line fleet, which increased the ln(R_0) and resulted in consistently larger recruitment estimates and lower *F* estimates until the mid-2000s (**Figure 102**).

Step 14 substantially modified the model structure by collapsing the commercial and recreational fleets-as-areas so each fleet operated across the entire Gulf, which greatly reduced the number of model parameters (**Table 35**). Virgin and annual SSB estimates were noticeably higher until about 1990, recruitment was higher from 1945-1980 but very similar thereafter, and *F* was slightly lower until 1980 (**Figure 103**). Step 15 input the discard data as numbers of fish (with uncertainty as provided) instead of fractions, and the model fit well to the inter-annual estimates of discards. This change led to higher *F* in the 1990s and lower estimates around 2010, and also noticeable shifts towards larger recruitment estimates and SSB ratios in the more recent years.

Step 16 allowed time-varying selectivity for the Recreational fleet, which led to better fits to the composition data. Virgin and annual estimates of SSB and recruitment were considerably higher until 1980, which reduced SSB ratio in recent years, and estimates of *F* were slightly lower until about 2000 (**Figure 103**). Enabling time-varying selectivity for the Commercial Vertical Line and Commercial Longline fleets in Steps 17 and 18 also led to improved fits to their respective compositions. Within Step 17, selectivity for the Commercial Vertical Line fleet was switched to logistic which did not affect model results. Considerably larger recruitment estimates were evident for Step 18, but time series of SSB and *F* remained very similar (**Figure 103**). Overall these steps reduced the NLL by about 200 units (**Table 35**) and did not lead to large deviations in key model parameter estimates (**Table 36**).

Step 19 fit to the mean weight of landings for the Recreational fleet, lowered the SD on the L_{Amin} parameter from 0.8 to 0.3 (to prevent it from bounding out at 5 cm FL), and estimated extra SD parameters for each index of relative abundance. Fitting to the mean weight of Recreational landings had very little difference on model results, whereas reducing the SD on the L_{Amin} parameter led to consistently lower recruitment estimates throughout the time series (**Figure 103**). Estimating extra SD parameters had a relatively large effect on the SSB ratio in the most

recent years, which declined to the lowest estimate of 0.29 of any model building runs (**Figure 103**).

Steps 20 and 21 fixed steepness at 0.99 and *SigmaR* at 0.6, respectively, which reduced the number of parameters with CVs > 1 (**Table 35**). Fixing steepness at 0.99 substantially shifted estimated SSB lower in the first half of the time series, which led to a higher SSB ratio in recent years (**Figure 104**). The ln(R_0) estimate decreased with each step (**Table 36**), and annual SSB ratios shifted slightly larger when *SigmaR* was fixed at 0.6. No large differences in *F* or recruitment (since 1981) were evident (**Figure 104**). During model building Step 19, we implemented the recruitment deviations option which does not constrain the sum of recruitment deviations to be zero after the model results did not differ greatly with this modification. However, after Steps 20 and 21, this recruitment setting had a large impact on model results. Therefore, in Step 22 we constrained the sum of the recruitment deviations to equal zero because their sum was very negative (-14) and not close to zero as is expected (within Step 19 they had summed to -2). This change substantially shifted estimated recruitment and SSB lower in the first half of the time series, which led to a higher SSB ratio in recent years up to 82% in 2024 (**Figure 104**).

Step 23 eliminated annual *F* parameters for the commercial fleets (**Table 35**) and implemented time-varying selectivity for the Combined Video Survey. Switching to the hybrid *F* method for the commercial fleets did not alter model results, whereas allowing time-varying selectivity for the Combined Video Survey did have a noticeable impact on model results. This selectivity change greatly improved the fit to the index of abundance, particularly in the last few years where the model now captured the decline in relative abundance. This reduced SSB and recruitment estimates in recent years (**Figure 104**). Step 24 re-evaluated retention parameters and estimated base values for the Recreational fleet to improve fits to compositions and discards, but overall this change had very little impact on key model results (**Table 36**) and time series of SSB, recruitment, or *F* (**Figure 104**).

Step 25 capped any years where the log-scale SE of recreational landings exceeded 0.25 at 0.25, which had no appreciable impact on key model parameter estimates (**Table 36**). This change led to slightly higher *F* in the late 1970s and lower *F* in 2018, which also led to small reductions in SSB in those years (**Figure 104**). Steps 26 and 27 allowed other selectivity parameters to be time-varying for the Recreational fleet and commercial fleets to improve fits to compositions, but no noticeable differences were evident in key model parameter estimates (**Table 36**) or time series of SSB, recruitment, or *F* (**Figure 104**). Collectively, these changes reduced the NLL by about 130 units (**Table 35**).

In the last step, Step 28, all five growth parameters were estimated without using priors, separate length-based selectivities were estimated for the SEAMAP Trawl Early Survey/Shrimp Bycatch fleet and SEAMAP Trawl Early Survey, and a few parameters were fixed at their model estimates including the CV_{Amin}, CV_{Amax}, the base peak and top-logit parameters for the Combined Video Survey, and the base retention inflection and width parameters for the Recreational and Commercial Vertical Line fleets. Estimating the growth parameters without priors led to considerably better fits to the composition data and fixing a few parameters at their estimates helped reduce the number of moderately correlated parameters but had no effect on model results. Estimating separate selectivity patterns for the SEAMAP Trawl Early Survey/Shrimp Bycatch fleet and SEAMAP Trawl Late Survey improved the fits to their respective length

compositions. Collectively, these changes in Step 28 shifted SSB estimates lower and recruitment and *F* estimates higher throughout the time series (**Figure 104**).

4.8.7. SEDAR 100 AP Model Sensitivity Runs

Results for the sensitivity runs summarized in **Section 3.4.7** for the SEDAR 100 AP Model are presented in **Tables 37-38** and discussed below.

Recreational Data and Uncertainty

Replacing the highly uncertain 2017 recreational landings estimate and excluding the 1981-1987 recreational discard estimates did not appreciably alter model results for key model parameters (**Tables 37-38**) or trajectories of SSB, SSB ratio, recruitment, or *F* (**Figure 105**). Using the recreational landings uncertainty estimates as provided (i.e., not capping at 0.25) also did not change model results substantially. Reducing recreational removals by 40% led to much lower virgin and annual estimates of SSB and recruitment (**Table 38**; **Figure 105**). However, the SSB ratio and *F* time series showed less divergence and remained within the confidence intervals of the SEDAR 100 AP Model results. Treating recreational landings as known, as done in SEDAR 43, led to noticeable differences in *F* in many years, but the time series of SSB, SSB ratio, and recruitment generally remained within the confidence intervals of the SEDAR 100 AP Model results (**Figure 105**). The 2024 estimates of SSB ratio at 55% and *F* at 0.21 from the SEDAR 100 AP Model fell within the range of values from these sensitivity runs (SSB ratio: 53-56%; *F*: 0.19-0.21).

Discard Mortality Rate

Alternative values of discard mortality rates had little effect on model fits (**Table 37**) but shifted the virgin and annual estimates of SSB and recruitment, particularly from the start to the early 1980s and from the mid-2000s to the most recent years (**Table 38**; **Figure 106**). A higher discard mortality rate of 60% scaled SSB and recruitment estimates upwards, whereas a lower discard mortality rate shifted SSB and recruitment downwards. However, the SSB ratio and *F* time series generally remained within the confidence interval of the SEDAR 100 AP Model results. The 2024 estimates of SSB ratio at 55% and *F* at 0.21 from the SEDAR 100 AP Model fell within the range of values from the sensitivity runs (SSB ratio: 53-57%; *F*: 0.18-0.24).

Shrimp Bycatch

Reducing shrimp bycatch by 50% and fitting only to the 1984-2023 median value using the super-period approach did not appreciably alter model results for key model parameters (**Tables 37-38**) or for time series of SSB, SSB ratio, recruitment, or *F* (**Figure 107**). The exclusion of shrimp bycatch led to lower virgin and annual estimates of SSB and recruitment, with differences most pronounced in the first half of the time series and more recently. In general, estimates of *F* fell within the confidence intervals of the SEDAR 100 AP Model results, whereas the SSB ratio showed more divergence (**Figure 107**). The 2024 estimates of SSB ratio at 55% and *F* at 0.21 from the SEDAR 100 AP Model fell just outside and within the range of values for SSB ratio (56-61%) and *F* (0.2-0.25), respectively.

Platoons

Enabling size-dependent survivorship led to similar virgin SSB and recruitment estimates (**Tables 37-38**) but very different trajectories, particularly in the last few years, of SSB, SSB ratio, recruitment, and *F* (**Figure 108**). In the recent years, the sensitivity runs estimated much lower recruitment, particularly in 2022. When 3 platoons were enabled, the model estimated a very large $L\infty$ at 68.327 cm FL (CV = 0.022; **Figure 109**). When 5 platoons were enabled, the model estimated an $L\infty$ at 59.73 cm FL (CV = 0.016; **Figure 110**). These estimates seem implausible given the range of age-length data submitted for the assessment (**Figure 3**), as only 0.17% of lengths exceeded 59 cm FL. Both sensitivity runs showed greater expected declines in the recent years for the Combined Video Survey compared to the SEDAR 100 AP Model, which was more pronounced for 5 platoons (**Figures 109-110**). Overall, estimates of SSB ratio in 2024 were substantially lower at 25-32% than the SEDAR 100 AP Model estimate of 55%, and estimates of *F* in 2024 were considerably larger (0.32-0.39) than the SEDAR 100 AP Model estimate of 0.21.

Steepness

Allowing the model to estimate steepness, as done in SEDAR 43, had a very significant impact on the results and led to a slightly better model fit (**Table 37**). Steepness was estimated at 0.422 (CV = 0.049) without a prior, which is close to the SEDAR 43 Standard Model estimate of 0.459 (**Table 38**). This lower steepness value led to much larger estimates of SSB and recruitment at virgin conditions and in the first half of the time series, and consequently much lower SSB ratios starting in the early 1980s, falling well below the confidence interval of the SEDAR 100 AP Model. The SSB ratio was substantially lower in 2024 at 0.18 (**Table 38**), whereas *F* was higher at 0.27 (**Figure 111**). The corresponding Beverton-Holt stock recruit relationship is shown in **Figure 112**.

Estimation of *F* and uncertainty estimates

Estimating annual *F* parameters for the commercial fleets and using the uncertainty estimates for commercial landings resulted in nearly identical key model parameters (**Tables 37-38**) and derived quantities (**Figure 113**).

Age-structured Production Model

Simpler models fitting only to the indices of abundance resulted in similar estimates of $\ln(R_0)$ and virgin SSB (**Tables 37-38**) and trends which generally followed the time series of SSB, SSB ratio, recruitment, and *F* estimates from the SEDAR 100 AP Model (**Figure 114**). As expected, time series of SSB and recruitment were more similar when recruitment deviations were estimated, although there were noticeable differences, suggesting that the composition data provided additional information to support these estimates. In the absence of recruitment deviations, the fits to indices of abundance were worse for all indices except the Combined Video Survey (**Figure 115**). The inclusion of recruitment deviations resulted in similar fits to most indices compared to the SEDAR 100 AP Model, and slightly better fits to the indices for the SEAMAP Trawl Early Survey and SEAMAP Trawl Late Survey. Estimates of SSB ratio in 2024 ranged between 51% and 59%, with the SEDAR 100 AP Model estimate of 55% falling within that range, while estimates of *F* in 2024 were identical to the SEDAR 100 AP Model estimate of 0.21.

Combining Dead Discards and Landings

Lumping dead discards into landings estimates for the Recreational and Commercial Vertical Line fleets led to fewer parameters estimated but more uncertain selectivity parameters (CV > 1; **Table 37**). Estimates of virgin SSB and recruitment were larger, with annual SSB estimates consistently larger and annual recruitment estimates generally larger with the exception of a few years (**Figure 116**). The biggest difference occurred in the 2010s where a much smaller *F* in 2013 led to much larger subsequent estimates of SSB, which were also affected by substantially larger recruitment estimates from 2011 through 2019. SSB and the SSB ratio dropped considerably in the last few years, with the SSB ratio in 2024 identical to the SEDAR 100 AP Model estimate of 55% whereas the *F* estimate in 2024 was slightly higher at 0.25 than the SEDAR 100 AP Model estimate of 0.21.

Start Year

Alternative start years, which started in a fished condition, generally led to similar key model parameters (**Tables 37-38**) and trajectories of SSB ratio, recruitment, and *F* for the more recent years (**Figure 117**). Estimates of SSB ratio in 2024 were similar to the SEDAR 100 AP Model estimate of 55% and ranged between 52% and 55%, whereas *F* estimates in 2024 ranged from 0.21 to 0.23. Large differences were identified towards the beginning of each time series due to the initial conditions. More uncertainty in the first few years was evident when the model started in 1963, as the likelihood profiling of the scalar value on initial equilibrium catches for fleets and Shrimp Bycatch initial *F* revealed indistinguishable results as almost all runs fell within 2 NLL units (**Figure 118**). This range of scalar values resulted in a large swath of SSB ratios in the earliest years, however they all converged to a similar SSB ratio by the end of the time series (**Figure 119**). The 1963 model estimated a very large and highly uncertain Shrimp Bycatch initial *F* of 0.397 (CV 0.915), which reduced the starting SSB ratio to 28% (**Figure 117**). The results were less uncertain when starting the model in 1981, as the likelihood profile analysis identified the lowest scalar value of 0.1 as the best fitting run (**Figure 120**). The 1981 model estimated a highly uncertain Shrimp Bycatch initial *F* of 0.011 (CV = 1.003), and started at an SSB ratio of 79%. The range of scalar values led to considerable variability in SSB ratios in the earliest years, but SSB ratios in more recent years did not vary greatly (**Figure 121**).

Jackknife Indices

The removal of the Recreational (SRHS) CPUE and SEAMAP Trawl Early Survey did not result in noticeable differences in key model parameters (**Tables 37-38**) nor annual estimates of SSB, SSB ratio, recruitment, or *F* (**Figure 122**). The removal of the SEAMAP Trawl Late Survey led to lower SSB, SSB ratio and higher *F* in the most recent years. In contrast, the removal of the Combined Video Survey led to much higher SSB, SSB ratio, and recruitment estimates, as this model better fit to the SEAMAP Trawl Late Survey which increased in recent years (**Figure 123**). Overall, estimates of SSB ratio in 2024 ranged between 47% and 85%, with the SEDAR 100 AP Model estimate of 55% falling within that range, whereas estimates of *F* in 2024 ranged from 0.13 to 0.25, which included the SEDAR 100 AP Model estimate of 0.21.

5. Discussion

The Gulf Gray Triggerfish Assessment implemented a number of new or improved procedures and methodologies including: revised age data using new ageing protocols and updated growth, natural mortality, and ageing error estimates; modeled maturity as a function of length; revised

estimates of commercial landings and discards; revised estimates of recreational landings and discards based on MRIP-FES and fully-calibrated estimates for Texas Parks and Wildlife Department and Louisiana Creel Survey; incorporated more error in landings and discard estimates to better reflect uncertainties in removals; updated discard mortality estimates based on recent research; updated time series of shrimp effort and shrimp bycatch estimates; re-evaluated indices of relative abundance for inclusion in the assessment; separated the SEAMAP Trawl Survey into two time periods based on differing survey designs and included length compositions; standardized the relative abundance and length compositions of the Combined Video Survey to account for differences in habitat and survey footprints of the three surveys; fitted to all available length composition data (discards, landings, and surveys) and used weighted length compositions where possible; inputted conditional age-at-length compositions for fishing fleets to enable the internal estimation of growth within the assessment model; re-evaluated recruitment parameters including steepness and *SigmaR*; and utilized the Dirichlet-multinomial internal re-weighting approach for composition data. Further, switching to a newer Stock Synthesis version allowed more flexibility in handling a number of processes including data weighting and projections, which were not available during SEDAR 43 when Stock Synthesis (version 3.24P) was first applied to this stock. Collectively, these changes to data inputs and model parameterization greatly affected the assessment results and improved many aspects of model performance.

Overall, the SEDAR 100 AP Model appears to perform well and exhibited some noticeable improvements in performance over the SEDAR 43 Standard Model, including fewer correlated and uncertain parameters and better diagnostics such as less retrospective bias in SSB and F. Likelihood profiles provided support for the SEDAR 100 AP Model estimates of ln(R_0) and the growth parameters. The SEDAR 100 AP Model fit most of the data sources well although some did exhibit residual patterns. The dominant data inputs were the length and conditional age-at-length compositions, as these produced the greatest impact on the model fit (as measured in the total likelihood). Time-varying selectivity and retention were implemented for fishing fleets to help improve model fits to discards and compositions, however residual patterns remained evident in some data streams, with the worst pattern observed for the length compositions of landings for the Recreational fleet. Patterns in residuals for fisheries data could be related to regulations for species other than Gray Triggerfish, especially since they are not generally a targeted species. This assessment, as well as other Gulf assessments, would greatly benefit from a better understanding of changes in management regulations for other species (e.g., Red Snapper) that fall within the multi-species fisheries in the Gulf, and how these regulations may affect the species under assessment (e.g., selectivity, catchability, etc.).

In addition to the vast number of data changes discussed above, this assessment also re-evaluated foundational model configuration decisions including: which composition data to include (length and/or age) and how to model selectivity (i.e., length- or age-based); whether a true two-area model was justified based on differences in biology; whether to maintain the fishing fleets-as-areas approach or collapse the recreational and commercial fleets into Gulf-wide fleets based on gears; and the start year of the model and specification of initial conditions if starting in a fished condition. Although not reflected in this report, which summarizes the SEDAR 100 AP Model and its Gulf-wide data inputs, all data products were provided for West, East, and Gulf-wide (detailed in their respective working papers) to enable reconsideration of the spatial structure of the assessment. Model building began from the SEDAR 43 Standard Model which implemented

fleets-as-areas, but after reviewing all of the information collectively and comparing model runs (**Section 4.8.6**), we chose to simplify the model structure by collapsing fleets-as-areas and modeling fishing fleets Gulf-wide by gear. As a result of these major changes in model configuration, combined with the various changes to data streams, traditional comparisons of data inputs and model fits with the SEDAR 43 Standard Model were not possible. Further, the revised age estimates for SEDAR 100 based on updated protocols for reading spines to reduce bias also complicates comparisons of the results to past Gray Triggerfish assessment outcomes. All previous age estimates submitted to past assessments (and used in age-growth studies based on spines) were biased low for ages 5+ (SEDAR100-DW14).

While the SEDAR 100 Assessment used the best available age data and alleviated some of the past concerns over the age data, ageing remains a key challenge for assessing Gray Triggerfish (**Section 2.2.2**). Huge variability remains in the length-at-age distribution (**Figure 3**), and this uncertainty degrades the ability of the assessment model to track cohorts through time because the age data lack any cohort signals (SEDAR100-DW04, SEDAR100-DW07). In addition to this variability, inconsistencies in how Gray Triggerfish are aged across laboratories may also contribute to the uncertainty within age estimates, as uncovered during the Data Workshop. Calendar ages were reviewed and adjusted for age-0 and age-1 fish, but similar adjustments were not feasible for older Gray Triggerfish (2+ years). While including an ageing error matrix can help account for some uncertainty in age estimates, it will not counter the underlying issues with potentially biased age estimates due to differences in age advancements or readings. Hopefully, ongoing research looking at obtaining age estimates from epigenetic clocks will help improve the age data provided for future assessments of Gray Triggerfish.

Recent research by Chamberlain et al. (2025) re-iterated the importance of including sexually dimorphic growth within the assessment model to more realistically capture the larger sizes of males compared to females (also supported by multiple studies reviewed in Jefferson et al. 2019 [SEDAR62-RD01]). Surprisingly, no difference in growth between sexes was evident based on the age data submitted for SEDAR 100, therefore a single growth curve was used in the SEDAR 100 AP Model. Additionally, the lack of sex-specific data (e.g., landings, compositions) complicates development of a two-sex model to model growth separately. The von Bertalanffy growth estimates recommended for each assessment have diverged greatly, particularly for the asymptotic length parameter $L\infty$. Recommendations have dropped from 87 cm FL for the SEDAR 9 Update (SEDAR 2011), to 59 cm FL for SEDAR 43 (SEDAR 2015), and now to 46 cm FL for SEDAR 100 (also noting that 46 cm FL was recommended for SEDAR 62 using otoliths rather than spines by Patterson et al. 2019 [SEDAR62-WP17]). Using the length data and age data conditional on length, the SEDAR 100 AP Model estimated $L\infty$ around 54 cm FL, but much larger estimates (60-68 cm FL) were estimated when implementing platoons to account for size-dependent survivorship. Additional investigation is needed to determine whether poor data quality (e.g., the highly variable age-length relationship) may be causing these seemingly unrealistic results.

Historical estimates of removals (i.e., pre-1963 for commercial and pre-1981 for recreational) remain very uncertain due to the assumptions and limited data used in their development. Although we increased the error surrounding historical landings estimates, the model essentially fits those historical landings estimates regardless of error estimates since no other data are informing those earlier years. For shrimp bycatch, we fit to the median of all available data using

the super-period approach to remove the influence of interannual variability within bycatch estimates. As requested in the SEDAR 100 AP Terms of Reference (**Section 1.2**), we re-evaluated the start year for the model and considered two alternative years: 1963 (start of commercial data) and 1981 (start of recreational data). The challenge of starting the model in a fished state is this requires the specification of initial conditions for the fishing fleets and shrimp bycatch, which we explored by profiling across different scalars on initial equilibrium catches for fishing fleets and Shrimp Bycatch initial *F* (as done in SEDAR 81; SEDAR 2023). Sensitivity runs highlighted high uncertainty specifying initial conditions for the Shrimp Bycatch fleet when starting in 1963 and to a lesser extent when starting in 1981. The model results in the more recent years were generally very similar and remained within the confidence intervals of the results from the SEDAR 100 AP Model, suggesting that stock status would be similar among runs. Given the concerns with initial conditions and similarity in model results, we retained the start year of 1945 in the SEDAR 100 AP Model and used the best available historical reconstruction of removals.

Shrimp bycatch of Gray Triggerfish has remained a controversial topic, particularly whether bycatch is substantial enough to warrant consideration in the assessment (it has been incorporated since SEDAR 9 in 2006). The absence of Gray Triggerfish on Shrimp Observer Program data forms prior to 2025 prevented the application of the recently CIE-approved approach for estimating shrimp bycatch that was implemented for Red Snapper in SEDAR 98 (Smith et al. 2025). In 2025, Gray Triggerfish were explicitly included on the Shrimp Observer Program data form and comprised 7% of positive tows and 30% of positive trips, further supporting that bycatch is an important source of removals. Sensitivity runs explored the influence of the shrimp bycatch estimates on the SEDAR 100 AP Model. In the most extreme case, excluding shrimp bycatch generally showed similar trends in SSB ratio and *F*, but much lower projected short-term and equilibrium yields (**Section 6.3.1**). During SEDAR 100, the availability of length composition and age composition of Gray Triggerfish from the SEAMAP Trawl Survey enabled a thorough investigation of the sizes and ages potentially impacted by the shrimp trawl. Previously, the SEDAR 43 Standard Model restricted data to fall only and assumed the survey only captured age-0s, but review of data at the SEDAR 100 Data Workshop showed similar length compositions between the summer and fall surveys and that ages 1+ were encountered in the Trawl survey, particularly in the East which has more natural reefs. Based on these insights unique to SEDAR 100, we fit to the length compositions and used length-based selectivity for the SEAMAP Trawl Surveys.

The G-FISHER video survey has become one of the most widely used fishery-independent indices in the Gulf for both stock assessments and interim analyses. However, concerns remain over its development given how the different surveys have been combined over time, the challenges of sampling in the West due to turbidity and limited coverage (**Table 11 in SEDAR100-DW18**), and poor habitat scores dominating the West. This index is especially important for the Gray Triggerfish assessment because it is tracking the adult population and its removal had a large effect on model results. The index shows a recent decline, which conflicts with the increased abundance observed in the SEAMAP Trawl Late Survey primarily tracking juveniles. Although considerable efforts have gone into developing a continuous standardized index of relative abundance (and weighted length compositions) from these surveys using a habitat-based approach (Thompson et al. 2022), the SEDAR 100 AP Model needed time-varying selectivity for this survey to better capture the trends in abundance and identified differences in

the selectivity curves across time periods. A similar approach was explored as a sensitivity during the SEDAR 88 Gulf Red Grouper (*Epinephelus morio*) assessment and demonstrated a similar outcome where time-varying selectivity altered the recent model trend, but ultimately was not incorporated into the SEDAR 88 Base Model (SEDAR 2025). Collectively, these results suggest that additional steps may be needed in the standardization process to ensure a continuous index of abundance and composition from this survey.

A key modeling uncertainty for the Gulf Gray Triggerfish stock assessment and most assessment models in general, is the stock-recruit relationship. Initial model building runs for SEDAR 100 estimated steepness and *SigmaR* as in the SEDAR 43 Standard Model, but ultimately steepness was fixed at 0.99 and *SigmaR* was fixed at 0.6 in the SEDAR 100 AP Model. The likelihood profile for steepness provided support for values between 0.38 and 0.47, which is similar to the value of 0.435 estimated by the SEDAR 43 Standard Model. However, given the uncertainty and concerns over the estimated steepness, we fixed steepness at the upper bound of 0.99. For this assessment report, benchmarks were determined through projections (see **Section 6**) using average recruitment (by fixing steepness at 0.99) rather than those from a stock-recruit curve. Since MSY-based reference points are not supported by the results, it may be more appropriate to use proxy reference points using spawning potential ratio (SPR) such as 30% as specified in the SEDAR 100 AP Terms of Reference (**Section 1.2**).

From an ecosystem perspective, additional research is needed to determine how Sargassum affects Gray Triggerfish recruitment, which could help reduce some of the uncertainty in recruitment estimates currently based solely on SEAMAP trawl data. For incorporating Sargassum as an environmental linkage into the stock assessment, it will be critical to identify the exact mechanism and life stage (larvae? age-0? juveniles?) that is affected. Further, a better understanding of interspecies interactions could help elucidate how other species affect Gray Triggerfish population dynamics and vice versa. For example, Gray Triggerfish abundance has been hypothesized to affect the catchability of Red Snapper, with more Gray Triggerfish preventing hooks from getting to target species such as Red Snapper (Gervasi et al. 2025; SEDAR100-DW21). Negative impacts were noted by lower growth rates of Red Snapper when held with Gray Triggerfish during laboratory experiments (Simmons and Szedlmayer 2018 [SEDAR62-RD07]) and aggressive behavior during the spawning season (Simmons and Szedlmayer 2012 [SEDAR62-RD11]). Red Snapper have been hypothesized to be important predators of Gray Triggerfish juveniles and eggs (SEDAR100-DW21), with increased Red Snapper abundance in the West suggested to correlate to the lack of Gray Triggerfish (SEDAR100-DW20).

Overall, the SEDAR 100 AP Model is improved since the SEDAR 43 Standard Model, and it incorporates the best available data and addressed many of the issues evident in the SEDAR 43 Standard Assessment. According to the SEDAR 100 AP Model, the Gulf Gray Triggerfish resource is not overfished nor undergoing overfishing in 2024, a result which differs from previous Gray Triggerfish assessments, all of which concluded poor stock status at different points in time (Valle et al. 2001, Porch 2001, SEDAR 9 [SEDAR 2006], SEDAR 9 Update [SEDAR 2011], SEDAR 43 [SEDAR 2015]). However, the biased age data used in previous age-structured assessments (since SEDAR 9) likely affected previous model outcomes. For the SEDAR 100 AP Model, the recent average recruitment warrants careful consideration for management implementation, as recruitment estimates in the late years of the assessment are higher than the time series average (**Figure 39**). The assumed recruitment values in the future

will have important implications for determination of short-term catch advice. Additional projection scenarios exploring recent mean recruitment estimates will be prepared and presented at the upcoming Gulf Council's Scientific and Statistical Committee meeting to demonstrate the effects of these projection specifications on forecasted yields and stock status. A number of research questions were raised during the SEDAR 100 AP, and the SEFSC strongly recommends that these topics (listed in **Section 8**) continue to be examined during future assessments.

6. Projections

6.1. Introduction

The SEDAR 100 projections were run for two key fishing mortality scenarios: $F_{MSYproxy}$ (for the Overfishing Limit; OFL) and 0.75 * Directed *F* at $F_{MSYproxy}$ (for the Acceptable Biological Catch; ABC). Both an MSY proxy of 30% SPR ($SPR_{30\%}$) and the Optimum Yield (OY; 0.9 * MSY proxy) were specified in Amendment 48 (GMFMC 2021) and were provided in the SEDAR 100 AP Terms of Reference (**Section 1.2**).

6.2. Projection Methods

The simulated dynamics used for projections assumed nearly identical parameter values and population dynamics as the SEDAR 100 AP Model. **Table 39** provides a summary of projection settings. Projections were run assuming that selectivity, retention, and discard mortality associated with the last three years (2022-2024) would remain the same into the future. Forecast recruitment values were derived from the Beverton-Holt stock-recruit relationship with steepness fixed at 0.99, essentially assuming mean recruitment.

The terminal year of SEDAR 100 was 2024 and the first year of management advice is anticipated to be 2028. Landings for the interim years (2025-2027) used the average of the last three years (2022-2024; **Table 39**). For the Shrimp Bycatch fleet, a fixed value of *F* (average over 2022-2024) was input for each year in the projection (0.034; **Figure 124**).

$F_{30\%SPR}$ was determined using a long-term 100-year projection assuming that equilibrium was obtained over the last 10 years (2115-2124). For the OFL projection, the $F_{30\%SPR}$ was applied to the stock starting in 2028. The fleet allocations for Gray Triggerfish are 21% commercial and 79% recreational per Amendment 30A (GMFMC 2008), and the projections assumed that those allocations would be achieved in every year of the projection.

The status determination criteria were updated in Amendment 48 (GMFMC 2021). The minimum stock size threshold (MSST) was determined by multiplying the reference spawning stock biomass, $SSB_{30\%SPR}$, by 0.5 (per Amendment 48 and the SEDAR 100 AP Terms of Reference) and was used to determine stock status (**Table 40**). The maximum fishing mortality threshold (MFMT) was equivalent to the harvest rate ($F_{30\%SPR}$; total biomass killed all ages / total biomass age 1+) that achieved $SSB_{30\%SPR}$, and was used to assess whether overfishing was occurring in a given year (**Table 40**). A stock is considered overfished when $SSB_{Current}$ < MSST and undergoing overfishing if $F_{Current}$ > MFMT, where $F_{Current}$ is defined as the geometric mean *F* over the most recent three years (2022-2024).

Once the proxy values were calculated, 2024 stock status was used to determine whether a rebuilding plan was required (i.e., if SSB < MSST then Gulf Gray Triggerfish would be considered overfished and a rebuilding plan would be required).

6.3. Projection Results

Benchmarks and reference points were calculated using SSB in metric tons.

6.3.1. Biological Reference Points

The status determination criteria based on an MSY proxy of 30% SPR were (**Table 40**; **Figure 125**):

- MSY proxy = yield at $F_{30\%SPR}$ = 1,014,183 pounds wwt
- MSST = 0.5*$SSB_{30\%SPR}$ = 1,315 metric tons
- MFMT = $F_{MSYproxy}$ ($F_{30\%SPR}$) = 0.567
- OY = 0.9*MSY proxy = 912,764 pounds wwt

A comparison of equilibrium yield estimates from this assessment to previous assessments is provided in **Table 41**. Estimates are also shown for projections for two sensitivity runs addressing critical data uncertainties: (1) reduced recreational removals based on the MRIP-FES pilot study results (Andrews 2022) and (2) excluding shrimp bycatch. Both of these data changes result in substantially lower equilibrium yield estimates.

6.3.2. Stock Status

Benchmarks and reference points are shown in **Table 40**. Detailed time series of derived quantities and benchmarks with SSB in metric tons are presented in **Table 42**. As of 2024, the Gulf Gray Triggerfish stock is not undergoing overfishing ($F_{Current}$ < MFMT) and is not overfished (SSB_{2024} > MSST) according to the SEDAR 100 AP Model (**Table 40**). The terminal year SSB (2024) is above $SSB_{30\%SPR}$ (**Figure 125**) at 184% of the biomass level needed to support MSY (**Table 42**). $F_{Current}$ was 0.214, which was equivalent to 38% of $F_{30\%SPR}$ (**Table 40**).

The Kobe plot (**Figure 126**) indicates that over the time horizon of the assessment (i.e., 1945-2024), the stock has not been overfished nor experienced overfishing in any year since 1945 (**Table 42**).

6.3.3. Overfishing Limit and Acceptable Biological Catch Projections

OFL and ABC projection results **assuming predicted recruitment follows the stock-recruit curve with steepness fixed at 0.99** are provided in **Tables 43-44** and **Figure 127**. Forecasts indicate that yields can increase in the near-term for both the OFL and the ABC projection scenarios (**Figure 127**). For the OFL projection, the 5-year (2028-2032) average was 1.399 million pounds wwt and the 3-year (2028-2030) average was 1.613 million pounds wwt. For the ABC projection, the 5-year (2028-2032) average was 1.232 million pounds wwt and the 3-year (2028-2030) average was 1.353 million pounds wwt.

These results are dependent upon the assumption of recruitment into the forecast period. Additional projection scenarios exploring recent mean recruitment estimates will be prepared and presented at an upcoming Gulf Council's Scientific and Statistical Committee meeting to demonstrate the effects of these projection specifications on forecasted yields and stock status. Compared to the average recruitment using a steepness of 0.99 (~95,000), the average recruitment over the last 10 years (2015-2024) and last 5 years (2020-2024) is 99,886 and 95,174, respectively.

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8. Research Recommendations

Recommendations for considerations of future research are provided below and do not indicate any particular order of priority.

Age and Growth
- Investigate methods to better collect age structure samples randomly and systematically from all fishing sectors including surveys
- Continue collaboration with ageing facilities throughout the Gulf and South Atlantic. These efforts will include the annual reading of references sets for Gray Triggerfish and other reef fish, and annual meetings to review the interpretation of ageing structures and the timing of annual band deposition
- Explore epigenetic ageing to potentially improve age estimates

Natural Mortality
- Explore more direct approaches to estimating natural mortality (e.g., Mark-recapture approaches (conventional, telemetry, or close-kin))
- Explore ways to better reflect uncertainty around the mortality at age vector

Reproduction
- Continue data collection for maturity and fecundity
- Update maturity-at-age estimates to see whether the age data updates have changed our understanding of maturity

Discard Mortality
- Continue data collection from observer programs or electronic monitoring programs (e.g.,

Roberts and Neidig 2019 [SEDAR62-WP10]), particularly to get a better handle on discard mortality for the commercial fleets

Shrimp Bycatch
- Estimates of shrimp bycatch are highly uncertain and considered best available in the interim; further investigation is needed once observer data allow more advanced approaches for estimation

Selectivity and Catchability
- Further investigate and quantify changes in selectivity/catchability through time to improve fit to the length and age composition

Surveys
- Increase collection of length and age information for compositions
- Continue to improve upon standardized indices from the video survey to account for survey design changes through time and space to ensure trends are representative of relative abundance

Sargassum
- Improve our understanding of how sargassum affects Gray Triggerfish recruitment and which life stages are most affected
- Develop indices (with uncertainty estimates) to enable hypothesis testing of environmental linkages within the assessment model

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10. Tables

Table 1. Conversion factors used to convert fork length in centimeters (cm FL) to whole weight (wwt) in kilograms and total length (TL) in centimeters to fork length for sexes combined. Statistic refers to RSE for the weight-length equation or R^2 for the length-length equation.

Model	N	Statistic	Range
wwt = 1.704 E-05 x $FL^{3.070}$	11,332	175.4	FL (cm): 6.1-61.7; wwt (kg): 0.006-5.840
FL = Max_TL*0.788 + 23.541	6,322	0.96	Max_TL (cm): 1.6-75.3; FL (cm): 6.5-61.7

Table 2. Growth parameters (and associated standard deviation, SD) recommended during the SEDAR 100 Assessment.

Parameter	Value	SD
L∞ (cm FL)	46.837	0.318
K (per year)	0.291	0.008
t_0 (year)	-0.900	
CV at age $\leq A_{min}$	0.140	0.454
CV at age $\geq A_{max}$	0.140	0.454

Table 3. Ageing error matrix (standard deviations associated with mean age) recommended for use in the SEDAR 100 Assessment to incorporate uncertainty at age.

Age	SEDAR 100
0	0.381
1	0.381
2	0.455
3	0.524
4	0.588
5	0.648
6	0.703
7	0.754
8	0.802
9	0.846
10	0.887
11	0.925
12	0.960
13	0.993
14	1.023
15	1.051

Table 4. Age-specific natural mortality (*M*, per year) estimated by Stock Synthesis. For implementing Lorenzen scaling in Stock Synthesis, the vulnerable ages were defined as ages 3-15 years and the target *M* (0.36) was obtained using Hamel and Cope (2022) and a maximum age of 15 yrs. The age-0 estimate accounts for settlement in July, corresponding to peak spawning, which leads to a reduced 6-month window of time for age-0s in the population.

Age	*M*
0	2.873
1	0.958
2	0.691
3	0.558
4	0.480
5	0.428
6	0.392
7	0.365
8	0.345
9	0.330
10	0.317
11	0.308
12	0.300
13	0.293
14	0.288
15	0.277

Table 5. Commercial vertical line (includes trap and other gears) and longline landings in pounds whole weight. In the absence of annual uncertainty estimates accompanying the submitted data, commercial landings for 1945-1985 were assigned a log-scale standard error (SE) based on expert opinion (**Table 6**). More recent estimates of uncertainty (1986-2024) are based on expert opinion values weighted by regional landings. "*" indicates confidential data.

Year	Vertical Line	Longline	Vertical Line SE	Longline SE	Methodology
1945	22		0.200		Assumed start
1946	3,592		0.200		Interpolated
1947	7,161		0.200		Interpolated
1948	10,730		0.200		Interpolated
1949	14,300		0.200		Estimated in DW05
1950	14,700		0.200		Estimated in DW05
1951	28,000		0.200		Estimated in DW05
1952	72,400		0.200		Estimated in DW05
1953	43,600		0.200		Estimated in DW05
1954	39,600		0.200		Estimated in DW05
1955	46,600		0.200		Estimated in DW05
1956	22,800		0.200		Estimated in DW05
1957	17,400		0.200		Estimated in DW05
1958	15,200		0.200		Estimated in DW05
1959	10,300		0.200		Estimated in DW05
1960	11,900		0.200		Estimated in DW05
1961	6,500		0.200		Estimated in DW05
1962	5,600		0.200		Estimated in DW05
1963	7,300		0.200		Estimated in DW05
1964	20,000		0.200		Estimated in DW05
1965	21,650		0.200		Estimated in DW05
1966	13,800		0.200		Estimated in DW05
1967	17,400		0.200		Estimated in DW05
1968	12,500		0.200		Estimated in DW05
1969	22,300		0.200		Estimated in DW05

Table 5 Continued. Commercial vertical line (includes trap and other gears) and longline landings in pounds whole weight. In the absence of annual uncertainty estimates accompanying the submitted data, commercial landings for 1945-1985 were assigned a log-scale standard error (SE) based on expert opinion (**Table 6**). More recent estimates of uncertainty (1986-2024) are based on expert opinion values weighted by regional landings. "*" indicates confidential data.

Year	Vertical Line	Longline	Vertical Line SE	Longline SE	Methodology
1970	24,051		0.200		Estimated in DW05
1971	40,400		0.200		Estimated in DW05
1972	62,600		0.200		Estimated in DW05
1973	53,200		0.200		Estimated in DW05
1974	53,552		0.200		Estimated in DW05
1975	78,000		0.200		Estimated in DW05
1976	84,500		0.200		Estimated in DW05
1977	59,386		0.100		Estimated in DW05
1978	58,823		0.100		Estimated in DW05
1979	97,484	3,919	0.100	0.100	Estimated in DW05
1980	92,776	3,700	0.100	0.100	Estimated in DW05
1981	82,101	7,759	0.100	0.100	Estimated in DW05
1982	81,633	15,040	0.100	0.100	Estimated in DW05
1983	59,836	13,583	0.100	0.100	Estimated in DW05
1984	*	11,683	0.100	0.100	Estimated in DW05
1985	75,563	17,063	0.100	0.100	Estimated in DW05
1986	88,853	8,149	0.060	0.098	Estimated in DW05
1987	124,185	642	0.062	0.100	Estimated in DW05
1988	193,745	2,589	0.063	0.098	Estimated in DW05
1989	309,534	10,543	0.061	0.097	Estimated in DW05
1990	402,653	*	0.061	0.060	Estimated in DW05
1991	423,456	20,887	0.062	0.081	Estimated in DW05
1992	447,129	23,028	0.063	0.077	Estimated in DW05
1993	*	15,293	0.067	0.052	Estimated in DW05
1994	385,853	19,424	0.071	0.051	Estimated in DW05

Table 5 Continued. Commercial vertical line (includes trap and other gears) and longline landings in pounds whole weight. In the absence of annual uncertainty estimates accompanying the submitted data, commercial landings for 1945-1985 were assigned a log-scale standard error (SE) based on expert opinion (**Table 6**). More recent estimates of uncertainty (1986-2024) are based on expert opinion values weighted by regional landings. "*" indicates confidential data.

Year	Vertical Line	Longline	Vertical Line SE	Longline SE	Methodology
1995	328,557	6,965	0.070	0.052	Estimated in DW05
1996	254,606	6,822	0.072	0.052	Estimated in DW05
1997	169,593	11,021	0.073	0.055	Estimated in DW05
1998	170,648	*	0.071	0.051	Estimated in DW05
1999	216,845	10,277	0.074	0.050	Estimated in DW05
2000	152,492	5,770	0.055	0.051	Estimated in DW05
2001	169,374	6,043	0.056	0.050	Estimated in DW05
2002	231,894	*	0.053	0.050	Estimated in DW05
2003	244,487	7,269	0.055	0.050	Estimated in DW05
2004	201,293	*	0.057	0.050	Estimated in DW05
2005	140,258	*	0.056	0.050	Estimated in DW05
2006	84,688	*	0.059	0.050	Estimated in DW05
2007	*	*	0.065	0.050	Estimated in DW05
2008	61,209	*	0.064	0.050	Estimated in DW05
2009	69,251	*	0.056	0.050	Estimated in DW05
2010	52,364	*	0.054	0.071	Estimated in DW05
2011	103,093	*	0.052	0.051	Estimated in DW05
2012	71,281	*	0.052	0.050	Estimated in DW05
2013	62,006	*	0.052	0.056	Estimated in DW05
2014	36,239	4,446	0.050	0.050	Estimated in DW05
2015	40,745	6,751	0.050	0.050	Estimated in DW05
2016	47,667	*	0.050	0.050	Estimated in DW05
2017	55,654	*	0.050	0.050	Estimated in DW05
2018	56,281	8,417	0.050	0.050	Estimated in DW05
2019	53,248	9,243	0.050	0.050	Estimated in DW05

Table 5 Continued. Commercial vertical line (includes trap and other gears) and longline landings in pounds whole weight. In the absence of annual uncertainty estimates accompanying the submitted data, commercial landings for 1945-1985 were assigned a log-scale standard error (SE) based on expert opinion (**Table 6**). More recent estimates of uncertainty (1986-2024) are based on expert opinion values weighted by regional landings. "*" indicates confidential data.

Year	Vertical Line	Longline	Vertical Line SE	Longline SE	Methodology
2020	48,923	3,857	0.050	0.050	Estimated in DW05
2021	37,384	*	0.050	0.050	Estimated in DW05
2022	37,164	8,117	0.050	0.050	Estimated in DW05
2023	47,316	7,543	0.050	0.050	Estimated in DW05
2024	43,340	8,264	0.050	0.050	Estimated in DW05

Table 6. Uncertainty estimates for commercial landings based on expert opinion derived from changes in reporting, following the approach taken in the South Atlantic and presented during the SEDAR 68 Gulf Scamp Grouper Research Track Assessment (SEDAR 2021). ALS = Accumulated Landings System.

Year Range	Texas (TX)	Louisiana (LA)	Mississippi (MS)	Alabama (AL)	Florida (FL)	Description
1962-1976	0.20	0.20	0.20	0.20	0.20	Annual state summaries
1977-1985	0.10	0.10	0.10	0.10	0.10	Monthly state summaries
1986-1999	0.10	0.10	0.10	0.10	0.05	FL starts state trip ticket in 1985; used starting in 1986
2000-2001	0.10	0.05	0.10	0.10	0.05	LA starts state trip ticket in 1997; used starting in 2000
2002-2013	0.10	0.05	0.10	0.05	0.05	AL starts state trip ticket and used starting in 2002
2014	0.05	0.05	0.10	0.05	0.05	TX starts state trip ticket in 2008; used starting in 2014
2015-Present	0.05	0.05	0.05	0.05	0.05	MS starts state trip ticket in 2012; used starting in 2015

Table 7. Percent difference (%Diff) in commercial landings between SEDAR 100 and SEDAR 43 for all commercial gears combined. Differences exceeding 10% are identified in red. "*" indicates confidential data for SEDAR 100 and hides SEDAR 43 and differences to maintain confidentiality.

Year	SEDAR 100	SEDAR 43	%Diff
1945	0.01	0.06	83.33
1946	1.63	0.19	-757.42
1947	3.25	0.37	-777.89
1948	4.87	0.55	-784.96
1949	6.49	0.73	-788.54
1950	6.67	0.92	-624.76
1951	12.70	1.11	-1044.2
1952	32.84	1.29	-2445.74
1953	19.78	1.48	-1236.26
1954	17.96	1.65	-988.62
1955	21.14	1.84	-1048.77
1956	10.34	2.02	-411.98
1957	7.89	2.21	-257.13
1958	6.89	2.40	-187.27
1959	4.67	2.57	-81.79
1960	5.40	2.76	-95.57
1961	2.95	2.94	-0.28
1962	2.54	3.13	18.85
1963	3.31	3.32	0.26
1964	9.07	9.07	-0.02
1965	9.82	9.84	0.2
1966	6.26	6.26	0
1967	7.89	7.90	0.09
1968	5.67	5.67	0
1969	10.12	10.11	-0.05
1970	10.91	10.98	0.64

Table 7 Continued. Percent difference (%Diff) in commercial landings between SEDAR 100 and SEDAR 43 for all commercial gears combined. Differences exceeding 10% are identified in red. "*" indicates confidential data for SEDAR 100 and hides SEDAR 43 and differences to maintain confidentiality.

Year	SEDAR 100	SEDAR 43	%Diff
1971	18.33	18.33	0.03
1972	28.39	28.41	0.05
1973	24.13	24.14	0.04
1974	24.29	24.09	-0.83
1975	35.38	35.39	0.03
1976	38.33	38.34	0.03
1977	26.94	26.95	0.05
1978	26.68	26.64	-0.16
1979	46.00	46.01	0.03
1980	43.76	43.75	-0.02
1981	40.76	40.77	0.02
1982	43.85	43.87	0.05
1983	33.30	33.31	0.02
1984	*	*	*
1985	42.01	42.02	0.01
1986	44.00	43.40	-1.38
1987	56.62	56.08	-0.96
1988	89.06	88.50	-0.63
1989	145.18	144.12	-0.74
1990	*	*	*
1991	201.55	201.69	0.07
1992	213.26	213.70	0.21
1993	*	*	*
1994	183.83	183.63	-0.11
1995	152.19	153.30	0.72
1996	118.58	121.38	2.30

Table 7 Continued. Percent difference (%Diff) in commercial landings between SEDAR 100 and SEDAR 43 for all commercial gears combined. Differences exceeding 10% are identified in red. "*" indicates confidential data for SEDAR 100 and hides SEDAR 43 and differences to maintain confidentiality.

Year	SEDAR 100	SEDAR 43	%Diff
1997	81.93	83.80	2.24
1998	*	*	*
1999	103.02	102.28	-0.72
2000	71.79	71.69	-0.13
2001	79.57	79.94	0.47
2002	*	*	*
2003	114.19	114.25	0.05
2004	*	*	*
2005	*	*	*
2006	*	*	*
2007	*	*	*
2008	*	*	*
2009	*	*	*
2010	*	*	*
2011	*	*	*
2012	*	*	*
2013	*	*	*

Table 8. Recreational landings in numbers and associated log-scaled standard errors (SE). Log-scale SEs were converted from CVs provided for landings in numbers (**Section 3.2**). These uncertainty estimates were used in the assessment model with the exception that any log-scale SEs > 0.25 were capped at 0.25.

Year	Headboat	Charter	Private	Recreational	Recreational SE	Methodology
1945				1,250	0.536	Assumed start
1946				24,709	0.536	Interpolated
1947				48,168	0.536	Interpolated
1948				71,627	0.536	Interpolated
1949				95,086	0.536	Interpolated
1950				118,545	0.536	Interpolated
1951				142,003	0.536	Interpolated
1952				165,462	0.536	Interpolated
1953				188,921	0.536	Interpolated
1954				212,380	0.536	Interpolated
1955				235,839	0.536	Estimated in DW03
1956				261,207	0.536	Estimated in DW03
1957				286,575	0.536	Estimated in DW03
1958				311,943	0.536	Estimated in DW03
1959				337,310	0.536	Estimated in DW03
1960				362,678	0.536	Estimated in DW03
1961				373,036	0.536	Estimated in DW03
1962				383,394	0.536	Estimated in DW03
1963				393,752	0.536	Estimated in DW03
1964				404,110	0.536	Estimated in DW03
1965				414,468	0.536	Estimated in DW03
1966				428,263	0.536	Estimated in DW03
1967				442,058	0.536	Estimated in DW03
1968				455,853	0.536	Estimated in DW03
1969				469,648	0.536	Estimated in DW03
1970				483,443	0.536	Estimated in DW03
1971				528,016	0.536	Estimated in DW03

Table 8 Continued. Recreational landings in numbers and associated log-scaled standard errors (SE). Log-scale SEs were converted from CVs provided for landings in numbers (**Section 3.2**). These uncertainty estimates were used in the assessment model with the exception that any log-scale SEs > 0.25 were capped at 0.25.

Year	Headboat	Charter	Private	Recreational	Recreational SE	Methodology
1972				572,590	0.536	Estimated in DW03
1973				617,163	0.536	Estimated in DW03
1974				661,736	0.536	Estimated in DW03
1975				706,310	0.536	Estimated in DW03
1976				708,678	0.536	Estimated in DW03
1977				711,046	0.536	Estimated in DW03
1978				713,414	0.536	Estimated in DW03
1979				715,782	0.536	Estimated in DW03
1980				718,150	0.536	Estimated in DW03
1981	69,711	85,258	439,552	594,521	0.380	Estimated in DW01,DW02
1982	465,437	736,728	108,800	1,310,965	0.306	Estimated in DW01,DW02
1983	71,368	87,911	484,624	643,902	0.437	Estimated in DW01,DW02
1984	61,015	76,749	16,421	154,184	0.317	Estimated in DW01,DW02
1985	52,910	74,547	137,495	264,952	0.416	Estimated in DW01,DW02
1986	45,042	451,982	81,962	578,985	0.185	Estimated in DW01,DW02
1987	38,730	283,117	560,014	881,861	0.428	Estimated in DW01,DW02
1988	68,561	233,918	521,492	823,971	0.239	Estimated in DW01,DW02
1989	80,509	375,297	925,818	1,381,625	0.181	Estimated in DW01,DW02
1990	130,901	895,732	768,209	1,794,842	0.156	Estimated in DW01,DW02
1991	89,247	1,055,24	135,100	1,279,590	0.230	Estimated in DW01,DW02
1992	110,676	576,125	684,824	1,371,625	0.154	Estimated in DW01,DW02
1993	102,971	414,588	493,901	1,011,461	0.188	Estimated in DW01,DW02
1994	110,179	457,219	335,432	902,830	0.135	Estimated in DW01,DW02
1995	97,666	634,058	366,412	1,098,136	0.197	Estimated in DW01,DW02
1996	76,524	143,237	237,264	457,025	0.137	Estimated in DW01,DW02
1997	63,685	153,169	242,261	459,115	0.115	Estimated in DW01,DW02
1998	53,188	152,559	456,806	662,554	0.176	Estimated in DW01,DW02

Table 8 Continued. Recreational landings in numbers and associated log-scaled standard errors (SE). Log-scale SEs were converted from CVs provided for landings in numbers (**Section 3.2**). These uncertainty estimates were used in the assessment model with the exception that any log-scale SEs > 0.25 were capped at 0.25.

Year	Headboat	Charter	Private	Recreational	Recreational SE	Methodology
1999	40,979	145,093	354,866	540,938	0.117	Estimated in DW01,DW02
2000	32,223	83,087	350,095	465,405	0.158	Estimated in DW01,DW02
2001	40,055	129,810	302,346	472,211	0.132	Estimated in DW01,DW02
2002	53,854	142,760	796,782	993,396	0.233	Estimated in DW01,DW02
2003	63,481	145,156	993,334	1,201,970	0.250	Estimated in DW01,DW02
2004	56,215	192,689	817,991	1,066,895	0.162	Estimated in DW01,DW02
2005	48,270	151,233	569,959	769,463	0.152	Estimated in DW01,DW02
2006	33,908	100,714	396,023	530,644	0.169	Estimated in DW01,DW02
2007	32,749	82,773	342,877	458,399	0.147	Estimated in DW01,DW02
2008	22,582	69,438	263,564	355,584	0.154	Estimated in DW01,DW02
2009	12,104	36,015	122,392	170,511	0.178	Estimated in DW01,DW02
2010	9,452	30,835	258,976	299,264	0.220	Estimated in DW01,DW02
2011	16,391	73,589	364,402	454,382	0.186	Estimated in DW01,DW02
2012	5,922	15,780	209,352	231,054	0.192	Estimated in DW01,DW02
2013	9,826	30,132	292,697	332,655	0.332	Estimated in DW01,DW02
2014	2,962	15,464	125,576	144,002	0.269	Estimated in DW01,DW02
2015	1,129	680	74,972	76,782	0.313	Estimated in DW01,DW02
2016	11,008	62,746	237,666	311,420	0.187	Estimated in DW01,DW02
2017	46	8,967	75,829	84,842	0.513	Estimated in DW01,DW02
2018	15,210	45,475	146,970	207,655	0.341	Estimated in DW01,DW02
2019	5,343	28,693	67,773	101,808	0.276	Estimated in DW01,DW02
2020	5,211	35,944	171,098	212,253	0.308	Estimated in DW01,DW02
2021	5,551	44,820	62,605	112,976	0.246	Estimated in DW01,DW02
2022	5,692	50,776	154,743	211,212	0.207	Estimated in DW01,DW02
2023	5,439	60,153	127,437	193,029	0.212	Estimated in DW01,DW02
2024	4,378	35,426	160,891	200,695	0.199	Estimated in DW01,DW02

Table 9. Percent difference (%Diff) in recreational landings in numbers between SEDAR 100 and SEDAR 43 for all recreational modes combined (headboat, charter, and private). Differences exceeding 10% are identified in red.

Year	SEDAR 100	SEDAR 43	%Diff
1945	1.25	1.25	0
1946	24.71	4.10	-502.66
1947	48.17	20.66	-133.15
1948	71.63	34.48	-107.73
1949	95.09	48.31	-96.82
1950	118.54	66.91	-77.17
1951	142.00	82.27	-72.61
1952	165.46	97.61	-69.51
1953	188.92	112.96	-67.25
1954	212.38	128.31	-65.52
1955	235.84	143.66	-64.16
1956	261.21	153.29	-70.40
1957	286.58	162.94	-75.88
1958	311.94	172.58	-80.75
1959	337.31	182.21	-85.12
1960	362.68	191.85	-89.04
1961	373.04	193.82	-92.47
1962	383.39	195.80	-95.81
1963	393.75	197.76	-99.11
1964	404.11	199.74	-102.32
1965	414.47	201.71	-105.48
1966	428.26	205.46	-108.44
1967	442.06	209.20	-111.31
1968	455.85	212.96	-114.06
1969	469.65	216.71	-116.72
1970	483.44	220.45	-119.30

Table 9 Continued. Percent difference (%Diff) in recreational landings in numbers between SEDAR 100 and SEDAR 43 for all recreational modes combined (headboat, charter, and private). Differences exceeding 10% are identified in red.

Year	SEDAR 100	SEDAR 43	%Diff
1971	528.02	225.66	-133.99
1972	572.59	242.43	-136.19
1973	617.16	260.28	-137.12
1974	661.74	266.28	-148.51
1975	706.31	276.23	-155.70
1976	708.68	288.10	-145.98
1977	711.05	312.91	-127.24
1978	713.41	325.15	-119.41
1979	715.78	336.31	-112.83
1980	718.15	343.69	-108.95
1981	594.52	722.29	17.69
1982	1,310.96	723.87	-81.10
1983	643.90	472.84	-36.18
1984	154.18	215.23	28.36
1985	264.95	183.71	-44.22
1986	578.98	423.45	-36.73
1987	881.86	263.83	-234.25
1988	823.97	847.89	2.82
1989	1,381.62	975.24	-41.67
1990	1,794.84	1,410.10	-27.28
1991	1,279.59	977.07	-30.96
1992	1,371.63	799.66	-71.53
1993	1,011.46	719.59	-40.56
1994	902.83	670.23	-34.70
1995	1,098.14	732.70	-49.88
1996	457.02	381.26	-19.87

Table 9 Continued. Percent difference (%Diff) in recreational landings in numbers between SEDAR 100 and SEDAR 43 for all recreational modes combined. Differences exceeding 10% are identified in red.

Year	SEDAR 100	SEDAR 43	%Diff
1997	459.12	354.96	-29.34
1998	662.55	344.28	-92.45
1999	540.94	291.69	-85.45
2000	465.40	250.71	-85.63
2001	472.21	307.67	-53.48
2002	993.40	419.68	-136.70
2003	1,201.97	507.96	-136.63
2004	1,066.90	617.38	-72.81
2005	769.46	419.95	-83.23
2006	530.64	268.61	-97.55
2007	458.40	282.86	-62.06
2008	355.58	209.05	-70.10
2009	170.51	141.42	-20.57
2010	299.26	117.13	-155.50
2011	454.38	187.27	-142.63
2012	231.05	92.38	-150.11
2013	332.65	177.71	-87.19

Table 10. Recreational landings in pounds whole weight and associated log-scaled standard errors (SE). Log-scale SEs were converted from CVs provided for landings in weights (**Section 3.2**).

Year	Headboat	Charter	Private	Recreational	Recreational SE
1981	106,820	142,757	1,014,15	1,263,728	0.420
1982	953,690	2,212,00	269,856	3,435,549	0.336
1983	159,361	208,530	2,082,64	2,450,539	0.486
1984	113,530	238,196	48,630	400,356	0.353
1985	142,017	352,605	359,393	854,014	0.379
1986	89,307	1,099,81	183,891	1,373,018	0.218
1987	63,363	776,302	1,544,09	2,383,764	0.448
1988	90,108	704,372	679,510	1,473,991	0.235
1989	151,514	884,496	1,248,76	2,284,775	0.201
1990	198,797	3,098,27	1,432,38	4,729,454	0.195
1991	153,051	2,719,42	291,989	3,164,462	0.254
1992	170,054	1,669,74	1,331,97	3,171,767	0.176
1993	183,068	1,160,46	1,091,64	2,435,177	0.211
1994	186,038	1,003,25	757,408	1,946,697	0.208
1995	171,742	1,182,54	671,986	2,026,272	0.214
1996	124,893	315,457	394,462	834,812	0.195
1997	109,032	616,626	452,437	1,178,095	0.158
1998	88,624	418,077	861,517	1,368,217	0.198
1999	69,481	382,512	802,399	1,254,392	0.159
2000	61,996	238,471	832,600	1,133,067	0.178
2001	67,529	297,777	542,420	907,726	0.150
2002	90,952	391,600	1,744,27	2,226,826	0.275
2003	104,410	411,549	1,865,38	2,381,339	0.354
2004	100,067	358,507	1,467,51	1,926,091	0.184
2005	84,130	285,722	1,037,33	1,407,185	0.204
2006	58,178	203,688	609,825	871,692	0.189

Table 10 Continued. Recreational landings in pounds whole weight and associated log-scaled standard errors (SE). Log-scale SEs were converted from CVs provided for landings in weights (**Section 3.2**).

Year	Headboat	Charter	Private	Recreational	Recreational SE
2007	62,685	179,213	578,250	820,149	0.175
2008	48,584	158,938	510,206	717,728	0.171
2009	34,615	97,515	338,764	470,893	0.220
2010	25,756	88,158	797,579	911,493	0.251
2011	50,449	204,583	1,011,64	1,266,681	0.202
2012	18,706	48,478	643,970	711,154	0.229
2013	27,112	97,865	1,115,02	1,240,001	0.358
2014	8,693	47,885	371,170	427,748	0.289
2015	4,112	1,568	161,518	167,197	0.342
2016	29,577	202,210	783,088	1,014,875	0.215
2017	96	28,534	186,525	215,155	0.504
2018	55,291	176,919	677,471	909,681	0.368
2019	21,256	132,027	373,603	526,886	0.296
2020	17,230	136,868	851,425	1,005,523	0.333
2021	14,813	199,552	224,142	438,507	0.251
2022	17,996	158,353	581,749	758,098	0.248
2023	20,893	204,985	463,081	688,960	0.231
2024	13,718	106,124	588,006	707,847	0.238

Table 11. Mean weight (kg, whole weight) landed by the recreational fleet and associated coefficient of variation (CV) input into the stock assessment model. Mean weight was obtained by dividing the estimated weights by the estimated numbers.

Year	Recreational	Recreational CV
1981	0.964	0.340
1982	1.189	0.206
1983	1.726	0.116
1984	1.178	0.094
1985	1.462	0.147
1986	1.076	0.144
1987	1.226	0.194
1988	0.811	0.175
1989	0.750	0.122
1990	1.195	0.156
1991	1.122	0.119
1992	1.049	0.115
1993	1.092	0.138
1994	0.978	0.222
1995	0.837	0.126
1996	0.829	0.191
1997	1.164	0.132
1998	0.937	0.137
1999	1.052	0.093
2000	1.104	0.085
2001	0.872	0.089
2002	1.017	0.105
2003	0.899	0.155
2004	0.819	0.079
2005	0.830	0.100
2006	0.745	0.103
2007	0.812	0.120

Table 11 Continued. Mean weight (kg, whole weight) landed by the recreational fleet and associated coefficient of variation (CV) input into the stock assessment model. Mean weight was obtained by dividing the estimated weights by the estimated numbers.

Year	Recreational	Recreational CV
2008	0.916	0.111
2009	1.253	0.119
2010	1.382	0.101
2011	1.264	0.069
2012	1.396	0.102
2013	1.691	0.141
2014	1.347	0.138
2015	0.988	0.198
2016	1.478	0.111
2017	1.150	0.061
2018	1.987	0.123
2019	2.347	0.123
2020	2.149	0.107
2021	1.761	0.111
2022	1.628	0.130
2023	1.619	0.090
2024	1.600	0.100

Table 12. Commercial discards in numbers with associated log-scale standard errors (SE) input into the stock assessment model. Discards refer to the total number of fish discarded before applying the discard mortality rate of 40%.

Year	Vertical Line	Vertical Line SE
2000	1,502	553
2001	1,632	601
2002	2,076	764
2003	2,264	834
2004	2,039	751
2005	1,565	576
2006	1,149	423
2007	1,078	397
2008	977	360
2009	15,977	4,619
2010	11,642	3,366
2011	14,944	4,320
2012	24,285	4,377
2013	13,827	1,668
2014	12,367	1,492
2015	12,920	1,558
2016	15,411	1,859
2017	13,869	1,673
2018	10,380	1,768
2019	11,735	1,999
2020	9,866	1,680
2021	9,729	1,657
2022	10,059	1,713
2023	11,630	1,981
2024	10,412	1,773

Table 13. Recreational discards in numbers with associated log-scale standard errors (SE) input into the assessment model. Discards refer to the total number of fish discarded before applying the discard mortality rate of 40%.

Year	Headboat	Charter	Private	Recreational	Recreational SE
1981	4,192	9,112	53,891	67,195	0.542
1982	4,448	16,476	202,264	223,188	0.545
1983	4,504	7,739	803,297	815,540	0.540
1984	29	334	221,570	221,934	0.604
1985	389	621	255,062	256,072	0.516
1986	249	4,320	114,603	119,173	0.745
1987	269	3,763	205,682	209,715	0.607
1988	213	1,942	248,862	251,017	0.416
1989	799	8,979	379,260	389,037	0.246
1990	24,426	216,343	292,823	533,592	0.332
1991	642	17,684	144,418	162,744	0.407
1992	2,277	20,520	259,067	281,864	0.174
1993	5,745	41,507	545,893	593,145	0.178
1994	689	12,240	162,598	175,527	0.202
1995	4,666	68,210	101,643	174,520	0.282
1996	7,728	31,457	212,977	252,162	0.363
1997	5,038	24,272	163,714	193,024	0.269
1998	14,303	55,109	523,085	592,497	0.294
1999	4,827	21,531	293,931	320,289	0.193
2000	2,273	8,147	157,183	167,603	0.308
2001	4,125	18,671	318,451	341,247	0.190
2002	2,980	17,879	711,247	732,106	0.387
2003	3,120	9,898	420,859	433,876	0.434
2004	5,007	22,979	623,400	651,386	0.293
2005	4,409	22,986	303,905	331,300	0.211
2006	2,395	10,697	243,681	256,773	0.295
2007	4,382	17,384	600,338	622,104	0.275

Table 13 Continued. Recreational discards in numbers with associated log-scale standard errors (SE) input into the assessment model. Discards refer to the total number of fish discarded before applying the discard mortality rate of 40%.

Year	Headboat	Charter	Private	Recreational	Recreational SE
2008	3,377	13,457	200,706	217,540	0.408
2009	11,406	65,816	339,199	416,421	0.153
2010	7,944	37,761	456,281	501,986	0.353
2011	15,909	112,695	379,318	507,923	0.238
2012	30,227	63,071	593,803	687,101	0.236
2013	37,348	85,770	709,812	832,930	0.453
2014	39,831	131,176	419,094	590,101	0.141
2015	85,781	202,416	1,545,99	1,834,189	0.234
2016	91,540	358,478	1,807,33	2,257,348	0.159
2017	152,119	475,491	2,890,26	3,517,873	0.157
2018	88,531	364,958	1,632,50	2,085,994	0.309
2019	84,247	296,379	1,616,88	1,997,506	0.179
2020	69,839	355,953	1,367,30	1,793,095	0.174
2021	126,832	489,164	1,875,38	2,491,379	0.241
2022	105,871	305,686	2,590,96	3,002,521	0.214
2023	116,672	507,539	1,543,80	2,168,014	0.131
2024	88,396	350,735	1,728,12	2,167,256	0.215

Table 14. Estimated shrimp bycatch in numbers with associated log-scale standard errors (SE) for the SEDAR 100 Assessment. All bycatch is assumed dead. The median value (1,612,310) was input into the assessment model and assumed reflective of the time period 1946-2023.

Year	Bycatch	Bycatch SE	Methodology
1947	26,000	0.121	Assumed start - first year of data for SEDAR 43
1948	152,257	0.121	Interpolated
1949	278,515	0.121	Interpolated
1950	404,772	0.121	Interpolated
1951	531,029	0.121	Interpolated
1952	657,287	0.121	Interpolated
1953	783,544	0.121	Interpolated
1954	909,802	0.121	Interpolated
1955	1,036,059	0.121	Interpolated
1956	1,162,316	0.121	Interpolated
1957	1,288,574	0.121	Interpolated
1958	1,414,831	0.121	Interpolated
1959	1,541,088	0.121	Interpolated
1960	1,667,346	0.121	Back-calculated using relative shrimp effort trend
1961	1,190,584	0.121	Back-calculated using relative shrimp effort trend
1962	1,446,184	0.121	Back-calculated using relative shrimp effort trend
1963	1,648,898	0.121	Back-calculated using relative shrimp effort trend
1964	1,783,632	0.121	Back-calculated using relative shrimp effort trend
1965	1,577,327	0.121	Back-calculated using relative shrimp effort trend
1966	1,494,624	0.121	Back-calculated using relative shrimp effort trend
1967	1,747,935	0.121	Back-calculated using relative shrimp effort trend
1968	1,795,857	0.121	Back-calculated using relative shrimp effort trend
1969	2,096,457	0.121	Back-calculated using relative shrimp effort trend
1970	1,772,486	0.121	Back-calculated using relative shrimp effort trend
1971	1,831,359	0.121	Back-calculated using relative shrimp effort trend
1972	2,179,223	0.121	Back-calculated using relative shrimp effort trend
1973	2,025,273	0.121	Back-calculated using relative shrimp effort trend

Table 14 Continued. Estimated shrimp bycatch in numbers with associated log-scale standard errors (SE) for the SEDAR 100 Assessment. All bycatch is assumed dead. The median value (1,612,310) was input into the assessment model and assumed reflective of the time period 1946-2023.

Year	Bycatch	Bycatch SE	Methodology
1974	2,029,788	0.121	Back-calculated using relative shrimp effort trend
1975	1,781,703	0.121	Back-calculated using relative shrimp effort trend
1976	2,141,524	0.121	Back-calculated using relative shrimp effort trend
1977	2,305,558	0.121	Back-calculated using relative shrimp effort trend
1978	2,800,405	0.121	Back-calculated using relative shrimp effort trend
1979	2,932,028	0.121	Back-calculated using relative shrimp effort trend
1980	1,999,861	0.121	Back-calculated using relative shrimp effort trend
1981	2,450,006	0.121	Back-calculated using relative shrimp effort trend
1982	2,410,732	0.121	Back-calculated using relative shrimp effort trend
1983	2,374,921	0.121	Back-calculated using relative shrimp effort trend
1984	2,530,668	0.121	Estimated in DW22
1985	2,788,041	0.113	Estimated in DW22
1986	3,105,696	0.112	Estimated in DW22
1987	3,637,803	0.117	Estimated in DW22
1988	3,182,324	0.134	Estimated in DW22
1989	3,049,864	0.129	Estimated in DW22
1990	2,955,209	0.107	Estimated in DW22
1991	2,982,042	0.117	Estimated in DW22
1992	3,037,806	0.191	Estimated in DW22
1993	2,969,446	0.113	Estimated in DW22
1994	2,210,772	0.124	Estimated in DW22
1995	2,045,915	0.143	Estimated in DW22
1996	2,300,476	0.152	Estimated in DW22
1997	2,664,584	0.171	Estimated in DW22
1998	2,191,771	0.135	Estimated in DW22
1999	2,140,668	0.114	Estimated in DW22
2000	1,988,938	0.102	Estimated in DW22

Table 14 Continued. Estimated shrimp bycatch in numbers with associated log-scale standard errors (SE) for the SEDAR 100 Assessment. All bycatch is assumed dead. The median value (1,612,310) was input into the assessment model and assumed reflective of the time period 1946-2023.

Year	Bycatch	Bycatch SE	Methodology
2001	1,612,308	0.110	Estimated in DW22
2002	1,789,791	0.113	Estimated in DW22
2003	1,376,498	0.141	Estimated in DW22
2004	1,203,723	0.125	Estimated in DW22
2005	938,446	0.127	Estimated in DW22
2006	841,732	0.121	Estimated in DW22
2007	602,379	0.246	Estimated in DW22
2008	670,997	0.266	Estimated in DW22
2009	966,090	0.123	Estimated in DW22
2010	540,201	0.094	Estimated in DW22
2011	758,124	0.102	Estimated in DW22
2012	704,027	0.134	Estimated in DW22
2013	484,904	0.141	Estimated in DW22
2014	660,309	0.085	Estimated in DW22
2015	463,600	0.114	Estimated in DW22
2016	437,446	0.119	Estimated in DW22
2017	477,767	0.111	Estimated in DW22
2018	424,302	0.096	Estimated in DW22
2019	387,097	0.084	Estimated in DW22
2020	368,221	0.085	Estimated in DW22
2021	392,766	0.094	Estimated in DW22
2022	257,934	0.076	Estimated in DW22
2023	250,215	0.107	Estimated in DW22

Table 15. Shrimp effort estimates (days), associated log-scale standard errors (SE), and the relative index of shrimp effort (scaled to a mean of 1) for the Gulf shrimp fishery.

Year	Effort	Effort SE	Index	Methodology
1945			0.001	Assumed start
1946			0.068	Interpolated
1947			0.135	Interpolated
1948			0.202	Interpolated
1949			0.269	Interpolated
1950			0.336	Interpolated
1951			0.403	Interpolated
1952			0.470	Interpolated
1953			0.537	Interpolated
1954			0.604	Interpolated
1955			0.671	Interpolated
1956			0.738	Interpolated
1957			0.805	Interpolated
1958			0.872	Interpolated
1959			0.939	Interpolated
1960	111,233		1.006	Summed by region; no CV provided
1961	79,427		0.719	Summed by region; no CV provided
1962	96,479		0.873	Summed by region; no CV provided
1963	110,002		0.995	Summed by region; no CV provided
1964	118,991		1.077	Summed by region; no CV provided
1965	105,228		0.952	Summed by region; no CV provided
1966	99,710		0.902	Summed by region; no CV provided
1967	116,609		1.055	Summed by region; no CV provided
1968	119,806		1.084	Summed by region; no CV provided
1969	139,860		1.265	Summed by region; no CV provided
1970	118,247		1.070	Summed by region; no CV provided
1971	122,175		1.105	Summed by region; no CV provided

Table 15 Continued. Shrimp effort estimates (days), associated log-scale standard errors (SE), and the relative index of shrimp effort (scaled to a mean of 1) for the Gulf shrimp fishery.

Year	Effort	Effort SE	Index	Methodology
1972	145,381		1.315	Summed by region; no CV provided
1973	135,111		1.223	Summed by region; no CV provided
1974	135,412		1.225	Summed by region; no CV provided
1975	118,862		1.076	Summed by region; no CV provided
1976	142,867		1.293	Summed by region; no CV provided
1977	153,810		1.392	Summed by region; no CV provided
1978	186,822		1.690	Summed by region; no CV provided
1979	195,603		1.770	Summed by region; no CV provided
1980	133,416		1.207	Summed by region; no CV provided
1981	163,446		1.479	Summed by region; no CV provided
1982	160,826		1.455	Summed by region; no CV provided
1983	158,437		1.434	Summed by region; no CV provided
1984	168,827	0.014	1.528	Estimated in DW22
1985	174,594	0.014	1.580	Estimated in DW22
1986	201,708	0.015	1.825	Estimated in DW22
1987	222,895	0.014	2.017	Estimated in DW22
1988	191,953	0.015	1.737	Estimated in DW22
1989	202,466	0.019	1.832	Estimated in DW22
1990	204,359	0.023	1.849	Estimated in DW22
1991	200,384	0.023	1.813	Estimated in DW22
1992	198,979	0.026	1.800	Estimated in DW22
1993	183,700	0.033	1.662	Estimated in DW22
1994	145,046	0.044	1.312	Estimated in DW22
1995	124,407	0.023	1.126	Estimated in DW22
1996	142,167	0.023	1.286	Estimated in DW22
1997	164,074	0.021	1.485	Estimated in DW22
1998	195,135	0.020	1.766	Estimated in DW22

Table 15 Continued. Shrimp effort estimates (days), associated log-scale standard errors (SE), and the relative index of shrimp effort (scaled to a mean of 1) for the Gulf shrimp fishery.

Year	Effort	Effort SE	Index	Methodology
1999	190,994	0.021	1.728	Estimated in DW22
2000	169,299	0.019	1.532	Estimated in DW22
2001	132,347	0.033	1.198	Estimated in DW22
2002	149,444	0.026	1.352	Estimated in DW22
2003	119,127	0.023	1.078	Estimated in DW22
2004	99,557	0.023	0.901	Estimated in DW22
2005	79,109	0.023	0.716	Estimated in DW22
2006	72,296	0.027	0.654	Estimated in DW22
2007	76,075	0.069	0.688	Estimated in DW22
2008	62,172	0.026	0.563	Estimated in DW22
2009	77,307	0.020	0.699	Estimated in DW22
2010	50,312	0.024	0.455	Estimated in DW22
2011	62,641	0.017	0.567	Estimated in DW22
2012	62,655	0.020	0.567	Estimated in DW22
2013	70,604	0.071	0.639	Estimated in DW22
2014	76,287	0.013	0.690	Estimated in DW22
2015	75,871	0.012	0.687	Estimated in DW22
2016	74,268	0.011	0.672	Estimated in DW22
2017	76,821	0.011	0.695	Estimated in DW22
2018	71,519	0.010	0.647	Estimated in DW22
2019	67,130	0.010	0.607	Estimated in DW22
2020	70,638	0.013	0.639	Estimated in DW22
2021	68,888	0.020	0.623	Estimated in DW22
2022	45,618	0.025	0.413	Estimated in DW22
2023	36,900	0.032	0.334	Estimated in DW22
2024	35,462	0.038	0.321	Estimated in DW22

Table 16. Standardized indices of relative abundance (catch-per-unit-effort, CPUE) and associated log-scale standard errors (SE) converted from the CVs provided.

Year	Rec CPUE	Rec SE	Trawl Early CPUE	Trawl Early SE	Trawl Late CPUE	Trawl Late SE	Video CPUE	Video SE
1986	0.871	0.283						
1987	0.725	0.293	0.568	0.192				
1988	0.877	0.282	0.495	0.188				
1989	1.309	0.267	0.945	0.160				
1990	2.048	0.236	0.455	0.189				
1991	1.470	0.238	2.121	0.120				
1992	1.481	0.241	0.274	0.206				
1993	1.245	0.246	1.380	0.144			0.403	0.186
1994	1.271	0.259	1.454	0.128			0.907	0.454
1995	1.047	0.287	0.920	0.154			0.454	0.290
1996	1.122	0.285	0.655	0.184			0.365	0.155
1997	1.060	0.282	0.570	0.172			1.534	0.197
1998	0.942	0.272	0.105	0.312				
1999	1.000	0.264	1.237	0.139				
2000	0.542	0.292	1.961	0.124				
2001	0.448	0.299	2.971	0.137				
2002	0.624	0.294	0.942	0.150			0.876	0.613
2003	0.732	0.286	0.498	0.183				
2004	0.797	0.274	0.502	0.164			0.634	0.334
2005	1.022	0.258	0.835	0.149			0.611	0.212
2006	0.642	0.280	1.380	0.150			1.167	0.174
2007	0.726	0.282	0.770	0.164			1.016	0.188
2008			0.961	0.123			1.056	0.154
2009					0.619	0.116	1.448	0.135
2010					0.700	0.145	0.721	0.157
2011					0.906	0.139	0.818	0.148
2012					1.212	0.120	0.670	0.147

Table 16 Continued. Standardized indices of relative abundance (catch-per-unit-effort, CPUE) and associated log-scale standard errors (SE) converted from the CVs provided.

Year	Rec CPUE	Rec SE	Trawl Early CPUE	Trawl Early SE	Trawl Late CPUE	Trawl Late SE	Video CPUE	Video SE
2013					0.643	0.175	0.553	0.131
2014					0.930	0.127	0.648	0.104
2015					1.265	0.110	0.835	0.095
2016					0.479	0.175	1.231	0.065
2017					0.757	0.136	1.043	0.073
2018					0.985	0.123	1.013	0.083
2019					1.146	0.135	0.880	0.078
2020					0.781	0.202	1.820	0.166
2021					1.319	0.128	1.610	0.091
2022					1.863	0.125	1.776	0.083
2023					1.724	0.116	1.668	0.077
2024					0.670	0.162	1.242	0.076

Table 17. List of Stock Synthesis parameters. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), the prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
NatM_Lorenzen_averageFem_GP_1	0.360	(0,1)				Fixed
L_at_Amin_Fem_GP_1	8.353	(5,25)	0.325	0.039		3
L_at_Amax_Fem_GP_1	53.804	(30,60)	0.617	0.011		5
VonBert_K_Fem_GP_1	0.153	(0.05,0.3)	0.007	0.048		5
CV_young_Fem_GP_1	0.437	(0.01,0.5)				Fixed
CV_old_Fem_GP_1	0.124	(0.01,0.5)				Fixed
Wtlen_1_Fem_GP_1	1.70e-05	(0,1)				Fixed
Wtlen_2_Fem_GP_1	3.070	(0,4)				Fixed
Mat50%_Fem_GP_1	15.259	(10,30)				Fixed
Mat_slope_Fem_GP_1	-0.232	(-1,0)				Fixed
Eggs_scalar_Fem_GP_1	1	(-1,1)				Fixed
Eggs_exp_wt_Fem_GP_1	1	(0,4)				Fixed
CohortGrowDev	1	(0.1,10)			Normal(1,1)	Fixed
FracFemale_GP_1	0.5	(1e-06,0.99)				Fixed
SR_LN(R0)	11.469	(3,20)	0.051	0.004		1
SR_BH_steep	0.99	(0.2,1)				Fixed
SR_sigmaR	0.6	(0.2,2)				Fixed
SR_regime	0	(-5,5)				Fixed
SR_autocorr	0	(0,0)				Fixed
Main_RecrDev_1981	0.954	(-5,5)	0.231	0.242		3
Main_RecrDev_1982	-0.224	(-5,5)	0.415	1.855		3
Main_RecrDev_1983	-0.591	(-5,5)	0.356	0.602		3
Main_RecrDev_1984	-0.705	(-5,5)	0.345	0.489		3
Main_RecrDev_1985	-0.037	(-5,5)	0.252	6.829		3
Main_RecrDev_1986	0.077	(-5,5)	0.261	3.410		3
Main_RecrDev_1987	0.805	(-5,5)	0.166	0.206		3
Main_RecrDev_1988	0.585	(-5,5)	0.196	0.335		3
Main_RecrDev_1989	-0.375	(-5,5)	0.299	0.799		3

Table 17 Continued. List of Stock Synthesis parameters. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), the prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Main_RecrDev_1990	0.235	(-5,5)	0.169	0.717		3
Main_RecrDev_1991	-0.684	(-5,5)	0.304	0.444		3
Main_RecrDev_1992	0.359	(-5,5)	0.149	0.414		3
Main_RecrDev_1993	-6.43e-04	(-5,5)	0.198	>>>1		3
Main_RecrDev_1994	-0.380	(-5,5)	0.25	0.660		3
Main_RecrDev_1995	0.294	(-5,5)	0.173	0.589		3
Main_RecrDev_1996	-0.145	(-5,5)	0.244	1.684		3
Main_RecrDev_1997	-0.524	(-5,5)	0.272	0.520		3
Main_RecrDev_1998	0.189	(-5,5)	0.161	0.849		3
Main_RecrDev_1999	0.367	(-5,5)	0.14	0.382		3
Main_RecrDev_2000	-0.060	(-5,5)	0.158	2.647		3
Main_RecrDev_2001	-0.039	(-5,5)	0.136	3.468		3
Main_RecrDev_2002	-0.187	(-5,5)	0.134	0.720		3
Main_RecrDev_2003	-0.483	(-5,5)	0.143	0.297		3
Main_RecrDev_2004	-0.508	(-5,5)	0.127	0.250		3
Main_RecrDev_2005	-0.495	(-5,5)	0.122	0.247		3
Main_RecrDev_2006	-0.212	(-5,5)	0.116	0.549		3
Main_RecrDev_2007	0.103	(-5,5)	0.109	1.063		3
Main_RecrDev_2008	-0.301	(-5,5)	0.132	0.439		3
Main_RecrDev_2009	-0.072	(-5,5)	0.107	1.489		3
Main_RecrDev_2010	-0.498	(-5,5)	0.124	0.249		3
Main_RecrDev_2011	0.121	(-5,5)	0.086	0.705		3
Main_RecrDev_2012	0.434	(-5,5)	0.08	0.184		3
Main_RecrDev_2013	0.768	(-5,5)	0.071	0.093		3
Main_RecrDev_2014	0.199	(-5,5)	0.1	0.503		3
Main_RecrDev_2015	-0.107	(-5,5)	0.123	1.144		3
Main_RecrDev_2016	-0.004	(-5,5)	0.127	>>>1		3
Main_RecrDev_2017	0.740	(-5,5)	0.097	0.131		3
Main_RecrDev_2018	0.305	(-5,5)	0.135	0.441		3

Table 17 Continued. List of Stock Synthesis parameters. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), the prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Main_RecrDev_2019	0.138	(-5,5)	0.154	1.114		3
Main_RecrDev_2020	-0.026	(-5,5)	0.183	7.150		3
Main_RecrDev_2021	0.065	(-5,5)	0.213	3.263		3
Main_RecrDev_2022	0.590	(-5,5)	0.211	0.357		3
Main_RecrDev_2023	-1.042	(-5,5)	0.369	0.354		3
Main_RecrDev_2024	0.372	(-5,5)	0.568	1.529		3
LnQ_base_Shrimp_Bycatch_4(4)	2.357	(-10,40)	0.104	0.044		1
LnQ_base_HB_Surv_5(5)	-7.974	(-25,25)				Fixed
Q_extraSD_HB_Surv_5(5)	0.074	(0,0.5)	0.049	0.669	Sym_Beta(0,1)	4
LnQ_base_TrawlEarly_6(6)	-9.533	(-25,25)				Fixed
Q_extraSD_TrawlEarly_6(6)	0.414	(0,0.5)	0.057	0.139	Sym_Beta(0,1)	4
LnQ_base_TrawlLate_7(7)	-9.823	(-25,25)				Fixed
Q_extraSD_TrawlLate_7(7)	0.231	(0,0.5)	0.066	0.288	Sym_Beta(0,1)	4
LnQ_base_Video_8(8)	-6.291	(-25,25)				Fixed
Q_extraSD_Video_8(8)	0.117	(0,0.5)	0.05	0.424	Sym_Beta(0,1)	4
Size_DblN_peak_Rec_1(1)	30.298	(10,60)	0.186	0.006		2
Size_DblN_top_logit_Rec_1(1)	-13.182	(-15,15)	34.97	2.653		3
Size_DblN_ascend_se_Rec_1(1)	3.641	(-15,15)	0.038	0.010		3
Size_DblN_descend_se_Rec_1(1)	4.226	(-15,15)	0.151	0.036		3
Size_DblN_start_logit_Rec_1(1)	-999	(-999,15)				Fixed
Size_DblN_end_logit_Rec_1(1)	-0.323	(-15,15)	0.146	0.450		4
Retain_L_infl_Rec_1(1)	25.722	(0,60)				Fixed
Retain_L_width_Rec_1(1)	2.598	(0,20)				Fixed
Retain_L_asymptote_logit_Rec_1(1)	4.981	(-10,10)	1.715	0.344		2
Retain_L_maleoffset_Rec_1(1)	0	(-1,2)				Fixed
DiscMort_L_infl_Rec_1(1)	-5	(-10,10)				Fixed
DiscMort_L_width_Rec_1(1)	1	(-1,2)				Fixed
DiscMort_L_level_old_Rec_1(1)	0.4	(0,2)				Fixed
DiscMort_L_male_offset_Rec_1(1)	0	(-1,2)				Fixed

Table 17 Continued. List of Stock Synthesis parameters. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), the prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Size_inflection_ComVL_2(2)	31.103	(10,60)	0.277	0.009		2
Size_95%width_ComVL_2(2)	5.354	(0.01,20)	0.273	0.051		3
Retain_L_infl_ComVL_2(2)	20.667	(0,60)				Fixed
Retain_L_width_ComVL_2(2)	1.073	(0,20)				Fixed
Retain_L_asymptote_logit_ComVL_2(2)	9.731	(-10,10)	7.331	0.753		2
Retain_L_maleoffset_ComVL_2(2)	0	(-1,2)				Fixed
DiscMort_L_infl_ComVL_2(2)	-5	(-10,10)				Fixed
DiscMort_L_width_ComVL_2(2)	1	(-1,2)				Fixed
DiscMort_L_level_old_ComVL_2(2)	0.4	(0,2)				Fixed
DiscMort_L_male_offset_ComVL_2(2)	0	(-1,2)				Fixed
Size_inflection_ComLL_3(3)	56.331	(10,60)	1.113	0.020		2
Size_95%width_ComLL_3(3)	10.470	(0.01,20)	0.438	0.042		3
Size_DblN_peak_Shrimp_Bycatch_4(4)	11.662	(5,20)	0.462	0.040		2
Size_DblN_top_logit_Shrimp_Bycatch_4(4)	-11.866	(-15,15)	50.946	4.294		3
Size_DblN_ascend_se_Shrimp_Bycatch_4(4)	2.748	(-15,15)	0.214	0.078		3
Size_DblN_descend_se_Shrimp_Bycatch_4(4)	2.659	(-15,15)	0.467	0.176		3
Size_DblN_start_logit_Shrimp_Bycatch_4(4)	-8.536	(-15,15)	0.756	0.089		2
Size_DblN_end_logit_Shrimp_Bycatch_4(4)	-0.427	(-15,15)	0.159	0.373		4
Size_DblN_peak_TrawlLate_7(7)	7.995	(5,20)	0.321	0.040		2
Size_DblN_top_logit_TrawlLate_7(7)	-2.906	(-15,15)	0.532	0.183		3
Size_DblN_ascend_se_TrawlLate_7(7)	0.788	(-15,15)	0.329	0.418		3
Size_DblN_descend_se_TrawlLate_7(7)	2.214	(-15,15)	1.162	0.525		3
Size_DblN_start_logit_TrawlLate_7(7)	-8.752	(-15,15)	1.012	0.116		2
Size_DblN_end_logit_TrawlLate_7(7)	0.315	(-15,15)	0.243	0.771		4
Size_DblN_peak_Video_8(8)	62.700	(10,72)				Fixed
Size_DblN_top_logit_Video_8(8)	-1.64e-07	(-15,15)	335.407	>>>1		3
Size_DblN_ascend_se_Video_8(8)	5.841	(-15,15)	0.041	0.007		3
Size_DblN_descend_se_Video_8(8)	1.84e-08	(-15,15)	335.407	>>>1		3
Size_DblN_start_logit_Video_8(8)	-14.900	(-15,15)				Fixed

Table 17 Continued. List of Stock Synthesis parameters. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), the prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Size_DblN_end_logit_Video_8(8)	999	(-15,999)				Fixed
ln(DM_theta)_Len_P1	7.858	(-5,10)	0.879	0.112	Normal(0,1.81)	6
ln(DM_theta)_Len_P2	5.503	(-5,10)	0.754	0.137	Normal(0,1.81)	6
ln(DM_theta)_Len_P3	-0.177	(-5,10)	0.107	0.606	Normal(0,1.81)	6
ln(DM_theta)_Len_P4	-0.394	(-5,10)	0.104	0.265	Normal(0,1.81)	6
ln(DM_theta)_Age_P5	0.471	(-5,10)	0.104	0.221	Normal(0,1.81)	6
ln(DM_theta)_Age_P6	0.503	(-5,10)	0.091	0.180	Normal(0,1.81)	6
Size_DblN_peak_Rec_1(1)_BLK4repl_2008	34.669	(10,60)	0.199	0.006		3
Size_DblN_descend_se_Rec_1(1)_BLK4repl_2008	2.716	(-15,15)	0.147	0.054		3
Size_DblN_end_logit_Rec_1(1)_BLK4repl_2008	-0.853	(-15,15)	0.096	0.113		4
Retain_L_infl_Rec_1(1)_BLK1repl_1999	26.412	(1,60)	0.136	0.005		3
Retain_L_infl_Rec_1(1)_BLK1repl_2009	37.152	(1,60)	0.257	0.007		3
Retain_L_infl_Rec_1(1)_BLK1repl_2018	38.470	(1,60)	0.129	0.003		3
Retain_L_width_Rec_1(1)_BLK1repl_1999	1.591	(0,20)	0.081	0.051		3
Retain_L_width_Rec_1(1)_BLK1repl_2009	2.190	(0,20)	0.078	0.035		3
Retain_L_width_Rec_1(1)_BLK1repl_2018	1.215	(0,20)	0.042	0.034		3
Retain_L_asymptote_logit_Rec_1(1)_BLK3repl_2012	-0.132	(-10,10)	0.133	1.009		3
Size_inflection_ComVL_2(2)_BLK4repl_2008	38.720	(10,60)	0.597	0.015		3
Size_95%width_ComVL_2(2)_BLK4repl_2008	9.094	(0.01,20)	0.386	0.042		3
Retain_L_infl_ComVL_2(2)_BLK2repl_1999	24.548	(1,60)	0.828	0.034		3
Retain_L_infl_ComVL_2(2)_BLK2repl_2009	38.121	(1,60)	0.483	0.013		3
Retain_L_width_ComVL_2(2)_BLK2repl_1999	1.467	(0,20)	0.497	0.339		3
Retain_L_width_ComVL_2(2)_BLK2repl_2009	3.004	(0,20)	0.244	0.081		3
Retain_L_asymptote_logit_ComVL_2(2)_BLK3repl_2012	1.577	(-10,10)	0.236	0.149		3
Size_inflection_ComLL_3(3)_BLK4repl_2008	47.703	(10,60)	0.501	0.011		3
Size_95%width_ComLL_3(3)_BLK4repl_2008	6.355	(0.01,20)	0.374	0.059		3
Size_DblN_peak_Video_8(8)_BLK5repl_2006	57.922	(10,72)	1.283	0.022		3
Size_DblN_peak_Video_8(8)_BLK5repl_2010	62.036	(10,72)	0.944	0.015		3
Size_DblN_peak_Video_8(8)_BLK5repl_2020	58.819	(10,72)	1.129	0.019		3

Table 18. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) combined across all fleets, which was used as the proxy for annual fishing mortality rate. Estimates are provided for the SEDAR 100 Assessment and the SEDAR 43 Standard Assessment.

Year	SEDAR 100	SEDAR 43	Year	SEDAR 100	SEDAR 43
1945	0.0002	0.0003	1985	0.1207	0.1841
1946	0.0056	0.0002	1986	0.1796	0.2526
1947	0.0111	0.0012	1987	0.2372	0.2313
1948	0.0166	0.0019	1988	0.2314	0.2297
1949	0.0222	0.0038	1989	0.2781	0.2482
1950	0.0278	0.0093	1990	0.3562	0.2947
1951	0.0341	0.0130	1991	0.2867	0.2830
1952	0.0422	0.0163	1992	0.3311	0.2634
1953	0.0468	0.0179	1993	0.4402	0.2529
1954	0.0527	0.0236	1994	0.2823	0.2472
1955	0.0594	0.0247	1995	0.2908	0.2658
1956	0.0648	0.0312	1996	0.2150	0.2297
1957	0.0714	0.0365	1997	0.1970	0.2462
1958	0.0783	0.0462	1998	0.3078	0.2665
1959	0.0852	0.0507	1999	0.2684	0.2543
1960	0.0928	0.0523	2000	0.2039	0.2262
1961	0.0833	0.0370	2001	0.1965	0.2228
1962	0.0915	0.0562	2002	0.3111	0.2350
1963	0.0988	0.0633	2003	0.3270	0.2150
1964	0.1054	0.0736	2004	0.3670	0.2291
1965	0.1030	0.0543	2005	0.2962	0.1704
1966	0.1029	0.0481	2006	0.2423	0.1328
1967	0.1118	0.0554	2007	0.2908	0.1377
1968	0.1154	0.0631	2008	0.2431	0.1154
1969	0.1263	0.0689	2009	0.1596	0.0974
1970	0.1216	0.0543	2010	0.2160	0.0774
1971	0.1312	0.0607	2011	0.2487	0.1052
1972	0.1482	0.0991	2012	0.2105	0.0772
1973	0.1515	0.0892	2013	0.4229	0.1310

Table 18 Continued. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) combined across all fleets, which was used as the proxy for annual fishing mortality rate. Estimates are provided for the SEDAR 100 Assessment and the SEDAR 43 Standard Assessment.

Year	SEDAR 100	SEDAR 43	Year	SEDAR 100	SEDAR 43
1974	0.1584	0.0992	2014	0.1169	
1975	0.1604	0.0963	2015	0.1316	
1976	0.1678	0.1132	2016	0.2120	
1977	0.1678	0.1275	2017	0.2245	
1978	0.1760	0.1426	2018	0.2088	
1979	0.1805	0.1514	2019	0.1855	
1980	0.1591	0.1511	2020	0.1895	
1981	0.1376	0.1652	2021	0.1696	
1982	0.1992	0.1776	2022	0.2298	
1983	0.1595	0.1646	2023	0.2019	
1984	0.0936	0.1632	2024	0.2102	

Table 19. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet and combined across all fleets (Total), which was used as the proxy for annual fishing mortality rate.

Year	Recreational	Commercial Vertical Line	Commercial Longline	Shrimp Bycatch	Total
1945	0.0001	0.0000		0.0000	0.0002
1946	0.0027	0.0002		0.0028	0.0056
1947	0.0053	0.0003		0.0055	0.0111
1948	0.0079	0.0005		0.0082	0.0166
1949	0.0106	0.0007		0.0110	0.0222
1950	0.0134	0.0007		0.0137	0.0278
1951	0.0163	0.0014		0.0164	0.0341
1952	0.0194	0.0037		0.0192	0.0422
1953	0.0226	0.0023		0.0219	0.0468
1954	0.0259	0.0021		0.0247	0.0527
1955	0.0293	0.0026		0.0275	0.0594
1956	0.0332	0.0013		0.0304	0.0648
1957	0.0372	0.0010		0.0332	0.0714
1958	0.0414	0.0009		0.0360	0.0783
1959	0.0457	0.0006		0.0389	0.0852
1960	0.0502	0.0008		0.0418	0.0928
1961	0.0528	0.0004		0.0301	0.0833
1962	0.0545	0.0004		0.0366	0.0915
1963	0.0565	0.0005		0.0418	0.0988
1964	0.0588	0.0014		0.0452	0.1054
1965	0.0613	0.0015		0.0402	0.1030
1966	0.0638	0.0010		0.0382	0.1029
1967	0.0660	0.0012		0.0446	0.1118
1968	0.0687	0.0009		0.0458	0.1154
1969	0.0714	0.0016		0.0533	0.1263
1970	0.0746	0.0018		0.0452	0.1216
1971	0.0815	0.0031		0.0466	0.1312

Table 19 Continued. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet and combined across all fleets (Total), which was used as the proxy for annual fishing mortality rate.

Year	Recreational	Commercial Vertical Line	Commercial Longline	Shrimp Bycatch	Total
1972	0.0885	0.0048		0.0549	0.1482
1973	0.0963	0.0042		0.0510	0.1515
1974	0.1031	0.0043		0.0509	0.1584
1975	0.1092	0.0064		0.0447	0.1604
1976	0.1079	0.0070		0.0529	0.1678
1977	0.1066	0.0050		0.0562	0.1678
1978	0.1046	0.0050		0.0664	0.1760
1979	0.1029	0.0085	0.0003	0.0688	0.1805
1980	0.1014	0.0082	0.0003	0.0491	0.1591
1981	0.0694	0.0072	0.0007	0.0603	0.1376
1982	0.1241	0.0064	0.0012	0.0676	0.1992
1983	0.0942	0.0045	0.0010	0.0598	0.1595
1984	0.0278	0.0046	0.0009	0.0604	0.0936
1985	0.0531	0.0062	0.0014	0.0600	0.1207
1986	0.1000	0.0078	0.0007	0.0711	0.1796
1987	0.1441	0.0120	0.0001	0.0811	0.2372
1988	0.1292	0.0187	0.0003	0.0832	0.2314
1989	0.1648	0.0273	0.0009	0.0850	0.2781
1990	0.2386	0.0361	0.0059	0.0757	0.3562
1991	0.1635	0.0416	0.0021	0.0796	0.2867
1992	0.2078	0.0483	0.0025	0.0725	0.3311
1993	0.3010	0.0650	0.0018	0.0724	0.4402
1994	0.1663	0.0520	0.0026	0.0614	0.2823
1995	0.1959	0.0445	0.0009	0.0495	0.2908
1996	0.1183	0.0335	0.0009	0.0623	0.2150
1997	0.1067	0.0210	0.0014	0.0679	0.1970
1998	0.2128	0.0212	0.0007	0.0731	0.3078

Table 19 Continued. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet and combined across all fleets (Total), which was used as the proxy for annual fishing mortality rate.

Year	Recreational	Commercial Vertical Line	Commercial Longline	Shrimp Bycatch	Total
1999	0.1580	0.0289	0.0014	0.0802	0.2684
2000	0.1062	0.0195	0.0007	0.0774	0.2039
2001	0.1189	0.0202	0.0007	0.0567	0.1965
2002	0.2239	0.0264	0.0003	0.0604	0.3111
2003	0.2494	0.0299	0.0009	0.0468	0.3270
2004	0.3001	0.0274	0.0020	0.0375	0.3670
2005	0.2423	0.0221	0.0010	0.0307	0.2962
2006	0.1976	0.0144	0.0013	0.0290	0.2423
2007	0.2432	0.0149	0.0014	0.0313	0.2908
2008	0.2028	0.0101	0.0026	0.0276	0.2431
2009	0.1130	0.0122	0.0013	0.0330	0.1596
2010	0.1863	0.0083	0.0004	0.0210	0.2160
2011	0.2084	0.0157	0.0001	0.0245	0.2487
2012	0.1723	0.0116	0.0001	0.0265	0.2105
2013	0.3840	0.0091	0.0001	0.0297	0.4229
2014	0.0737	0.0050	0.0005	0.0377	0.1169
2015	0.0934	0.0046	0.0006	0.0330	0.1316
2016	0.1770	0.0049	0.0009	0.0291	0.2120
2017	0.1887	0.0057	0.0006	0.0295	0.2245
2018	0.1720	0.0056	0.0007	0.0306	0.2088
2019	0.1526	0.0050	0.0007	0.0272	0.1855
2020	0.1573	0.0046	0.0003	0.0273	0.1895
2021	0.1394	0.0035	0.0006	0.0261	0.1696
2022	0.2086	0.0036	0.0006	0.0170	0.2298
2023	0.1815	0.0046	0.0006	0.0152	0.2019
2024	0.1923	0.0044	0.0007	0.0129	0.2102

Table 20. Expected biomass (metric tons) for all and exploited Gray Triggerfish (1+ years), spawning stock biomass (SSB, metric tons), exploited numbers (1+ years), age-0 recruits, and SSB ratio (SSB/SSB_0) where SSB_0 = 8,816 metric tons.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
1945	9,967	9,758	8,817.32	43,358,700	95,743,800	1.00
1946	9,965	9,757	8,815.85	43,356,400	95,743,800	1.00
1947	9,915	9,707	8,768.12	43,259,200	95,742,500	0.99
1948	9,822	9,614	8,678.77	43,107,400	95,740,000	0.98
1949	9,693	9,485	8,553.69	42,921,100	95,736,400	0.97
1950	9,535	9,326	8,399.35	42,712,600	95,731,800	0.95
1951	9,354	9,145	8,222.98	42,490,300	95,726,400	0.93
1952	9,152	8,944	8,026.09	42,256,100	95,720,000	0.91
1953	8,926	8,718	7,804.73	42,007,000	95,712,500	0.88
1954	8,705	8,496	7,587.87	41,766,000	95,704,700	0.86
1955	8,481	8,273	7,369.04	41,525,300	95,696,300	0.84
1956	8,255	8,046	7,147.04	41,283,000	95,687,400	0.81
1957	8,035	7,827	6,931.99	41,046,500	95,678,100	0.79
1958	7,817	7,609	6,718.57	40,810,600	95,668,400	0.76
1959	7,601	7,393	6,507.03	40,575,300	95,658,100	0.74
1960	7,389	7,180	6,299.30	40,342,200	95,647,300	0.71
1961	7,179	6,971	6,094.22	40,110,000	95,635,900	0.69
1962	7,094	6,885	6,003.83	40,239,200	95,630,700	0.68
1963	6,985	6,777	5,896.86	40,130,300	95,624,200	0.67
1964	6,857	6,649	5,773.55	39,938,400	95,616,500	0.66
1965	6,720	6,511	5,640.37	39,738,400	95,607,800	0.64
1966	6,636	6,428	5,556.08	39,730,800	95,602,100	0.63
1967	6,582	6,373	5,500.26	39,752,000	95,598,200	0.62
1968	6,491	6,283	5,413.26	39,598,100	95,592,000	0.61
1969	6,402	6,194	5,327.36	39,476,300	95,585,700	0.60
1970	6,271	6,063	5,202.05	39,222,900	95,576,100	0.59
1971	6,206	5,998	5,135.17	39,252,800	95,570,800	0.58

Table 20 Continued. Expected biomass (metric tons) for all and exploited Gray Triggerfish (1+ years), spawning stock biomass (SSB, metric tons), exploited numbers (1+ years), age-0 recruits, and SSB ratio (SSB/SSB_0) where SSB_0 = 8,816 metric tons.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
1972	6,119	5,911	5,049.21	39,185,100	95,563,700	0.57
1973	5,969	5,761	4,905.35	38,915,100	95,551,400	0.56
1974	5,850	5,642	4,788.10	38,823,000	95,540,800	0.54
1975	5,740	5,532	4,679.01	38,734,200	95,530,500	0.53
1976	5,670	5,462	4,606.81	38,780,400	95,523,400	0.52
1977	5,583	5,376	4,523.90	38,626,100	95,514,900	0.51
1978	5,514	5,306	4,457.49	38,494,900	95,507,900	0.51
1979	5,412	5,204	4,362.52	38,224,200	95,497,600	0.50
1980	5,314	5,106	4,268.93	38,040,100	95,486,900	0.48
1981	5,625	5,147	4,301.04	38,367,900	219,287,00	0.49
1982	5,946	5,799	4,400.04	67,889,400	67,373,000	0.50
1983	6,095	5,994	4,983.84	41,852,200	46,541,600	0.56
1984	5,914	5,824	5,123.77	28,958,300	41,422,700	0.58
1985	5,721	5,545	5,020.90	22,992,200	80,581,600	0.57
1986	5,346	5,150	4,537.62	29,461,400	89,974,700	0.52
1987	5,107	4,703	4,003.87	33,104,300	185,729,00	0.45
1988	5,020	4,696	3,533.23	56,769,000	148,568,00	0.40
1989	5,263	5,140	3,898.12	56,326,800	56,781,900	0.44
1990	5,295	5,068	4,216.56	34,837,000	104,231,00	0.48
1991	4,709	4,619	3,774.40	38,534,100	41,425,700	0.43
1992	4,454	4,199	3,616.22	24,581,900	117,237,00	0.41
1993	4,000	3,822	3,037.12	37,660,000	81,486,900	0.34
1994	3,487	3,366	2,632.83	32,896,100	55,557,200	0.30
1995	3,590	3,353	2,745.89	26,113,400	108,730,00	0.31
1996	3,600	3,448	2,672.47	36,434,200	69,897,600	0.30
1997	3,763	3,659	2,958.58	30,804,700	47,729,500	0.34
1998	3,864	3,653	3,097.68	23,808,700	97,195,800	0.35

Table 20 Continued. Expected biomass (metric tons) for all and exploited Gray Triggerfish (1+ years), spawning stock biomass (SSB, metric tons), exploited numbers (1+ years), age-0 recruits, and SSB ratio (SSB/SSB_0) where SSB_0 = 8,816 metric tons.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
1999	3,664	3,412	2,725.79	32,506,800	115,848,00	0.31
2000	3,721	3,557	2,708.77	39,769,200	75,594,800	0.31
2001	3,995	3,827	3,068.04	33,238,600	77,243,200	0.35
2002	4,143	3,998	3,277.88	31,956,300	66,689,800	0.37
2003	3,831	3,723	3,084.27	28,367,100	49,555,200	0.35
2004	3,452	3,347	2,820.29	23,017,700	48,300,600	0.32
2005	2,996	2,890	2,425.58	20,646,100	48,852,100	0.28
2006	2,810	2,669	2,223.93	20,025,000	64,816,100	0.25
2007	2,853	2,660	2,147.96	23,667,400	88,740,000	0.24
2008	2,878	2,749	2,096.19	30,515,900	59,226,400	0.24
2009	3,138	2,975	2,369.30	26,388,400	74,617,100	0.27
2010	3,433	3,326	2,681.52	29,012,700	48,780,200	0.30
2011	3,633	3,435	2,883.81	23,818,700	90,660,500	0.33
2012	3,785	3,515	2,832.97	31,809,000	123,901,00	0.32
2013	4,290	3,913	3,006.06	42,535,100	173,091,00	0.34
2014	4,402	4,189	2,956.48	57,686,500	97,942,100	0.34
2015	5,350	5,193	4,101.33	46,665,700	72,296,600	0.47
2016	5,872	5,698	4,813.20	37,385,500	80,200,000	0.55
2017	5,975	5,607	4,810.54	35,399,100	168,770,00	0.55
2018	5,954	5,716	4,565.39	55,231,700	109,249,00	0.52
2019	6,144	5,942	4,851.28	48,229,500	92,474,600	0.55
2020	6,258	6,087	5,110.58	42,505,300	78,527,200	0.58
2021	6,186	5,998	5,152.83	37,016,900	85,989,200	0.58
2022	6,186	5,869	5,056.32	36,664,100	145,332,00	0.57
2023	5,821	5,756	4,692.82	50,255,500	30,070,300	0.53
2024	5,846	5,550	4,851.16	27,984,400	135,949,00	0.55

Table 21. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish.

Year	Input N SE	Input N	Exp N	Exp B	Exp Mean Weight
1945	0.25	1,250	1,250	2,787	2.2
1946	0.25	24,709	24,709	55,089	2.2
1947	0.25	48,168	48,167	107,356	2.2
1948	0.25	71,627	71,624	159,504	2.2
1949	0.25	95,086	95,081	211,394	2.2
1950	0.25	118,545	118,536	262,866	2.2
1951	0.25	142,003	141,990	313,750	2.2
1952	0.25	165,462	165,442	363,837	2.2
1953	0.25	188,921	188,892	413,053	2.2
1954	0.25	212,380	212,340	461,469	2.2
1955	0.25	235,839	235,783	508,989	2.2
1956	0.25	261,207	261,131	559,729	2.1
1957	0.25	286,575	286,473	609,588	2.1
1958	0.25	311,943	311,807	658,491	2.1
1959	0.25	337,310	337,130	706,426	2.1
1960	0.25	362,678	362,441	753,376	2.1
1961	0.25	373,036	372,739	768,308	2.1
1962	0.25	383,394	383,005	782,660	2.0
1963	0.25	393,752	393,239	798,169	2.0
1964	0.25	404,110	403,425	814,583	2.0
1965	0.25	414,468	413,538	830,831	2.0
1966	0.25	428,263	426,956	853,087	2.0
1967	0.25	442,058	440,201	875,106	2.0
1968	0.25	455,853	453,195	897,424	2.0
1969	0.25	469,648	465,810	919,106	2.0
1970	0.25	483,443	477,883	939,342	2.0
1971	0.25	528,016	519,011	1,014,806	2.0

Table 21 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish.

Year	Input N SE	Input N	Exp N	Exp B	Exp Mean Weight
1972	0.250	572,590	558,288	1,085,207	1.9
1973	0.250	617,163	594,886	1,149,522	1.9
1974	0.250	661,736	627,923	1,204,944	1.9
1975	0.250	706,310	656,432	1,250,017	1.9
1976	0.250	708,678	644,372	1,218,059	1.9
1977	0.250	711,046	629,053	1,183,524	1.9
1978	0.250	713,414	610,690	1,145,785	1.9
1979	0.250	715,782	590,369	1,105,251	1.9
1980	0.250	718,150	572,402	1,068,167	1.9
1981	0.250	594,521	395,860	737,024	1.9
1982	0.250	1,310,960	803,064	1,477,492	1.8
1983	0.250	643,902	664,752	1,147,573	1.7
1984	0.250	154,184	185,531	333,802	1.8
1985	0.250	264,952	315,519	615,345	2.0
1986	0.185	578,985	520,251	1,081,644	2.1
1987	0.250	881,861	686,561	1,414,105	2.1
1988	0.239	823,971	652,961	1,246,869	1.9
1989	0.181	1,381,620	1,010,720	1,706,883	1.7
1990	0.156	1,794,840	1,491,140	2,446,775	1.6
1991	0.230	1,279,590	895,780	1,547,297	1.7
1992	0.154	1,371,630	1,013,240	1,792,830	1.8
1993	0.188	1,011,460	1,314,210	2,365,976	1.8
1994	0.135	902,830	671,381	1,133,986	1.7
1995	0.197	1,098,140	799,701	1,333,934	1.7
1996	0.137	457,025	484,813	833,241	1.7
1997	0.115	459,115	465,195	795,220	1.7
1998	0.176	662,554	914,029	1,593,219	1.7

Table 21 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish.

Year	Input N SE	Input N	Exp N	Exp B	Exp Mean Weight
1999	0.117	540,938	603,826	1,113,479	1.8
2000	0.158	465,405	426,936	771,249	1.8
2001	0.132	472,211	530,301	925,469	1.7
2002	0.233	993,396	1,040,230	1,834,530	1.8
2003	0.250	1,201,970	1,067,210	1,907,942	1.8
2004	0.162	1,066,900	1,149,910	2,066,972	1.8
2005	0.152	769,463	795,064	1,444,308	1.8
2006	0.169	530,644	592,464	1,088,430	1.8
2007	0.147	458,399	725,977	1,331,269	1.8
2008	0.154	355,584	591,979	1,196,015	2.0
2009	0.178	170,511	148,566	433,181	2.9
2010	0.220	299,264	278,834	804,611	2.9
2011	0.186	454,382	325,900	947,215	2.9
2012	0.192	231,054	162,890	479,736	2.9
2013	0.250	332,655	395,823	1,169,672	3.0
2014	0.250	144,002	77,570	222,373	2.9
2015	0.250	76,782	121,177	341,500	2.8
2016	0.187	311,420	262,475	743,277	2.8
2017	0.250	84,842	287,640	839,067	2.9
2018	0.250	207,655	182,700	653,101	3.6
2019	0.250	101,808	161,332	586,777	3.6
2020	0.250	212,253	164,638	593,856	3.6
2021	0.246	112,976	148,704	534,874	3.6
2022	0.207	211,212	226,785	824,294	3.6
2023	0.212	193,029	195,647	720,051	3.7
2024	0.199	200,695	191,002	705,342	3.7

Table 22. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Vertical Line fleet in biomass (B, pounds whole weight) and number (N). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. "*" indicates confidential data.

Year	Input B SE	Input B	Exp B	Exp N	Exp Mean Weight
1945	0.2	22	22	7	3.3
1946	0.2	3,592	3,592	1,075	3.3
1947	0.2	7,161	7,161	2,143	3.3
1948	0.2	10,731	10,731	3,213	3.3
1949	0.2	14,300	14,300	4,287	3.3
1950	0.2	14,700	14,700	4,415	3.3
1951	0.2	28,000	28,000	8,434	3.3
1952	0.2	72,400	72,400	21,895	3.3
1953	0.2	43,600	43,600	13,251	3.3
1954	0.2	39,600	39,600	12,104	3.3
1955	0.2	46,600	46,600	14,333	3.3
1956	0.2	22,800	22,800	7,061	3.2
1957	0.2	17,400	17,400	5,427	3.2
1958	0.2	15,200	15,200	4,777	3.2
1959	0.2	10,300	10,300	3,263	3.2
1960	0.2	11,900	11,900	3,801	3.1
1961	0.2	6,500	6,500	2,094	3.1
1962	0.2	5,600	5,600	1,821	3.1
1963	0.2	7,300	7,300	2,393	3.1
1964	0.2	20,000	20,000	6,600	3.0
1965	0.2	21,650	21,650	7,186	3.0
1966	0.2	13,800	13,800	4,608	3.0
1967	0.2	17,400	17,400	5,844	3.0
1968	0.2	12,500	12,500	4,219	3.0
1969	0.2	22,300	22,300	7,560	2.9
1970	0.2	24,051	24,051	8,187	2.9
1971	0.2	40,400	40,400	13,826	2.9

Table 22 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Vertical Line fleet in biomass (B, pounds whole weight) and number (N). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. "*" indicates confidential data.

Year	Input B SE	Input B	Exp B	Exp N	Exp Mean Weight
1972	0.200	62,600	62,601	21,558	2.9
1973	0.200	53,200	53,201	18,441	2.9
1974	0.200	53,552	53,553	18,700	2.9
1975	0.200	78,000	78,002	27,465	2.8
1976	0.200	84,500	84,502	30,011	2.8
1977	0.100	59,386	59,388	21,230	2.8
1978	0.100	58,823	58,825	21,118	2.8
1979	0.100	97,484	97,488	35,104	2.8
1980	0.100	92,776	92,777	33,522	2.8
1981	0.100	82,101	82,102	29,751	2.8
1982	0.100	81,633	81,638	29,722	2.7
1983	0.100	59,836	59,837	22,903	2.6
1984	0.100	*	*	*	2.6
1985	0.100	75,563	75,563	27,277	2.8
1986	0.060	88,853	88,857	30,026	3.0
1987	0.062	124,185	124,205	40,837	3.0
1988	0.063	193,744	193,767	66,016	2.9
1989	0.061	309,533	309,586	117,662	2.6
1990	0.061	402,652	402,773	166,068	2.4
1991	0.062	423,455	423,494	172,036	2.5
1992	0.063	447,128	447,227	175,837	2.5
1993	0.067	*	*	*	2.6
1994	0.071	385,853	385,888	153,808	2.5
1995	0.070	328,557	328,588	135,309	2.4
1996	0.072	254,607	254,614	103,105	2.5
1997	0.073	169,593	169,598	68,040	2.5
1998	0.071	170,648	170,692	67,838	2.5

Table 22 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Vertical Line fleet in biomass (B, pounds whole weight) and number (N). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. "*" indicates confidential data.

Year	Input B SE	Input B	Exp B	Exp N	Exp Mean Weight
1999	0.074	216,844	216,871	82,630	2.6
2000	0.055	152,492	152,498	57,921	2.6
2001	0.056	169,373	169,379	66,393	2.6
2002	0.053	231,893	231,948	91,717	2.5
2003	0.055	244,486	244,558	95,793	2.6
2004	0.057	201,293	201,406	78,380	2.6
2005	0.056	140,258	140,290	54,114	2.6
2006	0.059	84,688	84,697	32,185	2.6
2007	0.065	*	*	*	2.6
2008	0.064	61,209	61,224	17,385	3.5
2009	0.056	69,251	69,253	15,989	4.3
2010	0.054	52,364	52,370	12,325	4.2
2011	0.052	103,093	103,108	24,310	4.2
2012	0.052	71,281	71,286	16,640	4.3
2013	0.052	62,005	62,238	14,405	4.3
2014	0.050	36,239	36,239	8,545	4.2
2015	0.050	40,745	40,746	9,780	4.2
2016	0.050	47,667	47,670	11,534	4.1
2017	0.050	55,654	55,659	13,214	4.2
2018	0.050	56,281	56,287	12,933	4.4
2019	0.050	53,248	53,253	11,971	4.4
2020	0.050	48,923	48,927	11,052	4.4
2021	0.050	37,384	37,386	8,473	4.4
2022	0.050	37,163	37,170	8,334	4.5
2023	0.050	47,316	47,322	10,464	4.5
2024	0.050	43,340	43,347	9,536	4.5

Table 23. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Longline fleet in biomass (B, pounds whole weight) and number (N). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. "*" indicates confidential data.

Year	Input B SE	Input B	Exp B	Exp N	Exp Mean Weight
1979	0.100	3,919	3,919	535	7.3
1980	0.100	3,700	3,701	506	7.3
1981	0.100	7,759	7,759	1,065	7.3
1982	0.100	15,040	15,041	2,072	7.3
1983	0.100	13,583	13,583	1,888	7.2
1984	0.100	11,683	11,683	1,643	7.1
1985	0.100	17,063	17,063	2,398	7.1
1986	0.098	8,149	8,149	1,126	7.2
1987	0.100	642	642	87	7.4
1988	0.098	2,589	2,589	345	7.5
1989	0.097	10,543	10,545	1,419	7.4
1990	0.060	*	*	*	7.1
1991	0.081	20,887	20,889	3,100	6.7
1992	0.077	23,028	23,034	3,473	6.6
1993	0.052	15,293	15,309	2,298	6.7
1994	0.051	19,424	19,426	2,918	6.7
1995	0.052	6,965	6,966	1,058	6.6
1996	0.052	6,822	6,822	1,048	6.5
1997	0.055	11,021	11,021	1,685	6.5
1998	0.051	*	*	*	6.6
1999	0.050	10,277	10,278	1,541	6.7
2000	0.051	5,770	5,770	855	6.7
2001	0.050	6,043	6,044	892	6.8
2002	0.050	*	*	*	6.7
2003	0.050	7,269	7,271	1,093	6.7
2004	0.050	*	*	*	6.6
2005	0.050	*	*	*	6.7

Table 23 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Longline fleet in biomass (B, pounds whole weight) and number (N). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. "*" indicates confidential data.

Year	Input B SE	Input B	Exp B	Exp N	Exp Mean Weight
2006	0.050	*	*	*	6.7
2007	0.050	*	*	*	6.8
2008	0.050	*	*	*	6.2
2009	0.050	*	*	*	6.1
2010	0.071	*	*	*	6.0
2011	0.051	*	*	*	6.0
2012	0.050	*	*	*	6.0
2013	0.056	*	*	*	6.0
2014	0.050	4,446	4,446	742	6.0
2015	0.050	6,751	6,751	1,137	5.9
2016	0.050	*	*	*	5.9
2017	0.050	*	*	*	5.9
2018	0.050	8,417	8,418	1,401	6.0
2019	0.050	9,243	9,244	1,508	6.1
2020	0.050	3,857	3,857	625	6.2
2021	0.050	*	*	*	6.2
2022	0.050	8,117	8,119	1,315	6.2
2023	0.050	7,543	7,544	1,212	6.2
2024	0.050	8,264	8,265	1,318	6.3

Table 24. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1945			382	153	329	131	0.9
1946			7,550	3,020	6,496	2,598	0.9
1947			14,734	5,894	12,672	5,069	0.9
1948			21,967	8,787	18,877	7,551	0.9
1949			29,290	11,716	25,137	10,055	0.9
1950			36,734	14,694	31,473	12,588	0.9
1951			44,327	17,731	37,908	15,163	0.9
1952			52,106	20,843	44,463	17,785	0.9
1953			60,070	24,028	51,141	20,454	0.9
1954			68,194	27,277	57,924	23,168	0.8
1955			76,506	30,603	64,827	25,931	0.8
1956			85,621	34,248	72,375	28,949	0.8
1957			94,924	37,970	80,043	32,018	0.8
1958			104,438	41,775	87,850	35,139	0.8
1959			114,172	45,669	95,795	38,319	0.8
1960			124,131	49,652	103,886	41,555	0.8
1961			129,177	51,671	107,815	43,127	0.8
1962			134,114	53,645	111,732	44,694	0.8
1963			138,409	55,363	115,238	46,094	0.8
1964			142,651	57,060	118,648	47,459	0.8
1965			147,183	58,873	122,215	48,887	0.8
1966			153,104	61,241	126,924	50,770	0.8
1967			158,680	63,472	131,437	52,576	0.8
1968			163,940	65,576	135,701	54,280	0.8
1969			169,270	67,708	139,958	55,984	0.8
1970			174,748	69,899	144,235	57,693	0.8
1971			191,454	76,581	157,714	63,085	0.8

Table 24 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1972			207,557	83,023	170,721	68,288	0.8
1973			223,056	89,222	183,094	73,237	0.8
1974			238,036	95,214	194,897	77,960	0.8
1975			251,540	100,616	205,490	82,195	0.8
1976			248,939	99,576	203,103	81,240	0.8
1977			243,785	97,514	198,817	79,527	0.8
1978			237,162	94,865	193,317	77,327	0.8
1979			230,031	92,012	187,289	74,915	0.8
1980			224,543	89,817	182,461	72,984	0.8
1981	0.542	67,195	155,360	62,144	126,338	50,534	0.8
1982	0.545	223,188	354,306	141,722	272,685	109,074	0.8
1983	0.540	815,540	304,845	121,938	241,432	96,571	0.8
1984	0.604	221,934	67,377	26,951	57,490	22,996	0.9
1985	0.516	256,072	94,783	37,913	84,351	33,740	0.9
1986	0.745	119,173	153,244	61,297	132,932	53,173	0.9
1987	0.607	209,715	244,942	97,977	199,013	79,604	0.8
1988	0.416	251,017	302,936	121,174	227,486	90,993	0.8
1989	0.246	389,037	532,150	212,860	400,923	160,371	0.8
1990	0.332	533,592	684,770	273,910	549,127	219,646	0.8
1991	0.407	162,744	356,890	142,760	292,813	117,125	0.8
1992	0.174	281,864	395,220	158,090	326,800	130,721	0.8
1993	0.178	593,145	535,150	214,060	425,712	170,285	0.8
1994	0.202	175,527	324,317	129,727	250,147	100,059	0.8
1995	0.282	174,520	356,339	142,534	285,547	114,219	0.8
1996	0.363	252,162	209,084	83,634	165,686	66,275	0.8
1997	0.269	193,024	206,200	82,480	163,700	65,479	0.8
1998	0.294	592,497	366,101	146,441	301,352	120,542	0.8

Table 24 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1999	0.193	320,289	255,713	102,285	187,413	74,964	0.7
2000	0.308	167,603	216,324	86,530	153,298	61,319	0.7
2001	0.190	341,247	267,213	106,885	194,070	77,627	0.7
2002	0.387	732,106	469,690	187,870	347,748	139,098	0.7
2003	0.434	433,876	468,520	187,410	347,516	139,006	0.7
2004	0.293	651,386	495,120	198,050	369,596	147,833	0.7
2005	0.211	331,300	332,716	133,086	248,864	99,545	0.7
2006	0.295	256,773	249,219	99,688	185,382	74,152	0.7
2007	0.275	622,104	326,393	130,556	237,898	95,160	0.7
2008	0.408	217,540	87,435	34,974	82,658	33,063	0.9
2009	0.153	416,421	510,394	204,157	770,460	308,184	1.5
2010	0.353	501,986	910,236	364,094	1,404,418	561,764	1.5
2011	0.238	507,923	1,013,210	405,284	1,577,670	631,066	1.6
2012	0.236	687,101	1,197,270	478,910	2,138,426	855,366	1.8
2013	0.453	832,930	3,080,797	1,232,317	5,357,436	2,142,968	1.7
2014	0.141	590,101	689,578	275,831	1,144,780	457,911	1.7
2015	0.234	1,834,190	1,098,463	439,387	1,820,522	728,208	1.7
2016	0.159	2,257,350	2,144,005	857,605	3,701,546	1,480,612	1.7
2017	0.157	3,517,870	2,069,500	827,800	3,734,505	1,493,795	1.8
2018	0.309	2,085,990	2,048,400	819,360	3,785,152	1,514,060	1.8
2019	0.179	1,997,510	1,977,418	790,968	3,530,505	1,412,205	1.8
2020	0.174	1,793,090	2,129,542	851,822	3,793,051	1,517,217	1.8
2021	0.241	2,491,380	1,795,086	718,033	3,269,859	1,307,944	1.8
2022	0.214	3,002,520	2,520,045	1,008,015	4,686,484	1,874,580	1.9
2023	0.131	2,168,010	2,129,413	851,763	3,958,285	1,583,314	1.9
2024	0.215	2,167,260	2,279,388	911,758	4,118,146	1,647,252	1.8

Table 25. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Commercial Vertical Line fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1945			0	0	0	0	0.5
1946			2	1	1	0	0.5
1947			5	2	2	1	0.5
1948			7	3	4	1	0.5
1949			10	4	5	2	0.5
1950			10	4	5	2	0.5
1951			19	8	10	4	0.5
1952			51	20	26	10	0.5
1953			31	12	16	6	0.5
1954			29	12	15	6	0.5
1955			35	14	17	7	0.5
1956			18	7	9	4	0.5
1957			14	6	7	3	0.5
1958			13	5	6	2	0.5
1959			9	4	4	2	0.5
1960			11	4	5	2	0.5
1961			6	2	3	1	0.5
1962			5	2	3	1	0.5
1963			7	3	3	1	0.5
1964			20	8	9	4	0.5
1965			22	9	10	4	0.5
1966			14	6	7	3	0.5
1967			18	7	9	3	0.5
1968			13	5	6	2	0.5
1969			24	10	11	4	0.5
1970			26	10	12	5	0.5
1971			45	18	21	8	0.5

Table 25 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Commercial Vertical Line fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1972			71	29	33	13	0.5
1973			62	25	29	11	0.5
1974			64	26	30	12	0.5
1975			97	39	45	18	0.5
1976			107	43	49	20	0.5
1977			77	31	35	14	0.5
1978			77	31	35	14	0.5
1979			129	51	59	23	0.5
1980			125	50	57	23	0.5
1981			111	44	50	20	0.5
1982			156	62	65	26	0.4
1983			107	43	49	19	0.5
1984			63	25	32	13	0.5
1985			55	22	29	11	0.5
1986			69	27	33	13	0.5
1987			134	53	60	24	0.5
1988			376	151	154	62	0.4
1989			783	313	333	134	0.4
1990			783	313	362	143	0.5
1991			680	272	306	123	0.5
1992			612	245	289	117	0.5
1993			951	381	403	161	0.4
1994			871	348	377	152	0.4
1995			629	252	284	115	0.5
1996			503	202	214	86	0.4
1997			319	128	143	57	0.4
1998			251	100	117	47	0.5

Table 25 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Commercial Vertical Line fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1999			2,188	875	1,742	697	0.8
2000	0.368	1,502	1,861	745	1,426	571	0.8
2001	0.368	1,632	2,244	898	1,763	705	0.8
2002	0.368	2,076	2,756	1,102	2,213	884	0.8
2003	0.368	2,264	2,743	1,097	2,209	884	0.8
2004	0.368	2,039	2,190	876	1,774	710	0.8
2005	0.368	1,565	1,452	581	1,179	472	0.8
2006	0.368	1,149	854	342	690	276	0.8
2007	0.368	1,078	929	372	734	294	0.8
2008	0.368	977	801	320	403	161	0.5
2009	0.289	15,977	13,383	5,353	26,740	10,696	2.0
2010	0.289	11,642	10,283	4,113	21,031	8,412	2.0
2011	0.289	14,944	19,345	7,738	40,331	16,132	2.1
2012	0.180	24,285	18,552	7,421	46,604	18,642	2.5
2013	0.121	13,827	16,606	6,642	40,500	16,200	2.4
2014	0.121	12,367	11,237	4,495	25,677	10,271	2.3
2015	0.121	12,920	13,225	5,290	30,260	12,104	2.3
2016	0.121	15,412	14,528	5,811	34,809	13,924	2.4
2017	0.121	13,869	14,742	5,897	37,345	14,938	2.5
2018	0.170	10,380	13,241	5,296	34,601	13,841	2.6
2019	0.170	11,735	12,476	4,991	32,088	12,835	2.6
2020	0.170	9,866	11,964	4,786	30,478	12,191	2.5
2021	0.170	9,729	8,868	3,547	23,090	9,236	2.6
2022	0.170	10,060	8,242	3,297	22,027	8,811	2.7
2023	0.170	11,630	10,107	4,043	27,181	10,872	2.7
2024	0.170	10,412	9,544	3,818	25,190	10,076	2.6

Table 26. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Shrimp Bycatch fleet in numbers (N) and biomass (B, pounds whole weight). All discards are assumed dead. Mean weight (MW, pounds whole weight per fish) was determined by dividing the expected discards in weights by the expected discards in numbers. Input and expected super-period median values are 1,612,310 and 1,314,100, respectively.

Year	Input N SE	Input N	Exp N	Exp B	Exp MW
1945			1,865	977	0.5
1946			114,652	60,030	0.5
1947	0.121	26,000	225,734	117,838	0.5
1948	0.121	152,257	336,089	174,437	0.5
1949	0.121	278,515	445,095	229,078	0.5
1950	0.121	404,772	552,665	281,404	0.5
1951	0.121	531,029	658,750	331,136	0.5
1952	0.121	657,287	763,183	377,839	0.5
1953	0.121	783,544	866,142	421,739	0.5
1954	0.121	909,802	967,723	463,208	0.5
1955	0.121	1,036,060	1,067,840	502,049	0.5
1956	0.121	1,162,320	1,166,560	538,494	0.5
1957	0.121	1,288,570	1,263,890	572,716	0.5
1958	0.121	1,414,830	1,359,790	604,599	0.4
1959	0.121	1,541,090	1,454,300	634,265	0.4
1960	0.121	1,667,350	1,547,390	661,767	0.4
1961	0.121	1,190,580	1,104,700	462,889	0.4
1962	0.121	1,446,180	1,342,420	555,992	0.4
1963	0.121	1,648,900	1,522,540	624,218	0.4
1964	0.121	1,783,630	1,636,080	663,015	0.4
1965	0.121	1,577,330	1,442,750	576,801	0.4
1966	0.121	1,494,620	1,367,620	541,137	0.4
1967	0.121	1,747,940	1,593,780	626,341	0.4
1968	0.121	1,795,860	1,628,040	634,388	0.4
1969	0.121	2,096,460	1,883,410	727,386	0.4
1970	0.121	1,772,490	1,586,270	604,604	0.4
1971	0.121	1,831,360	1,633,180	615,958	0.4

Table 26 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Shrimp Bycatch fleet in numbers (N) and biomass (B, pounds whole weight). All discards are assumed dead. Mean weight (MW, pounds whole weight per fish) was determined by dividing the expected discards in weights by the expected discards in numbers. Input and expected super-period median values are 1,612,310 and 1,314,100, respectively.

Year	Input N SE	Input N	Exp N	Exp B	Exp MW
1972	0.121	2,179,220	1,918,720	715,670	0.4
1973	0.121	2,025,270	1,766,100	648,024	0.4
1974	0.121	2,029,790	1,753,430	633,473	0.4
1975	0.121	1,781,700	1,532,930	545,465	0.4
1976	0.121	2,141,520	1,807,280	637,181	0.4
1977	0.121	2,305,560	1,904,840	666,344	0.3
1978	0.121	2,800,400	2,233,870	776,641	0.3
1979	0.121	2,932,030	2,291,190	788,729	0.3
1980	0.121	1,999,860	1,625,570	553,115	0.3
1981	0.121	2,450,010	2,011,100	684,169	0.3
1982	0.121	2,410,730	3,546,440	864,253	0.2
1983	0.121	2,374,920	2,165,420	790,579	0.4
1984	0.121	2,530,670	1,578,110	774,904	0.5
1985	0.113	2,788,040	1,299,200	733,389	0.6
1986	0.112	3,105,700	1,941,990	806,975	0.4
1987	0.117	3,637,800	2,445,090	840,586	0.3
1988	0.134	3,182,320	3,659,340	861,812	0.2
1989	0.129	3,049,860	3,770,700	963,598	0.3
1990	0.107	2,955,210	2,343,660	845,602	0.4
1991	0.117	2,982,040	2,602,190	810,546	0.3
1992	0.191	3,037,810	1,658,610	671,313	0.4
1993	0.113	2,969,450	2,339,710	610,018	0.3
1994	0.124	2,210,770	1,652,780	455,294	0.3
1995	0.143	2,045,920	1,123,520	365,872	0.3
1996	0.152	2,300,480	1,800,190	473,407	0.3
1997	0.171	2,664,580	1,745,950	547,658	0.3
1998	0.135	2,191,770	1,575,500	588,803	0.4

Table 26 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Shrimp Bycatch fleet in numbers (N) and biomass (B, pounds whole weight). All discards are assumed dead. Mean weight (MW, pounds whole weight per fish) was determined by dividing the expected discards in weights by the expected discards in numbers. Input and expected super-period median values are 1,612,310 and 1,314,100, respectively.

Year	Input N SE	Input N	Exp N	Exp B	Exp MW
1999	0.114	2,140,670	2,166,330	602,926	0.3
2000	0.102	1,988,940	2,396,270	607,170	0.3
2001	0.11	1,612,310	1,567,300	478,619	0.3
2002	0.113	1,789,790	1,673,260	532,447	0.3
2003	0.141	1,376,500	1,173,710	384,184	0.3
2004	0.125	1,203,720	789,037	276,748	0.4
2005	0.127	938,446	570,287	195,873	0.3
2006	0.121	841,732	513,234	170,527	0.3
2007	0.246	602,379	637,152	183,308	0.3
2008	0.266	670,997	668,989	167,287	0.3
2009	0.123	966,090	718,907	216,714	0.3
2010	0.094	540,201	510,544	153,907	0.3
2011	0.102	758,124	520,503	185,421	0.4
2012	0.134	704,027	708,740	205,284	0.3
2013	0.141	484,904	1,053,310	255,791	0.2
2014	0.085	660,309	1,553,650	348,125	0.2
2015	0.114	463,600	1,247,010	377,627	0.3
2016	0.119	437,446	962,309	365,870	0.4
2017	0.111	477,767	950,504	364,812	0.4
2018	0.096	424,302	1,397,910	385,057	0.3
2019	0.084	387,097	1,120,790	355,905	0.3
2020	0.085	368,221	1,023,340	366,963	0.4
2021	0.094	392,766	871,785	345,460	0.4
2022	0.076	257,934	577,763	220,541	0.4
2023	0.107	250,215	649,728	192,496	0.3
2024			342,475	157,931	0.5

Table 27. Observed (Obs) versus expected (Exp) standardized index of fishing effort for the Shrimp Bycatch fleet.

Year	Shrimp Effort (Obs)	Shrimp Effort (Exp)	Shrimp Effort (SE)
1945	0.001	0.001	0.2
1946	0.068	0.068	0.2
1947	0.135	0.135	0.2
1948	0.202	0.203	0.2
1949	0.269	0.270	0.2
1950	0.336	0.337	0.2
1951	0.403	0.405	0.2
1952	0.470	0.472	0.2
1953	0.537	0.539	0.2
1954	0.604	0.607	0.2
1955	0.671	0.675	0.2
1956	0.738	0.742	0.2
1957	0.805	0.810	0.2
1958	0.872	0.878	0.2
1959	0.939	0.945	0.2
1960	1.006	1.013	0.2
1961	0.719	0.722	0.2
1962	0.873	0.878	0.2
1963	0.995	1.001	0.2
1964	1.077	1.083	0.2
1965	0.952	0.957	0.2
1966	0.902	0.906	0.2
1967	1.055	1.059	0.2
1968	1.084	1.087	0.2
1969	1.266	1.267	0.2
1970	1.070	1.069	0.2
1971	1.105	1.101	0.2

Table 27 Continued. Observed (Obs) versus expected (Exp) standardized index of fishing effort for the Shrimp Bycatch fleet.

Year	Shrimp Effort (Obs)	Shrimp Effort (Exp)	Shrimp Effort (SE)
1972	1.315	1.302	0.2
1973	1.223	1.204	0.2
1974	1.225	1.199	0.2
1975	1.075	1.047	0.2
1976	1.293	1.238	0.2
1977	1.392	1.311	0.2
1978	1.690	1.552	0.2
1979	1.770	1.604	0.2
1980	1.207	1.130	0.2
1981	1.479	1.378	0.2
1982	1.455	1.379	0.2
1983	1.434	1.375	0.2
1984	1.528	1.481	0.2
1985	1.580	1.551	0.2
1986	1.825	1.789	0.2
1987	2.017	1.981	0.2
1988	1.737	1.704	0.2
1989	1.832	1.789	0.2
1990	1.849	1.852	0.2
1991	1.813	1.844	0.2
1992	1.800	1.858	0.2
1993	1.662	1.689	0.2
1994	1.312	1.333	0.2
1995	1.126	1.148	0.2
1996	1.286	1.308	0.2
1997	1.485	1.511	0.2
1998	1.766	1.814	0.2

Table 27 Continued. Observed (Obs) versus expected (Exp) standardized index of fishing effort for the Shrimp Bycatch fleet.

Year	Shrimp Effort (Obs)	Shrimp Effort (Exp)	Shrimp Effort (SE)
1999	1.728	1.787	0.2
2000	1.532	1.594	0.2
2001	1.198	1.246	0.2
2002	1.352	1.416	0.2
2003	1.078	1.116	0.2
2004	0.901	0.930	0.2
2005	0.716	0.739	0.2
2006	0.654	0.677	0.2
2007	0.688	0.707	0.2
2008	0.563	0.568	0.2
2009	0.699	0.706	0.2
2010	0.455	0.459	0.2
2011	0.567	0.574	0.2
2012	0.567	0.579	0.2
2013	0.639	0.646	0.2
2014	0.690	0.691	0.2
2015	0.686	0.694	0.2
2016	0.672	0.685	0.2
2017	0.695	0.712	0.2
2018	0.647	0.659	0.2
2019	0.607	0.604	0.2
2020	0.639	0.634	0.2
2021	0.623	0.623	0.2
2022	0.413	0.415	0.2
2023	0.334	0.336	0.2
2024	0.321	0.322	0.2

Table 28. Observed (Obs) versus expected (Exp) standardized fishery-dependent catch-per-unit-effort (CPUE) indices for the Recreational fleet (SRHS). SEs shown below include extra SD estimated (**Table 17**) and added to the input SE values for each year (**Table 16**).

Year	Recreational SRHS (Obs)	Recreational SRHS (Exp)	Recreational SRHS (SE)
1986	0.871	1.142	0.357
1987	0.725	0.987	0.367
1988	0.877	1.018	0.356
1989	1.309	1.290	0.341
1990	2.048	1.403	0.310
1991	1.470	1.244	0.312
1992	1.481	1.092	0.315
1993	1.245	0.863	0.320
1994	1.271	0.881	0.333
1995	1.047	0.935	0.361
1996	1.122	0.928	0.359
1997	1.060	1.012	0.356
1998	0.942	0.971	0.346
1999	1.000	0.853	0.337
2000	0.542	0.909	0.365
2001	0.448	1.063	0.373
2002	0.624	1.064	0.368
2003	0.732	0.971	0.360
2004	0.797	0.858	0.348
2005	1.022	0.754	0.332
2006	0.642	0.697	0.354
2007	0.726	0.664	0.356

Table 29. Observed (Obs) versus expected (Exp) standardized survey indices. SEs shown below include extra SD estimated (**Table 17**) and added to the input SE values for each year (**Table 16**).

Yr	Trawl Early (Obs)	Trawl Early (Exp)	Trawl Early (SE)	Trawl Late (Obs)	Trawl Late (Exp)	Trawl Late (SE)	Video (Obs)	Video (Exp)	Video (SE)
1987	0.568	0.903	0.606						
1988	0.495	1.571	0.602						
1989	0.945	1.547	0.573						
1990	0.455	0.931	0.603						
1991	2.121	1.036	0.534						
1992	0.274	0.656	0.619						
1993	1.380	1.012	0.558				0.403	0.580	0.303
1994	1.454	0.912	0.542				0.907	0.523	0.571
1995	0.920	0.720	0.568				0.454	0.529	0.407
1996	0.655	1.011	0.598				0.365	0.561	0.272
1997	0.570	0.852	0.586				1.534	0.607	0.314
1998	0.105	0.638	0.726						
1999	1.237	0.887	0.553						
2000	1.961	1.104	0.538						
2001	2.971	0.928	0.551						
2002	0.942	0.869	0.564				0.876	0.639	0.731
2003	0.498	0.774	0.597						
2004	0.502	0.625	0.577				0.634	0.537	0.452
2005	0.835	0.569	0.563				0.611	0.485	0.329
2006	1.380	0.559	0.563				1.167	0.879	0.291
2007	0.770	0.663	0.578				1.016	0.844	0.305
2008	0.961	0.869	0.537				1.056	0.866	0.271
2009				0.619	0.668	0.346	1.448	0.970	0.252
2010				0.700	0.731	0.376	0.721	0.606	0.274
2011				0.906	0.598	0.370	0.818	0.638	0.265
2012				1.212	0.798	0.351	0.670	0.664	0.264
2013				0.643	1.052	0.406	0.553	0.625	0.249

Table 29 Continued. Observed (Obs) versus expected (Exp) standardized survey indices. SEs shown below include extra SD estimated (**Table 17**) and added to the input SE values for each year (**Table 16**).

Yr	Trawl Early (Obs)	Trawl Early (Exp)	Trawl Early (SE)	Trawl Late (Obs)	Trawl Late (Exp)	Trawl Late (SE)	Video (Obs)	Video (Exp)	Video (SE)
2014				0.930	1.455	0.358	0.648	0.707	0.221
2015				1.265	1.183	0.340	0.835	0.910	0.212
2016				0.479	0.936	0.406	1.231	1.056	0.182
2017				0.757	0.883	0.366	1.043	1.098	0.190
2018				0.985	1.381	0.354	1.013	1.107	0.200
2019				1.146	1.218	0.366	0.880	1.132	0.195
2020				0.781	1.069	0.433	1.820	1.823	0.283
2021				1.319	0.932	0.359	1.610	1.859	0.208
2022				1.863	0.921	0.355	1.776	1.799	0.200
2023				1.724	1.267	0.346	1.668	1.742	0.194
2024				0.670	0.713	0.393	1.242	1.682	0.193

Table 30. Summary of correlated parameters with correlation coefficients exceeding 0.7 for the SEDAR 100 AP Model.

Parameter 1	Parameter 2	Correlation
Size_DblN_ascend_se_Shrimp_Bycatch_4(4)	Size_DblN_peak_Shrimp_Bycatch_4(4)	0.870
Size_DblN_ascend_se_TrawlLate_7(7)	Size_DblN_peak_TrawlLate_7(7)	0.866
Retain_L_asymptote_logit_ComVL_2(2)_BLK3repl_2012	Retain_L_infl_ComVL_2(2)_BLK2repl_2009	0.850
Size_95%width_ComVL_2(2)_BLK4repl_2008	Size_inflection_ComVL_2(2)_BLK4repl_2008	0.823
Size_DblN_peak_Rec_1(1)_BLK4repl_2008	Size_DblN_ascend_se_Rec_1(1)	0.768
Retain_L_width_Rec_1(1)_BLK1repl_2009	Retain_L_infl_Rec_1(1)_BLK1repl_2009	0.752
Retain_L_width_ComVL_2(2)_BLK2repl_2009	Retain_L_infl_ComVL_2(2)_BLK2repl_2009	0.737
Size_95%width_ComVL_2(2)	Size_inflection_ComVL_2(2)	0.731
Size_DblN_peak_Video_8(8)_BLK5repl_2010	Size_DblN_ascend_se_Video_8(8)	0.720
Size_DblN_descend_se_Rec_1(1)_BLK4repl_2008	Size_DblN_peak_Rec_1(1)_BLK4repl_2008	-0.762
VonBert_K_Fem_GP_1	L_at_Amin_Fem_GP_1	-0.849
VonBert_K_Fem_GP_1	L_at_Amax_Fem_GP_1	-0.850
Size_DblN_descend_se_TrawlLate_7(7)	Size_DblN_top_logit_TrawlLate_7(7)	-0.855
Retain_L_width_ComVL_2(2)_BLK2repl_1999	Retain_L_infl_ComVL_2(2)_BLK2repl_1999	-0.881

Table 31. Retrospective analysis and retrospective forecast spawning stock biomass (SSB, metric tons) and fishing mortality (F, total biomass killed all ages / total biomass age 1+) for the last five terminal years and combined (grey rows) for the SEDAR 100 AP Model. N = number of observations to compute each statistic. Values within -0.15 to 0.2 are highlighted in green and are considered acceptable levels of retrospective bias. Values outside the acceptable range of -0.15 to 0.2 for longer-lived species (Hurtado-Ferro et al. 2015) are highlighted in red and indicate an undesirable retrospective pattern. See Carvalho et al. (2021) for additional details.

Quantity	Statistic	Value	N
SSB (-2023)	Mohn's Rho	0.043	1
SSB (-2022)	Mohn's Rho	-0.125	1
SSB (-2021)	Mohn's Rho	-0.064	1
SSB (-2020)	Mohn's Rho	-0.210	1
SSB (-2019)	Mohn's Rho	0.028	1
SSB (-Combined)	Mohn's Rho	-0.065	5
SSB (-2023)	Forecast bias	0.079	1
SSB (-2022)	Forecast bias	0.015	1
SSB (-2021)	Forecast bias	0.018	1
SSB (-2020)	Forecast bias	-0.219	1
SSB (-2019)	Forecast bias	0.051	1
SSB (-Combined)	Forecast bias	-0.011	5
F (-2023)	Mohn's Rho	-0.059	1
F (-2022)	Mohn's Rho	0.015	1
F (-2021)	Mohn's Rho	0.117	1
F (-2020)	Mohn's Rho	0.142	1
F (-2019)	Mohn's Rho	-0.240	1
F (-Combined)	Mohn's Rho	-0.005	5
F (-2023)	Forecast bias	-0.066	1
F (-2022)	Forecast bias	4.437	1
F (-2021)	Forecast bias	1.274	1
F (-2020)	Forecast bias	5.787	1
F (-2019)	Forecast bias	4.518	1
F (-Combined)	Forecast bias	3.190	5

Table 32. Joint residual summary statistics for the SEDAR 100 AP Model. N = number of observations to compute each statistic. RMSE = root mean squared error (as a percentage), with values above 30% for individual or joint residuals (grey rows) highlighted in red if present and acceptable values below 30% highlighted in green. See Carvalho et al. (2021) for additional details.

Quantity	Statistic	Value	N
Index			
Shrimp Effort	RMSE(%)	2.7	80
Recreational SRHS CPUE	RMSE(%)	32.3	22
Trawl Early Survey	RMSE(%)	69.4	22
Trawl Late Survey	RMSE(%)	37.1	16
Combined Video Survey	RMSE(%)	29.4	27
Combined	RMSE(%)	32.3	167
Conditional Age-at-Length			
Recreational	RMSE(%)	8.9	21
Commercial Vertical Line	RMSE(%)	11.5	17
Commercial Longline	RMSE(%)	12.3	14
Combined	RMSE(%)	10.8	52
Length			
Recreational	RMSE(%)	1.6	44
Commercial Vertical Line	RMSE(%)	4.4	35
Commercial Longline	RMSE(%)	5	24
Shrimp Bycatch	RMSE(%)	17.1	40
Trawl Early Survey	RMSE(%)	10.8	22
Trawl Late Survey	RMSE(%)	17.1	16
Combined Video Survey	RMSE(%)	8.7	23
Combined	RMSE(%)	10.4	204

Table 33. Runs tests summary statistics for the SEDAR 100 AP Model. N = number of observations to compute each statistic. P-values greater than 0.05% (in green) provide support for randomly distributed residuals whereas p-values less than 0.05% (in red) indicate non-randomly distributed residuals. See Carvalho et al. (2021) for additional details.

Quantity	Statistic	Value	N
Index			
Shrimp Effort	p-value	0	80
Recreational SRHS CPUE	p-value	0.042	22
Trawl Early Survey	p-value	0.042	22
Trawl Late Survey	p-value	0.203	16
Combined Video Survey	p-value	0.002	27
Conditional Age-at-Length			
Recreational	p-value	0.066	14
Commercial Vertical Line	p-value	0.047	17
Commercial Longline	p-value	0.658	21
Length			
Recreational	p-value	0	44
Commercial Vertical Line	p-value	0.002	35
Commercial Longline	p-value	0.89	24
Shrimp Bycatch	p-value	0.001	40
Trawl Early Survey	p-value	0.036	22
Trawl Late Survey	p-value	0.609	16
Combined Video Survey	p-value	0.619	23

Table 34. Hindcast cross-validation summary statistics for the SEDAR 100 AP Model. N = number of observations to compute each statistic. MASE = mean absolute scaled error, with individual or joint values (grey rows) < 1 (in green) indicative of superior prediction skill over a naïve baseline forecast (random walk) and values > 1 (in red) indicative of poor prediction skill. See Carvalho et al. (2021) for additional details.

Quantity	Statistic	Value	N
Index			
Shrimp Effort	MASE	43.21	5
Recreational SRHS CPUE	MASE		0
Trawl Early Survey	MASE		0
Trawl Late Survey	MASE	2.061	5
Combined Video Survey	MASE	2.796	5
Joint	MASE	9.332	15
Length			
Recreational	MASE	1.148	5
Commercial Vertical Line	MASE	0.778	5
Commercial Longline	MASE	0.836	3
Shrimp Bycatch	MASE	5.711	4
Trawl Early Survey	MASE		0
Trawl Late Survey	MASE	0.92	5
Combined Video Survey	MASE	2.758	5
Joint	MASE	1.483	27

Table 35. Summary of key model building steps towards the SEDAR 100 AP Model and associated convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation). Note that steps within each model progression are not shown due to the vast number of intermediate runs conducted.

Model Name	Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
1_SEDAR43	SEDAR 43 Base Model	225	0.0331	410 (0)	28
2_SEDAR43_3.3	SEDAR 43 Base Model converted to 3.30.21	225	0.0035	411 (0)	28
3_Continuity	Step 2 + update all data streams (except age composition)	313	0.0019	477 (1)	22
4_3+UpdatedAge	Step 3 + updated age data	920	11.4730	467 (3)	24
5_4+LengthData&Sel	Step 4 + use length data & length-based selectivity	12,679	247.005	489 (3)	34
6_5+UpdateM	Step 5 + update natural mortality	12,647	0.4127	489 (1)	36
7_6+UpdateGrowth	Step 6 + update growth	10,880	0.0403	489 (2)	26
8_7+ShrimpSel	Step 7 + estimate length-based selectivity for shrimp	10,630	0.6675	495 (2)	32
9_8+DiscMort	Step 8 + update discard mortality to 40%	10,643	0.3269	495 (2)	31
10_9+TVRetention	Step 9 + allow time-varying retention parameters	9,287	0.2434	515 (2)	30
11_10+CAAL	Step 10 + switch to conditional age-at-length	15,696	0.6513	515 (2)	25
12_11+EstGrowth (priors)	Step 11 + estimate Growth (priors on L_{Amin}, $L\infty$, and K)	14,820	0.2044	520 (0)	25
13_12+SepLongline	Step 12 + separate commercial longline	15,922	0.0660	568 (0)	26
14_13+CollapseFleets	Step 13 + collapse fleets-as-areas	13,819	0.0203	382 (0)	22
15_14+DiscNums	Step 14 + fit to discards in numbers	14,112	0.0280	382 (1)	20

Table 35 Continued. Summary of key model building steps towards the SEDAR 100 AP Model and associated convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation). Note that steps within each model progression are not shown due to the vast number of intermediate runs conducted.

Model Name	Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
16_15+TVRecSel	Step 15 + fit time-varying recreational selectivity (peak)	14,074	0.0413	383 (2)	18
17_16+TVComVL Sel	Step 16 + fit time-varying commercial vertical line selectivity (inflection)	13,987	0.1617	380 (1)	21
18_17+TVComLLSel	Step 17 + fit time-varying commercial longline selectivity (inflection)	13,892	0.0152	381 (2)	18
19_18+ExtraSD Indices	Step 18 + estimate extra SD for indices of abundance	13,536	0.0253	384 (0)	22
20_19+FixSteep0.99	Step 19 + fix steepness as 0.99	13,543	0.0617	383 (0)	18
21_20+FixSigmaR0.6	Step 20 + fix SigmaR at 0.6	13,551	0.0380	382 (0)	15
22_21+RecDevSum Zero	Step 21 + constrain recruitment deviations to sum to 0	13,654	0.1010	382 (0)	23
23_22+TVVideoSel	Step 22 + time-varying video selectivity (peak)	13,503	0.0384	256 (0)	18
24_23+EstBase RecRet	Step 23 + estimate base recreational retention	13,768	0.0023	261 (0)	19
25_24+CapRec LandingsSE	Step 24 + cap large recreational landings SE	13,788	0.0858	261 (0)	18
26_25+TVRecSel (other)	Step 25 + time-varying recreational retention (estimate other parameters)	13,715	0.0127	270 (1)	20
27_26+TVComSel (other)	Step 26 + time-varying commercial retention (estimate other parameters)	13,652	0.0055	272 (0)	21
28_27+EstGrowth (no_priors)	Step 27 + estimate growth without priors	13,582	0.0054	268 (0)	20

Table 36. Summary of key model building steps towards the SEDAR 100 AP Model and associated key estimates and derived quantities. ln(R_0) = virgin recruitment (log-scale), SSB defined in number of eggs for steps 1-7 and metric tons (mt) thereafter, Recr = recruitment. SSB ratio was calculated as annual SSB divided by SSB_0. Note that steps within each model progression are not shown due to the vast number of intermediate runs conducted.

Model Name	Steep-ness	*SigmaR*	ln(R_0)	Virgin SSB	Virgin Recr (1,000s)	SSB ratio Start	SSB ratio End
1_SEDAR43	0.46	0.36	9.76	3.24E+10	17,340	1	0.19
2_SEDAR43_3.3	0.46	0.36	9.76	3.24 E+10	17,340	1	0.19
3_Continuity	1.00	0.40	9.67	2.97 E+10	15,898	1	0.99
4_3+UpdatedAge	0.48	0.81	10.72	8.42 E+10	45,025	1	1.19
5_4+LengthData&Sel	0.99	0.42	8.97	1.47 E+10	7,876	1	0.73
6_5+UpdateM	1.00	0.42	9.15	1.51 E+10	9,426	1	0.80
7_6+UpdateGrowth	0.36	0.57	10.81	2.69 E+10	49,306	1	0.42
8_7+ShrimpSel	0.35	0.45	11.06	27,075	63,531	1	0.33
9_8+DiscMort	0.40	0.43	11.08	27,648	64,876	1	0.43
10_9+TVRetention	0.52	0.44	10.50	15,505	36,383	1	0.50
11_10+CAAL	0.52	0.38	10.50	15,439	36,228	1	0.50
12_11+EstGrowth (priors)	0.59	0.36	10.78	12,103	48,210	1	0.60
13_12+SepLongline	0.52	0.39	11.11	15,143	66,941	1	0.58
14_13+CollapseFleets	0.42	0.43	11.38	20,042	87,242	1	0.43
15_14+DiscNums	0.47	0.42	11.25	17,736	76,597	1	0.54
16_15+TVRecSel	0.43	0.46	11.43	20,383	92,394	1	0.50
17_16+TVComVLSel	0.40	0.46	11.46	21,819	94,744	1	0.44

Table 36 Continued. Summary of key model building steps towards the SEDAR 100 AP Model and associated key estimates and derived quantities. ln(R_0) = virgin recruitment (log-scale), SSB defined in number of eggs for steps 1-7 and metric tons (mt) thereafter, Recr = recruitment. SSB ratio was calculated as annual SSB divided by SSB_0. Note that steps within each model progression are not shown due to the vast number of intermediate runs conducted.

Model Name	Steep-ness	*SigmaR*	ln(R_0)	Virgin SSB	Virgin Recr (1,000s)	SSB ratio Start	SSB ratio End
18_17+TVComLLSel	0.41	0.54	12.14	22,164	187,007	1	0.41
19_18+ExtraSDIndices	0.39	0.50	11.57	23,864	105,541	1	0.29
20_19+FixSteep0.99	0.99	0.83	11.26	17,250	77,877	1	0.47
21_20+FixSigmaR0.6	0.99	0.60	11.05	14,260	62,683	1	0.56
22_21+RecDevSumZero	0.99	0.60	10.82	11,166	49,778	1	0.82
23_22+TVVideoSel	0.99	0.60	11.09	11,529	65,174	1	0.67
24_23+EstBaseRecRet	0.99	0.60	11.04	10,738	62,462	1	0.61
25_24+CapRecLandings SE	0.99	0.60	11.04	10,674	62,291	1	0.62
26_25+TVRecSel(other)	0.99	0.60	11.00	10,420	60,023	1	0.59
27_26+TVComSel (other)	0.99	0.60	11.02	10,206	61,230	1	0.60
28_27+EstGrowth (no_priors)	0.99	0.60	11.47	8,817	95,744	1	0.55

Table 37. Summary of sensitivity runs conducted for the SEDAR 100 AP Model and associated convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation).

Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
SEDAR 100 AP Model	13,582	0.0054	268 (0)	20
Recreational Removals				
Replace uncertain landings estimates	13,572	0.0472	268 (0)	20
Exclude uncertain discard estimates	13,577	0.0024	268 (0)	20
Reduce removals by 40%	13,590	0.0008	268 (0)	18
Use landings log-scale SE as provided	13,565	0.0003	268 (0)	19
Landings log-scale SE of 0.05	13,717	0.1407	268 (0)	21
Discard Mortality				
26% for all fleets	13,585	0.1634	268 (0)	19
60% for all fleets	13,580	0.0267	268 (0)	20
Shrimp Bycatch				
None	13,695	0.0147	187 (0)	21
Reduced by 50%	13,574	0.1710	268 (0)	18
Fit to super-period of 1984-2023	13,578	0.0379	268 (0)	19
Jackknife Indices				
No Recreational (SRHS) CPUE	13,594	0.0248	268 (0)	20
No Trawl Early Survey	13,579	0.0055	268 (0)	23
No Trawl Late Survey	13,589	0.0207	268 (0)	19
No Video Survey	13,589	0.0213	268 (0)	14

Table 37 Continued. Summary of sensitivity runs conducted for the SEDAR 100 AP Model and associated convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation).

Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
Platoons				
Estimate 3 platoons	13,627	0.0756	268 (0)	26
Estimate 5 platoons	13,534	0.0293	268 (0)	21
Steepness				
Estimate steepness without prior	13,559	0.0409	269 (0)	17
Fishing Mortality				
Estimate annual Fs for all fleets and use uncertainty estimates	13,581	0.1651	394 (0)	20
Age-structured Production Model				
No recruitment deviations	1,794	0.0000	2 (0)	0
With recruitment deviations	619	0.0000	46 (0)	9
Combining Dead Discards and Landings				
Lumped dead discards and landings	13,341	0.0047	254 (0)	23
Start Year				
Start 1963	13,610	0.0126	235 (1)	21
Start 1981	13,624	0.0002	200 (1)	20

Table 38. Summary of sensitivity runs conducted for the SEDAR 100 AP Model and associated key estimates and derived quantities. ln(R_0) = virgin recruitment (log-scale), SSB defined in metric tons (mt), Recr = recruitment. SSB ratio was calculated as annual SSB divided by SSB_0.

Description	Steep-ness	*SigmaR*	ln(R_0)	Virgin SSB (mt)	Virgin Recr (1,000s)	SSB ratio Start	SSB ratio End
SEDAR 100 AP Model	0.99	0.6	11.47	8,817	95,744	1	0.55
Recreational Removals							
Replace uncertain landings estimates	0.99	0.6	11.47	8,867	96,018	1	0.55
Exclude uncertain discard estimates	0.99	0.6	11.47	8,822	95,808	1	0.56
Reduce removals by 40%	0.99	0.6	11.13	6,310	68,118	1	0.53
Use landings log-scale SE as provided	0.99	0.6	11.47	8,812	95,334	1	0.55
Landings log-scale SE of 0.05	0.99	0.6	11.59	9,792	108,419	1	0.56
Discard Mortality							
26% for all fleets	0.99	0.6	11.37	8,117	86,511	1	0.53
60% for all fleets	0.99	0.6	11.58	9,733	107,441	1	0.57
Shrimp Bycatch							
None	0.99	0.6	11.13	6,327	68,322	1	0.61
Reduced by 50%	0.99	0.6	11.33	7,712	83,569	1	0.57
Fit to super-period of 1984-2023	0.99	0.6	11.39	8,182	88,786	1	0.56
Jackknife Indices							
No Recreational (SRHS) CPUE	0.99	0.6	11.47	8,829	95,689	1	0.54
No Trawl Early Survey	0.99	0.6	11.47	8,850	96,200	1	0.55
No Trawl Late Survey	0.99	0.6	11.44	8,583	93,172	1	0.47
No Video Survey	0.99	0.6	11.55	9,614	104,014	1	0.85

Table 38 Continued. Summary of sensitivity runs conducted for the SEDAR 100 AP Model and associated key estimates and derived quantities. ln(R_0) = virgin recruitment (log-scale), SSB defined in metric tons (mt), Recr = recruitment. SSB ratio was calculated as annual SSB divided by SSB_0.

Description	Steep-ness	*SigmaR*	ln(R_0)	Virgin SSB (mt)	Virgin Recr (1,000s)	SSB ratio Start	SSB ratio End
Platoons							
Estimate 3 platoons	0.990	0.6	11.42	8,872	90,778	1.00	0.32
Estimate 5 platoons	0.990	0.6	11.46	8,861	95,052	1.00	0.25
Steepness							
Estimate steepness without prior	0.422	0.6	12.29	19,799	217,028	1.00	0.18
Fishing Mortality							
Estimate annual Fs for all fleets and use uncertainty estimates	0.990	0.6	11.47	8,816	95,747	1.00	0.55
Age-structured Production Model							
No recruitment deviations	0.990	0.6	11.41	8,323	90,373	1.00	0.51
With recruitment deviations	0.990	0.6	11.49	8,983	97,546	1.00	0.59
Combining Dead Discards and Landings							
Lumped dead discards and landings	0.990	0.6	11.71	11,270	121,679	1.00	0.55
Start Year							
Start 1963	0.990	0.6	11.46	8,706	94,511	0.28	0.55
Start 1981	0.990	0.6	11.42	8,317	90,774	0.79	0.52

Table 39. Settings used for projections.

Parameter	Value	Comment
Relative *F*		Not used due to allocations below
Selectivity	Average from 2022-2024	Fleet specific selectivity estimated over terminal three years of model
Retention	Average from 2022-2024	Fleet specific retention estimated over terminal three years of model
Recruitment	Average recruitment	Derived from the Beverton-Holt stock-recruit relationship with steepness fixed at 0.99
Interim Landings (2025-2027)	201.64 numbers (Recreational); 19.33 metric tons (Commercial Vertical Line); 3.62 metric tons (Commercial Longline)	For 2025 through 2027, used 3-year average of landings (2022-2024)
Shrimp bycatch *F*	0.034	Average F over 2022-2024
Allocation Ratio	21:79	Commercial:Recreational

Table 40. Summary of Magnuson-Stevens Reauthorization Act benchmarks and reference points **assuming mean recruitment (i.e., steepness fixed at 0.99) throughout the projection period**. Spawning Stock Biomass (SSB) is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2**).

Criteria	Definition	Value
Base *M*	Target *M* for fully selected ages in the Lorenzen scaling	0.36
Steepness	Steepness of the Beverton-Holt stock-recruit relationship (fixed)	0.99
Unfished Recruitment (R_0)	Unfished recruitment (1,000s)	95,750
Generation Time	Fecundity-weighted mean age	7.12
Unfished SSB (SSB_0)	Unfished spawning stock biomass (metric tons)	8,816
	Mortality Rate Criteria	
$F_{MSYproxy}$	Equilibrium *F* that achieves SPR30%	0.567
MFMT	$F_{MSYproxy}$	0.567
$F_{Current}$	Geometric mean of the last 3 years of the assessment ($F_{2022-2024}$), including shrimp bycatch fleet	0.214
$F_{Current}$/MFMT	Current stock status based on MFMT	0.377
	Biomass Criteria	
$SSB_{MSYproxy}$	Equilibrium SSB at $F_{SPR\ 30\ \%}$	2,629
MSST	0.5 * $SSB_{SPR30\%}$	1,315
$SSB_{Current}$	SSB in 2024	4,849
$SSB_{Current}/SSB_{FMSYproxy}$	Current stock status based on $SSB_{SPR30\%}$ (Equil)	1.84
$SSB_{Current}$/MSST	Current stock status based on MSST	3.69
$SSB_{Current}/SSB_0$	SSB ratio in 2024	0.55

Table 41. Comparison of equilibrium yield (million pounds whole weight) estimated from previous Gray Triggerfish assessments, the SEDAR 100 AP Model, and the two sensitivity runs which reduced recreational removals by 40% (to mimic the MRIP-FES pilot study results; Andrews 2022) and excluded shrimp bycatch. The type of assessment model used is also provided for context.

Assessment (Reference)	Model	Yield
SEDAR 9 (SEDAR 2006)	State Space Age-Structured Production Model (SS-ASPM)	1.638
SEDAR 9 Update (SEDAR 2011)	State Space Age-Structured Production Model (SS-ASPM)	0.984
SEDAR 43 (SEDAR 2015)	Stock Synthesis	2.230
SEDAR 100 AP Model	Stock Synthesis	1.014
SEDAR 100 Sensitivity Runs		
Reduced Recreational Removals by 40%	Stock Synthesis	0.718
No Shrimp Bycatch	Stock Synthesis	0.785

Table 42. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming mean recruitment (i.e., steepness fixed at 0.99) throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include $F_{30\%SPR}$ = 0.567, $SSB_{F30\%SPR}$ = 2,629 metric tons, and $MSST_{F30\%SPR}$ = 1,315 metric tons which was calculated as (0.5) * $SSB_{F30\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 8,816 metric tons. Red indicates overfishing and/or overfished states if present. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2**).

Year	F	$F/F_{30\%SPR}$	SSB	$SSB/SSB_{30\%SPR}$	SSB/MSST	SSB ratio
1945	0.000	0.000	8,816	3.353	6.706	1.000
1946	0.006	0.010	8,815	3.353	6.705	1.000
1947	0.011	0.020	8,767	3.334	6.669	0.994
1948	0.017	0.029	8,678	3.300	6.601	0.984
1949	0.022	0.039	8,553	3.253	6.506	0.970
1950	0.028	0.049	8,398	3.194	6.388	0.953
1951	0.034	0.060	8,222	3.127	6.254	0.933
1952	0.042	0.074	8,025	3.052	6.104	0.910
1953	0.047	0.082	7,804	2.968	5.936	0.885
1954	0.053	0.093	7,587	2.886	5.771	0.861
1955	0.059	0.105	7,368	2.802	5.605	0.836
1956	0.065	0.114	7,146	2.718	5.436	0.811
1957	0.071	0.126	6,931	2.636	5.272	0.786
1958	0.078	0.138	6,718	2.555	5.110	0.762
1959	0.085	0.150	6,506	2.475	4.949	0.738
1960	0.093	0.164	6,299	2.396	4.791	0.714
1961	0.083	0.147	6,094	2.318	4.635	0.691
1962	0.092	0.161	6,003	2.283	4.566	0.681
1963	0.099	0.174	5,896	2.242	4.485	0.669
1964	0.105	0.186	5,773	2.196	4.391	0.655

Table 42 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming mean recruitment (i.e., steepness fixed at 0.99) throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include $F_{30\%SPR}$ = 0.567, $SSB_{F30\%SPR}$ = 2,629 metric tons, and $MSST_{F30\%SPR}$ = 1,315 metric tons which was calculated as (0.5) * $SSB_{F30\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 8,816 metric tons. Red indicates overfishing and/or overfished states if present. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2**).

Year	F	$F/F_{30\%SPR}$	SSB	$SSB/SSB_{30\%SPR}$	SSB/MSST	SSB ratio
1965	0.103	0.182	5,640	2.145	4.290	0.640
1966	0.103	0.182	5,555	2.113	4.226	0.630
1967	0.112	0.197	5,500	2.092	4.183	0.624
1968	0.115	0.204	5,413	2.059	4.117	0.614
1969	0.126	0.223	5,327	2.026	4.052	0.604
1970	0.122	0.215	5,201	1.978	3.956	0.590
1971	0.131	0.231	5,135	1.953	3.906	0.582
1972	0.148	0.261	5,049	1.920	3.840	0.573
1973	0.151	0.267	4,905	1.865	3.731	0.556
1974	0.158	0.279	4,788	1.821	3.642	0.543
1975	0.160	0.283	4,678	1.779	3.559	0.531
1976	0.168	0.296	4,606	1.752	3.504	0.522
1977	0.168	0.296	4,523	1.720	3.441	0.513
1978	0.176	0.310	4,457	1.695	3.390	0.506
1979	0.180	0.318	4,362	1.659	3.318	0.495
1980	0.159	0.281	4,268	1.623	3.247	0.484
1981	0.138	0.243	4,301	1.636	3.271	0.488
1982	0.199	0.351	4,400	1.673	3.347	0.499
1983	0.160	0.281	4,983	1.895	3.791	0.565
1984	0.094	0.165	5,123	1.948	3.897	0.581

Table 42 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming mean recruitment (i.e., steepness fixed at 0.99) throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include $F_{30\%SPR}$ = 0.567, $SSB_{F30\%SPR}$ = 2,629 metric tons, and $MSST_{F30\%SPR}$ = 1,315 metric tons which was calculated as (0.5) * $SSB_{F30\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 8,816 metric tons. Red indicates overfishing and/or overfished states if present. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2**).

Year	F	$F/F_{30\%SPR}$	SSB	$SSB/SSB_{30\%SPR}$	SSB/MSST	SSB ratio
1985	0.121	0.213	5,020	1.909	3.819	0.569
1986	0.180	0.317	4,537	1.726	3.451	0.515
1987	0.237	0.418	4,003	1.523	3.045	0.454
1988	0.231	0.408	3,533	1.344	2.687	0.401
1989	0.278	0.490	3,898	1.482	2.965	0.442
1990	0.356	0.628	4,217	1.604	3.207	0.478
1991	0.287	0.505	3,775	1.436	2.871	0.428
1992	0.331	0.584	3,617	1.376	2.751	0.410
1993	0.440	0.777	3,038	1.155	2.311	0.345
1994	0.282	0.498	2,633	1.001	2.003	0.299
1995	0.291	0.513	2,746	1.044	2.088	0.311
1996	0.215	0.379	2,672	1.016	2.032	0.303
1997	0.197	0.348	2,957	1.125	2.250	0.335
1998	0.308	0.543	3,096	1.178	2.355	0.351
1999	0.269	0.474	2,724	1.036	2.072	0.309
2000	0.204	0.360	2,707	1.029	2.059	0.307
2001	0.196	0.346	3,066	1.166	2.332	0.348
2002	0.311	0.548	3,277	1.246	2.493	0.372
2003	0.327	0.576	3,084	1.173	2.346	0.350
2004	0.367	0.647	2,821	1.073	2.146	0.320

Table 42 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming mean recruitment (i.e., steepness fixed at 0.99) throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include $F_{30\%SPR}$ = 0.567, $SSB_{F30\%SPR}$ = 2,629 metric tons, and $MSST_{F30\%SPR}$ = 1,315 metric tons which was calculated as (0.5) * $SSB_{F30\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 8,816 metric tons. Red indicates overfishing and/or overfished states if present. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2**).

Year	F	$F/F_{30\%SPR}$	SSB	$SSB/SSB_{30\%SPR}$	SSB/MSST	SSB ratio
2005	0.296	0.522	2,427	0.923	1.846	0.275
2006	0.242	0.427	2,225	0.846	1.693	0.252
2007	0.291	0.513	2,149	0.817	1.635	0.244
2008	0.243	0.429	2,097	0.798	1.595	0.238
2009	0.160	0.282	2,370	0.901	1.803	0.269
2010	0.216	0.381	2,682	1.020	2.040	0.304
2011	0.249	0.438	2,884	1.097	2.194	0.327
2012	0.211	0.372	2,834	1.078	2.156	0.321
2013	0.423	0.747	3,006	1.143	2.287	0.341
2014	0.117	0.206	2,955	1.124	2.248	0.335
2015	0.132	0.232	4,100	1.559	3.119	0.465
2016	0.212	0.374	4,812	1.830	3.660	0.546
2017	0.224	0.396	4,809	1.829	3.658	0.546
2018	0.209	0.368	4,565	1.736	3.473	0.518
2019	0.185	0.327	4,853	1.846	3.691	0.550
2020	0.189	0.334	5,113	1.945	3.889	0.580
2021	0.169	0.299	5,155	1.961	3.922	0.585
2022	0.230	0.405	5,058	1.924	3.847	0.574
2023	0.202	0.356	4,693	1.785	3.570	0.532
2024	0.210	0.371	4,849	1.844	3.688	0.550

Table 43. Results of the OFL projection (fishing set at $F_{30\%SPR}$) **assuming mean recruitment (i.e., steepness fixed at 0.99) throughout the projection period**. Recruitment (Recr) is in 1,000s of age-0 fish, *F* is a harvest rate (total biomass killed all ages / total biomass age 1+), SSB is in metric tons, and OFL is the overfishing limit in millions of pounds whole weight. Reference points include $F_{30\%SPR}$ = 0.567, $SSB_{F30\%SPR}$ = 2,629 metric tons, and $MSST_{F30\%SPR}$ = 1,315 metric tons which was calculated as (0.5) * $SSB_{F30\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 8,816 metric tons. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2**).

Year	Recr	F	$F/F_{30\%SPR}$	SSB	$SSB/SSB_{30\%SPR}$	SSB/ MSST	SSB ratio	OFL
2028	95,511	0.567	1	4,463	1.697	3.394	0.506	2.081
2029	95,373	0.567	1	3,456	1.314	2.629	0.392	1.522
2030	95,275	0.567	1	2,978	1.133	2.265	0.338	1.236
2031	95,222	0.567	1	2,770	1.053	2.107	0.314	1.104
2032	95,198	0.567	1	2,686	1.021	2.043	0.305	1.050
2033	95,188	0.567	1	2,653	1.009	2.018	0.301	1.029

Table 44. Results of the ABC projection (directed *F* = 0.75 * Directed *F* at $F_{30\%SPR}$ (0.567)) **assuming mean recruitment (i.e., steepness fixed at 0.99) throughout the projection period**. Recruitment (Recr) is in 1,000s of age-0 fish, *F* is a harvest rate (total biomass killed all ages / total biomass age 1+), SSB is in metric tons, and yield in millions of pounds whole weight. Reference points include $F_{30\%SPR}$ = 0.567, $SSB_{F30\%SPR}$ = 2,629 metric tons, and $MSST_{F30\%SPR}$ = 1,315 metric tons which was calculated as (0.5) * $SSB_{F30\%SPR}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 8,816 metric tons. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2**).

Year	Recr	F	$F/F_{30\%SPR}$	SSB	$SSB/SSB_{30\%SPR}$	SSB/ MSST	SSB ratio	Yield
2028	95,511	0.425	0.75	4,463	1.697	3.394	0.506	1.571
2029	95,437	0.425	0.75	3,861	1.468	2.937	0.438	1.322
2030	95,383	0.425	0.75	3,511	1.335	2.671	0.398	1.166
2031	95,348	0.425	0.75	3,321	1.263	2.526	0.377	1.075
2032	95,330	0.425	0.75	3,226	1.227	2.454	0.366	1.026
2033	95,320	0.425	0.75	3,180	1.210	2.419	0.361	1.003

11. Figures

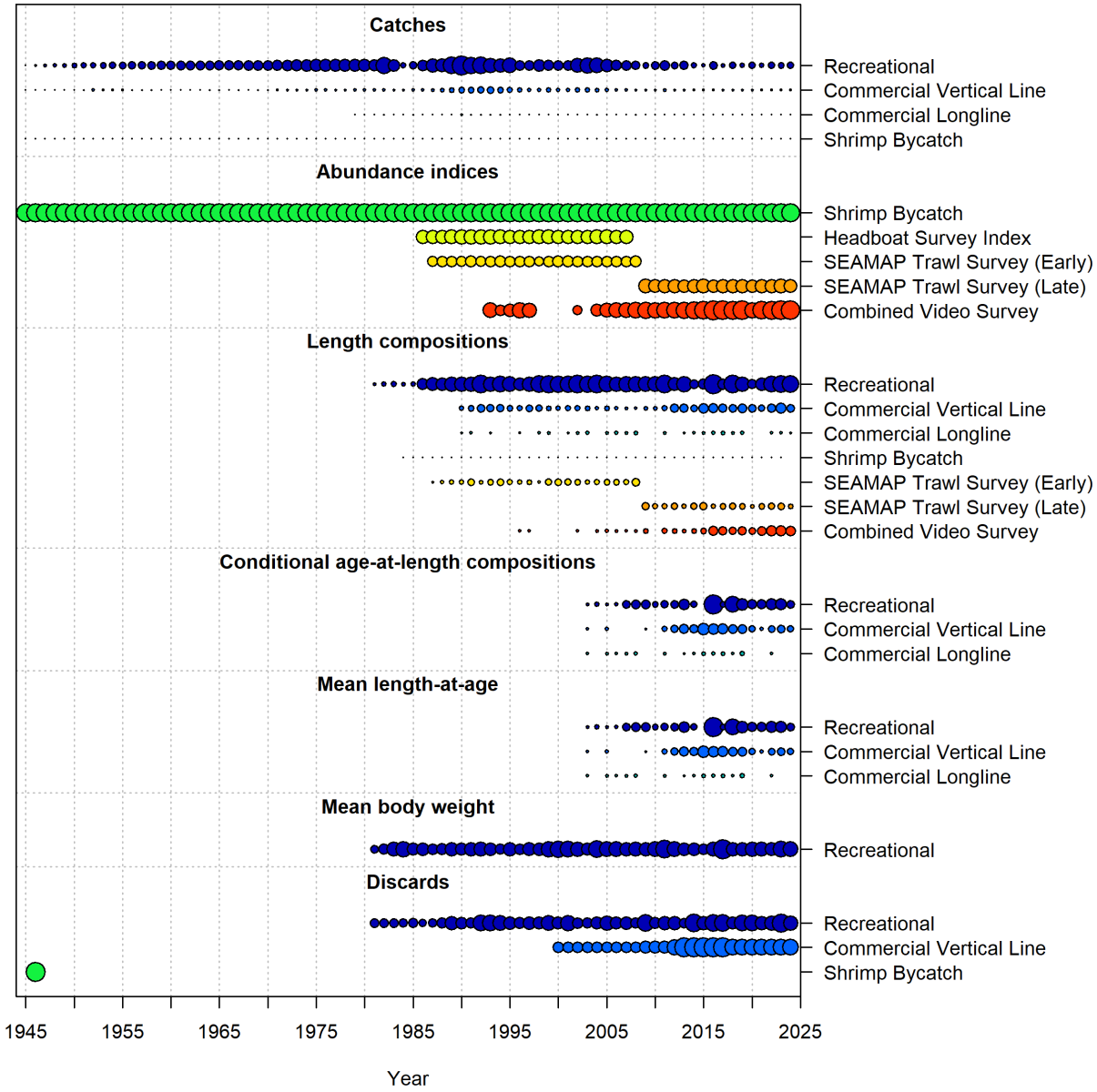


Figure 1. Data sources used in the Stock Synthesis assessment model. Circle area is relative within a data type. Circles are proportional to total catch for catches; to precision for indices, discards, and mean body weight observations; and to total sample size for compositions or mean length-at-age observations. Note that since the circles are scaled relative to the maximum within each type, the scaling between separate data types should not be compared. Shrimp bycatch estimates were aggregated and input using the super-period approach.

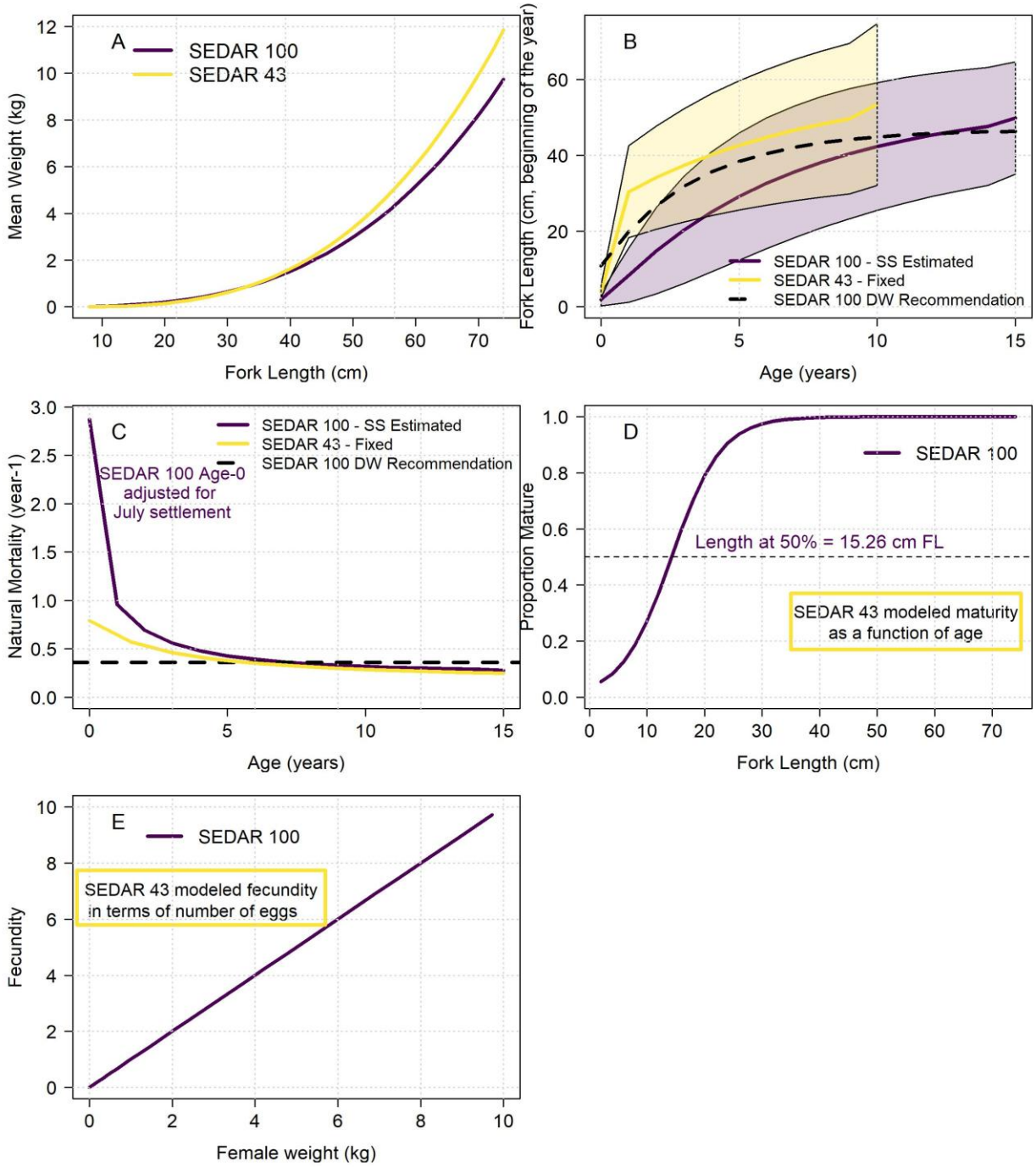


Figure 2. Comparison of life history relationships between SEDAR 100 and SEDAR 43. (A) mean weight-at-length, (B) recommended (SEDAR 100) and estimated growth curves (shaded area indicates the 95% distribution of length-at-age), (C) recommended point estimate (SEDAR 100) and natural mortality-at-age vectors, (D) maturity-at-length, and (E) fecundity at weight.

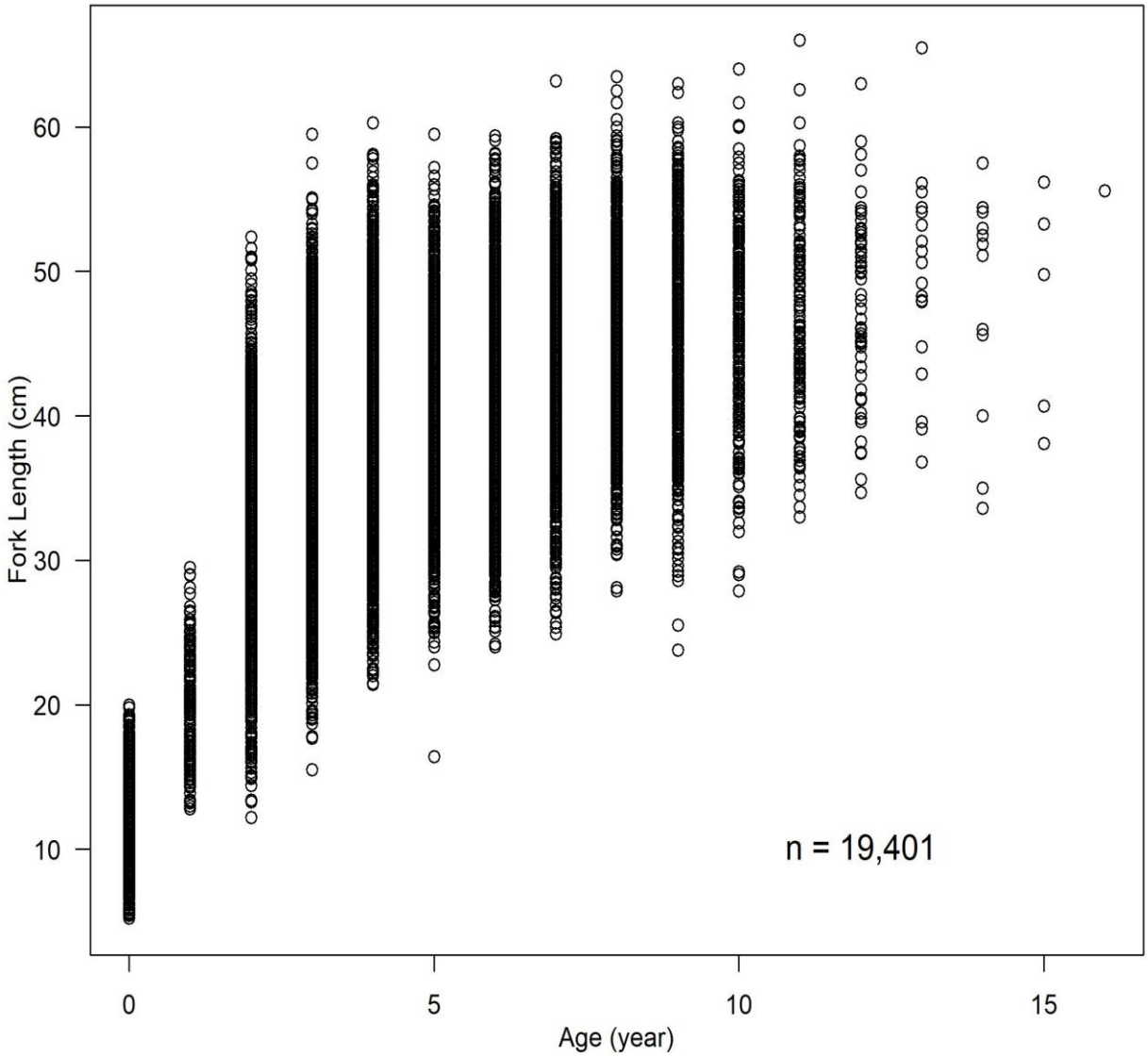


Figure 3. Scatterplot of age (year) versus Fork Length (cm) for age samples collected from 1999 to 2024. No age samples were collected in 2001. Age samples were updated as described in ***Section 2.2.2****, and data prior to this update can be found in* ***Figure 3 of SEDAR100-DW14****.*

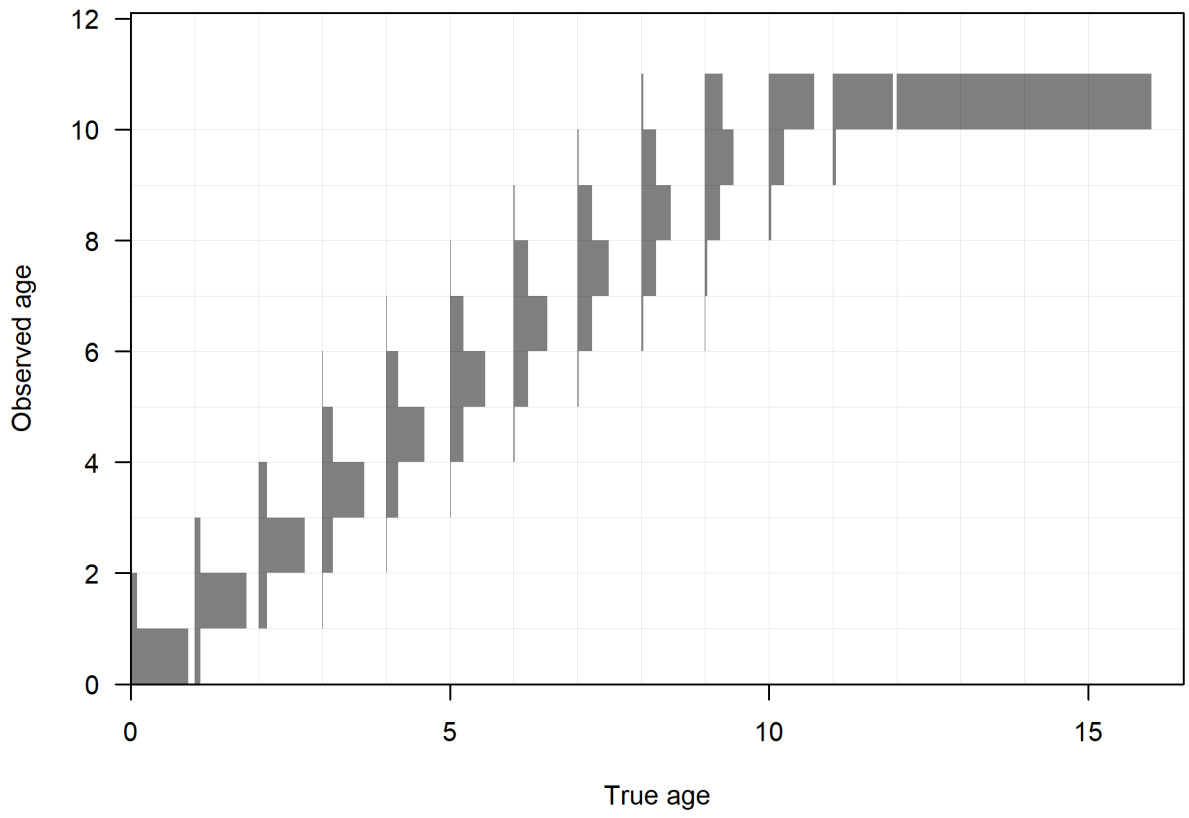


Figure 4. Distribution of observed age at true age for the ageing error matrix developed for the SEDAR 100 Assessment.

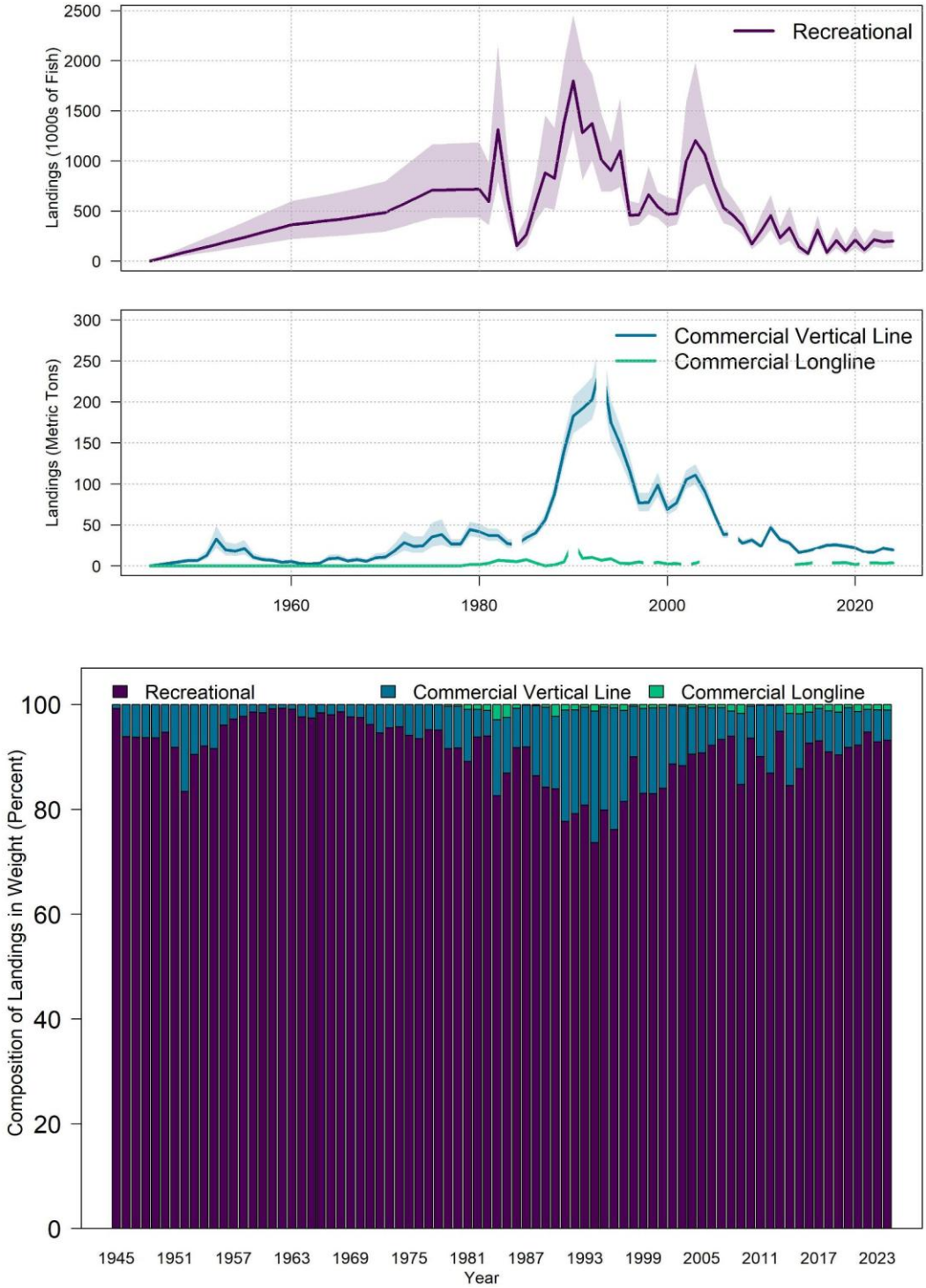


Figure 5. Observed landings by fleet (with associated error estimates) and by percent (by weight based on landings expected by Stock Synthesis). Commercial landings are input into the stock assessment model in units of metric tons. Recreational landings are shown and input in numbers (1,000s of fish). Confidential data have been excluded.

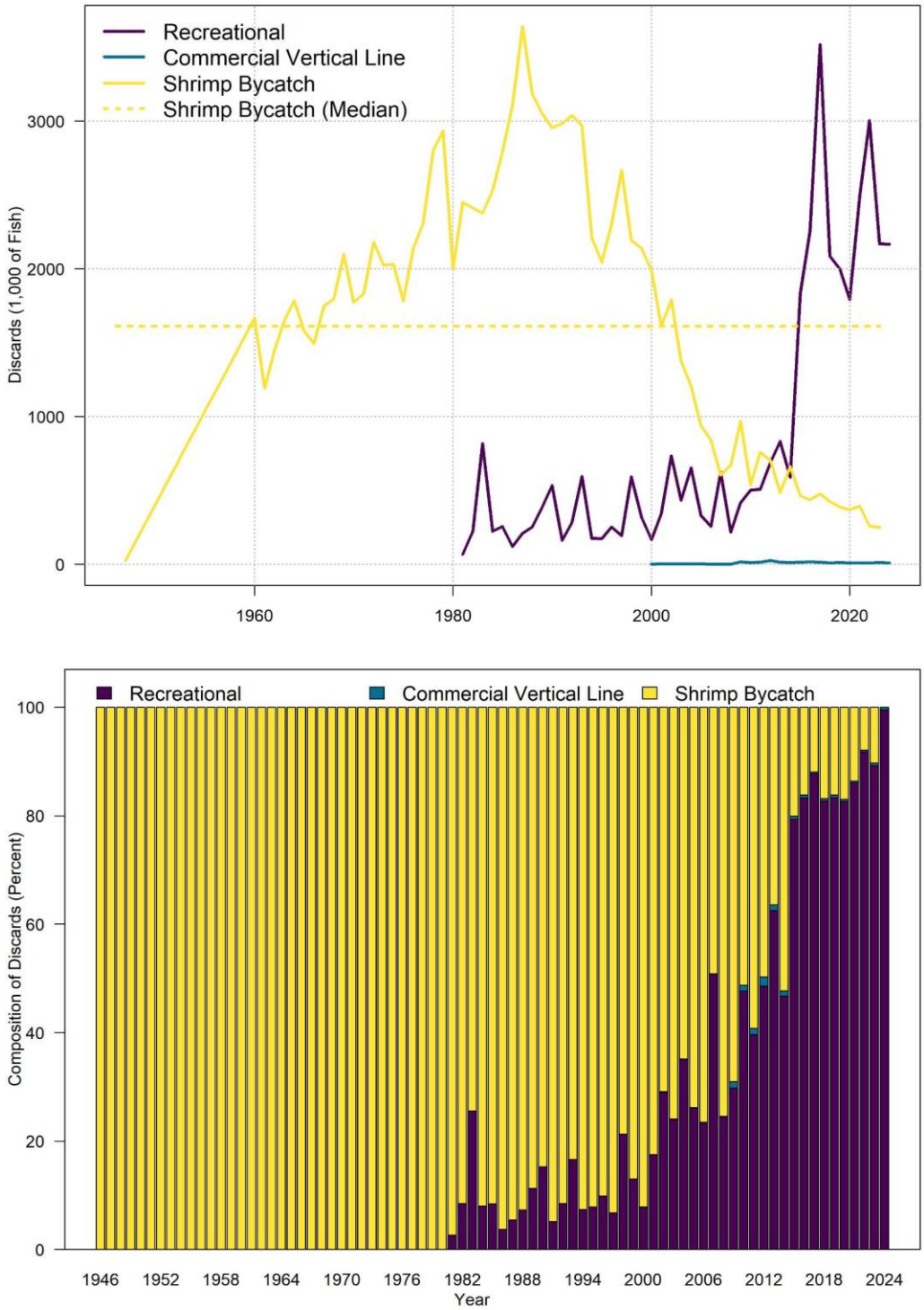


Figure 6. Observed discards by fleet and by percent. Recreational, commercial, and shrimp bycatch discards are all in numbers of fish (1,000s of fish).

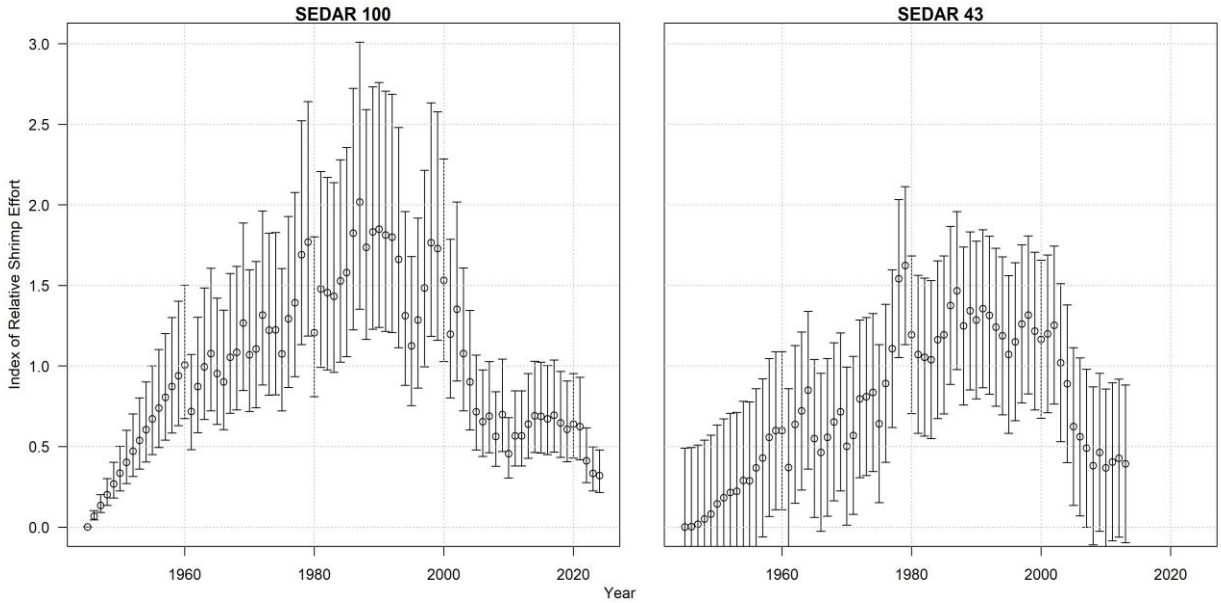


Figure 7. Comparison of the shrimp effort time series used in SEDAR 100 (assumed a lognormal distribution) and SEDAR 43 (assumed a normal distribution). Both time series have been scaled to a mean of 1.

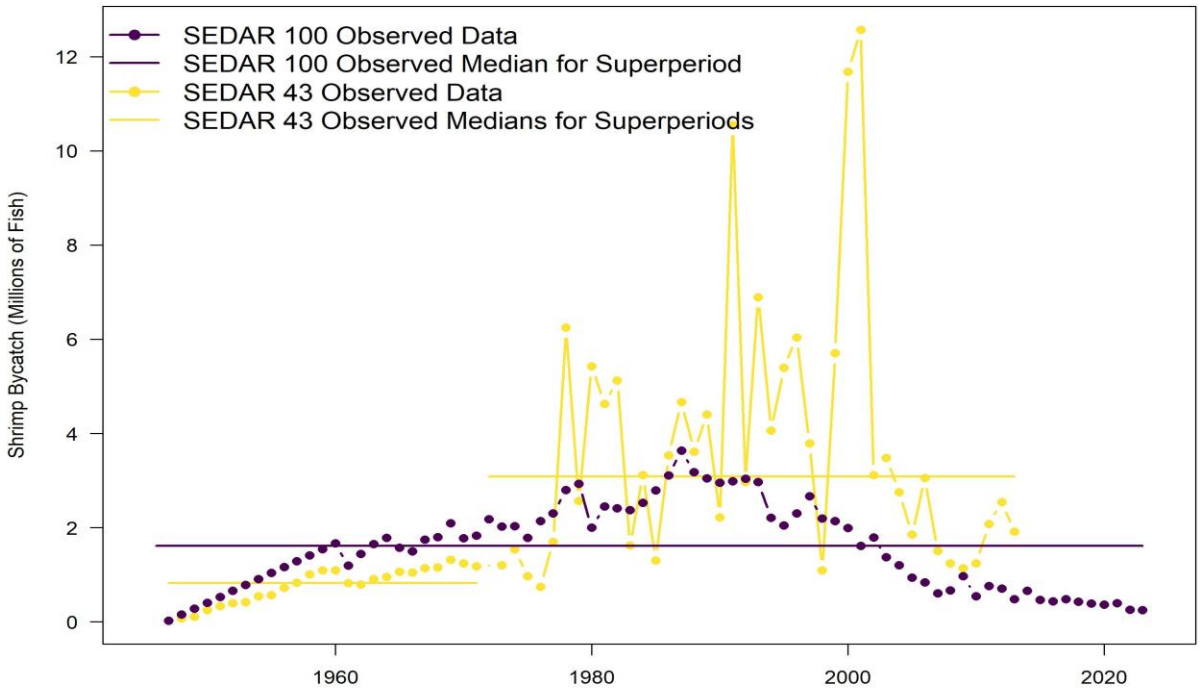


Figure 8. Comparison of the shrimp bycatch (numbers) time series used in SEDAR 100 and SEDAR 43. Median value(s) were input into the assessment model using the super-period approach.

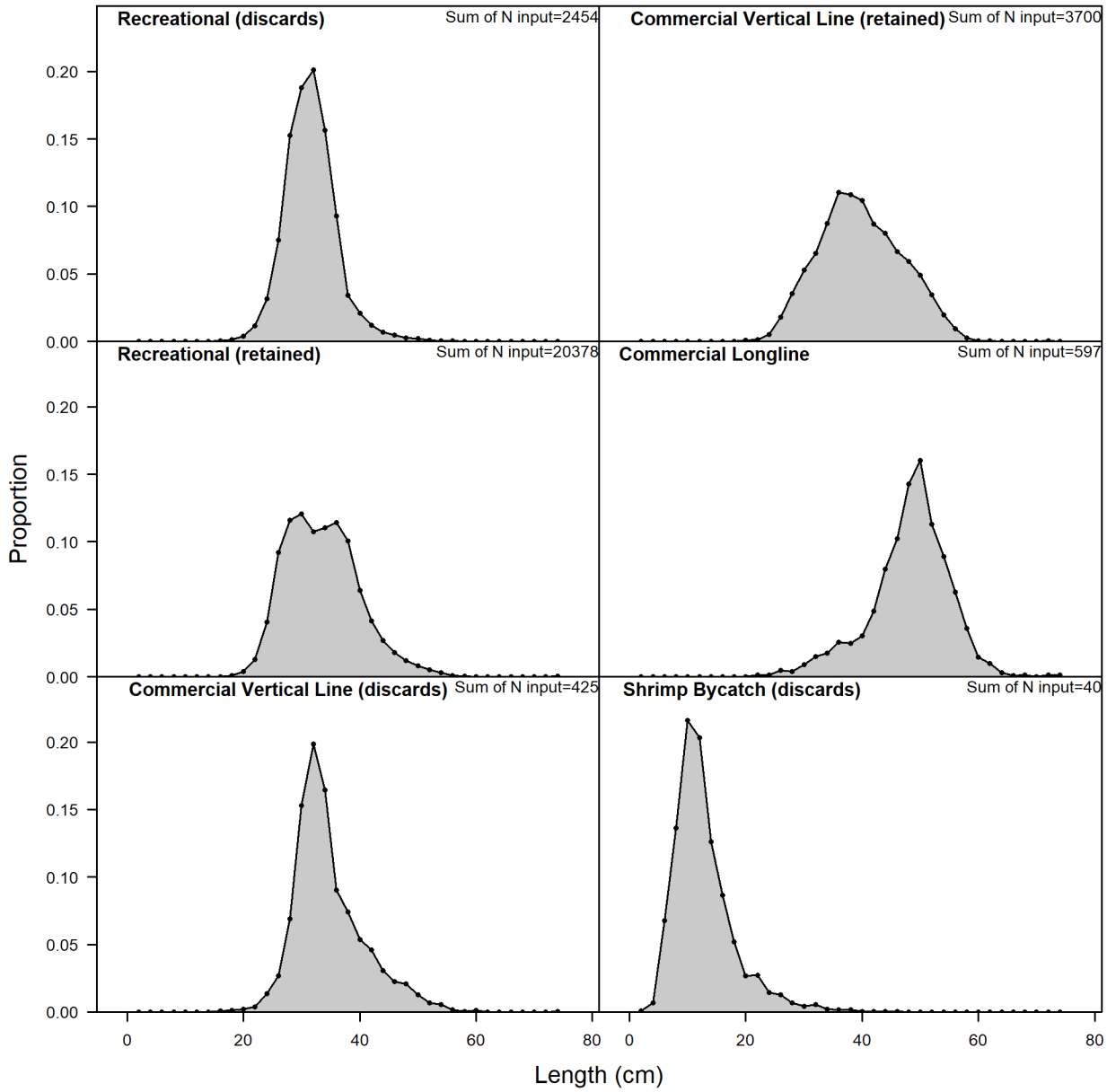


Figure 9. Length compositions aggregated across years for the recreational and commercial fleets and shrimp bycatch. 'N input' is the number of trips for the fleets (N input in terms of trips was not available for shrimp bycatch).

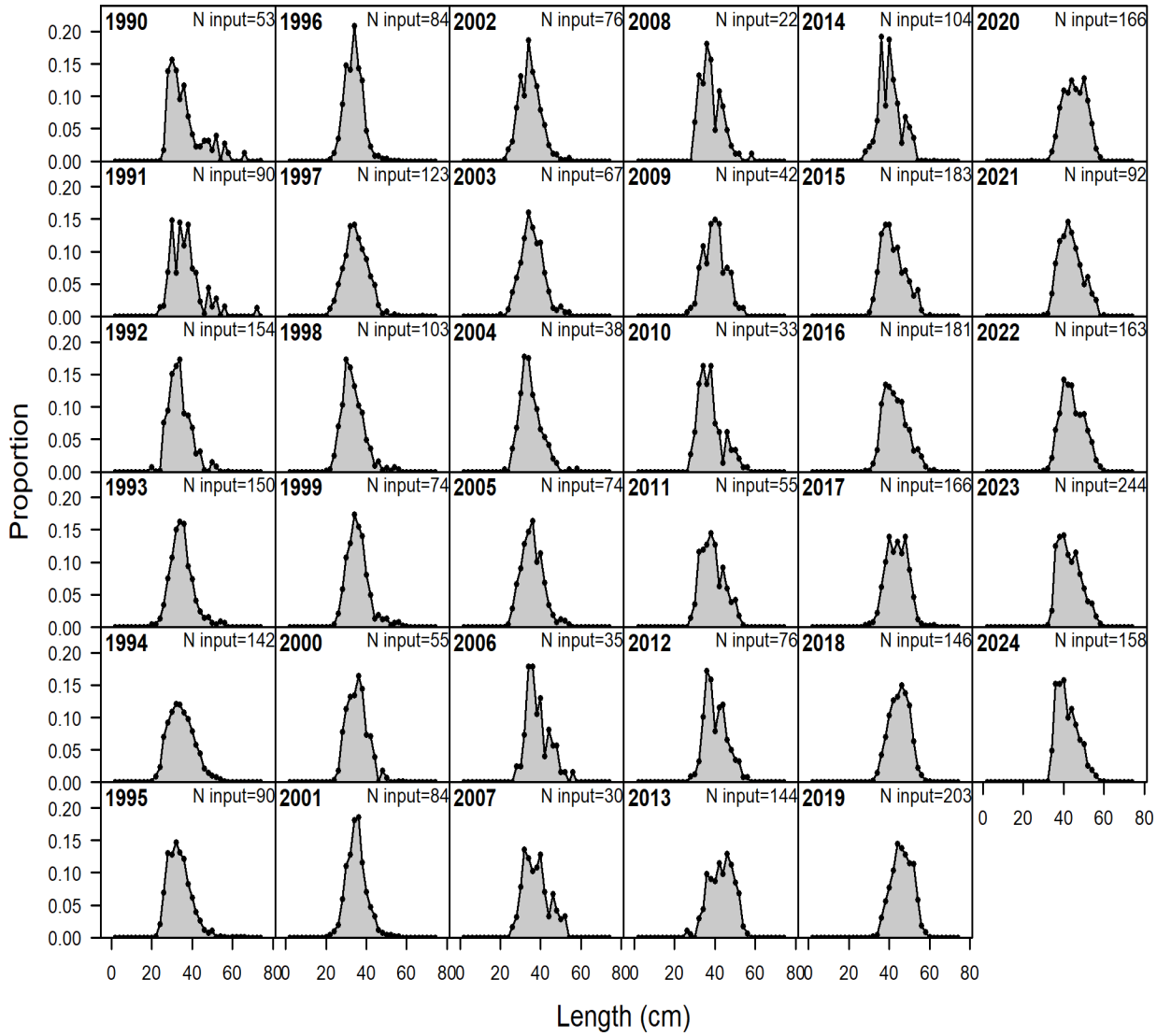


Figure 10. Observed length composition (retained) for the Commercial Vertical Line fleet. 'N input' is the number of trips.

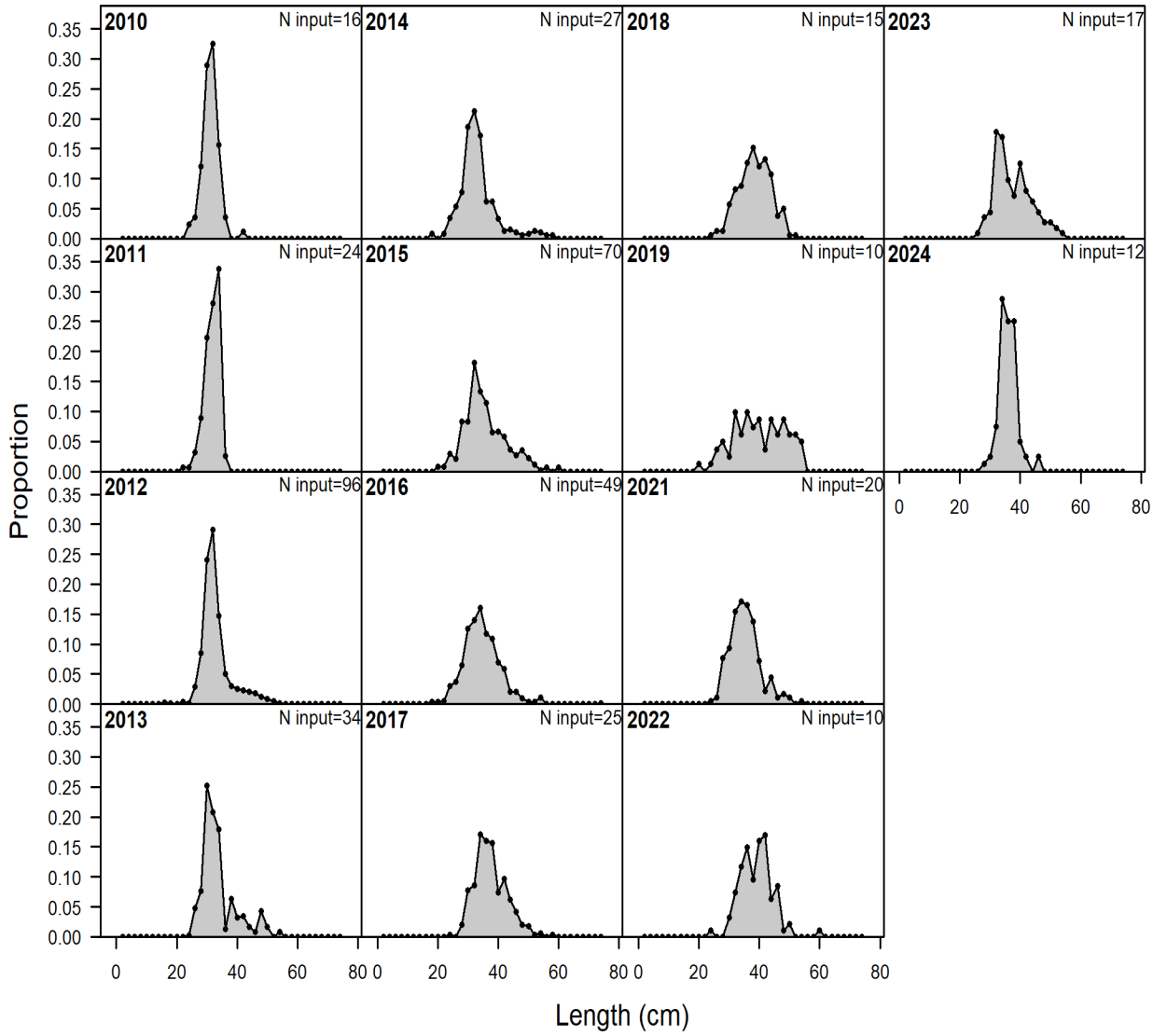


Figure 11. Observed length composition (discarded) for the Commercial Vertical Line fleet. 'N input' is the number of trips.

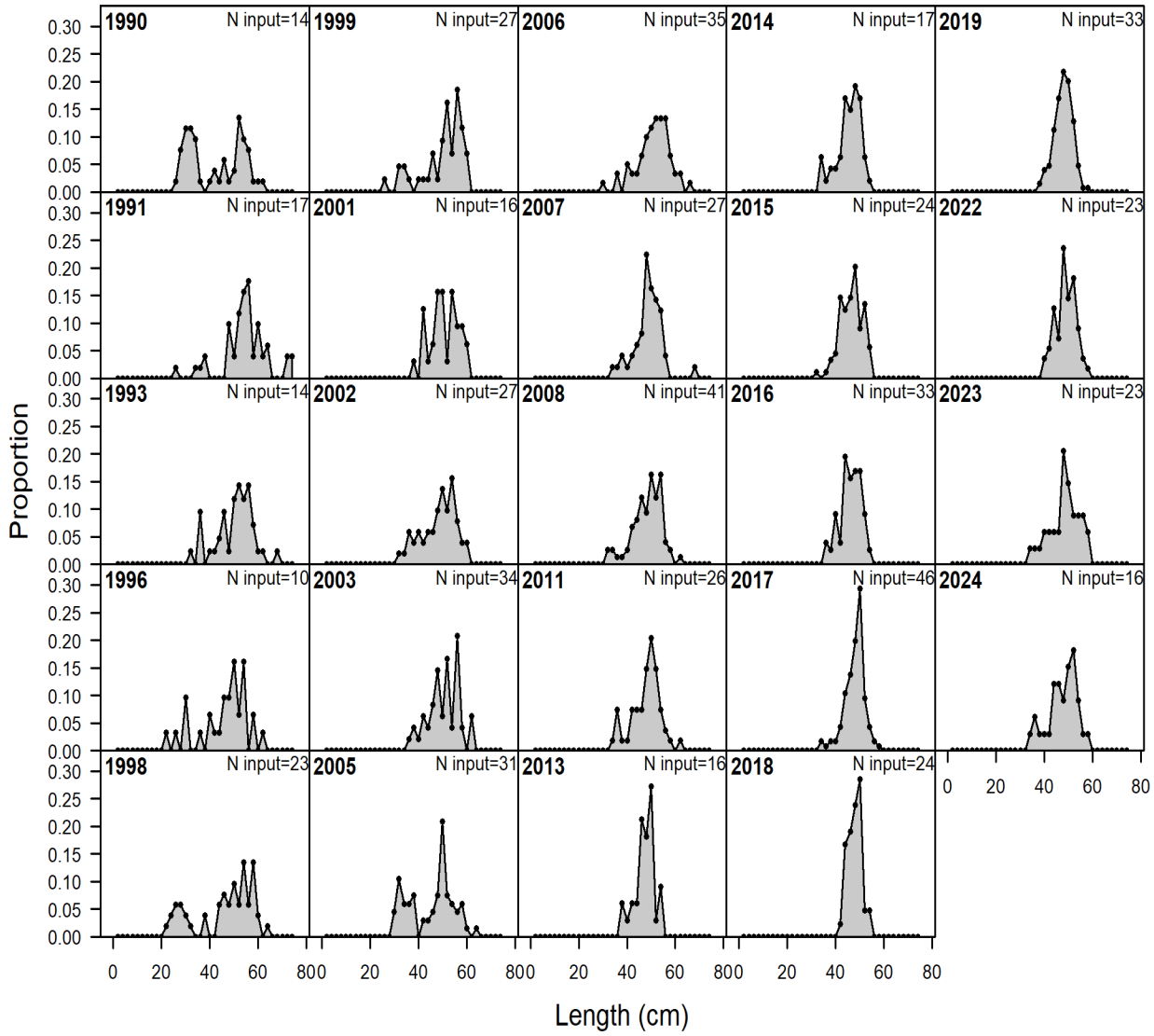


Figure 12. Observed length composition (retained) for the Commercial Longline fleet. 'N input' is the number of trips.

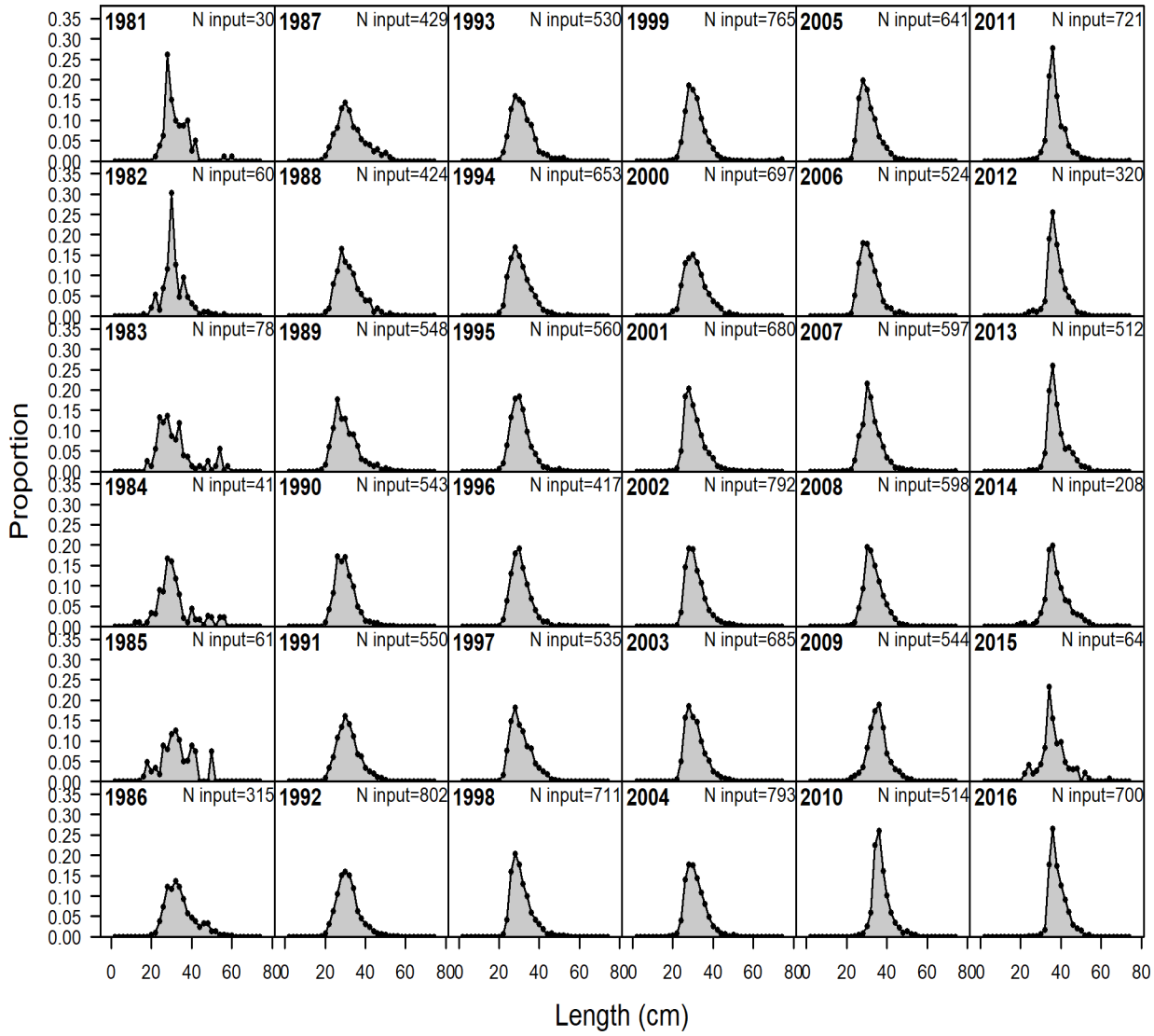


Figure 13. Observed length composition (retained) for the Recreational fleet. 'N input' is the number of trips.

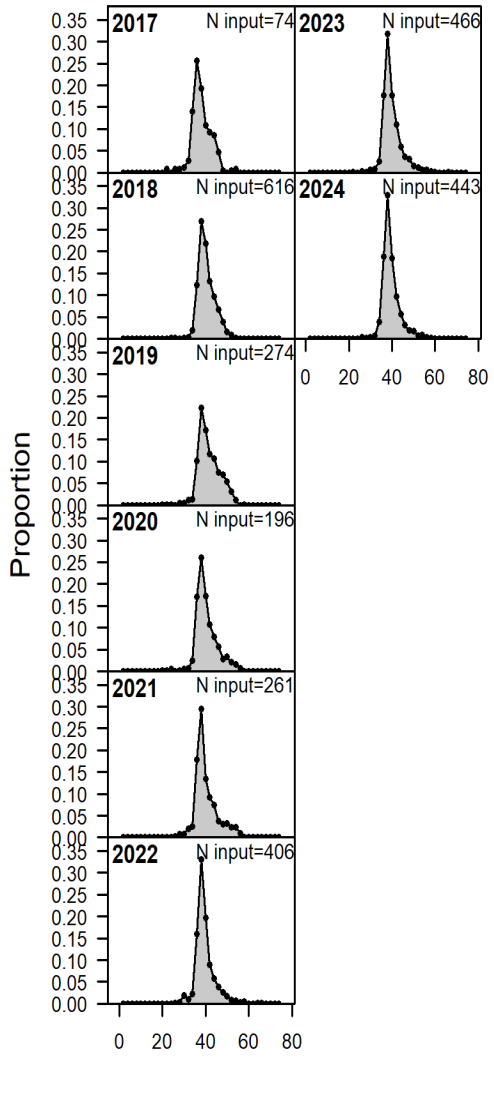


Figure 13 Continued. Observed length composition (retained) for the Recreational fleet. 'N input' is the number of trips.

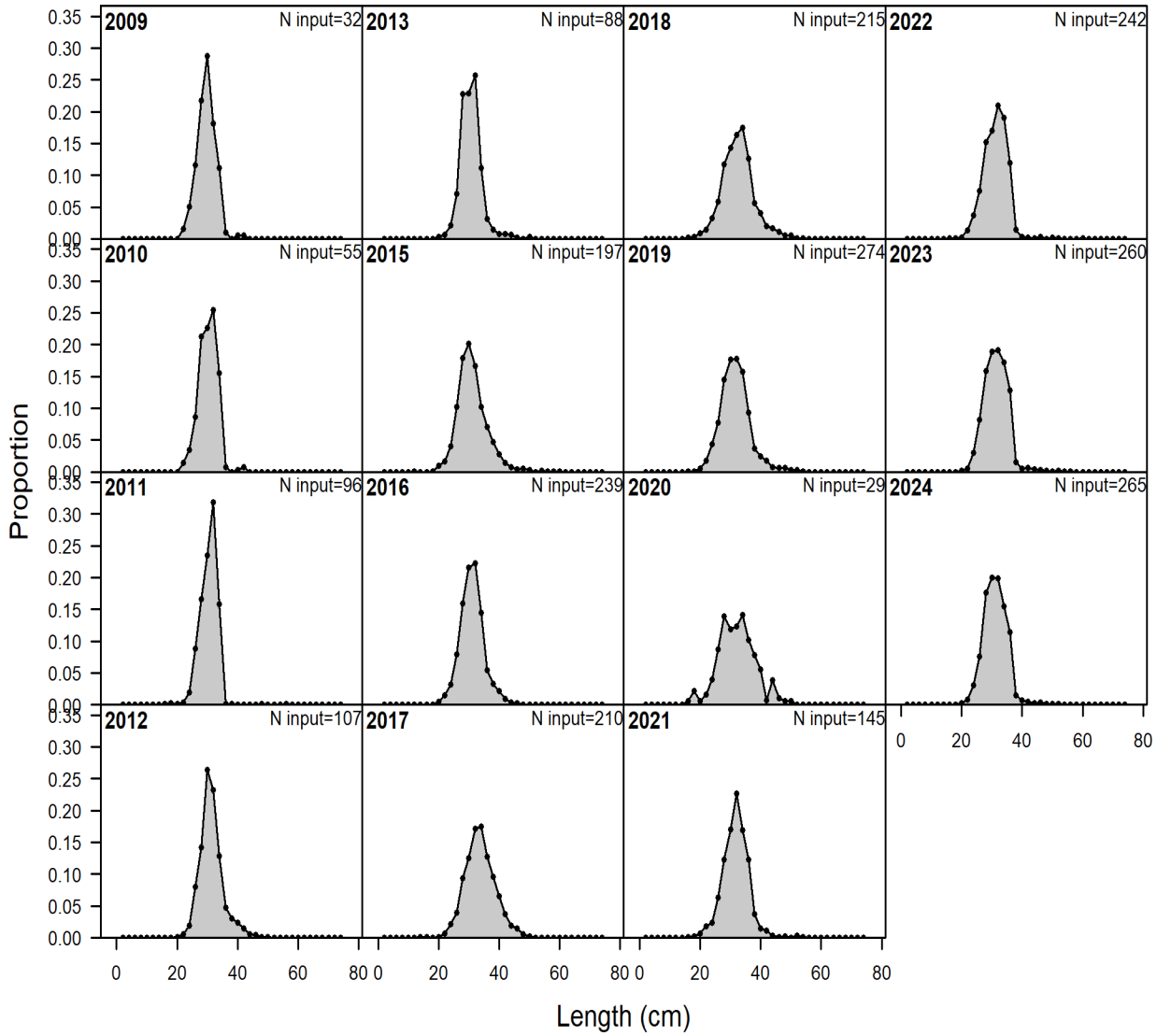


Figure 14. Observed length composition (discarded) for the Recreational fleet. 'N input' is the number of trips.

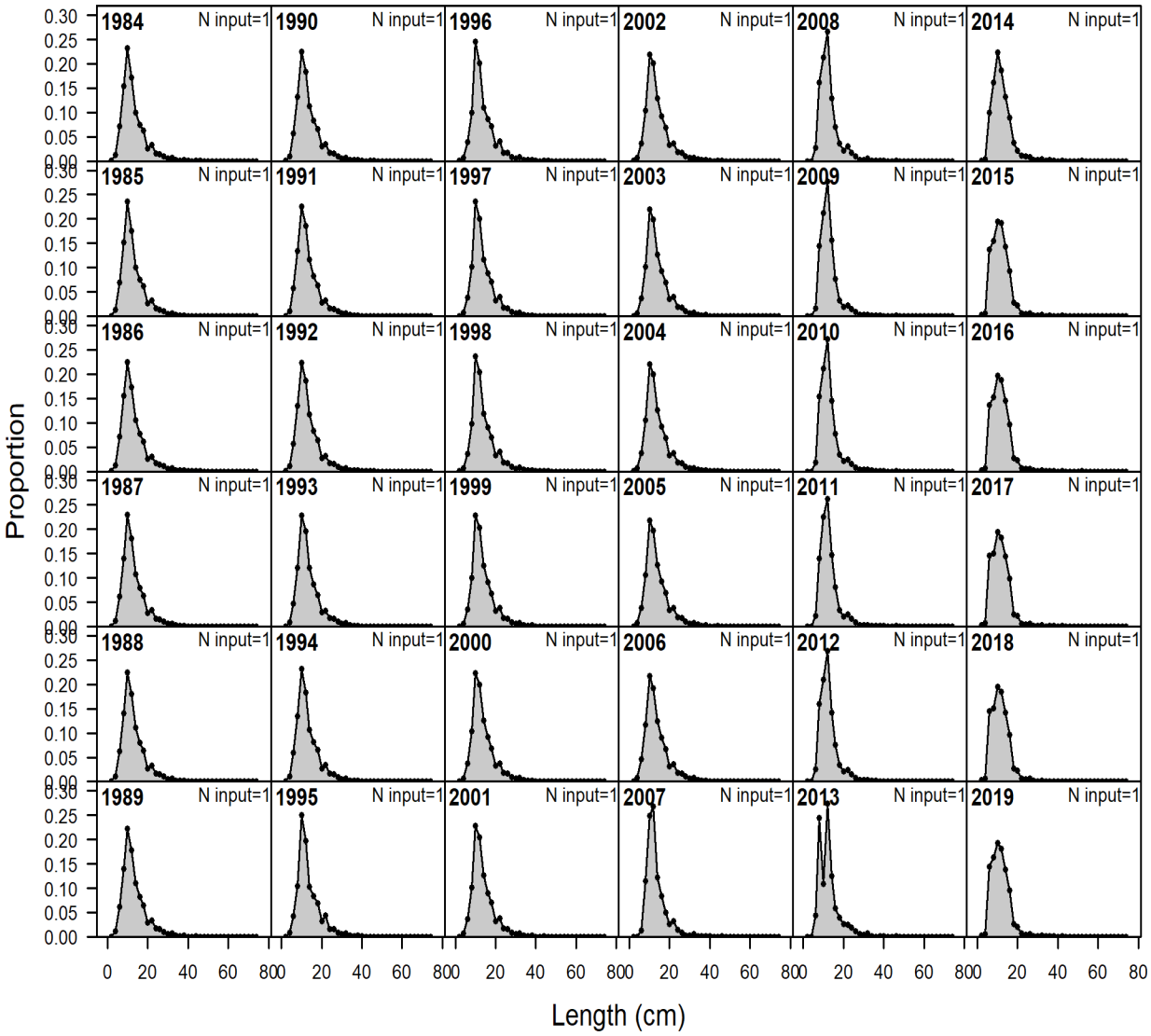


Figure 15. Proxy length composition (discarded) for the Shrimp Bycatch fleet, which was obtained using SEAMAP length data (see ***Section 2.3.8****). 'N input' as the number of trips was not available and therefore a placeholder of 1 was used. This data input was included as a model check and was not fit to within the assessment model (i.e., sample size was not relevant).*

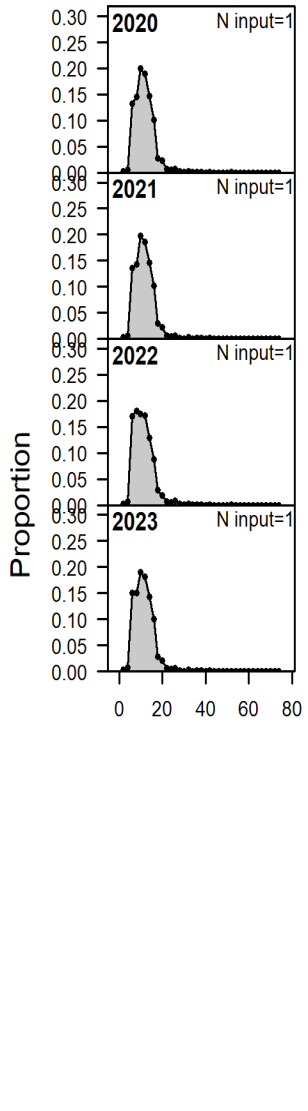


Figure 15 Continued. Proxy length composition (discarded) for the Shrimp Bycatch fleet, which was obtained using SEAMAP length data (see ***Section 2.3.8****). 'N input' as the number of trips was not available and therefore a placeholder of 1 was used. This data input was included as a model check and was not fit to within the assessment model (i.e., sample size was not relevant).*

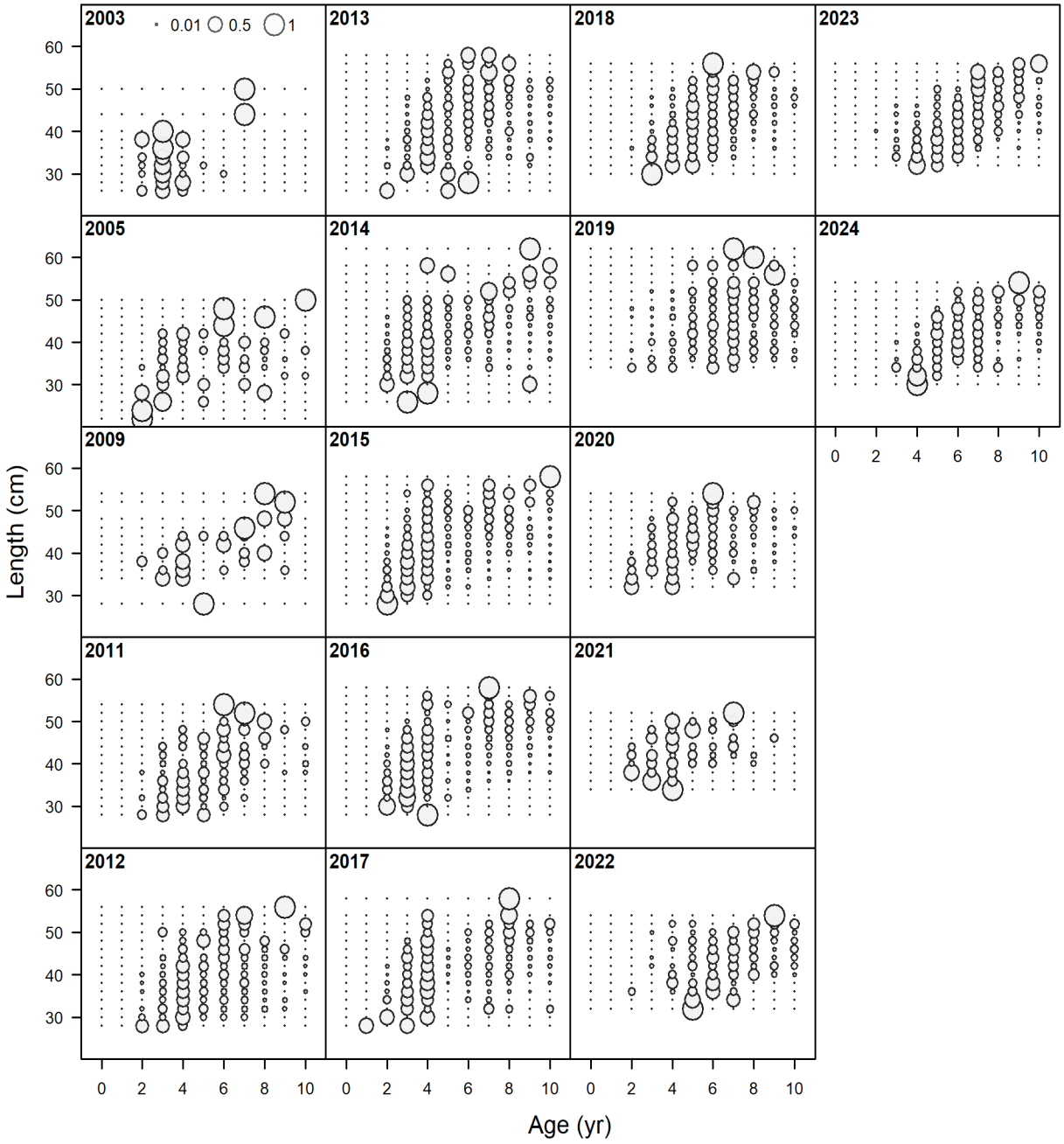


Figure 16. Observed conditional age-at-length composition (retained) for the Commercial Vertical Line fleet.

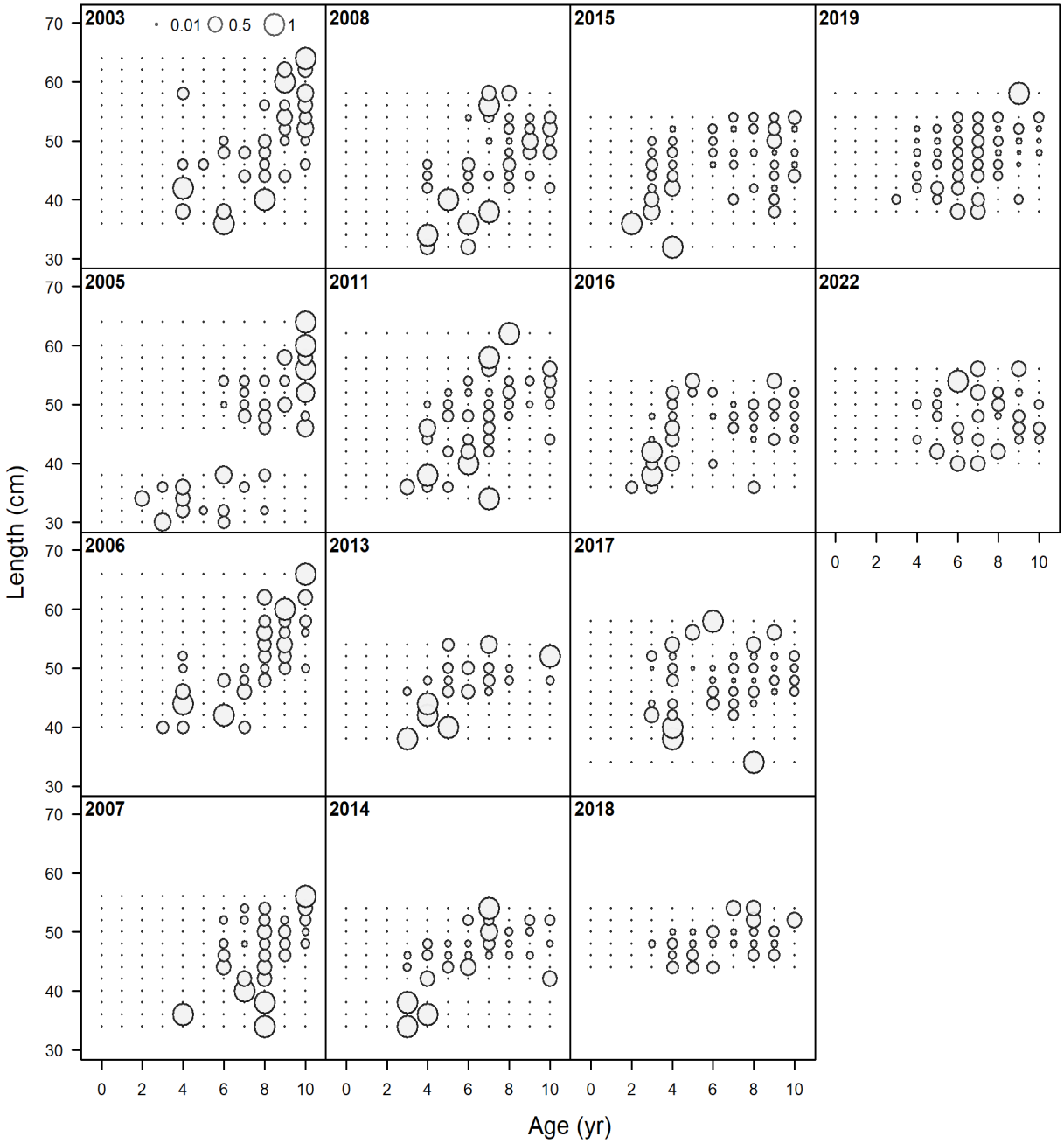


Figure 17. Observed conditional age-at-length composition (retained) for the Commercial Longline fleet.

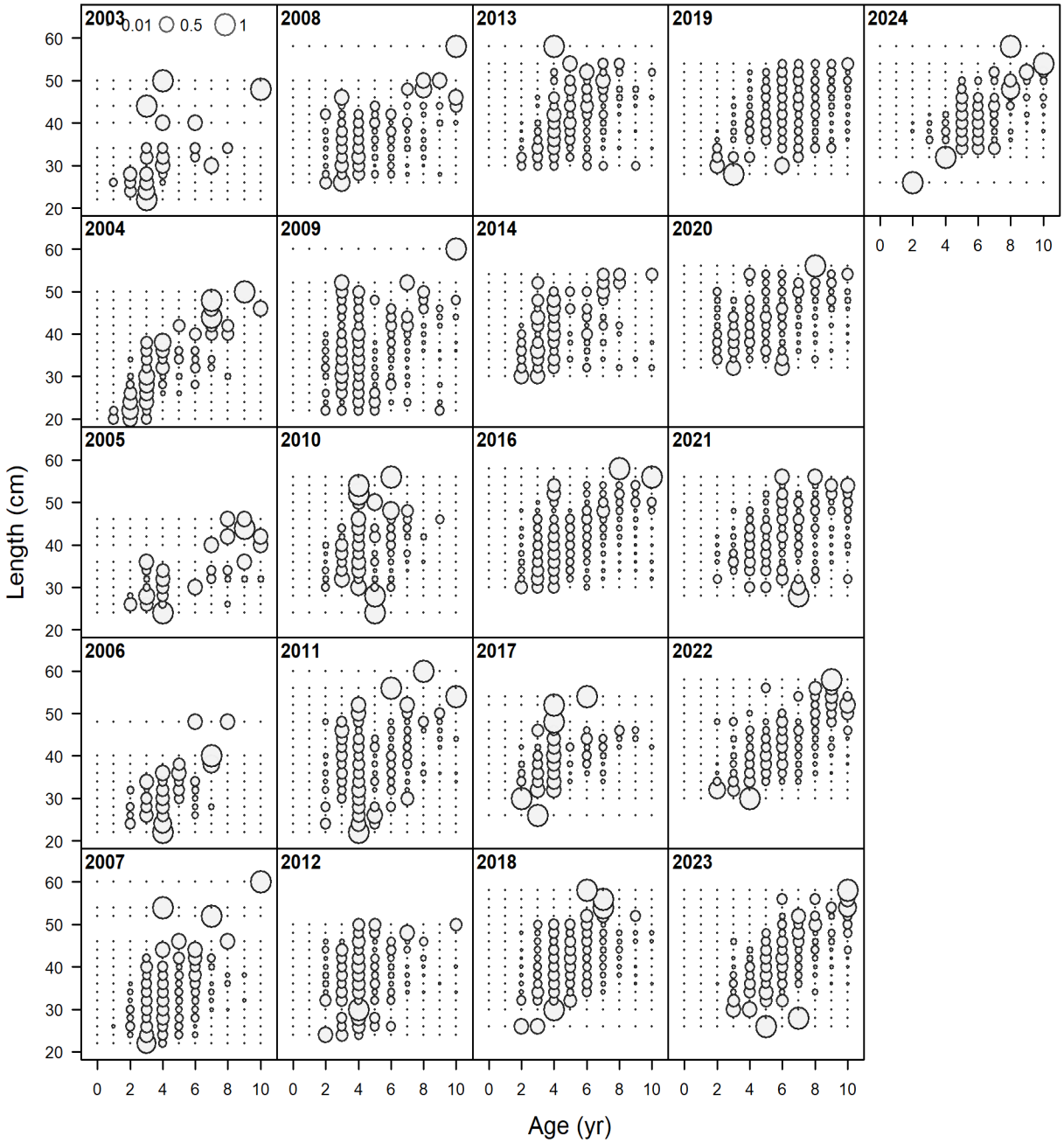


Figure 18. Observed conditional age-at-length composition (retained) for the Recreational fleet.

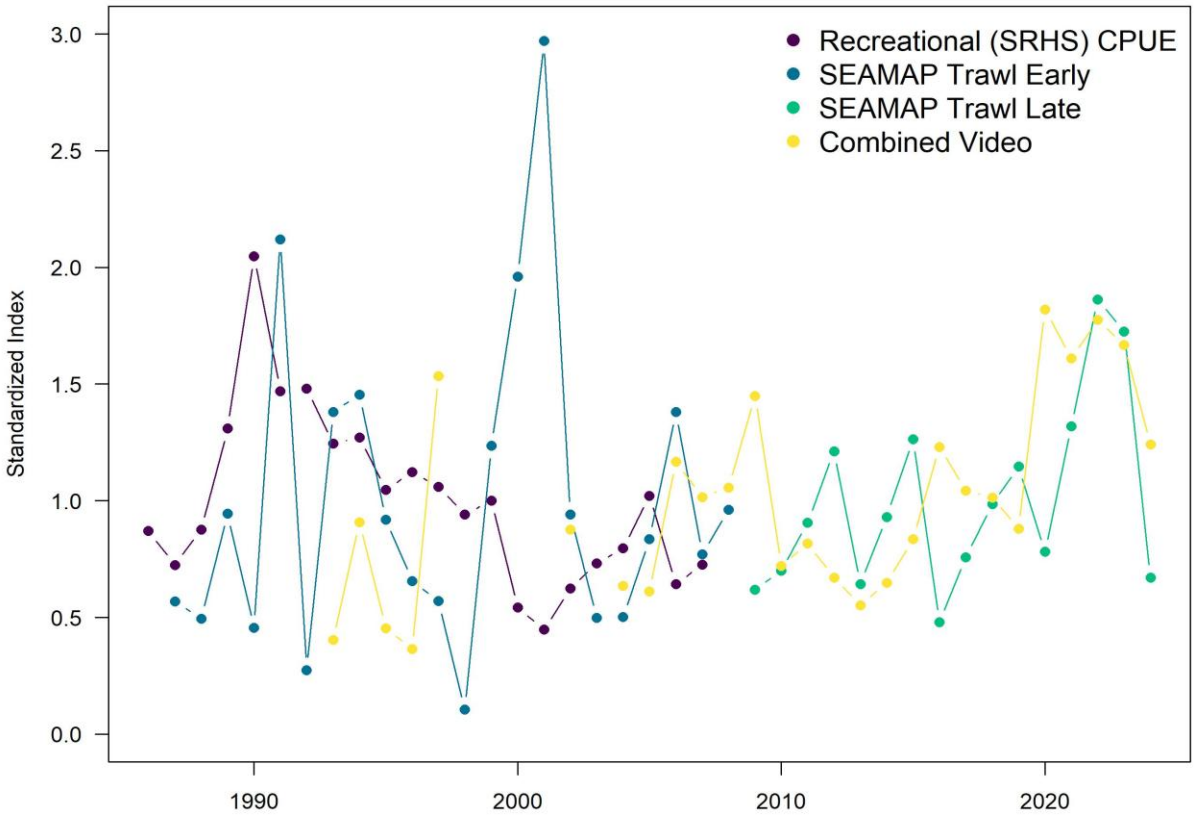


Figure 19. Standardized indices of relative abundance recommended for use during the SEDAR 100 Assessment. Each index has been rescaled to have a mean of 1. Error bars for each index are shown in ***Figures 59-62****.*

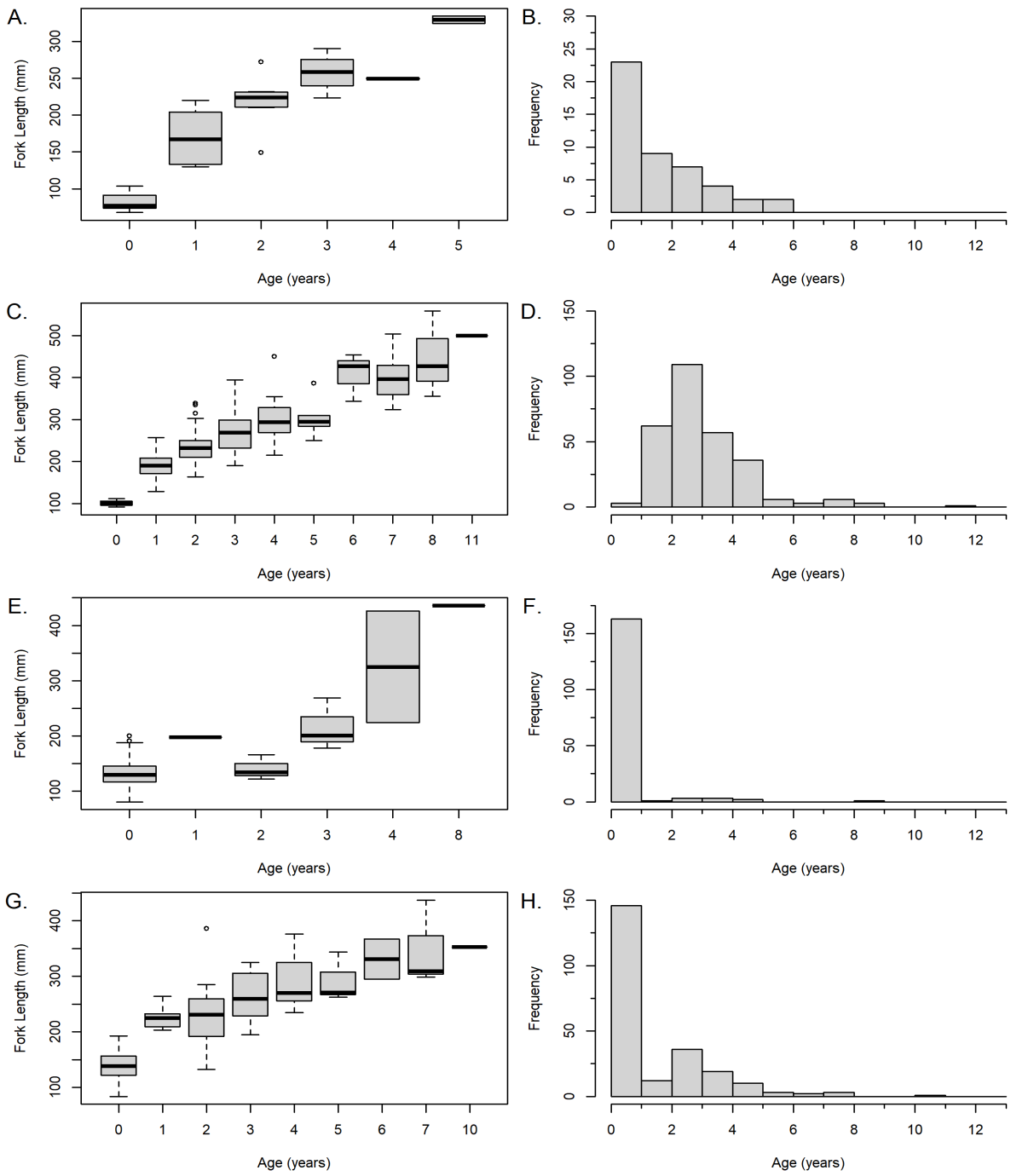


Figure 20. Length at age distribution and age distribution for Gray Triggerfish captured during the SEAMAP Groundfish Trawl Survey (2008-2024) in the: A. and B. Summer - West, C. and D. Summer - East, E. and F. Fall - West, and G. and H. Fall – East. Age samples were updated as described in ***Section 2.2.2****, and plots prior to this update can be found in* ***Figure 5 of SEDAR100-DW16****.*

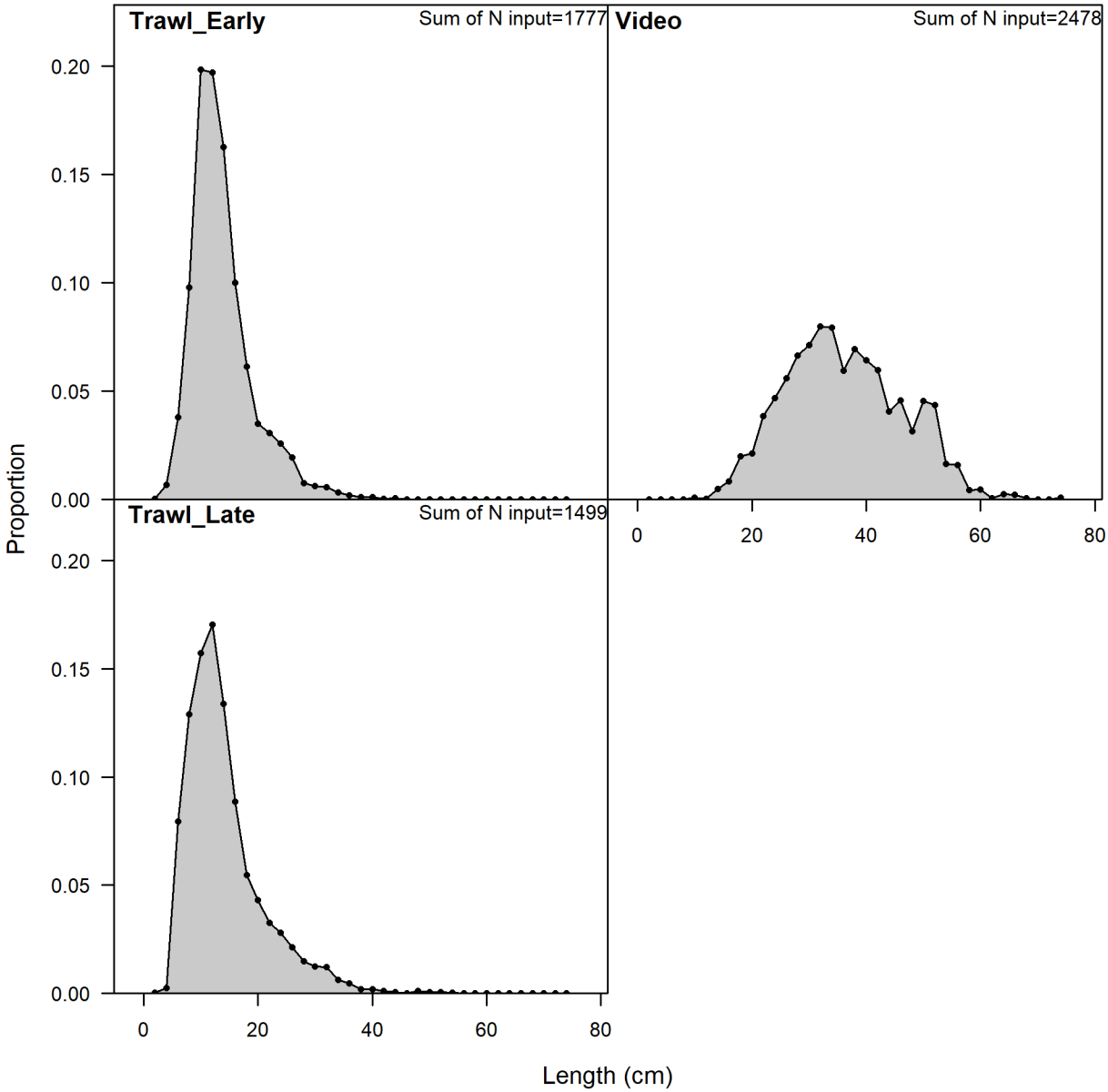


Figure 21. Length compositions aggregated across years for the fishery-independent surveys. 'N input' is the number of stations.

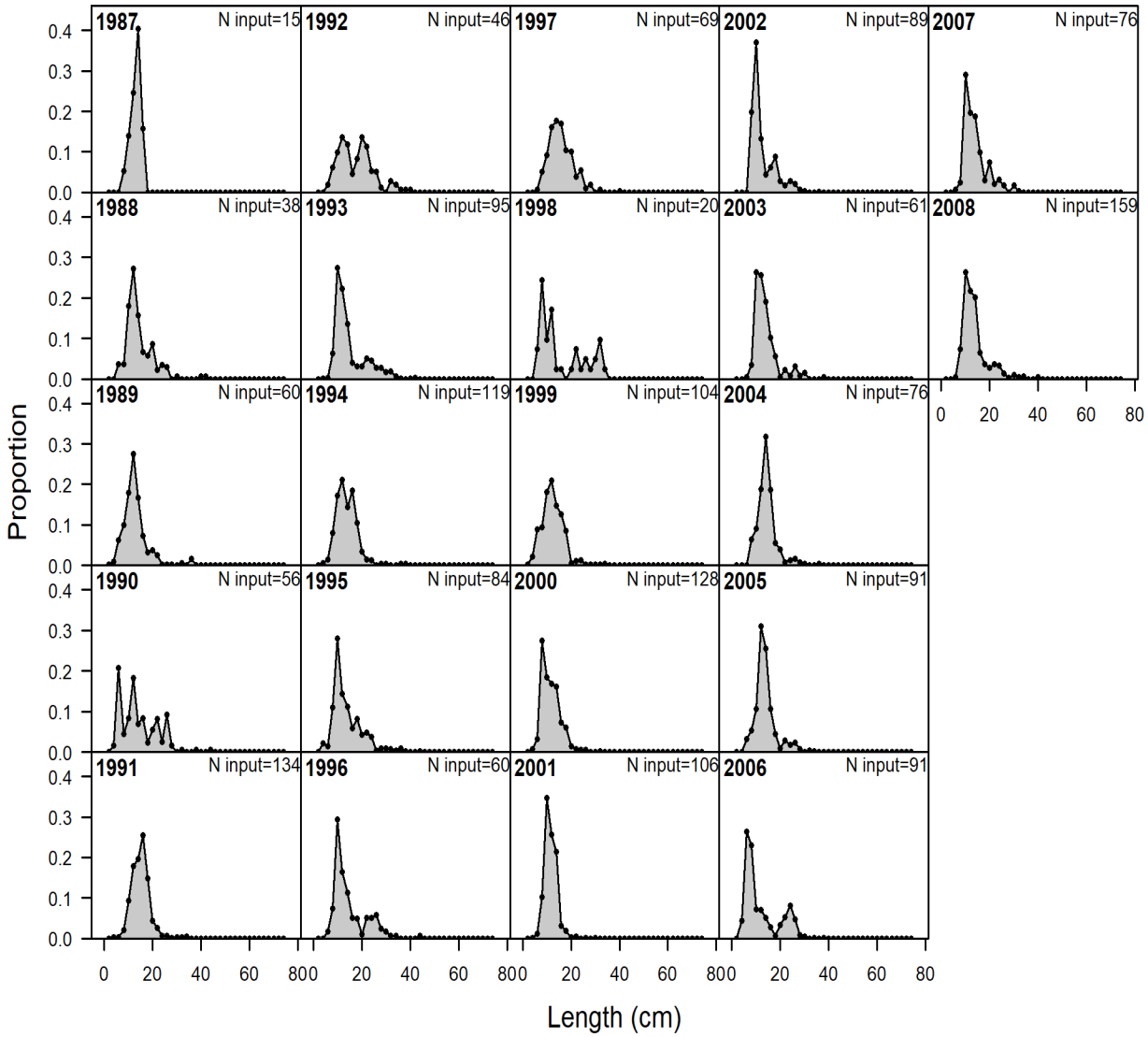


Figure 22. Observed length composition from the SEAMAP Trawl Early Survey. 'N input' is the number of stations.

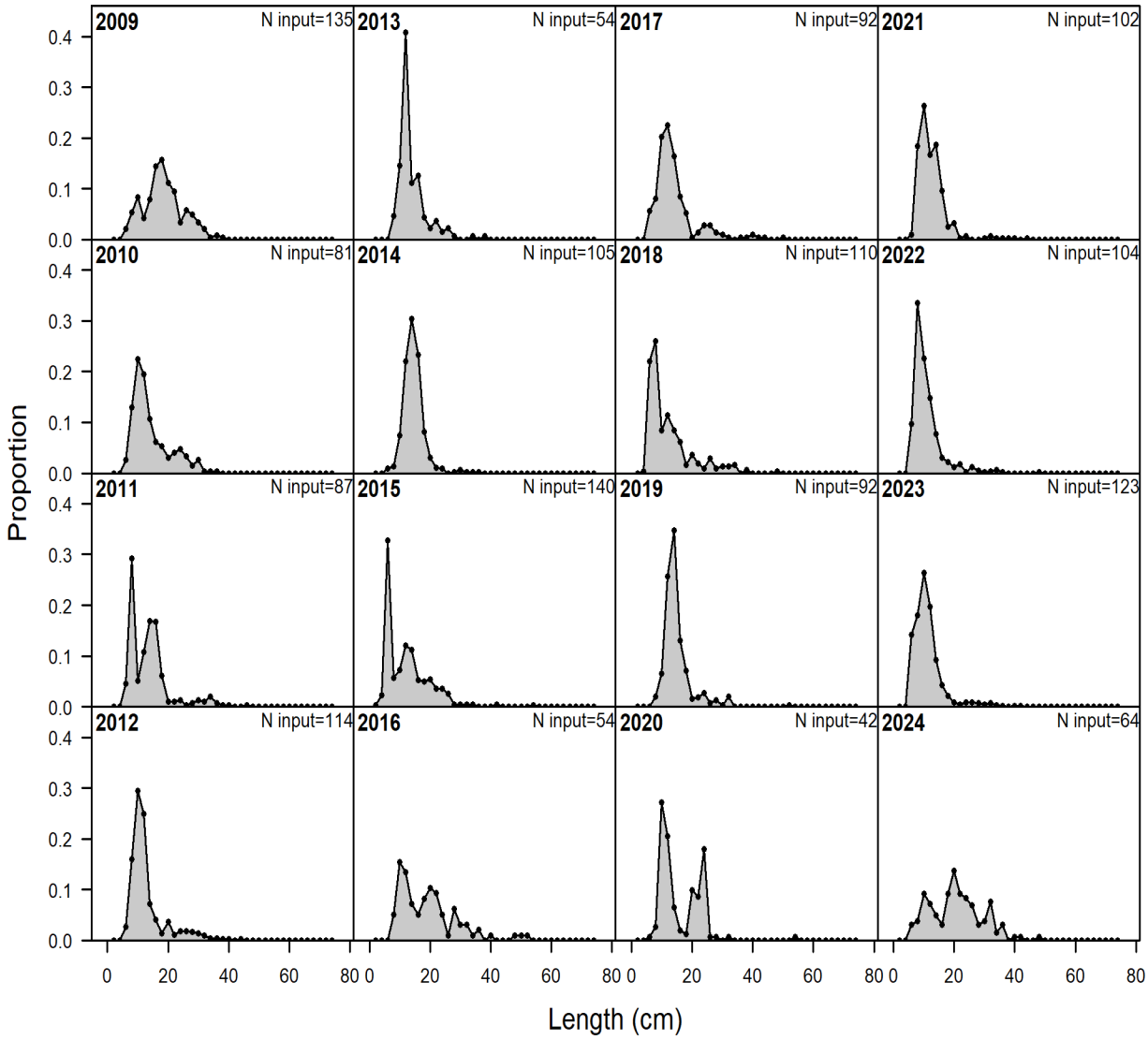


Figure 23. Observed length composition from the SEAMAP Trawl Late Survey. 'N input' is the number of stations.

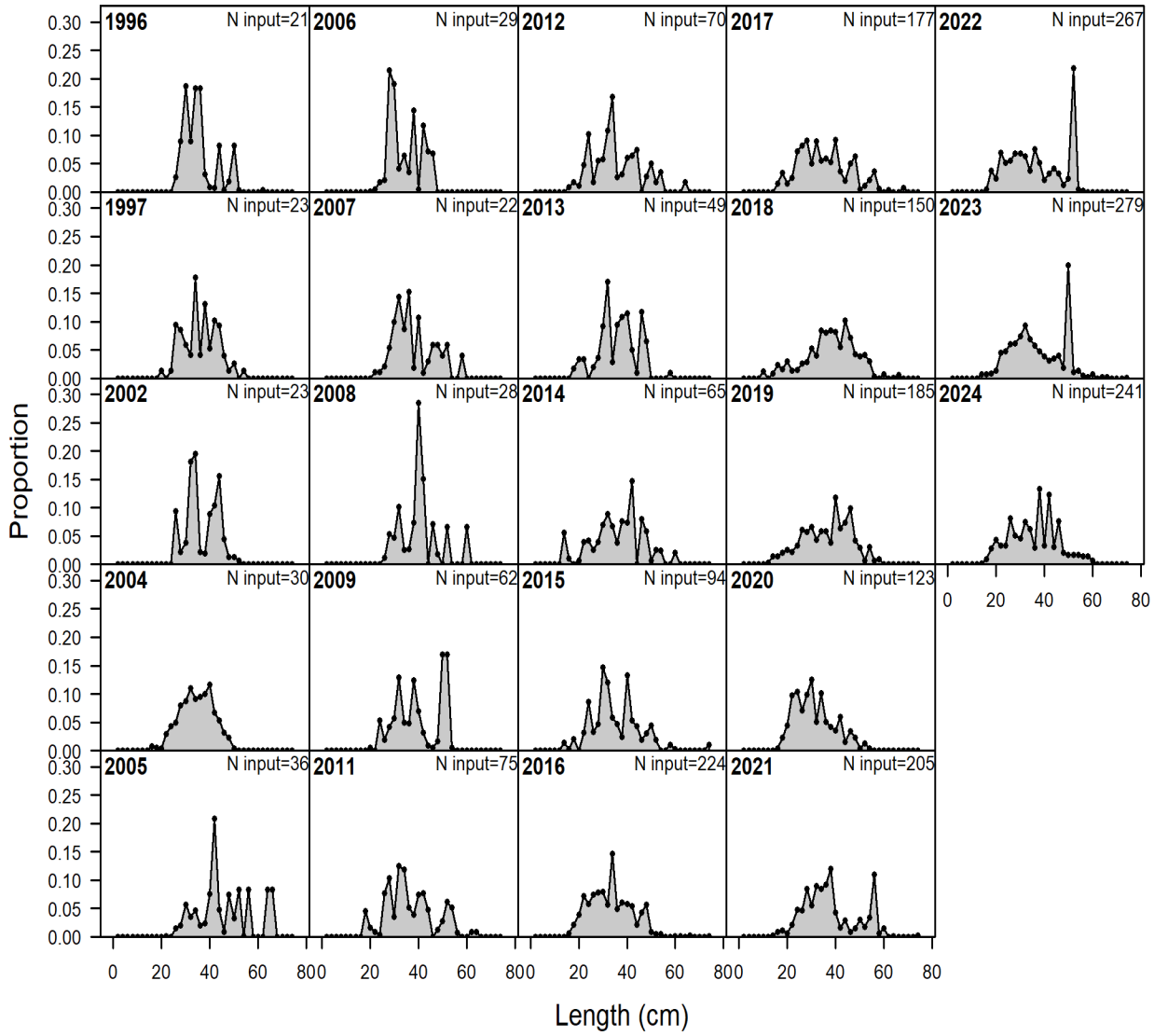


Figure 24. Observed length composition from the Combined Video Survey. 'N input' is the number of stations.

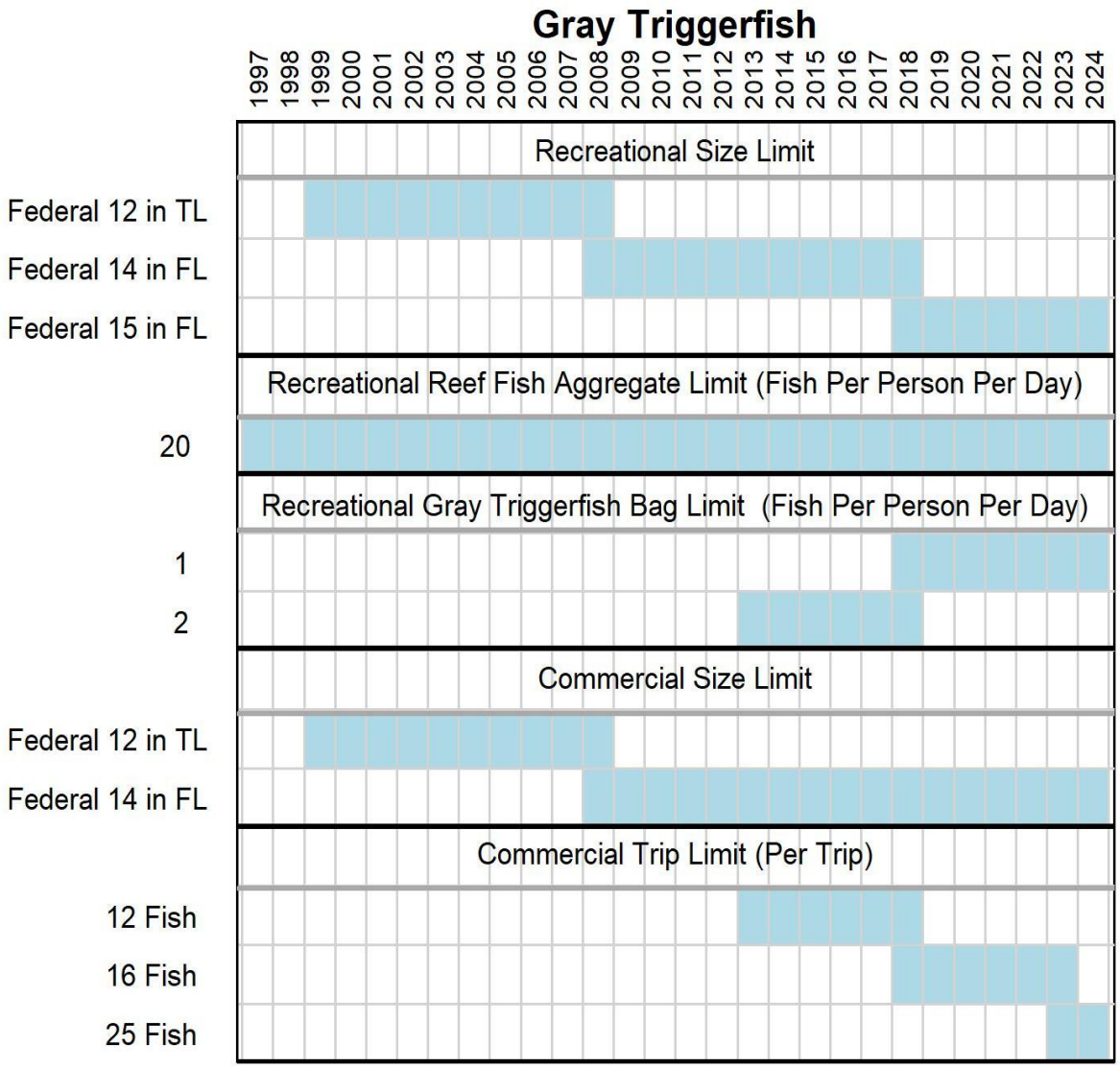


Figure 25. Summary of federal management regulations. Size limits shown are for inches total length (in TL) or fork length (in FL). Not included are time or area closures.

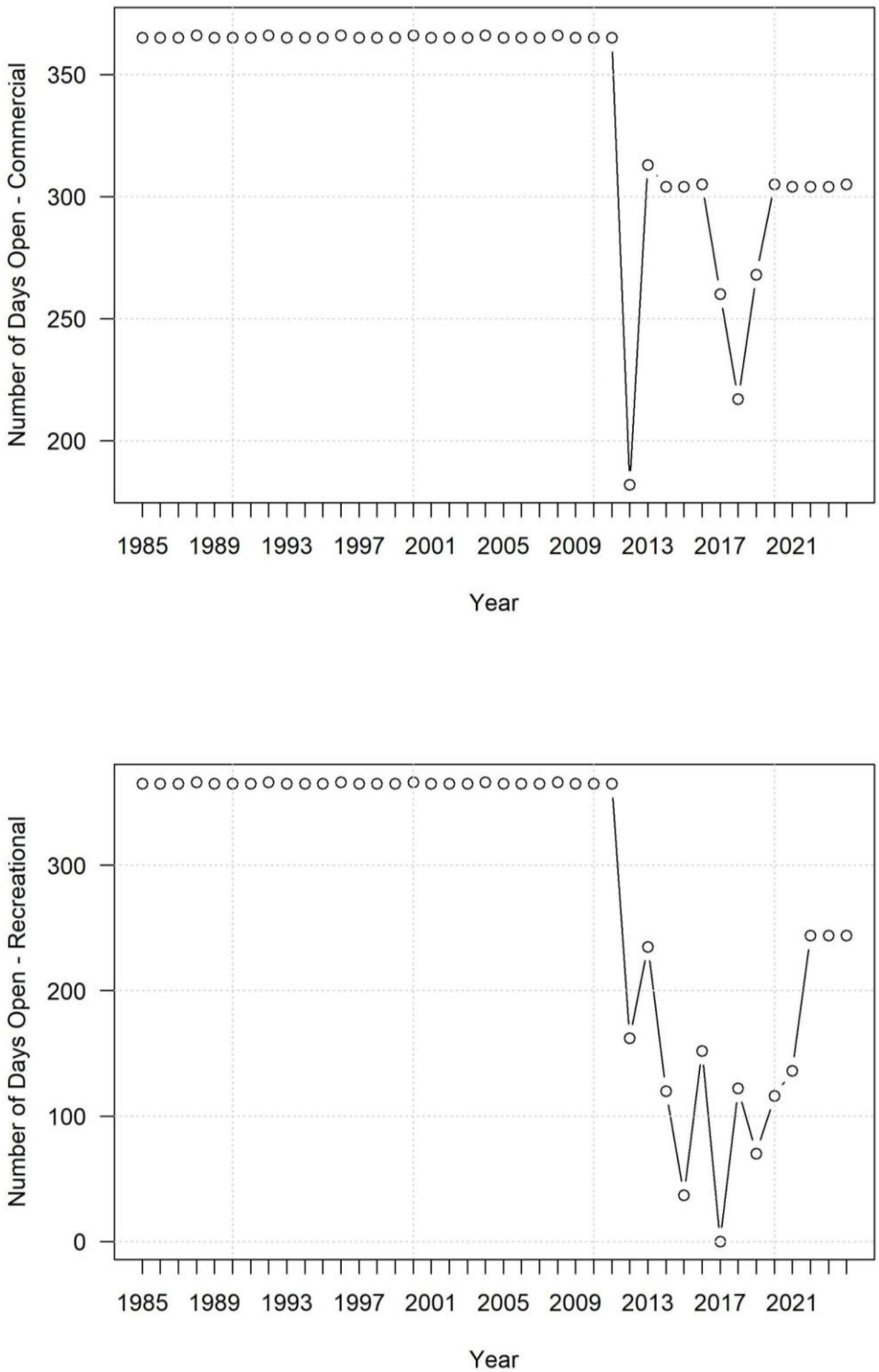


Figure 26. Summary of open season lengths (i.e., number of calendar days open) for the commercial and recreational fleets.

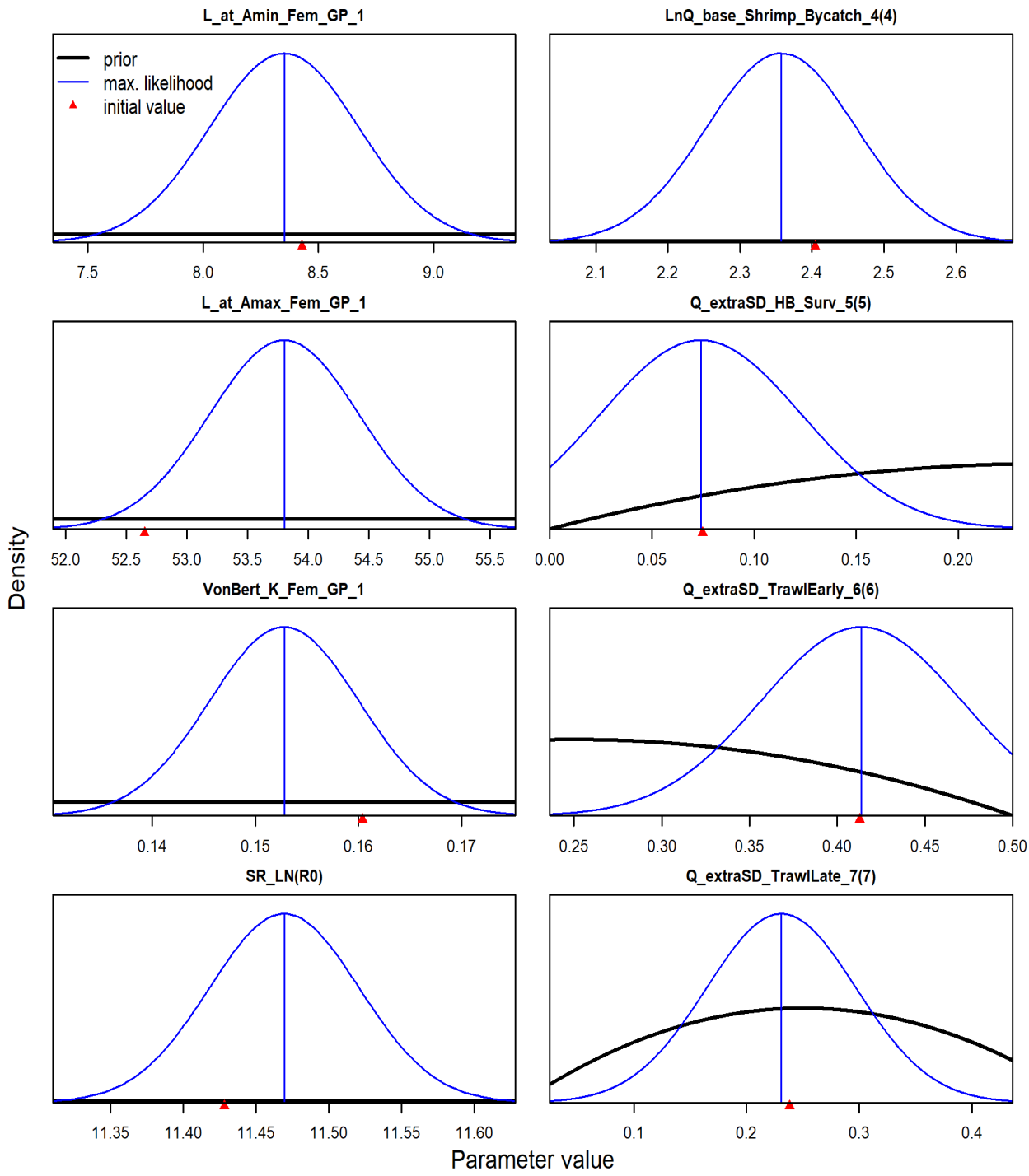


Figure 27. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

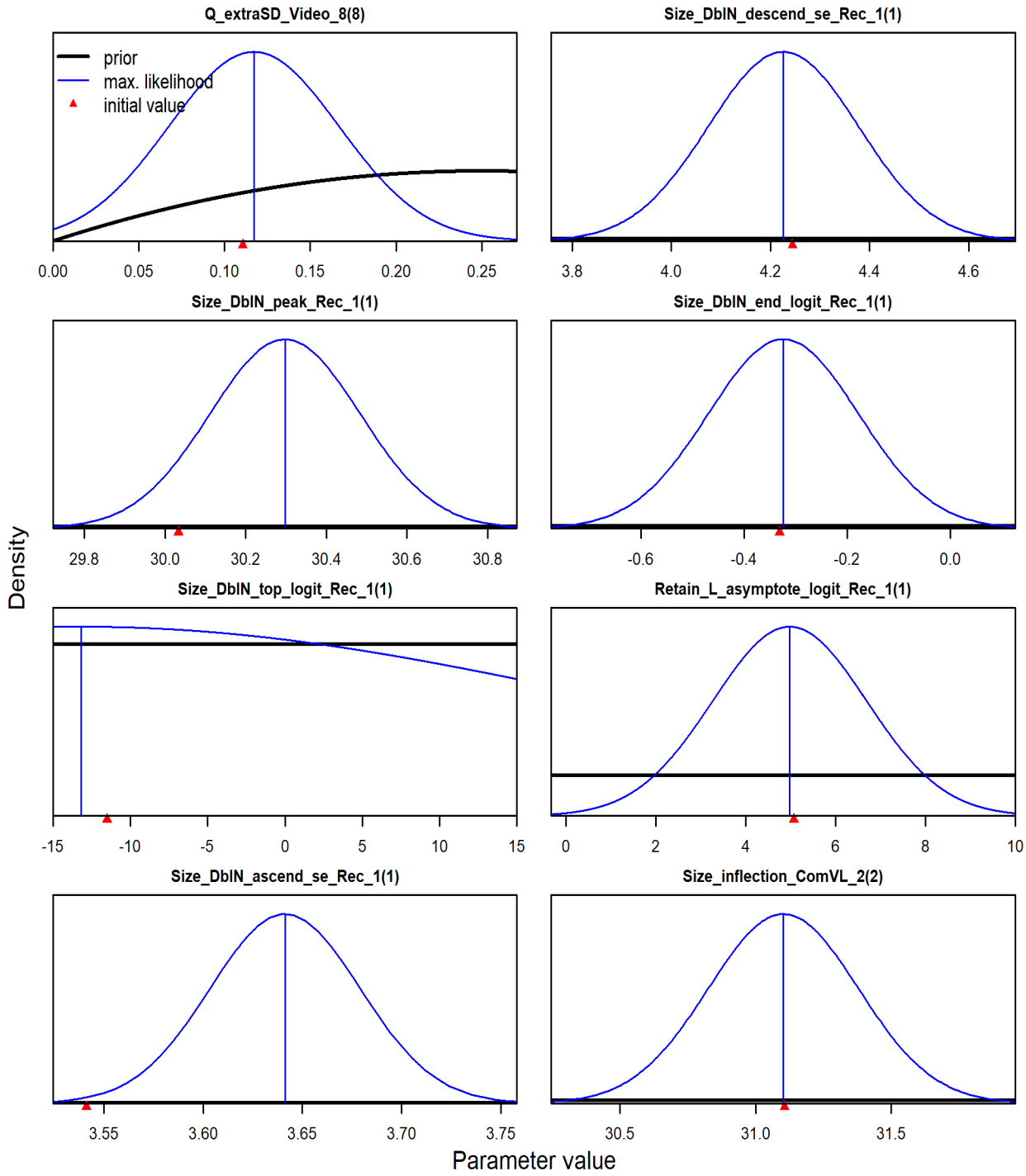


Figure 27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

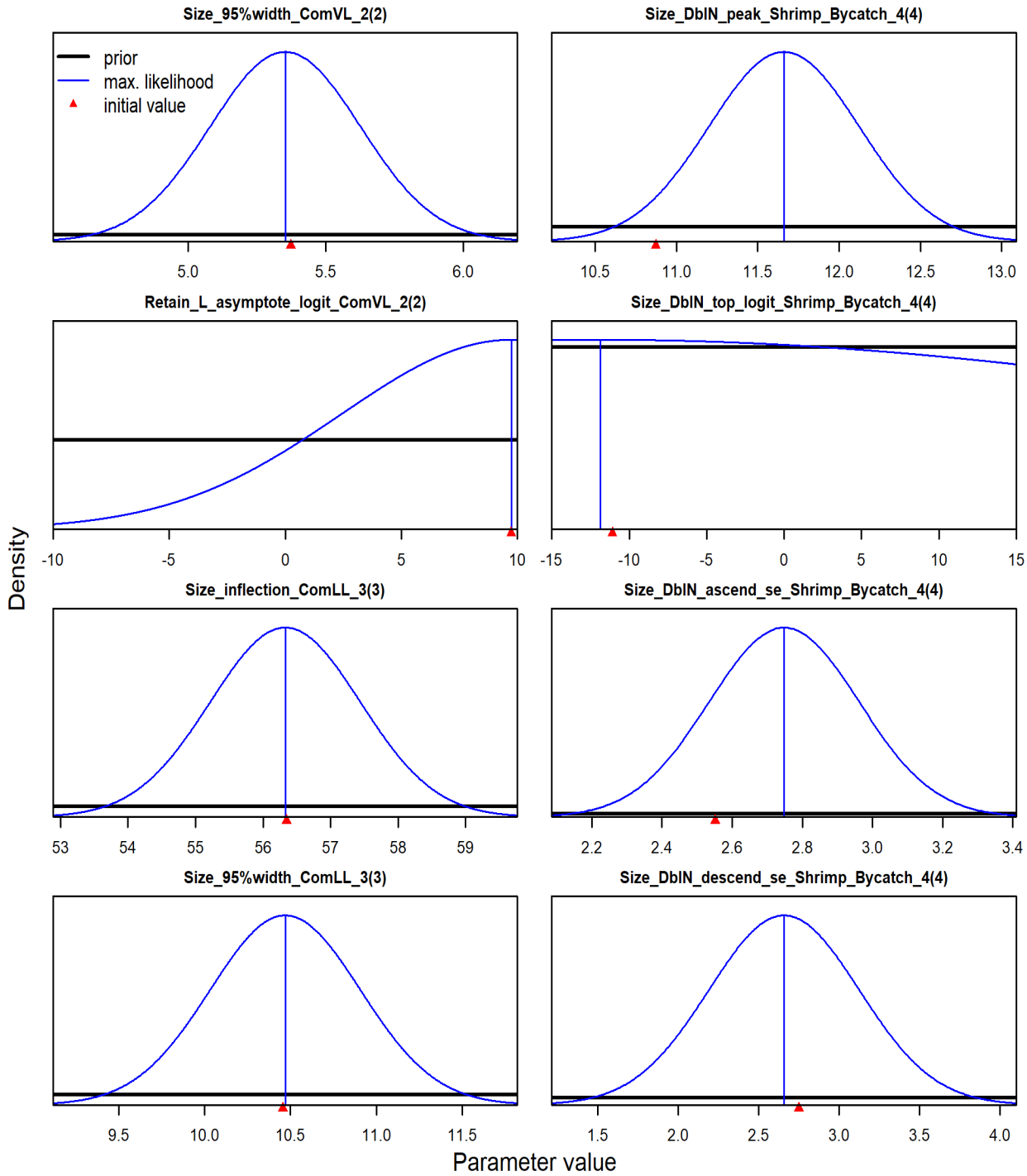


Figure 27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

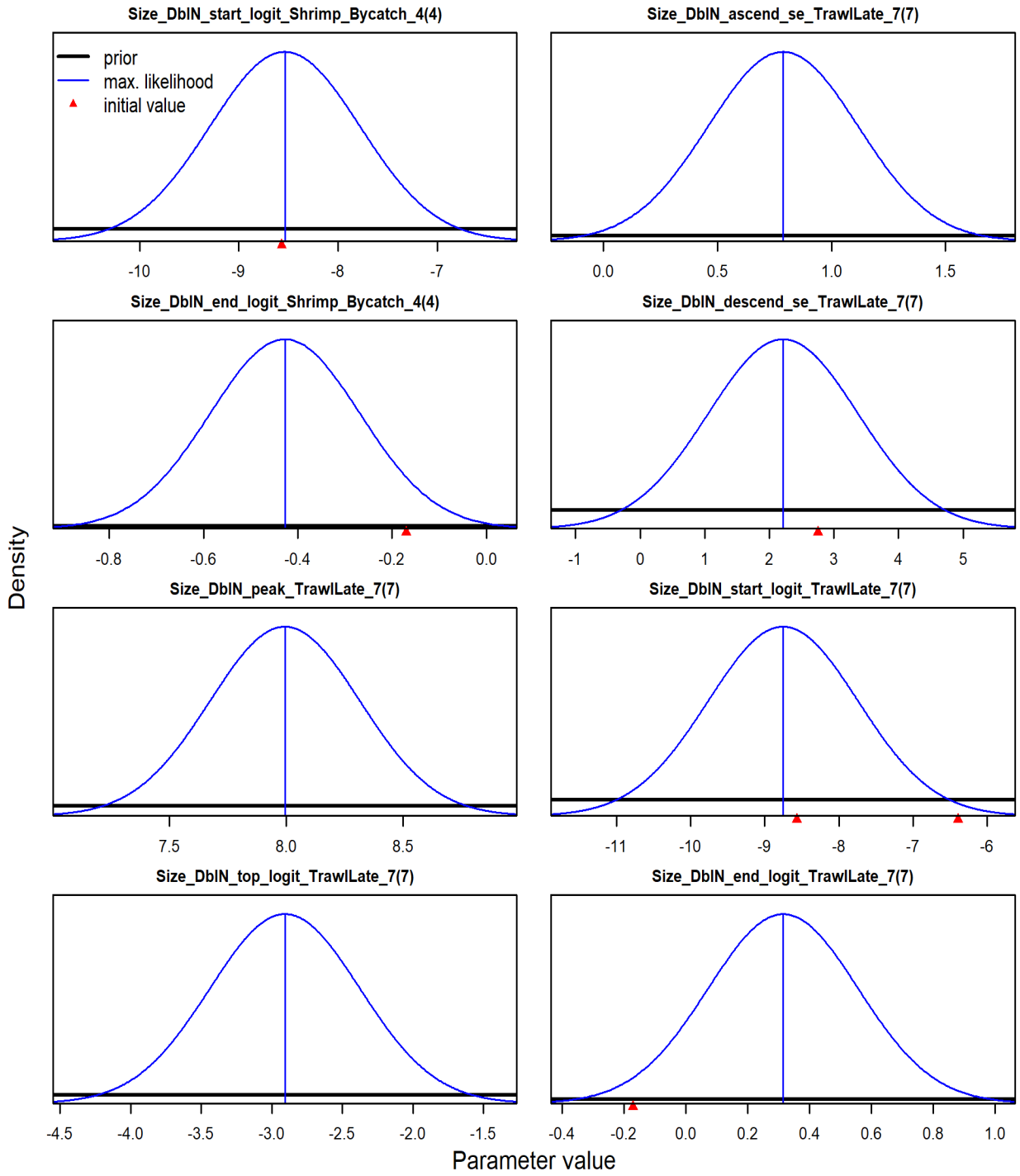


Figure 27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

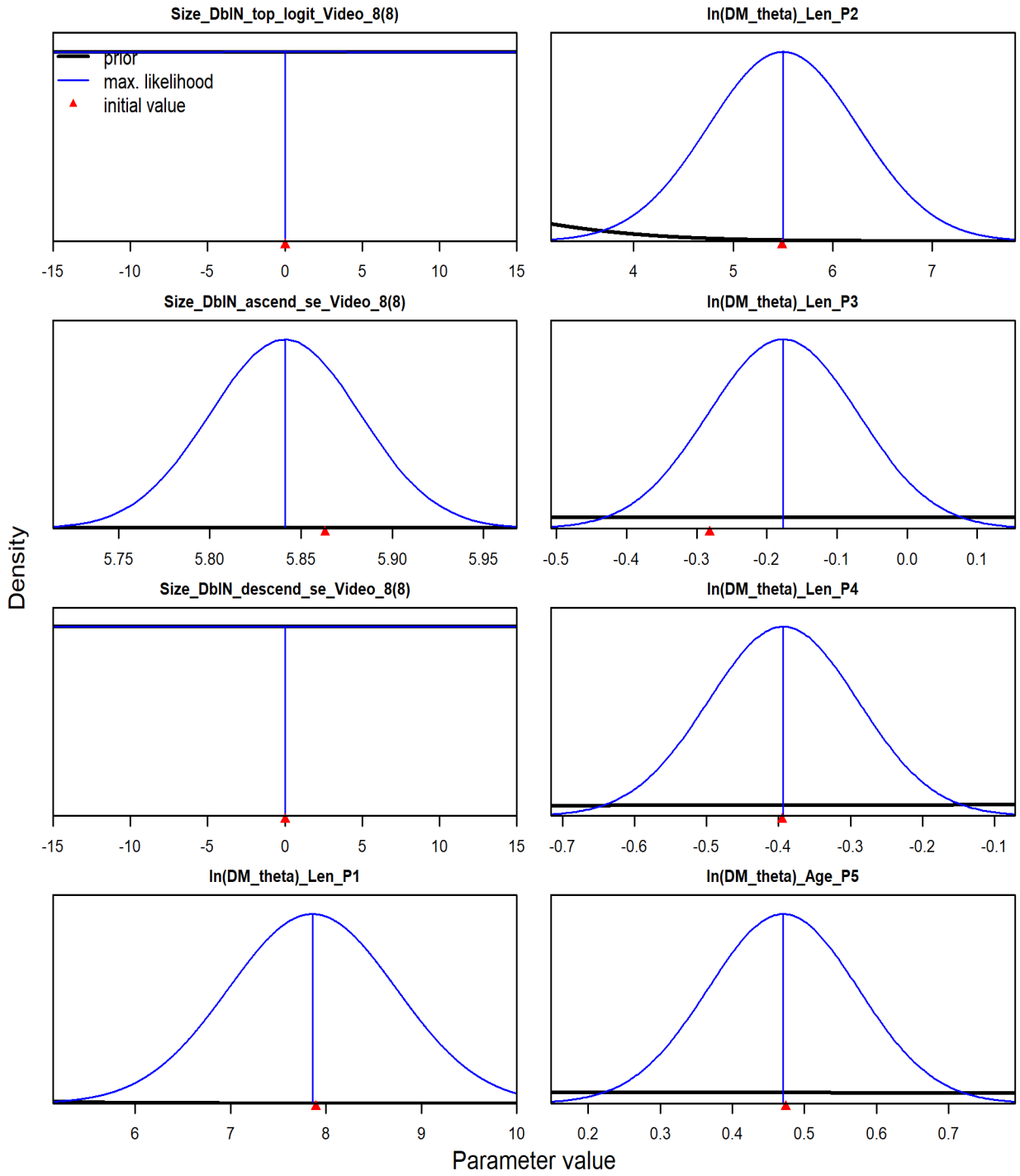


Figure 27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

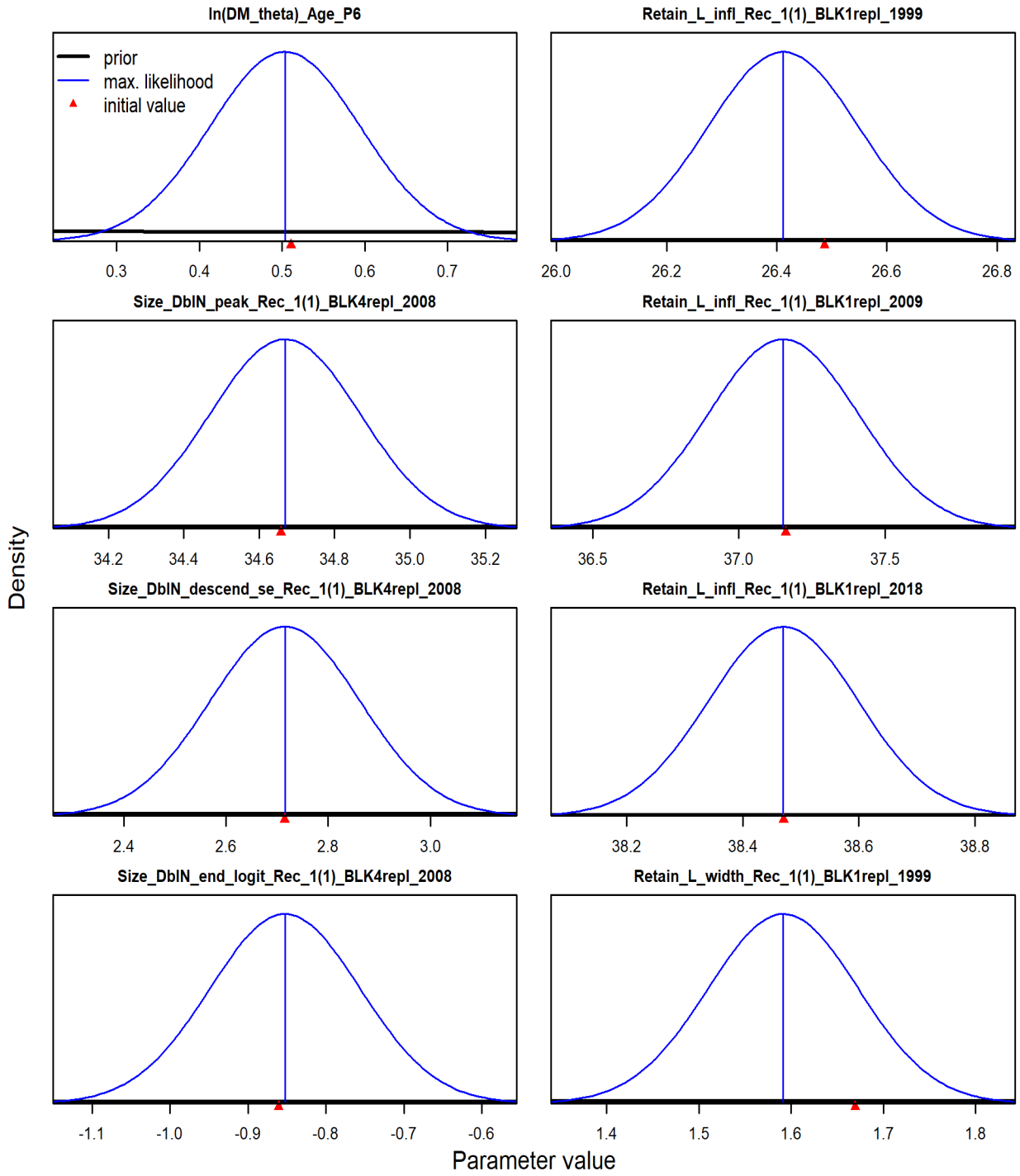


Figure 27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

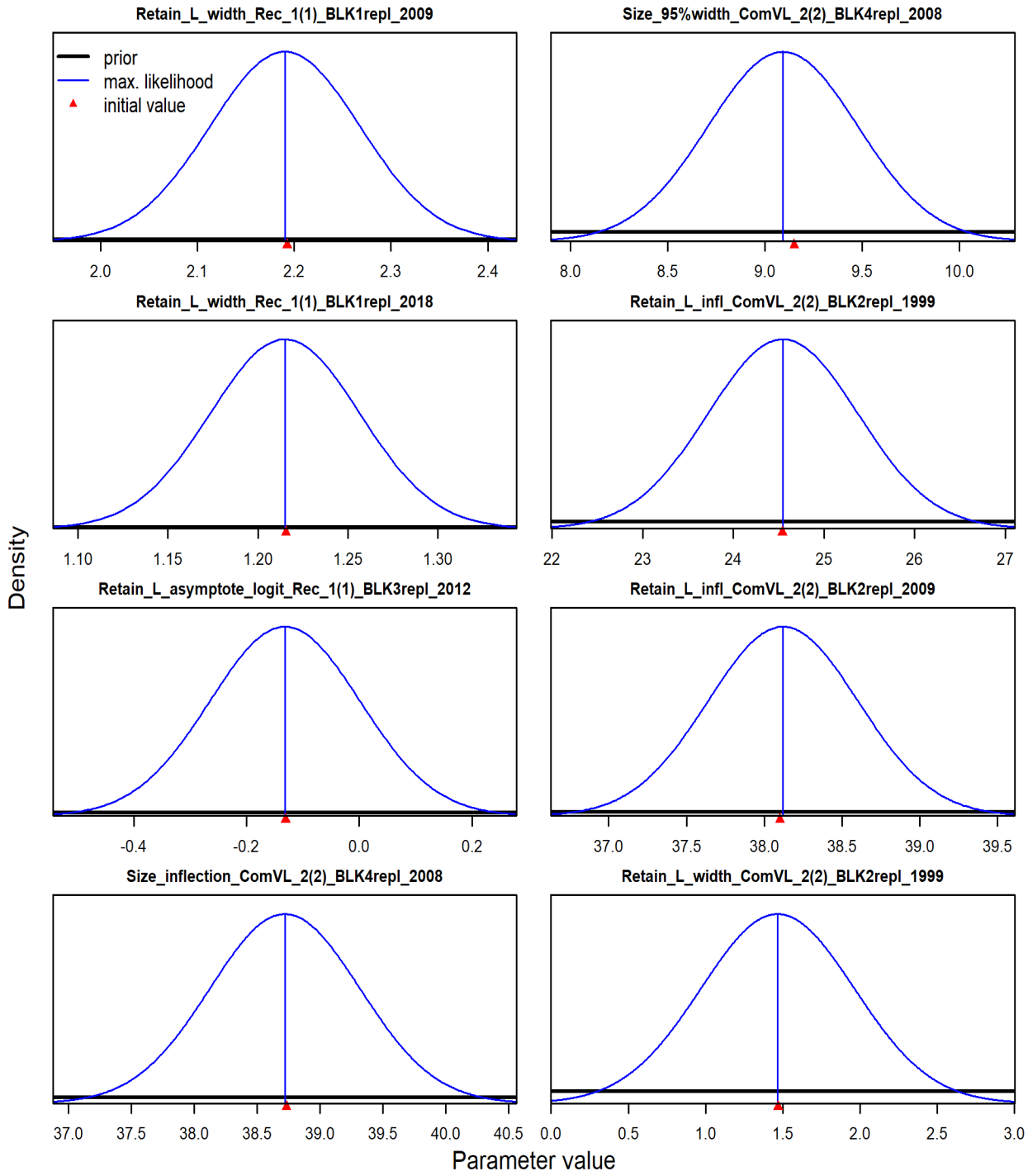


Figure 27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

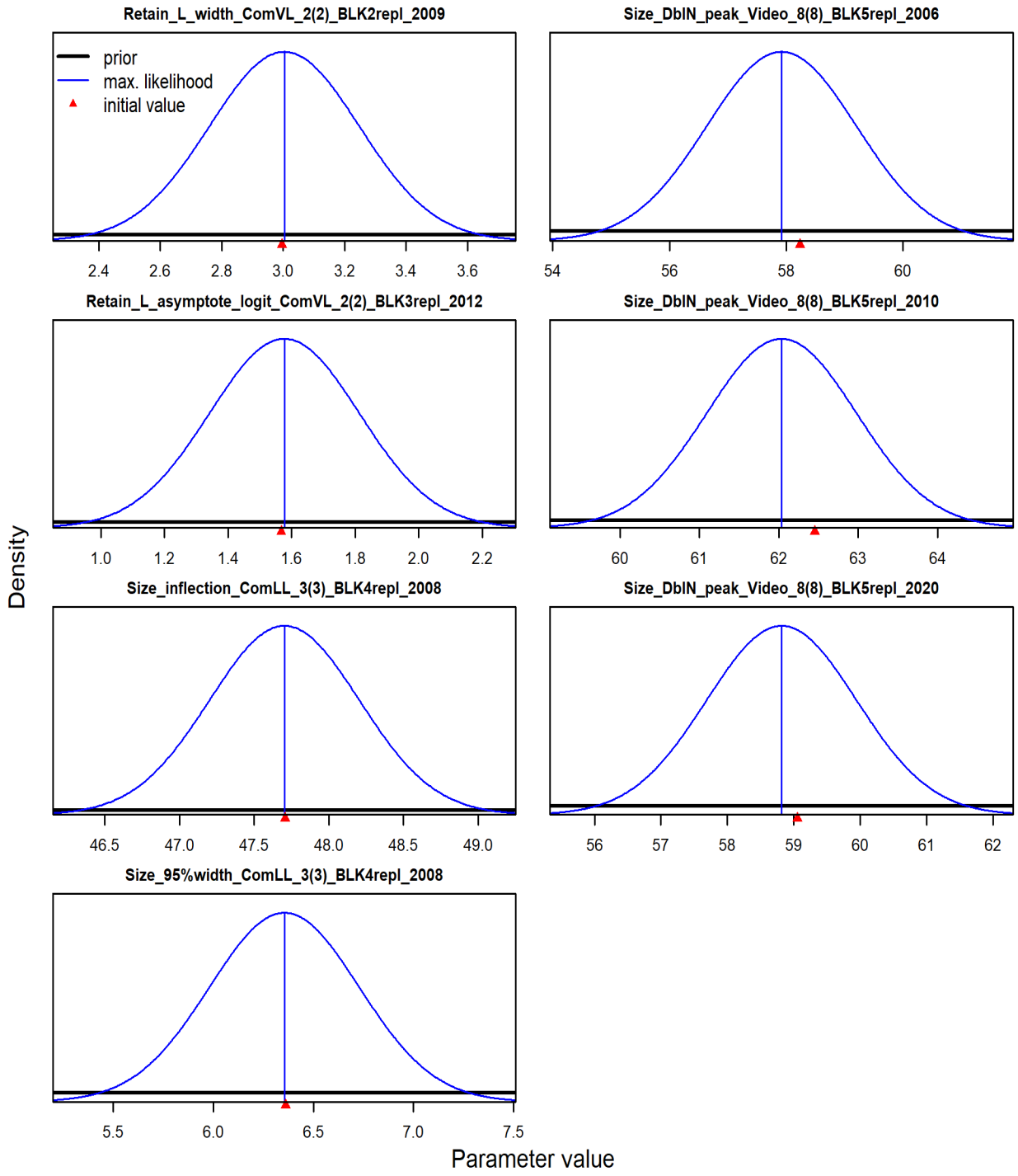
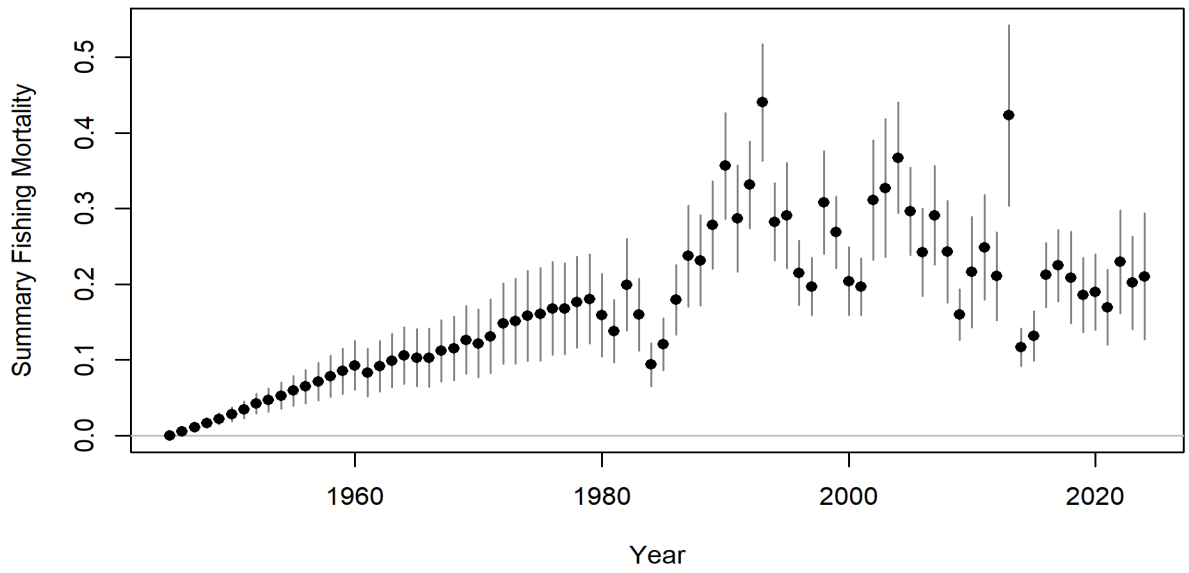


Figure 27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

SEDAR 100



SEDAR 43

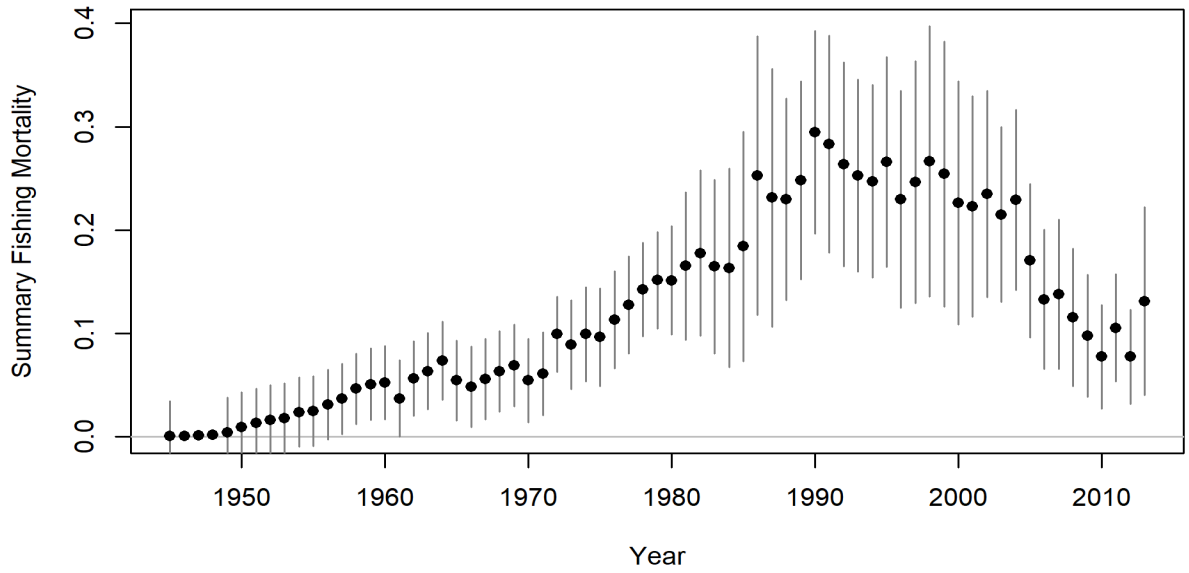
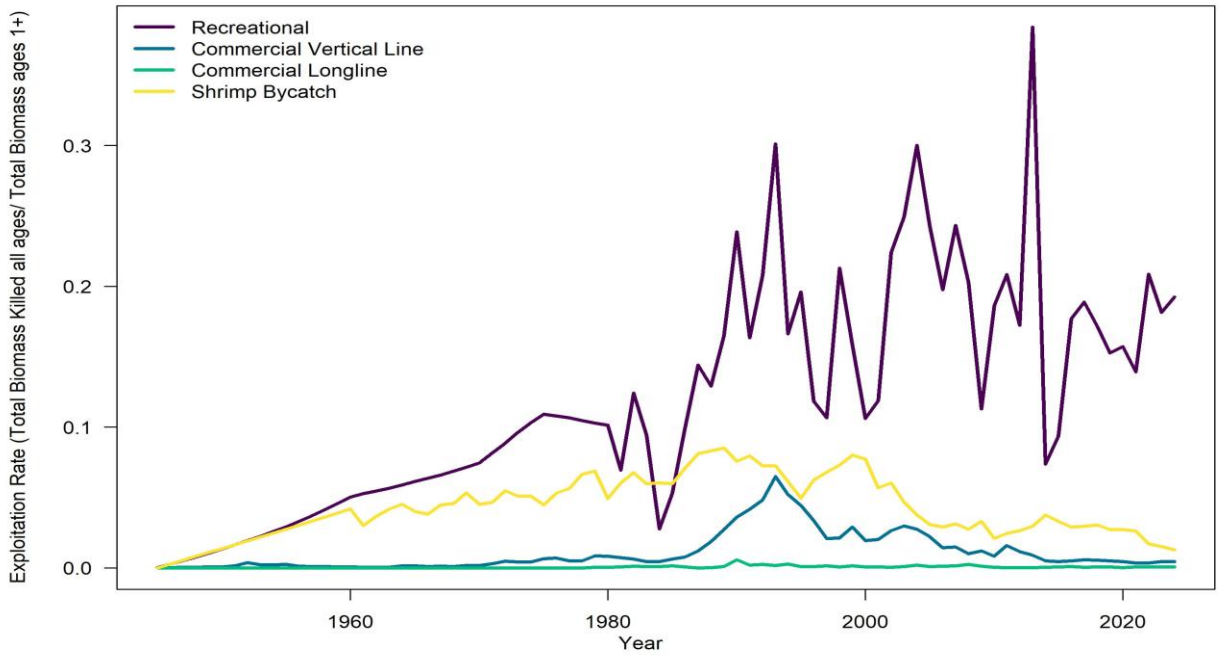


Figure 28. Annual exploitation rate estimates (total biomass killed all ages / total biomass age 1+) for SEDAR 100 and SEDAR 43.

SEDAR 100



SEDAR 43

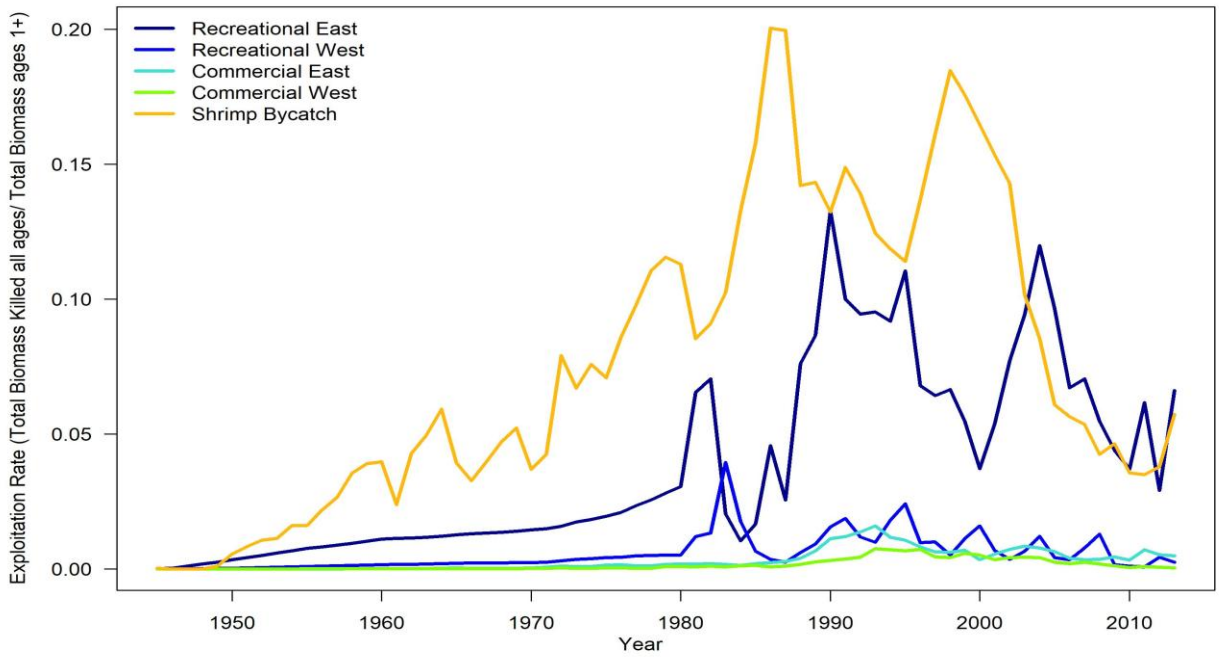


Figure 29. Annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet for SEDAR 100 and SEDAR 43.

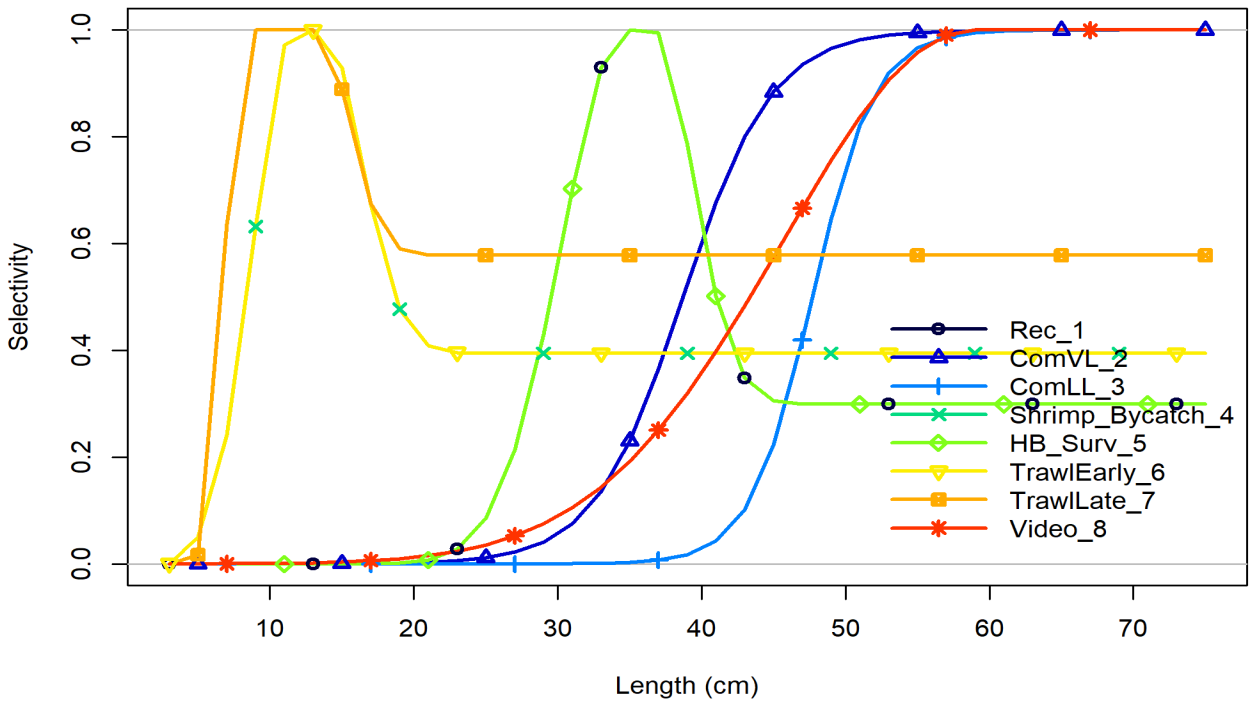


Figure 30. Length-based selectivity for each fleet and survey in the terminal year of the assessment, 2024.

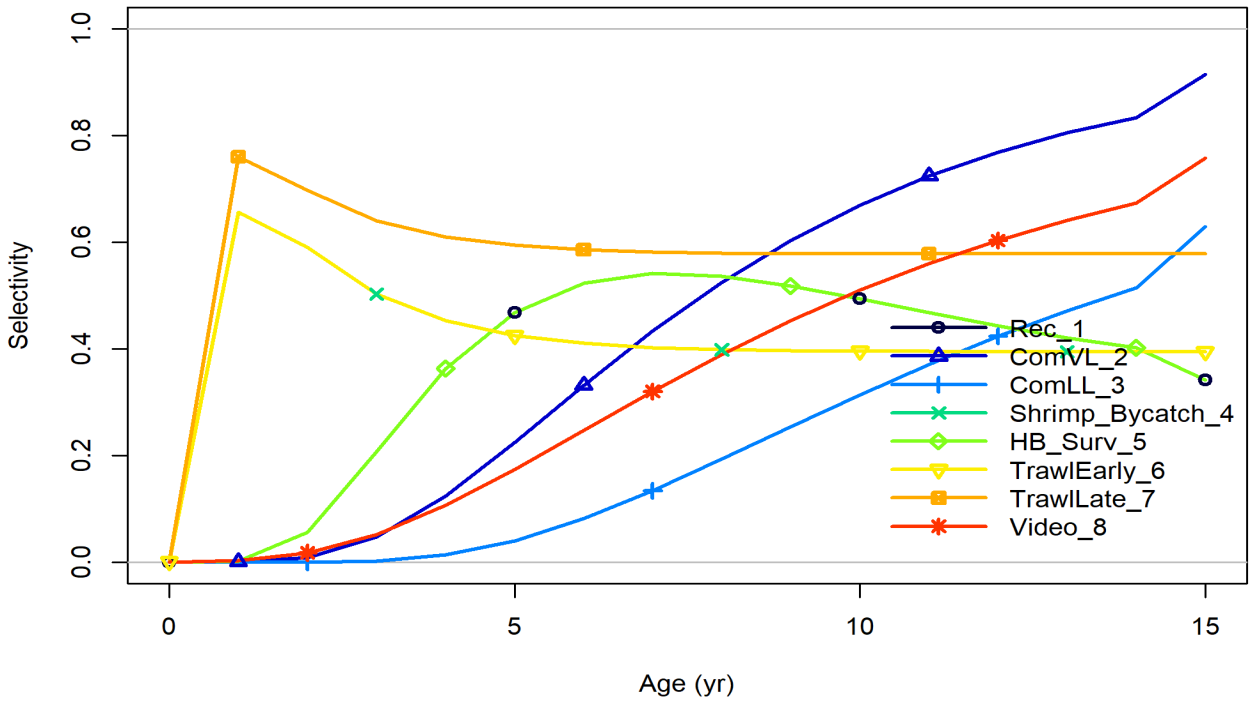


Figure 31. Derived age-based selectivity for each fleet and survey in the terminal year of the assessment, 2024.

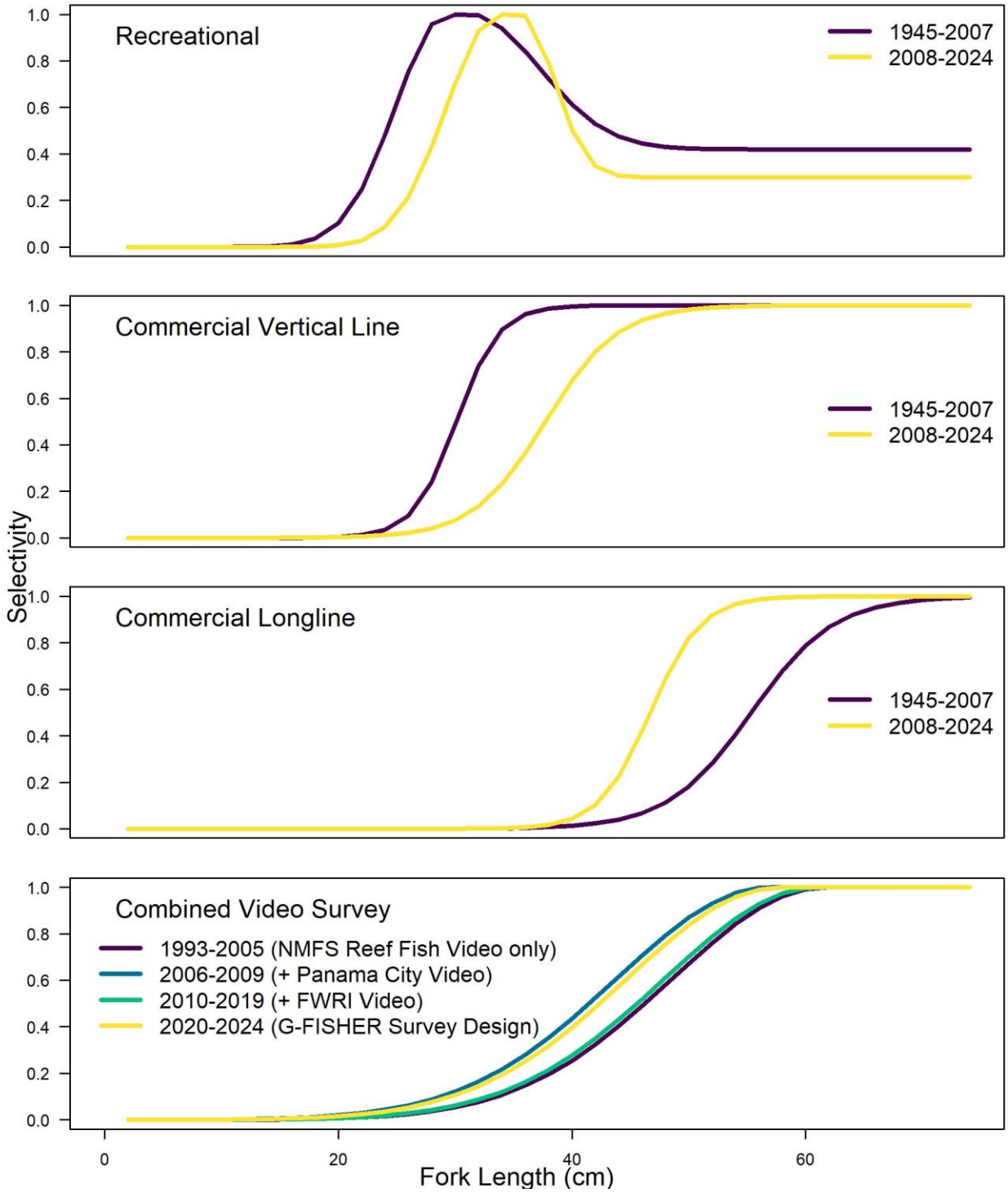


Figure 32. Time-varying selectivity at length for the fishing fleets and the Combined Video Survey.

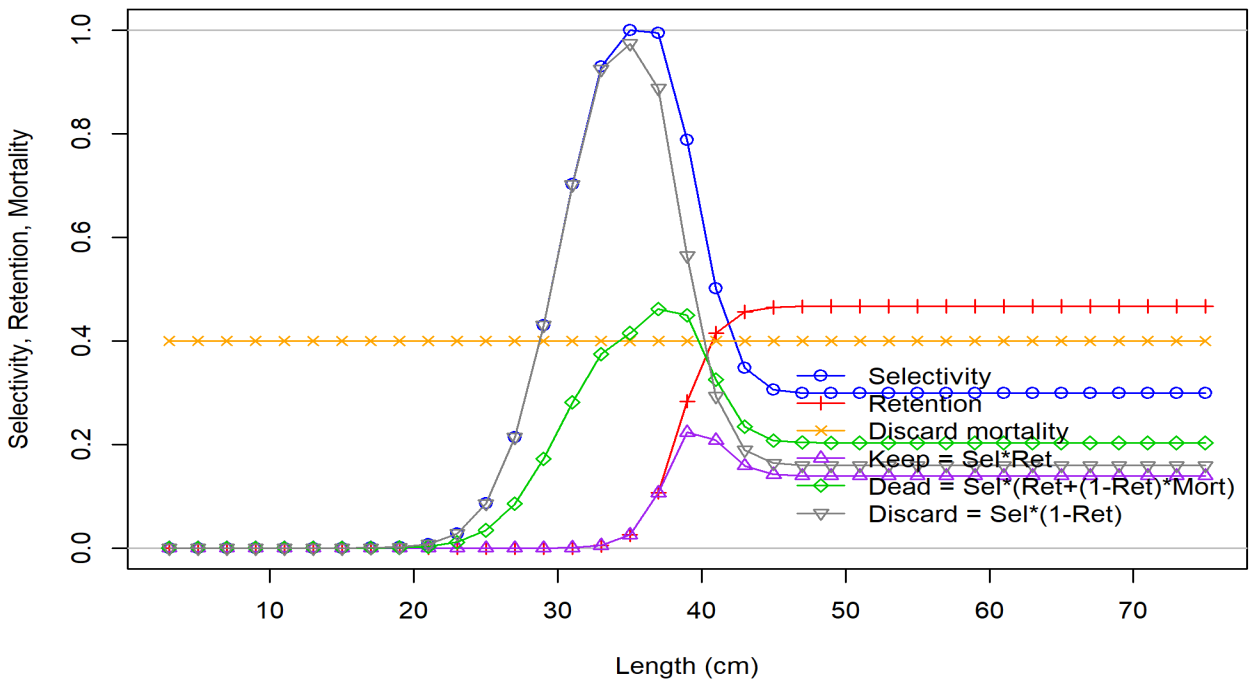


Figure 33. Length-based selectivity, retention, and discard mortality for the Recreational fleet in the terminal year of the assessment, 2024.

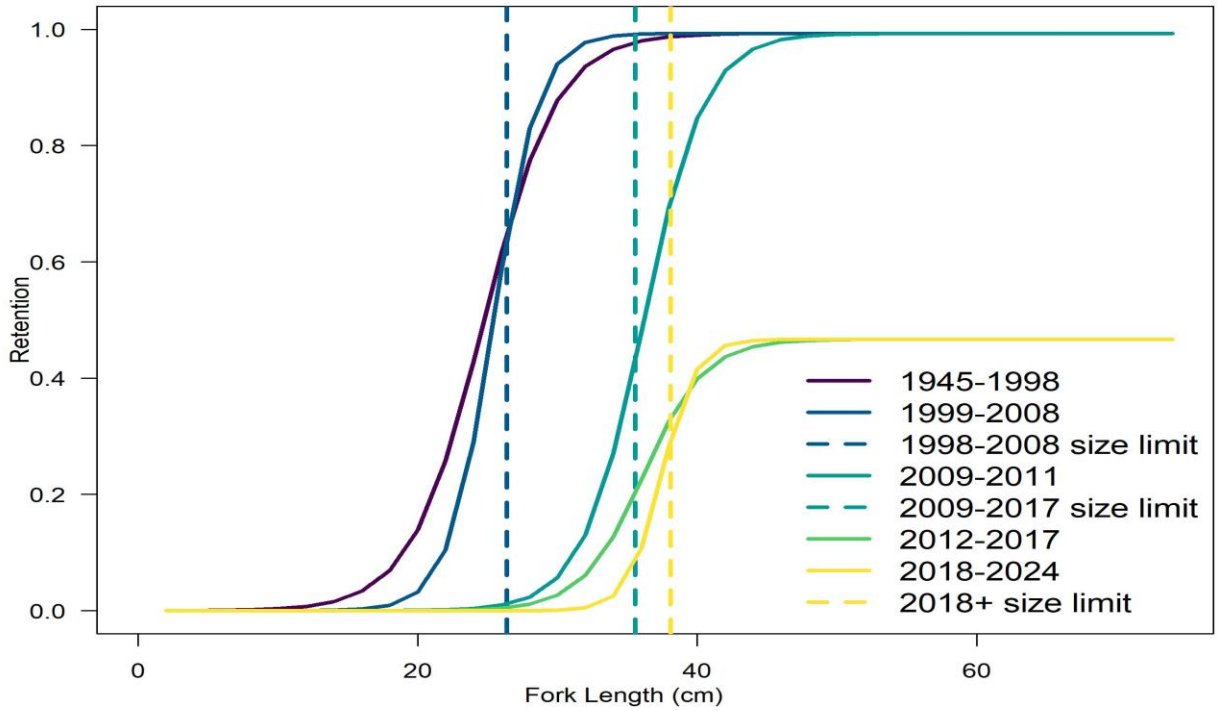


Figure 34. Time-varying retention at length for the Recreational fleet.

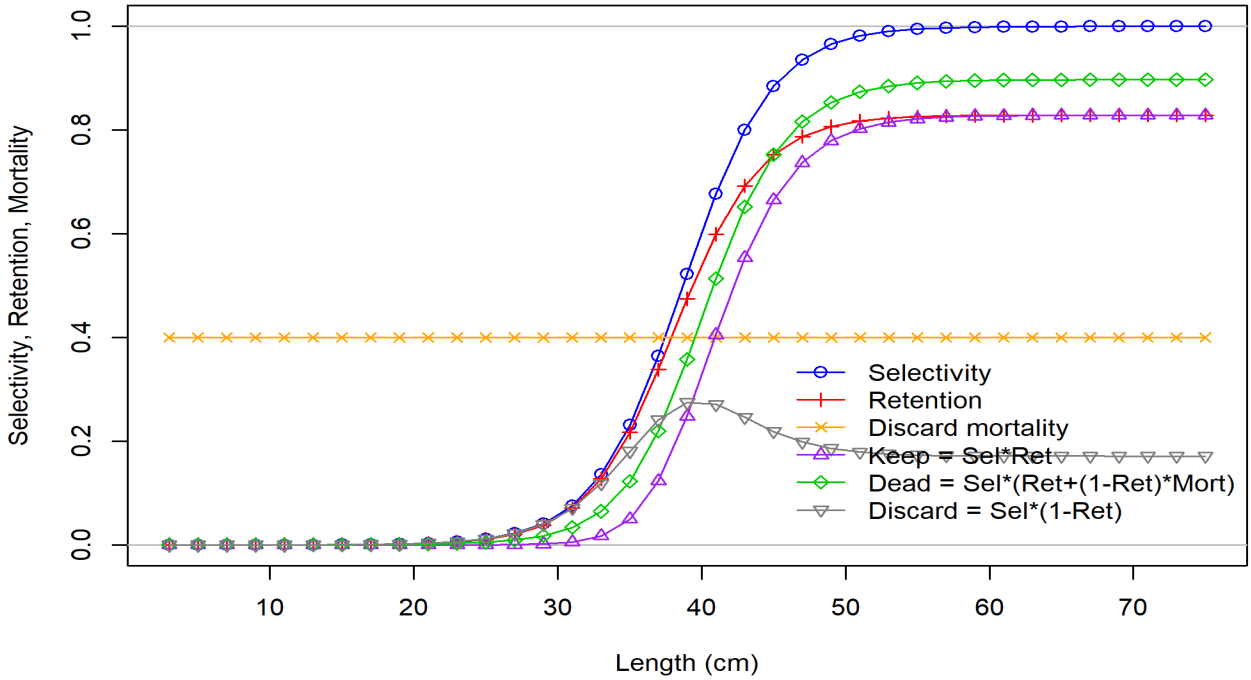


Figure 35. Length-based selectivity, retention, and discard mortality for the Commercial Vertical Line fleet in the terminal year of the assessment, 2024.

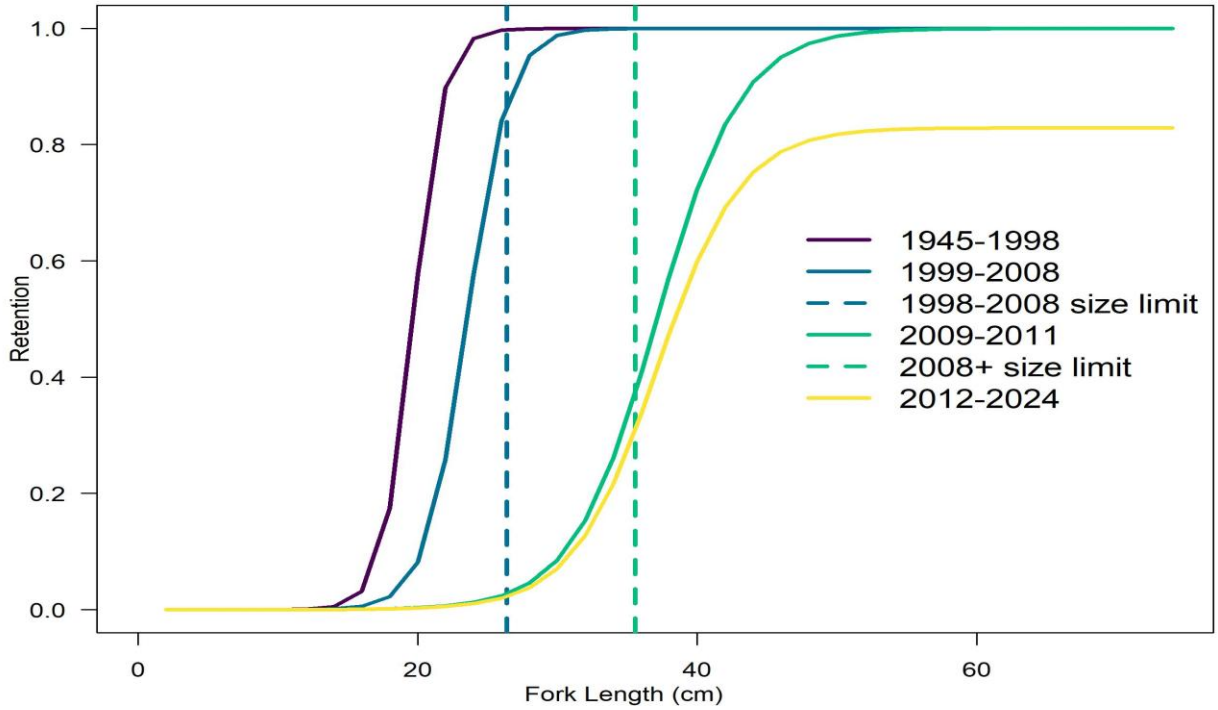


Figure 36. Time-varying retention at length for the Commercial Vertical Line fleet.

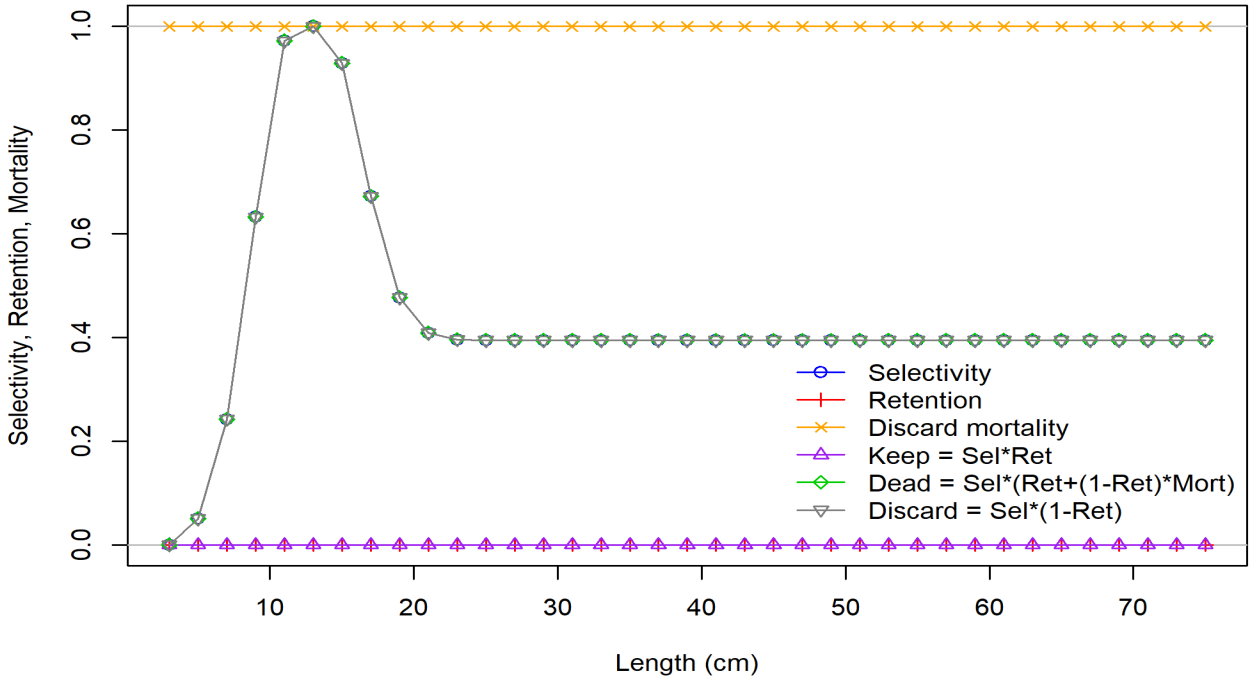
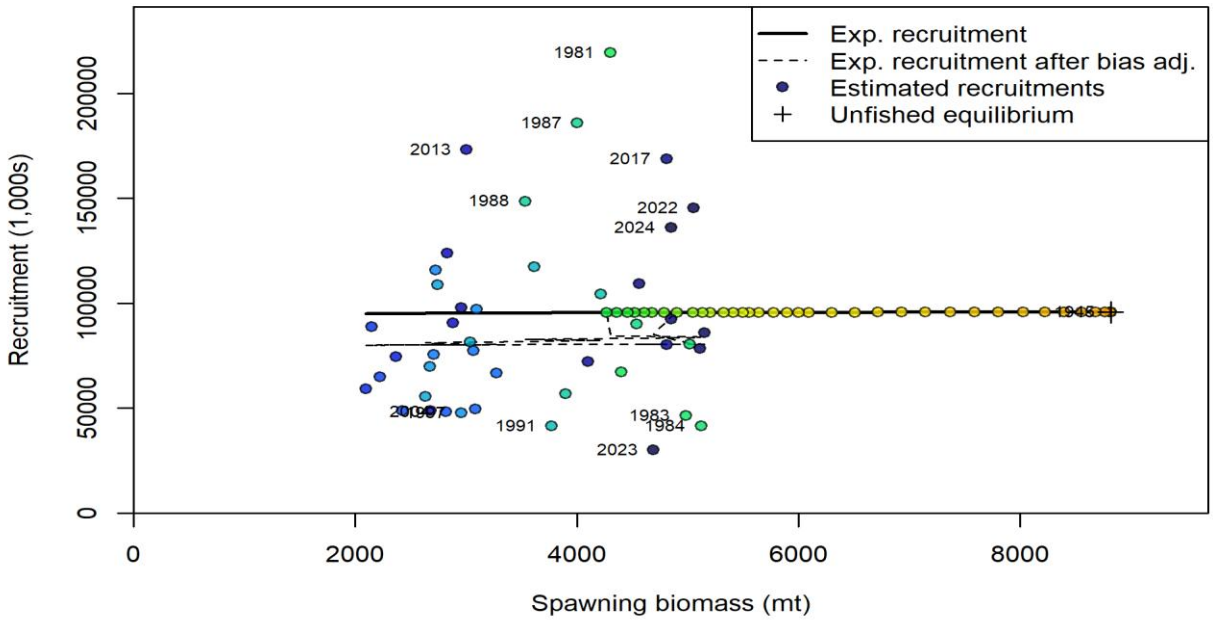


Figure 37. Length-based selectivity, retention, and discard mortality (100%) for the Shrimp Bycatch fleet in the terminal year of the assessment, 2024. Selectivity (blue line) is constant over the entire assessment time period (1945-2024).

SEDAR 100



SEDAR 43

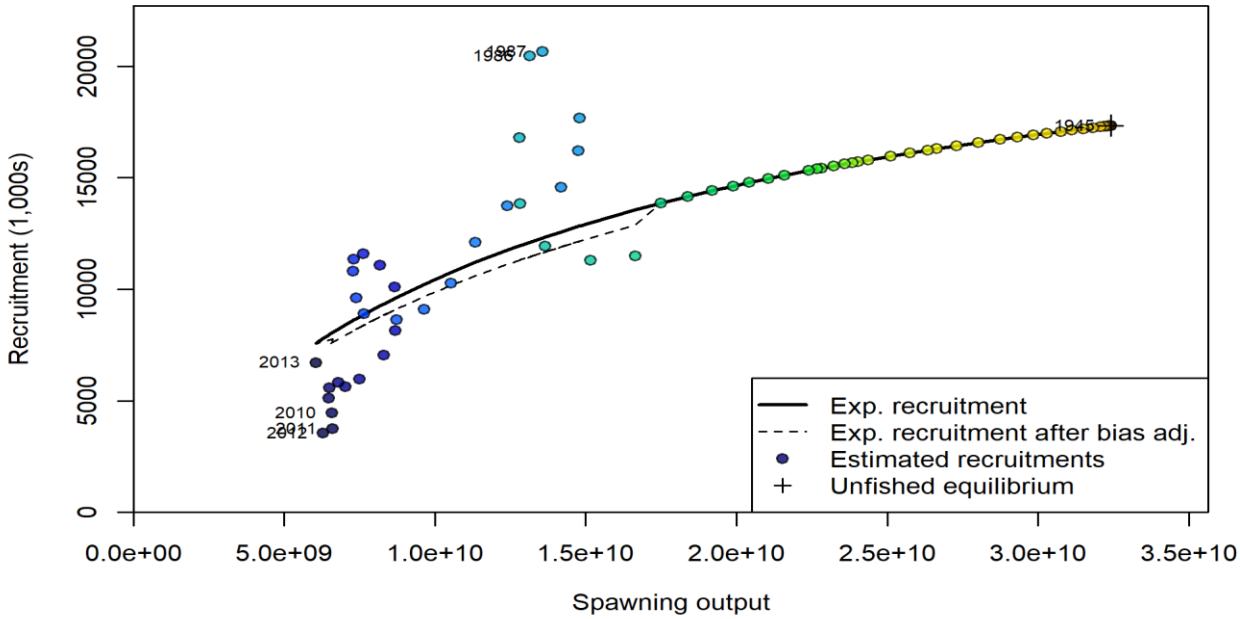
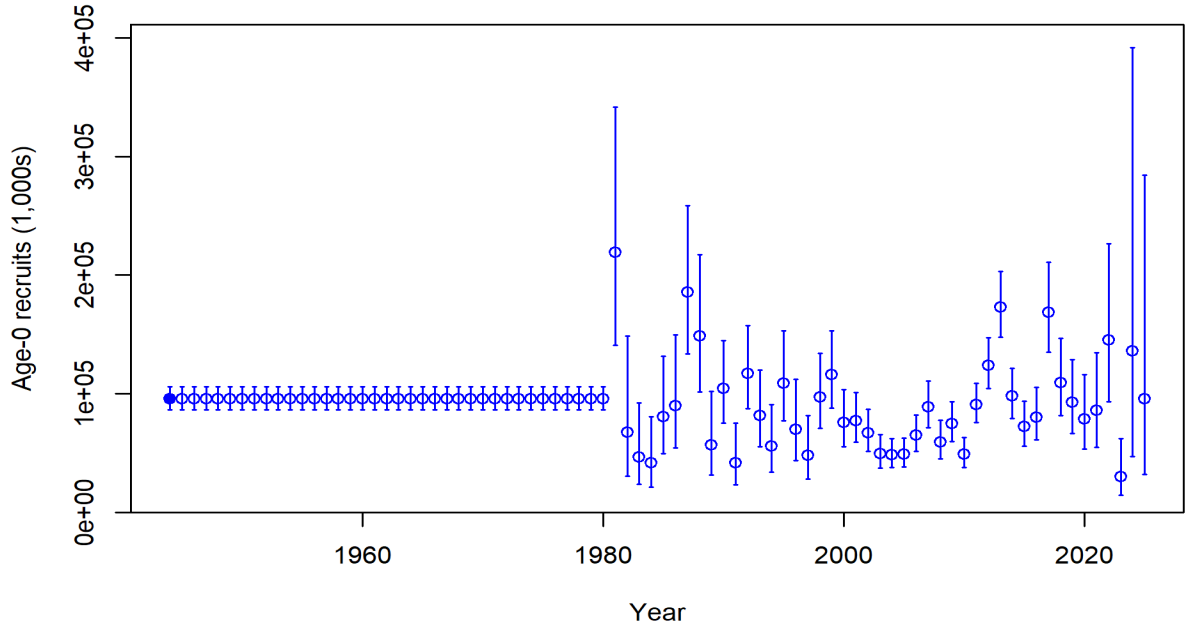


Figure 38. Predicted stock-recruit relationship for SEDAR 100 and SEDAR 43. SEDAR 100 fixed steepness and SigmaR at 0.99 and 0.6, respectively, whereas both were estimated in SEDAR 43. Plotted are predicted annual recruitments from Stock Synthesis (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line).

SEDAR 100



SEDAR 43

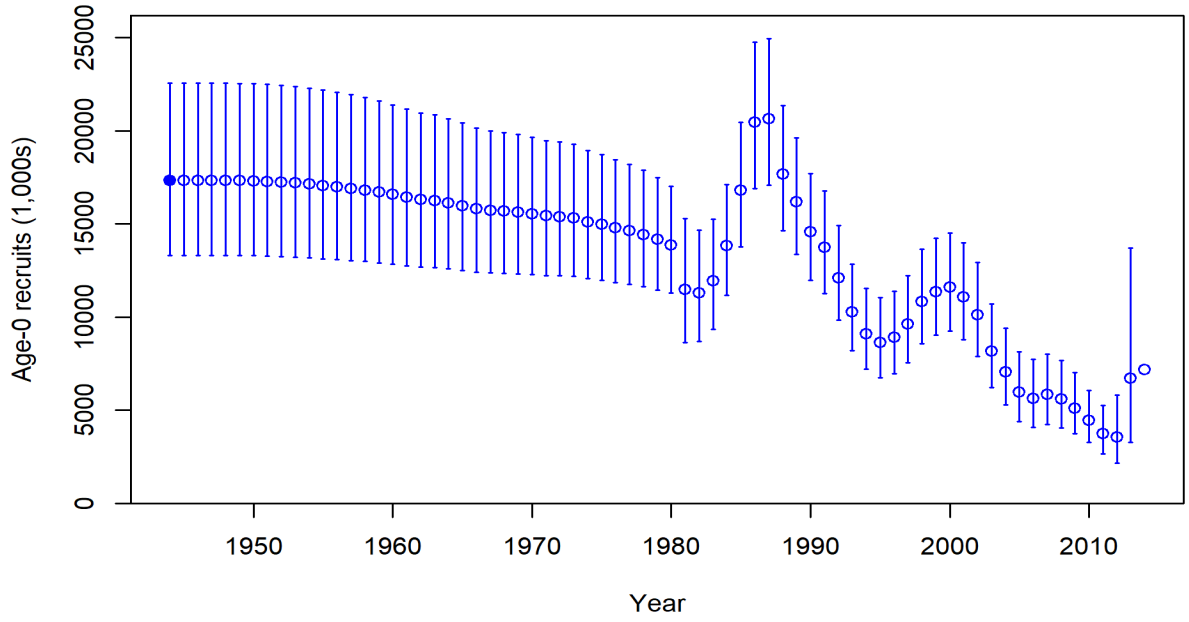
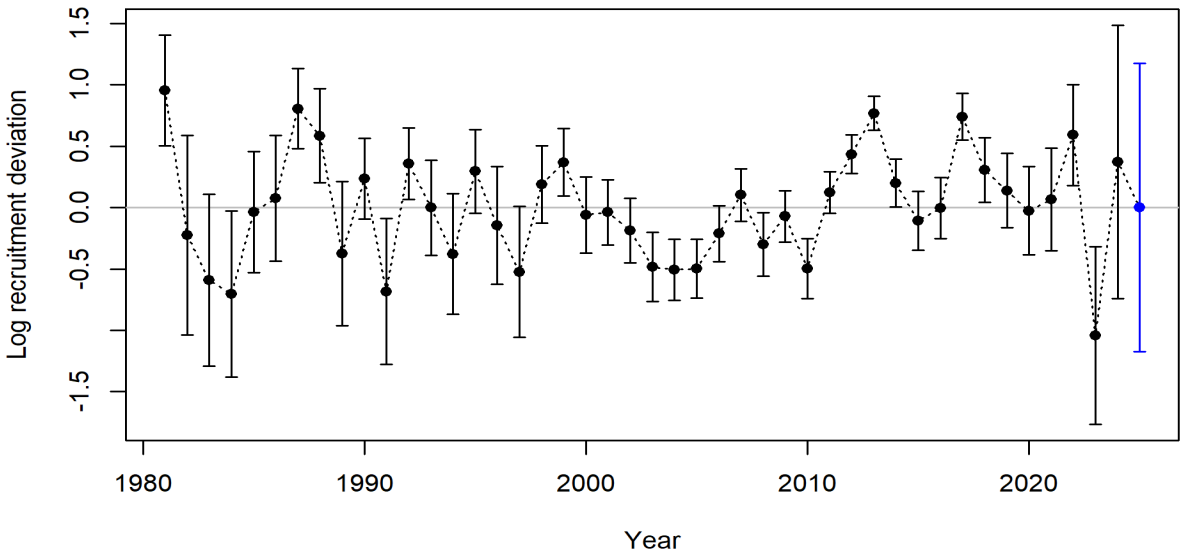


Figure 39. Estimated Age-0 recruitment with 95% confidence intervals for SEDAR 100 and SEDAR 43. SEDAR 100 fixed steepness and SigmaR at 0.99 and 0.6, respectively, whereas both were estimated in SEDAR 43.

SEDAR 100



SEDAR 43

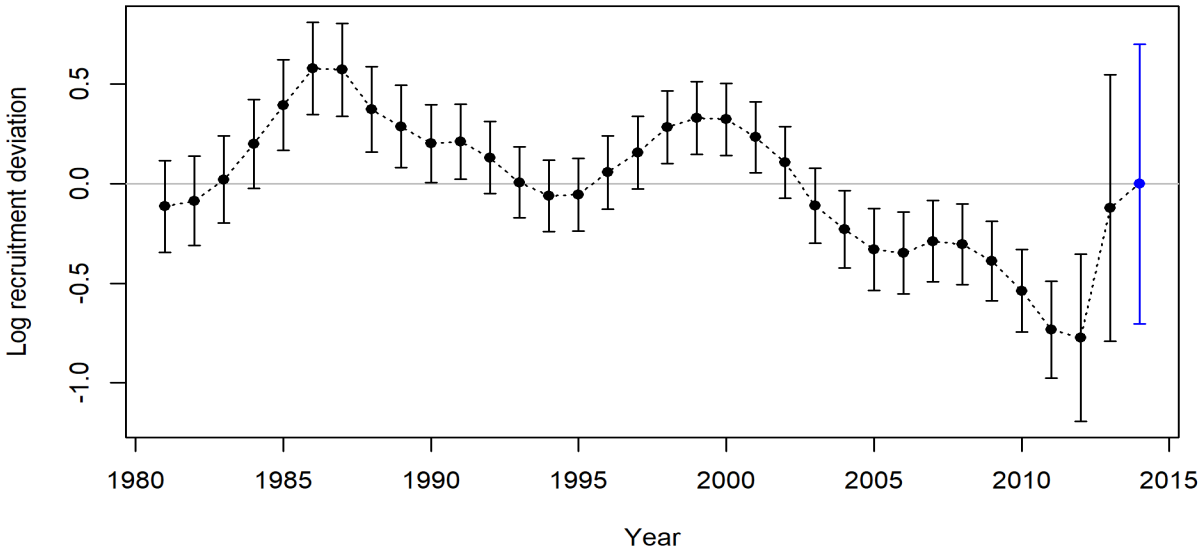
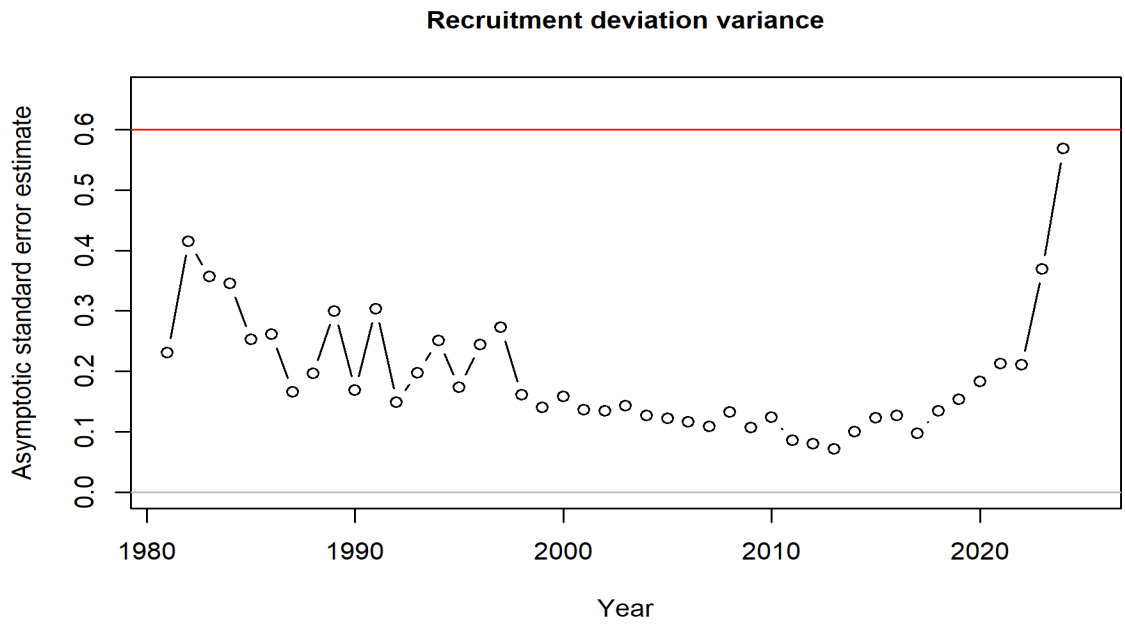


Figure 40. Estimated log recruitment deviations for SEDAR 100 and SEDAR 43. SEDAR 100 fixed steepness and SigmaR at 0.99 and 0.6, respectively, whereas both were estimated in SEDAR 43. Blue dots identify years where recruitment deviations were not estimated.

SEDAR 100



SEDAR 43

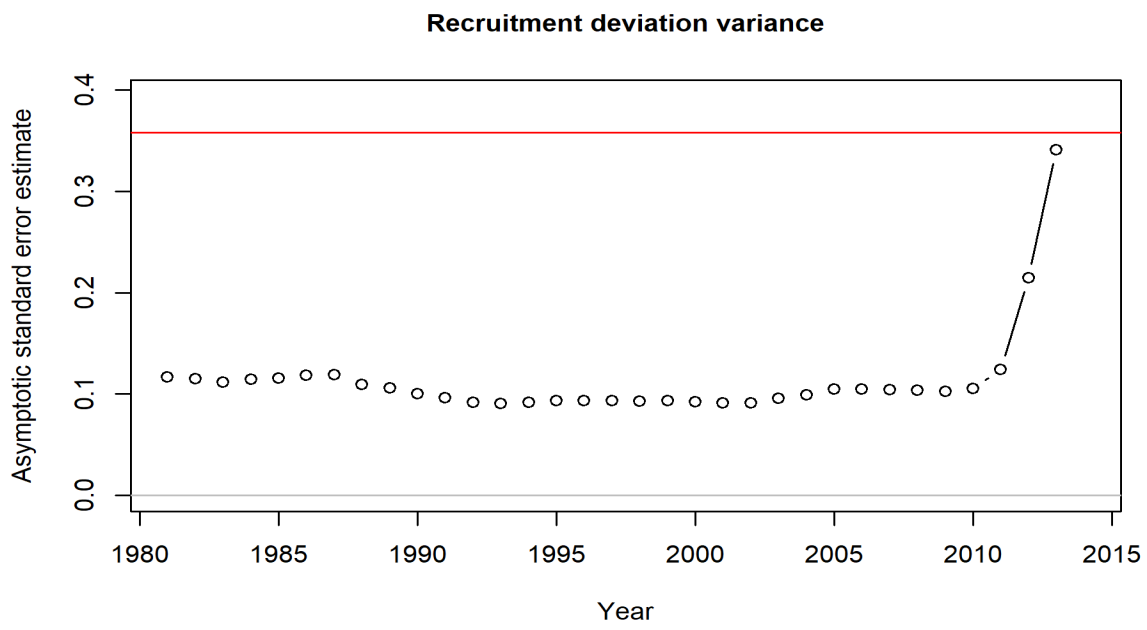


Figure 41. Asymptotic standard errors for recruitment deviations for SEDAR 100 and SEDAR 43. The red line represents the fixed value of 0.6 and estimated value of 0.358 from the SEDAR 100 and SEDAR 43 models, respectively.

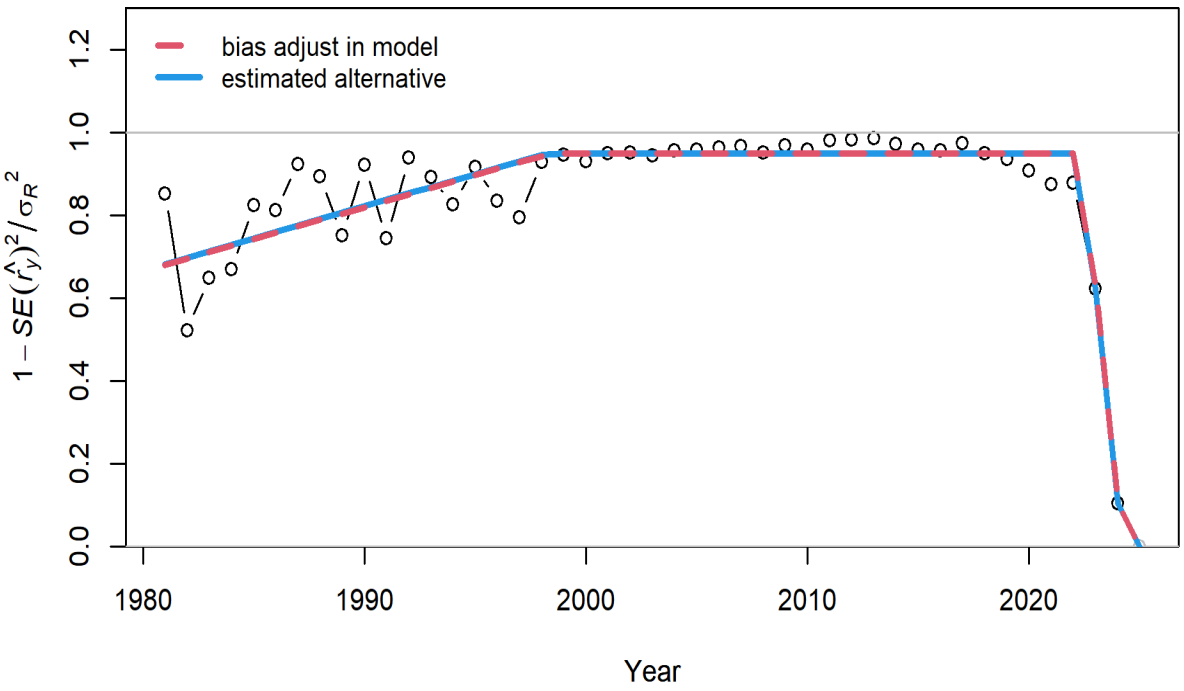


Figure 42. Points are transformed variances. Red line shows current settings for bias adjustment specified for the SEDAR 100 AP Model, which coincides with the least squares estimate of alternative bias adjustment relationship for recruitment deviations (dashed red line). For more information, see Methot and Taylor (2011).

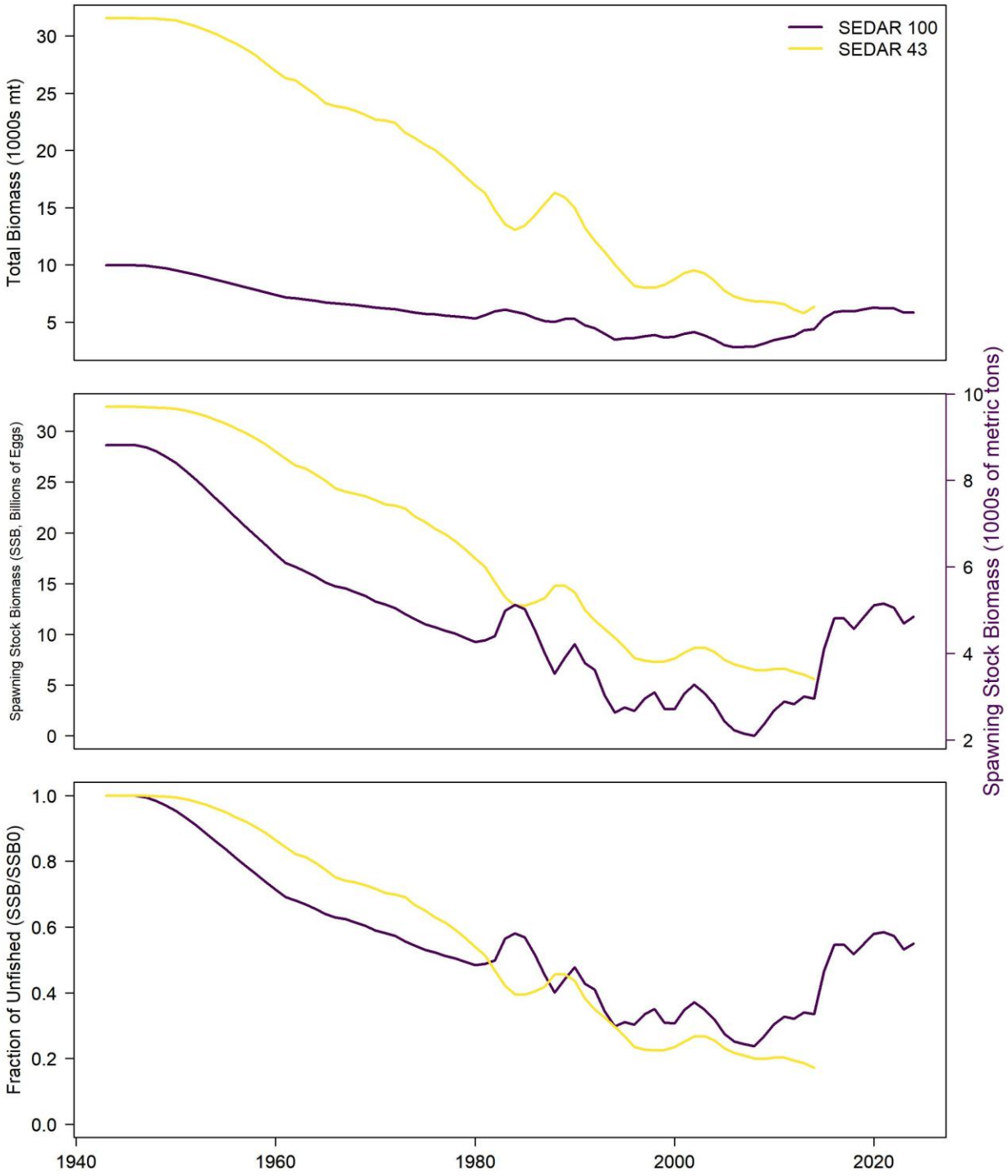
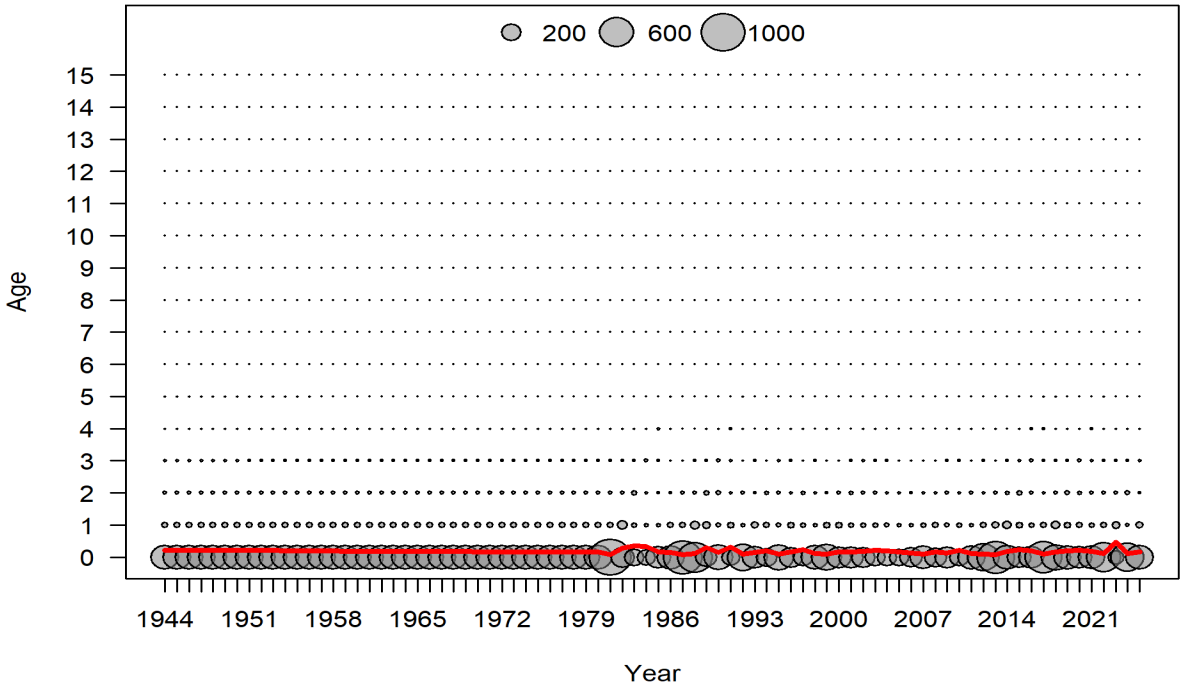


Figure 43. Estimates of annual total biomass (in 1000s of metric tons; top panel), spawning stock biomass (middle panel), and the fraction of virgin or unfished SSB (SSB/SSB_0; bottom panel) for SEDAR 100 and SEDAR 43. Note that the units of SSB changed from the number of eggs in SEDAR 43 to metric tons in SEDAR 100.

SEDAR 100



SEDAR 43

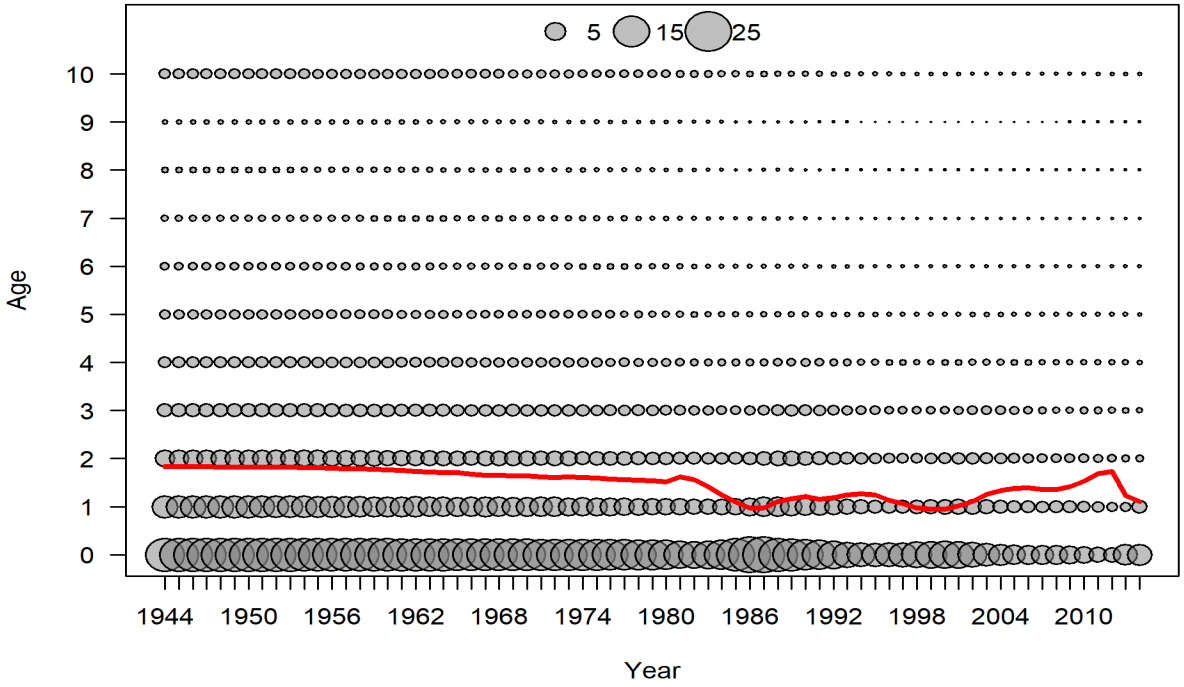


Figure 44. Expected beginning of year numbers-at-age (bubbles) and mean age (red line) for SEDAR 100 and SEDAR 43.

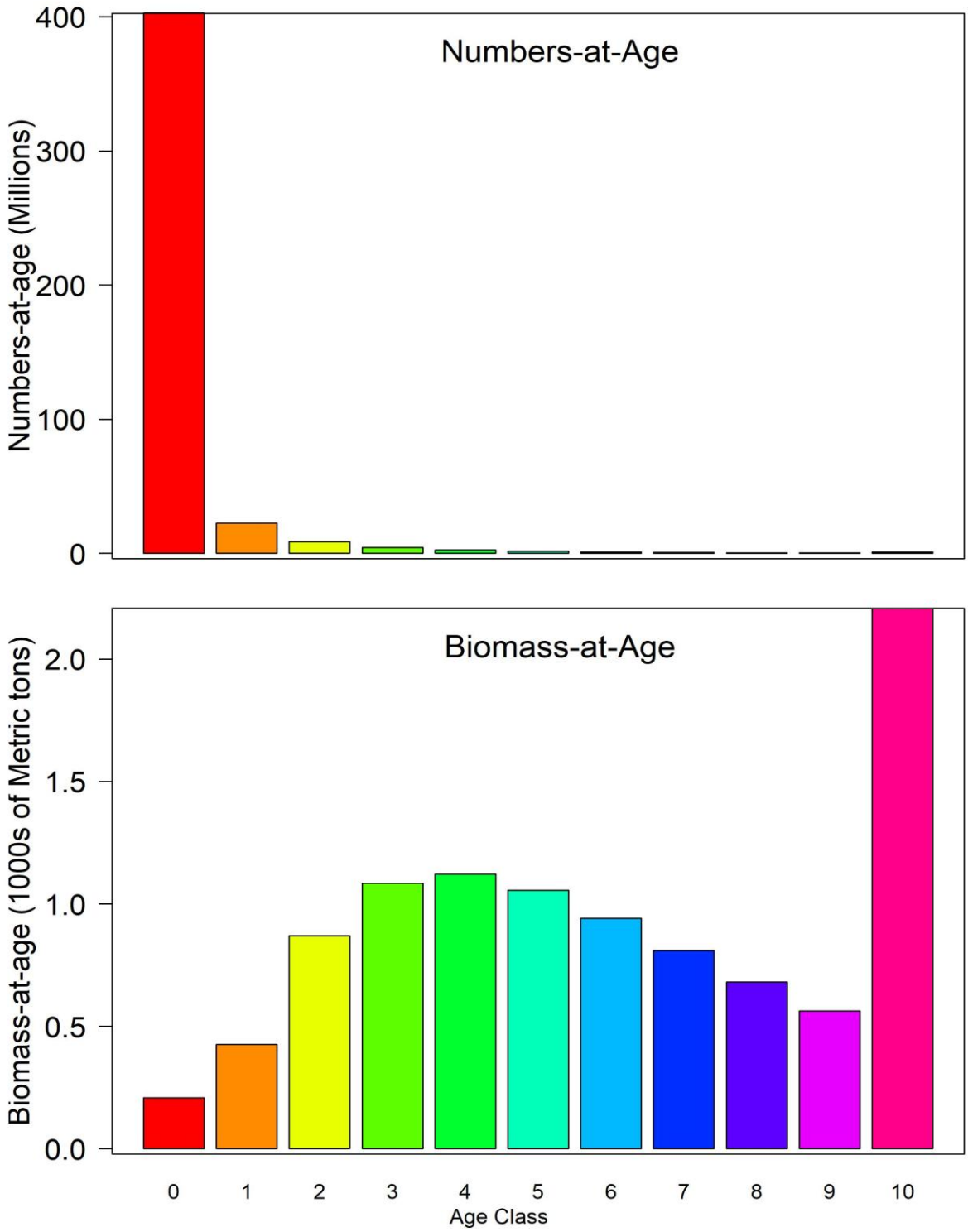


Figure 45. Expected numbers-at-age and biomass-at-age at virgin stock conditions.

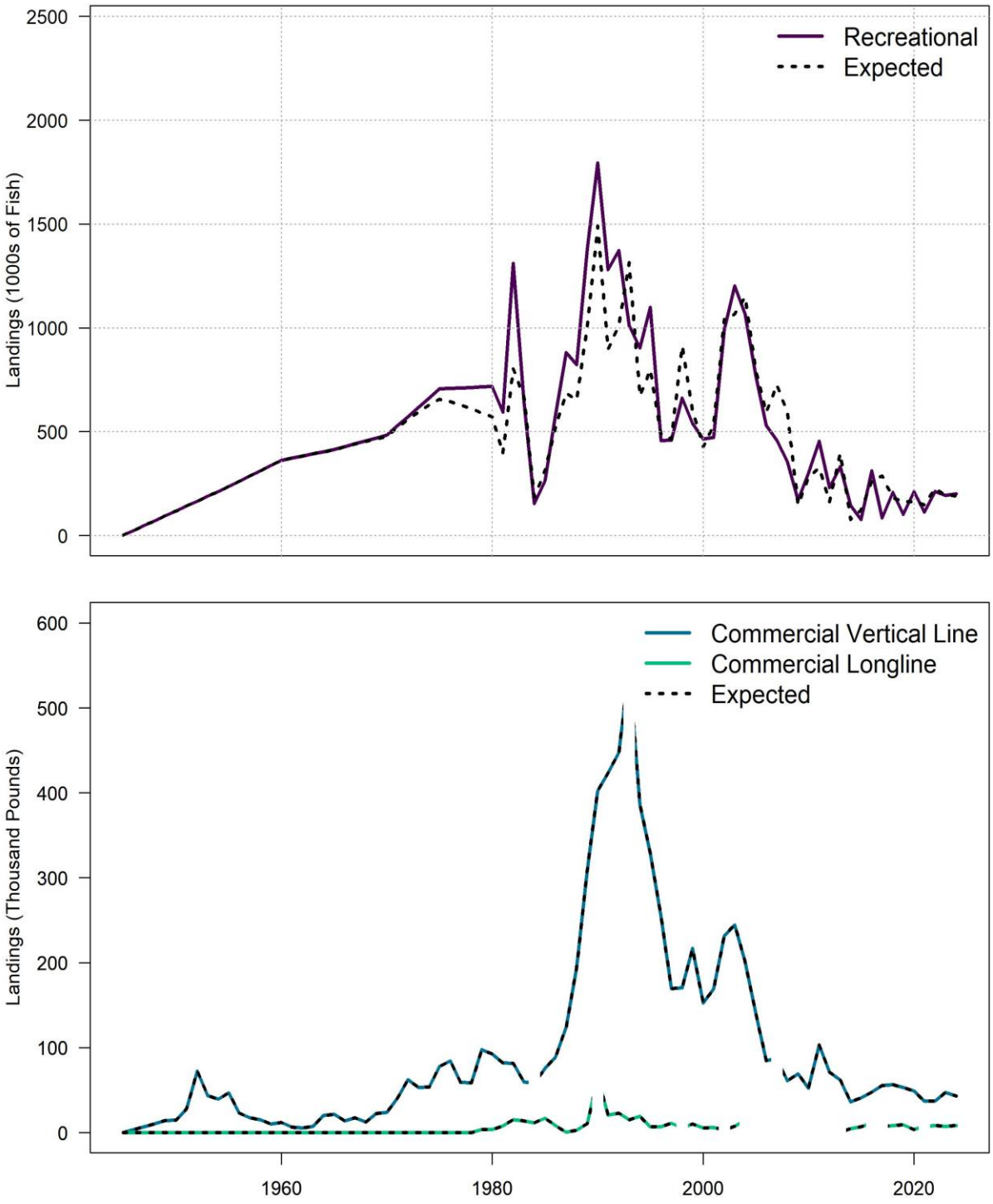
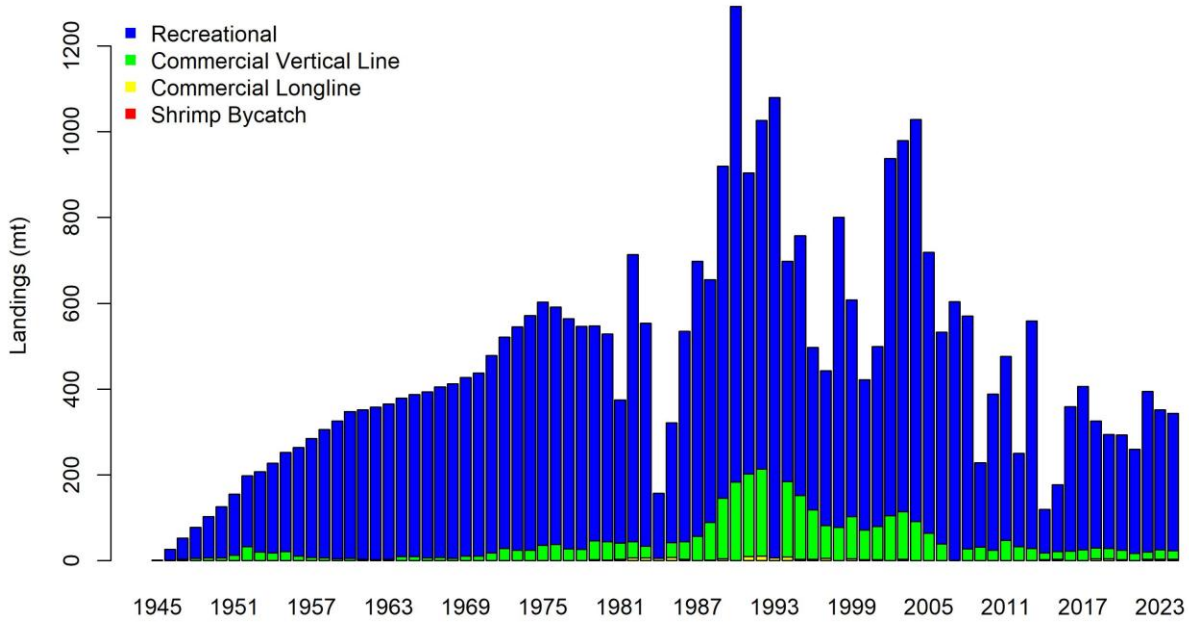


Figure 46. Observed (thick colored lines) and expected (dashed lines) landings by fleet. Commercial landings were input into the stock assessment model as metric tons in whole weight, and are shown in thousands of pounds. Associated log-scale standard errors are provided in ***Tables 21-23****. Confidential data have been excluded.*

SEDAR 100



SEDAR 43

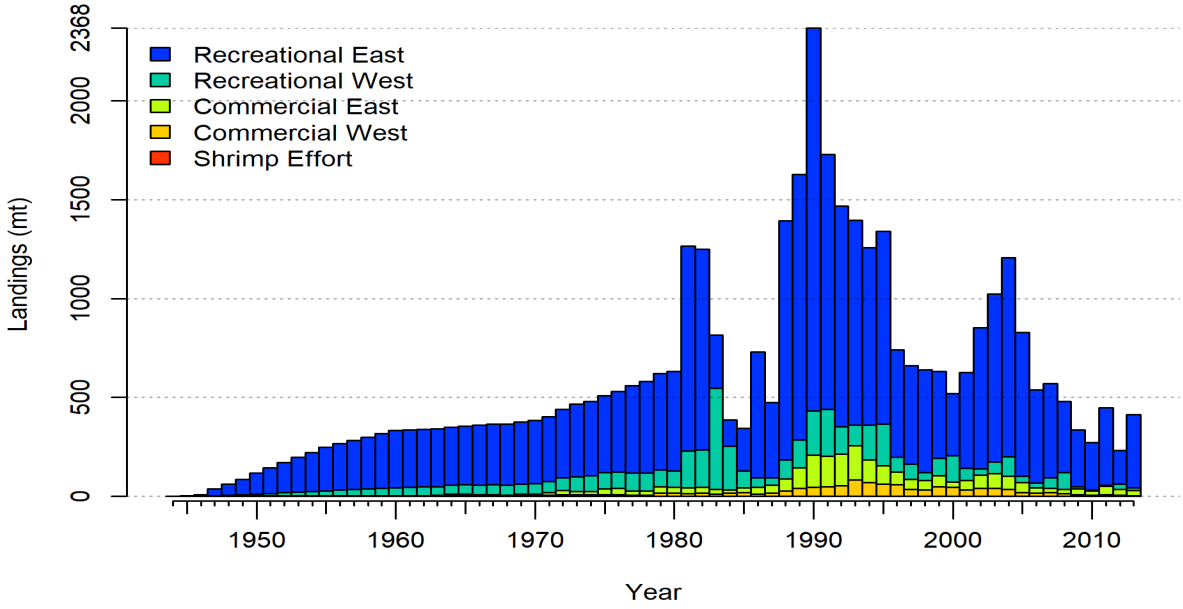


Figure 47. Expected landings (metric tons, mt) by fleet for SEDAR 100 and SEDAR 43. Confidential data for SEDAR 100 have been excluded for the Commercial Vertical Line and Commercial Longline fleets.

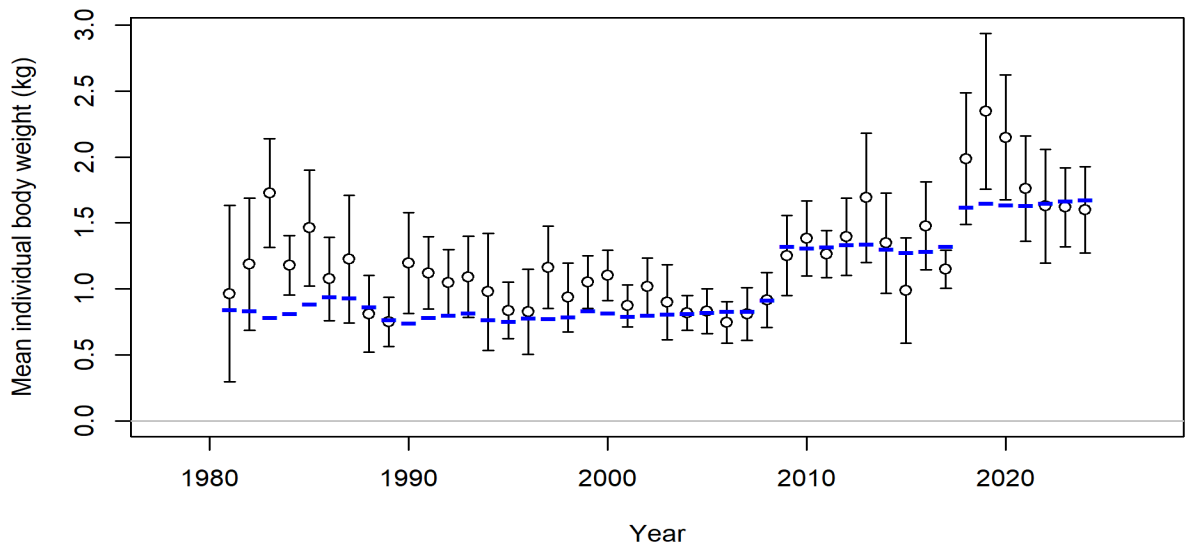
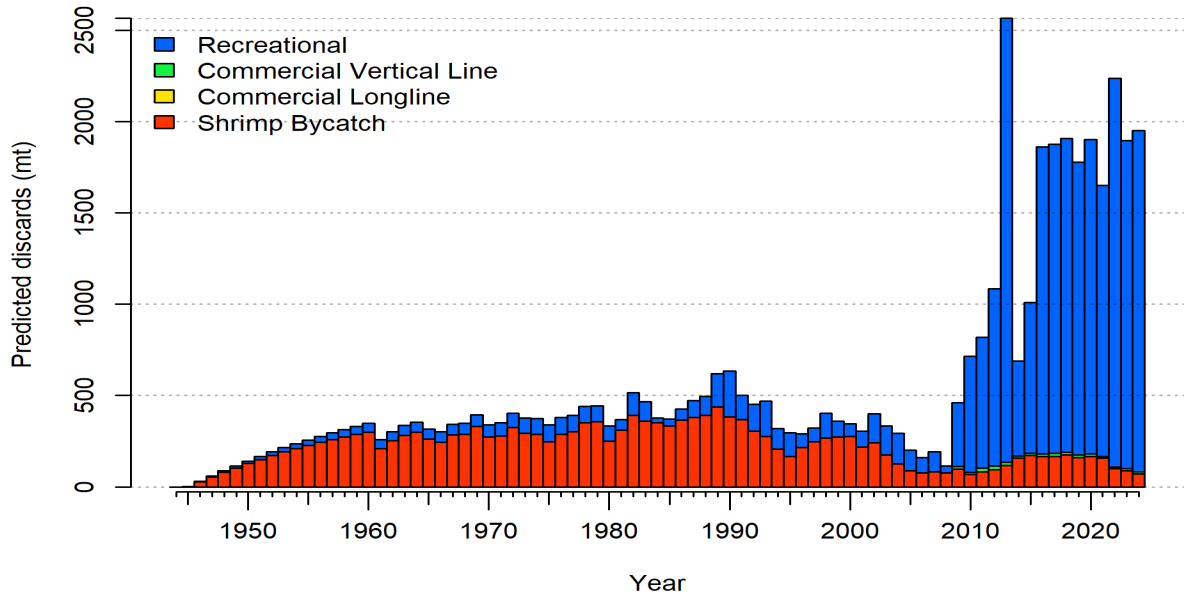


Figure 48. Input (dots with 95% confidence intervals) and expected (blue dashes) mean weight (kg, whole weight) of Gray Triggerfish landed by the Recreational fleet.

SEDAR 100



SEDAR 43

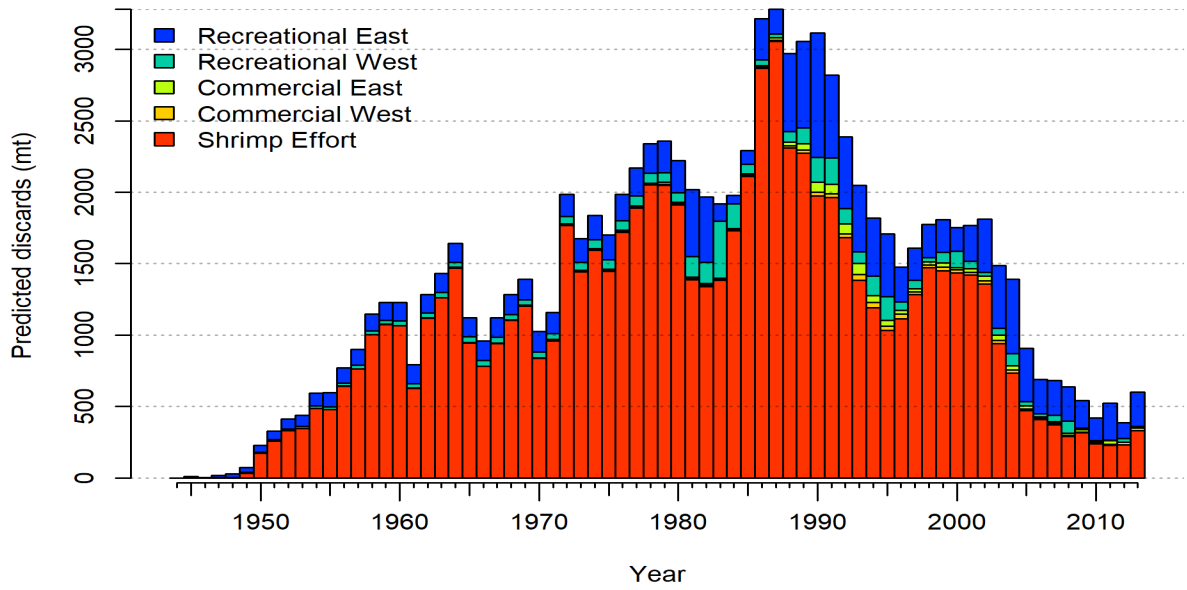
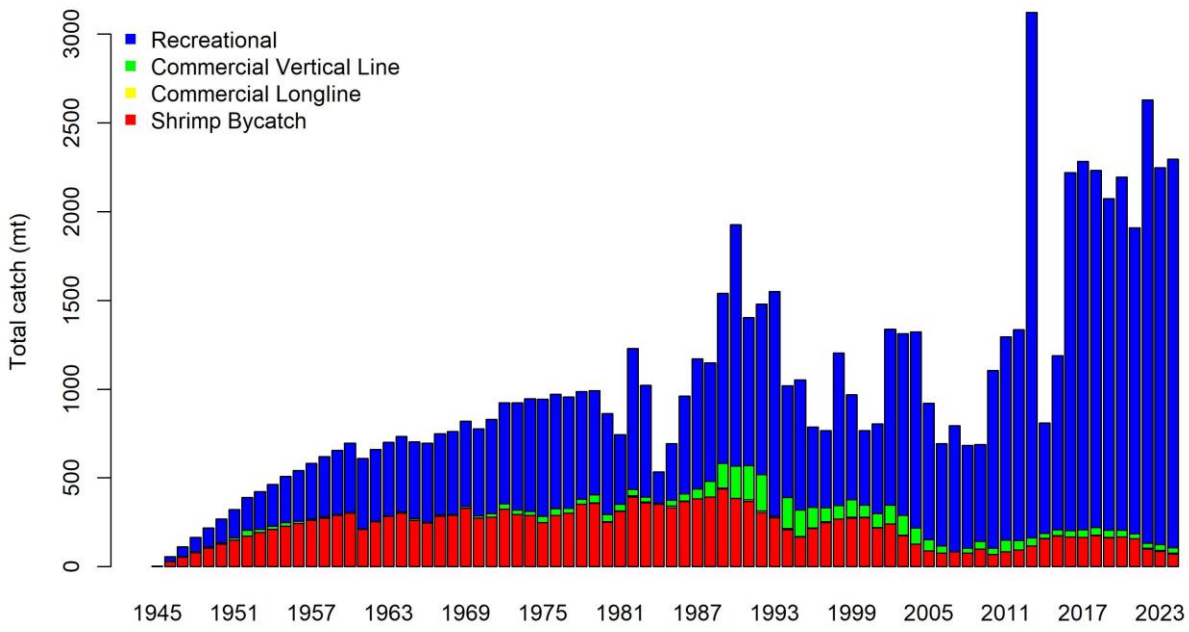


Figure 49. Expected discards (metric tons, mt) by fleet for SEDAR 100 and SEDAR 43.

SEDAR 100



SEDAR 43

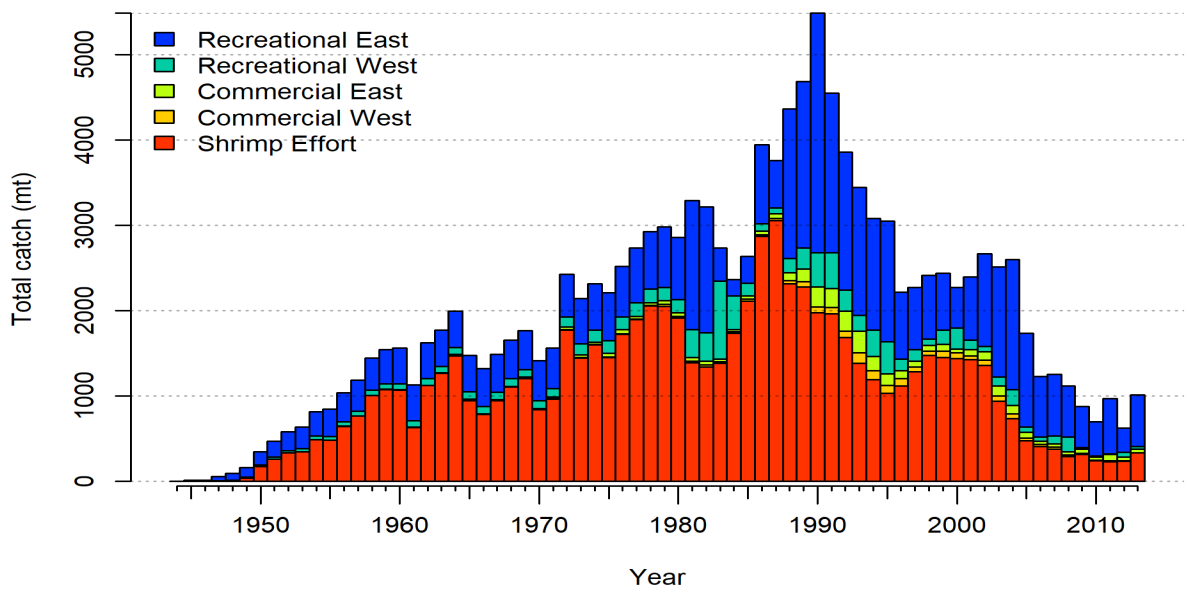
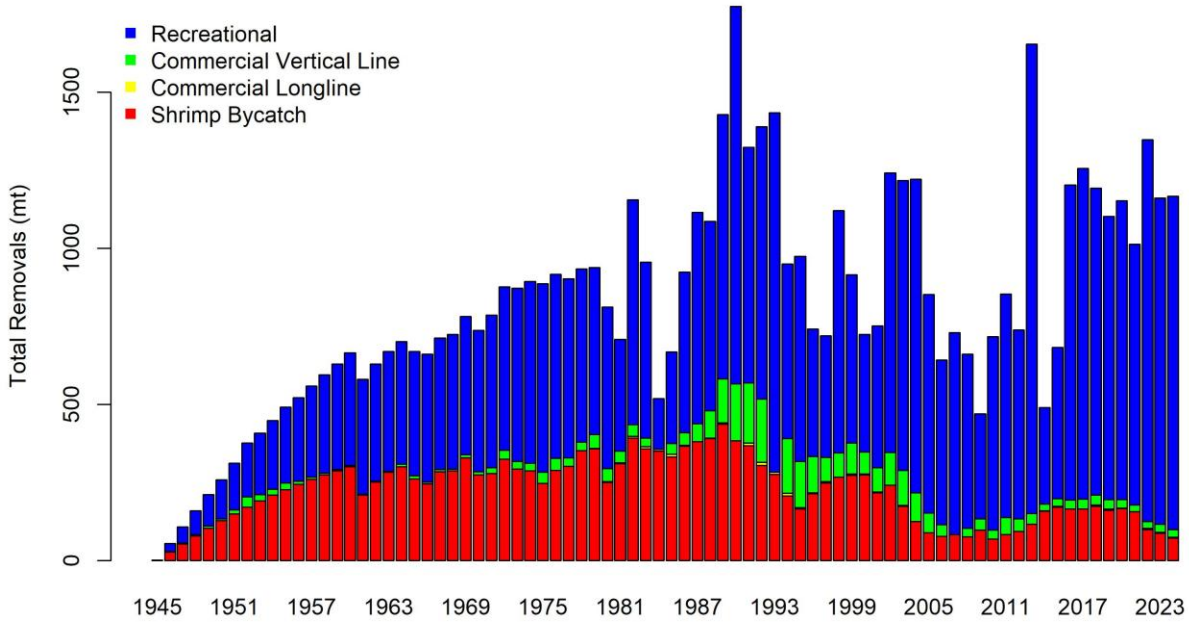


Figure 50. Expected total catch (landings + discards in metric tons, mt) by fleet for SEDAR 100 and SEDAR 43. Confidential data for SEDAR 100 have been excluded for the Commercial Vertical Line and Commercial Longline fleets.

SEDAR 100



SEDAR 43

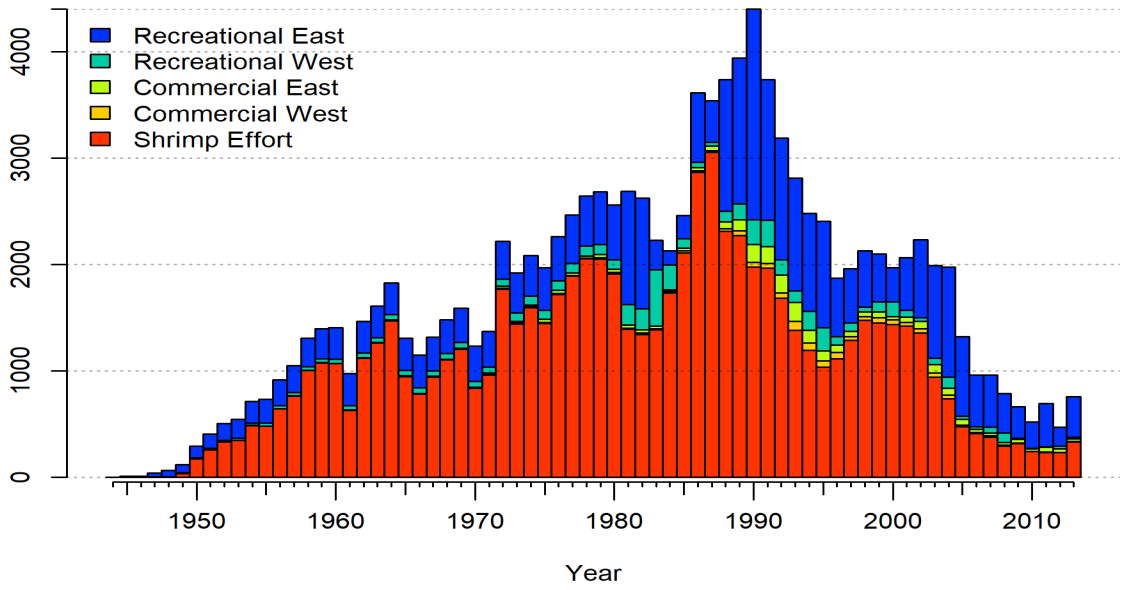
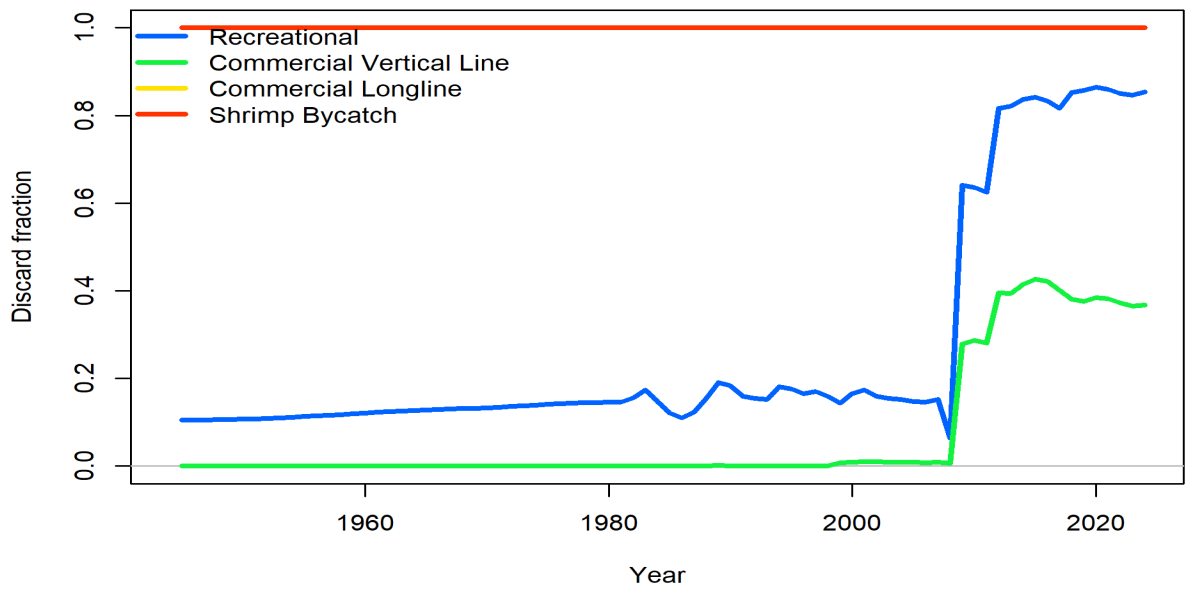


Figure 51. Expected total removals (landings + dead discards in metric tons, mt) by fleet for SEDAR 100 and SEDAR 43. Confidential data for SEDAR 100 have been excluded for the Commercial Vertical Line and Commercial Longline fleets.

SEDAR 100



SEDAR 43

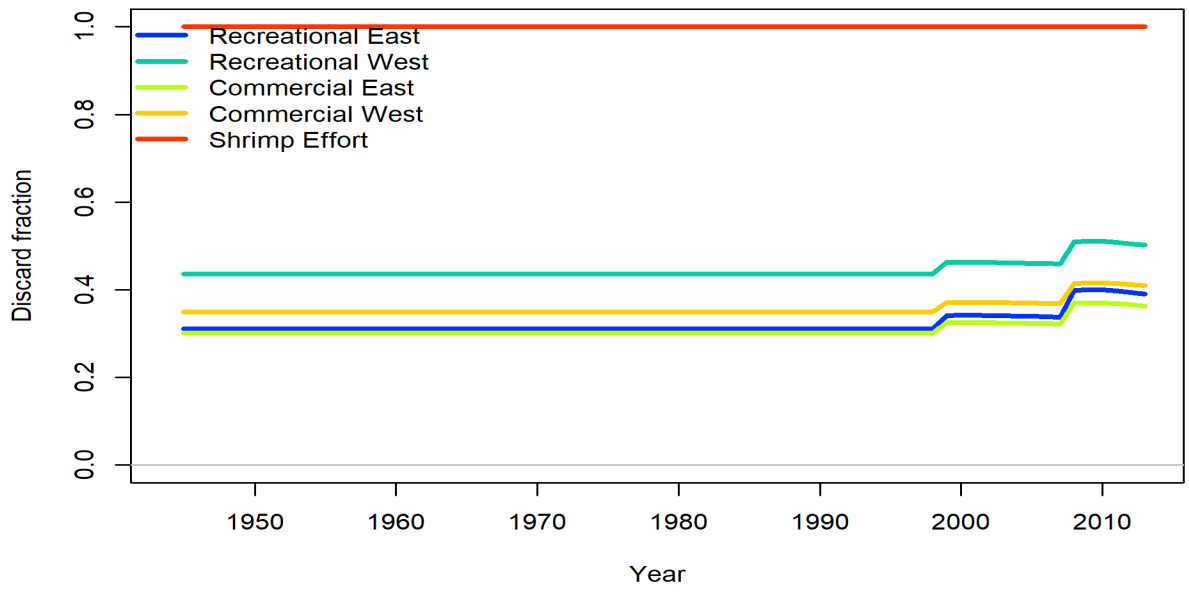


Figure 52. Discard fraction by fleet for SEDAR 100 and SEDAR 43.

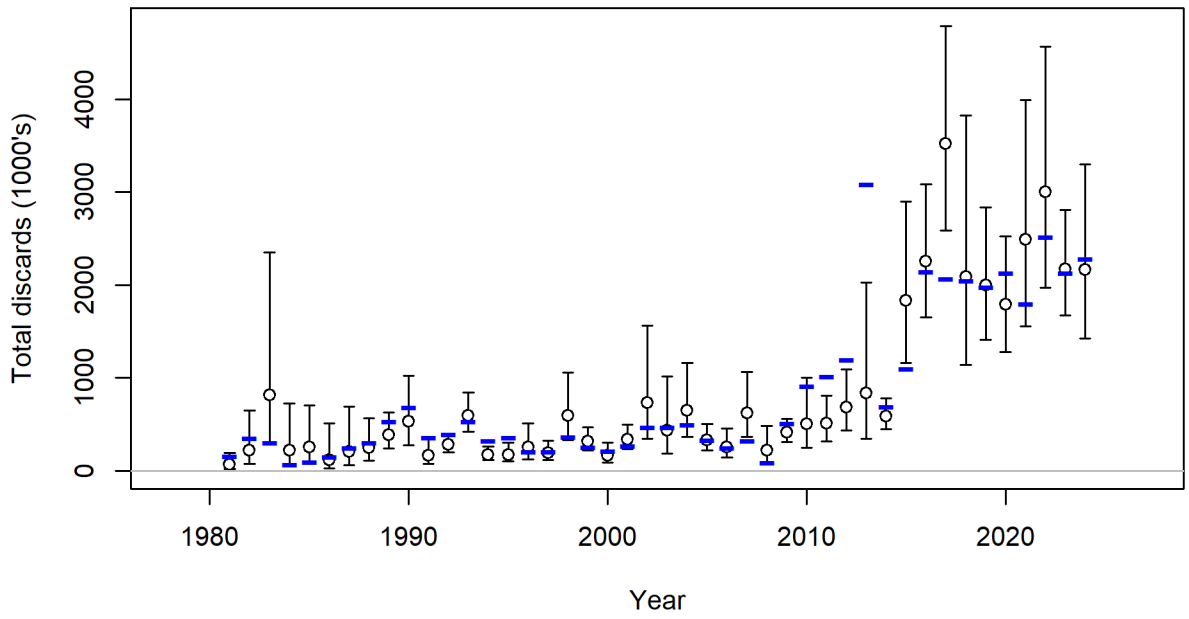


Figure 53. Observed (dots with 95% confidence intervals) and expected (blue lines) discards by the Recreational fleet. Discards are in numbers of fish (1,000s) and reflect released fish (i.e., before discard mortality has been applied).

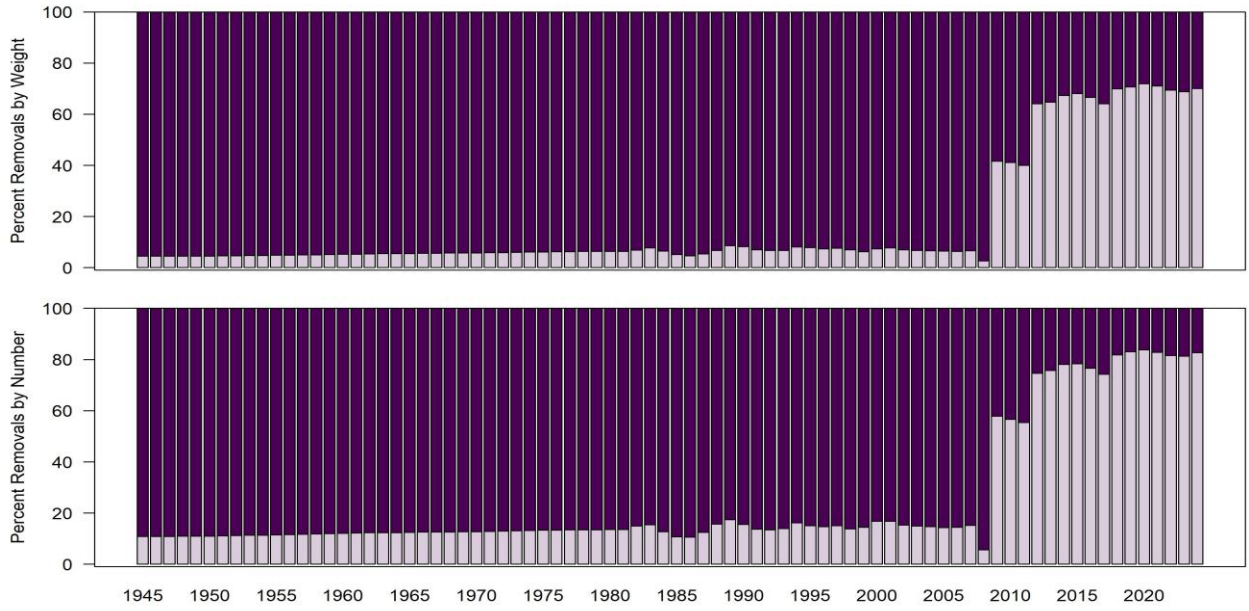


Figure 54. Comparison of landings (dark bars) and dead discards (light bars) for weights (top panel) and numbers of fish (bottom panel) for the Recreational fleet. Estimates of dead discards in both numbers and weights are provided in ***Table 24****.*

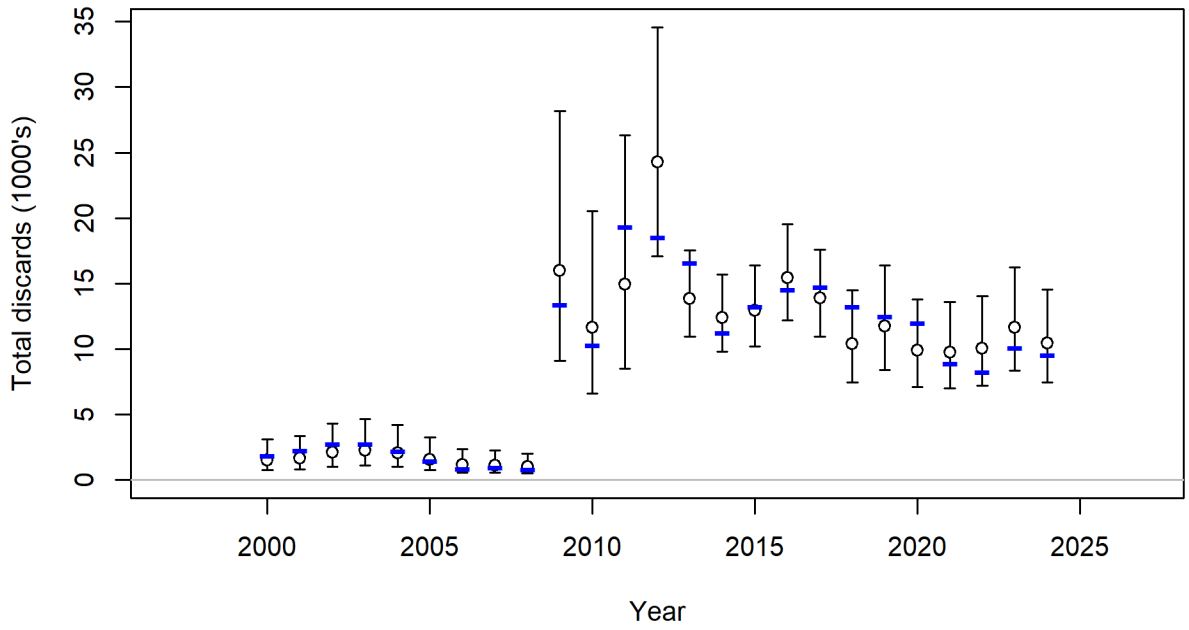


Figure 55. Observed (dots with 95% confidence intervals) and expected (blue lines) discards by the Commercial Vertical Line fleet. Discards are in numbers of fish (1,000s) and reflect released fish (i.e., before discard mortality has been applied).

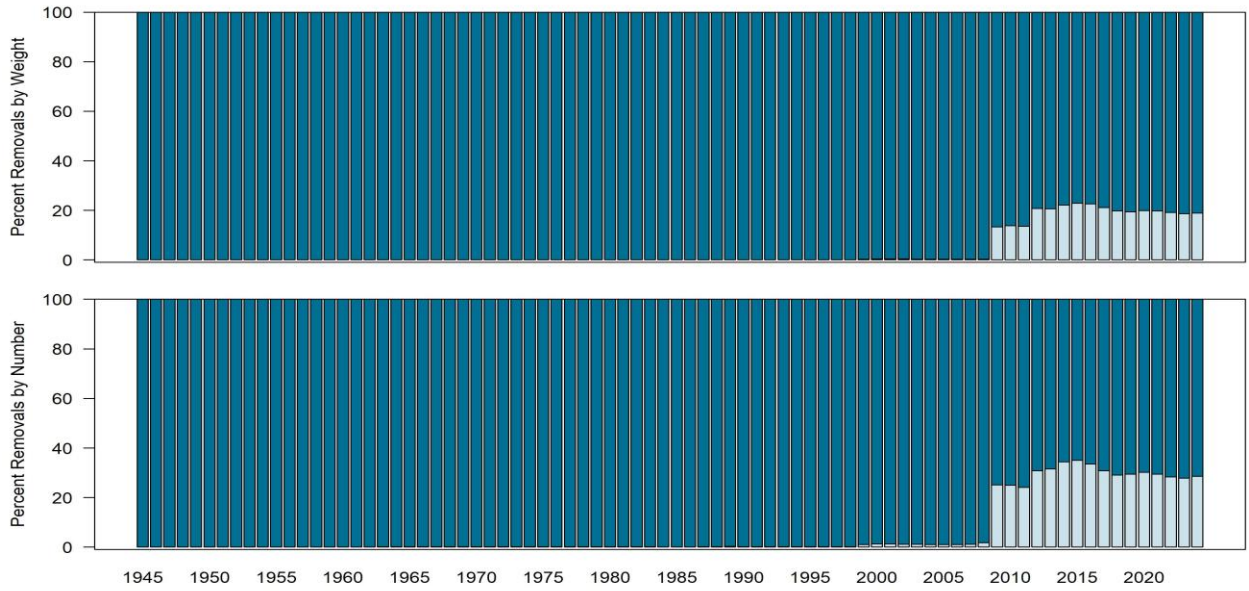


Figure 56. Comparison of landings (dark bars) and dead discards (light bars) for weights (top panel) and numbers of fish (bottom panel) for the Commercial Vertical Line fleet. Estimates of dead discards in both numbers and weights are provided in ***Table 25****.*

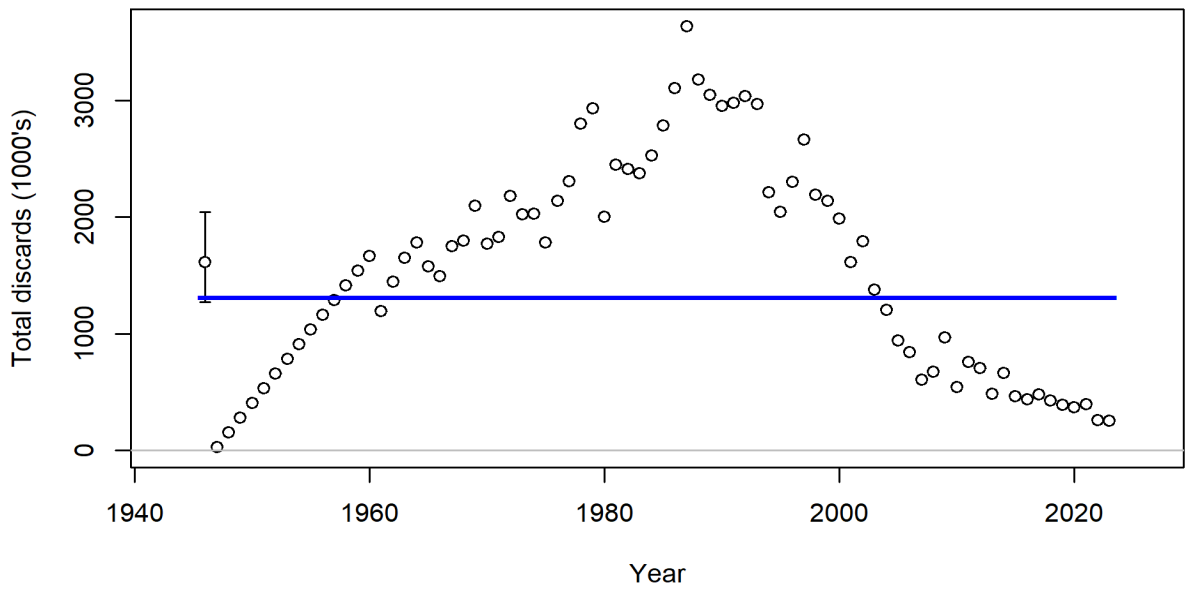


Figure 57. Observed (dots with 95% confidence intervals) and expected (blue lines) discards by the Shrimp Bycatch fleet. Discards are in numbers of fish (1,000s) and all fish are assumed dead. Estimates of dead discards in both numbers and weights are provided in ***Table 26****.*

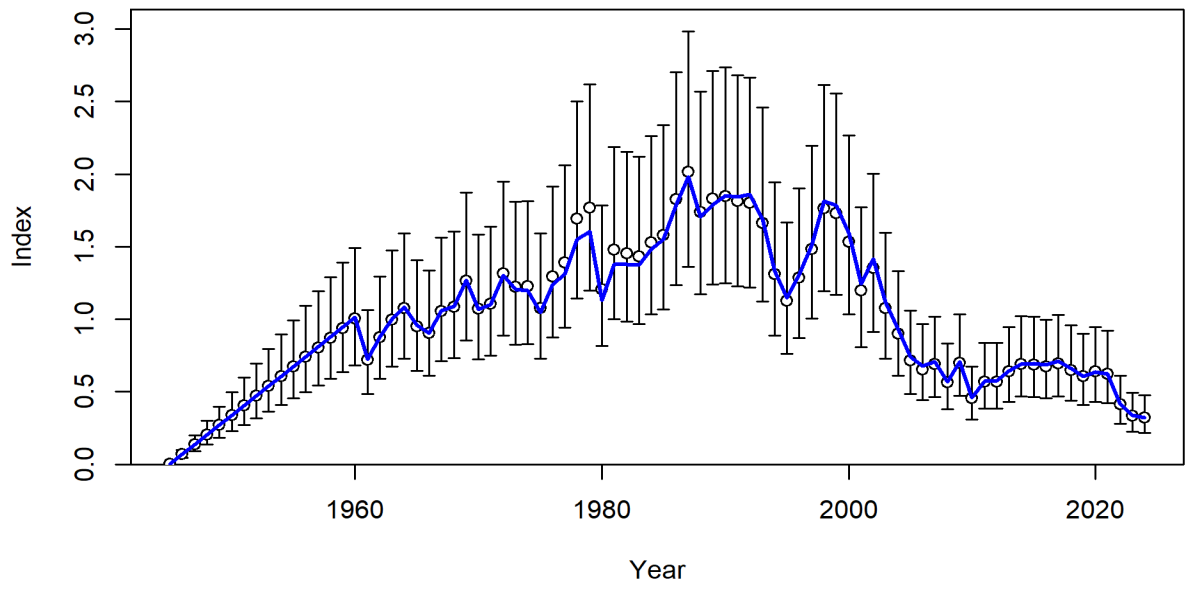


Figure 58. Observed (dots with 95% confidence intervals) and expected (blue lines) indices of fishing effort for the Gulf Shrimp fishery. The stock assessment model assumes lognormal error around the standardized index.

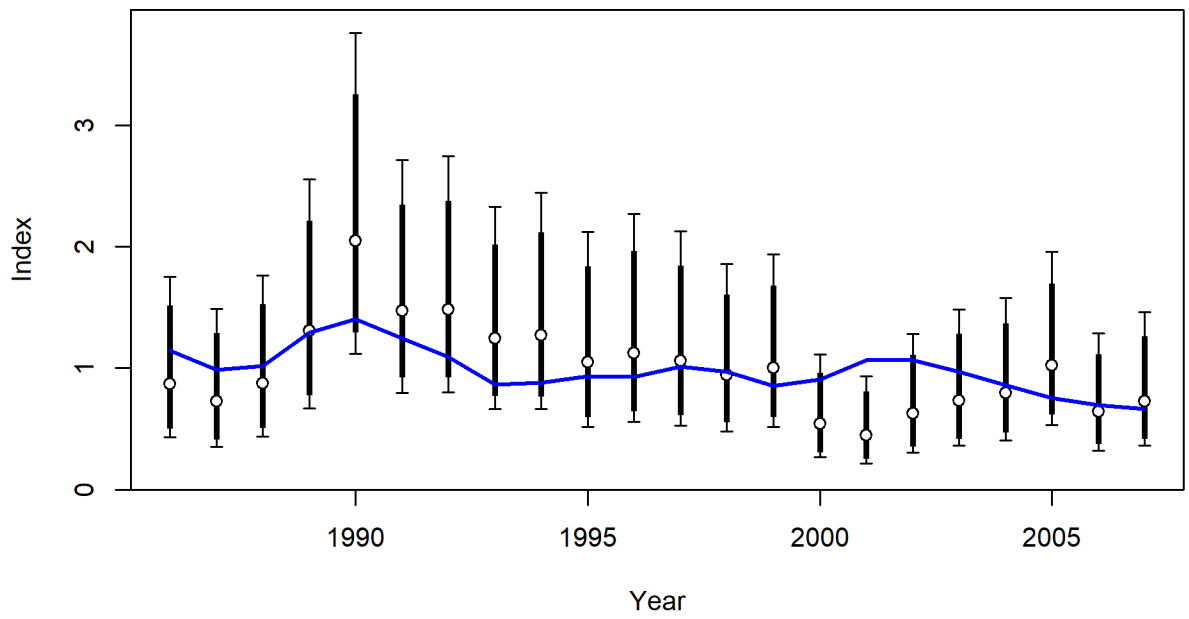


Figure 59. Observed (dots with 95% confidence intervals) and expected (blue lines) indices of relative abundance from the Recreational (SRHS) CPUE. The stock assessment model assumes lognormal error around the standardized index. Thicker lines indicate input uncertainty before addition of the estimated additional uncertainty parameter (0.074).

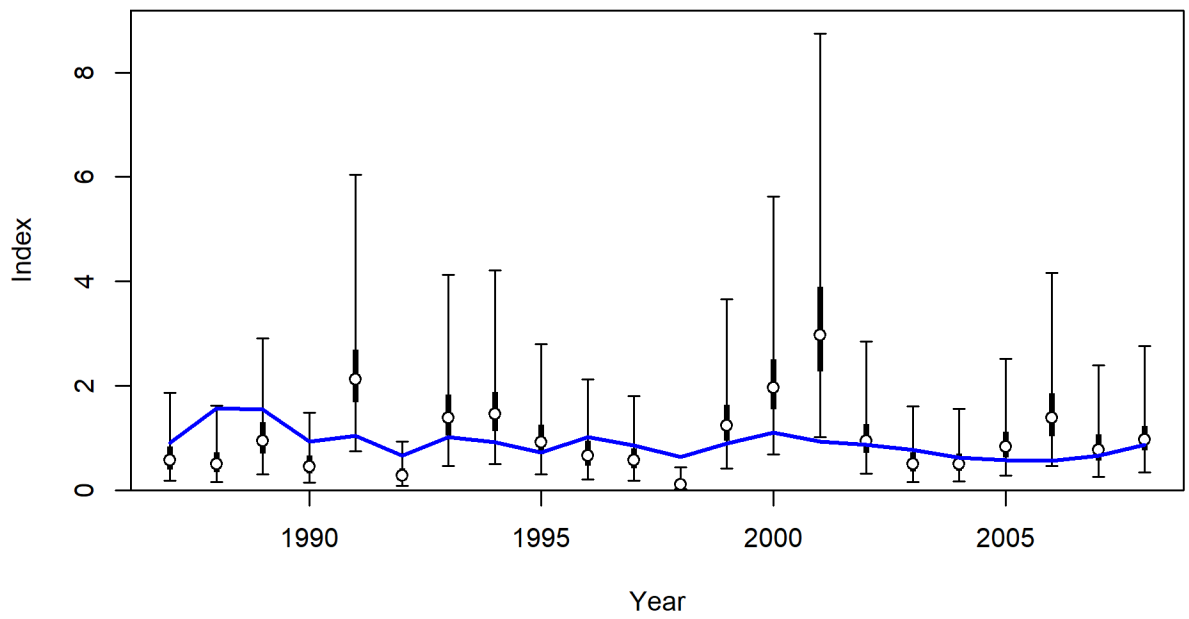


Figure 60. Observed (dots with 95% confidence intervals) and expected (blue lines) indices of relative abundance from the SEAMAP Trawl Early Survey. The stock assessment model assumes lognormal error around the standardized index. Thicker lines indicate input uncertainty before addition of the estimated additional uncertainty parameter (0.414).

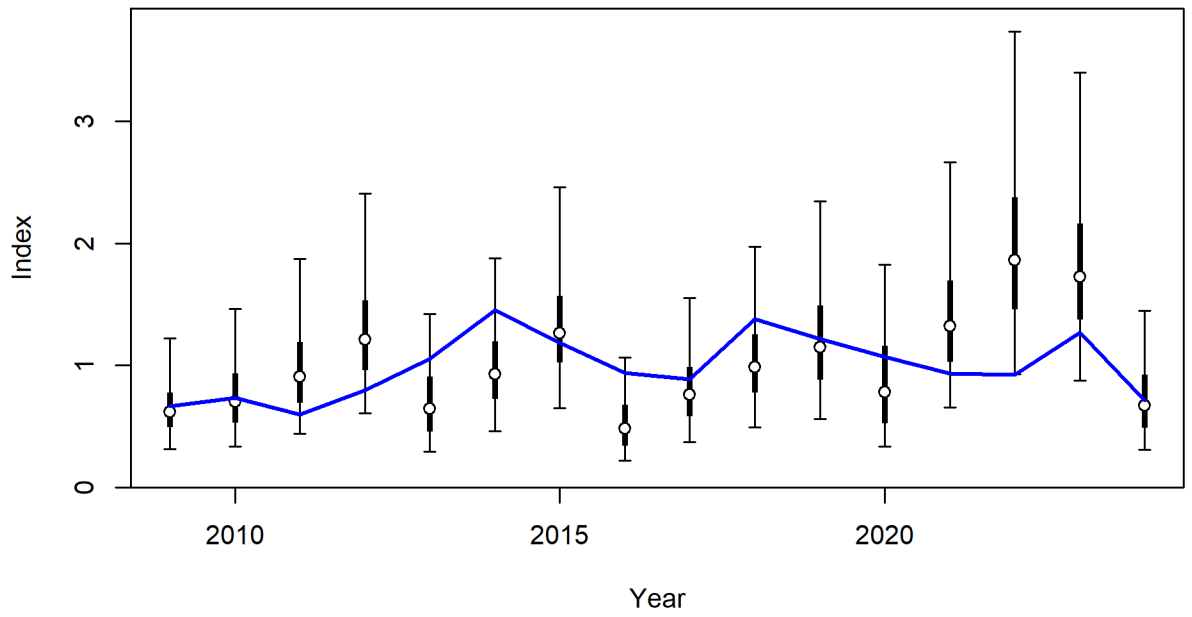


Figure 61. Observed (dots with 95% confidence intervals) and expected (blue lines) indices of relative abundance from the SEAMAP Trawl Late Survey. The stock assessment model assumes lognormal error around the standardized index. Thicker lines indicate input uncertainty before addition of the estimated additional uncertainty parameter (0.231).

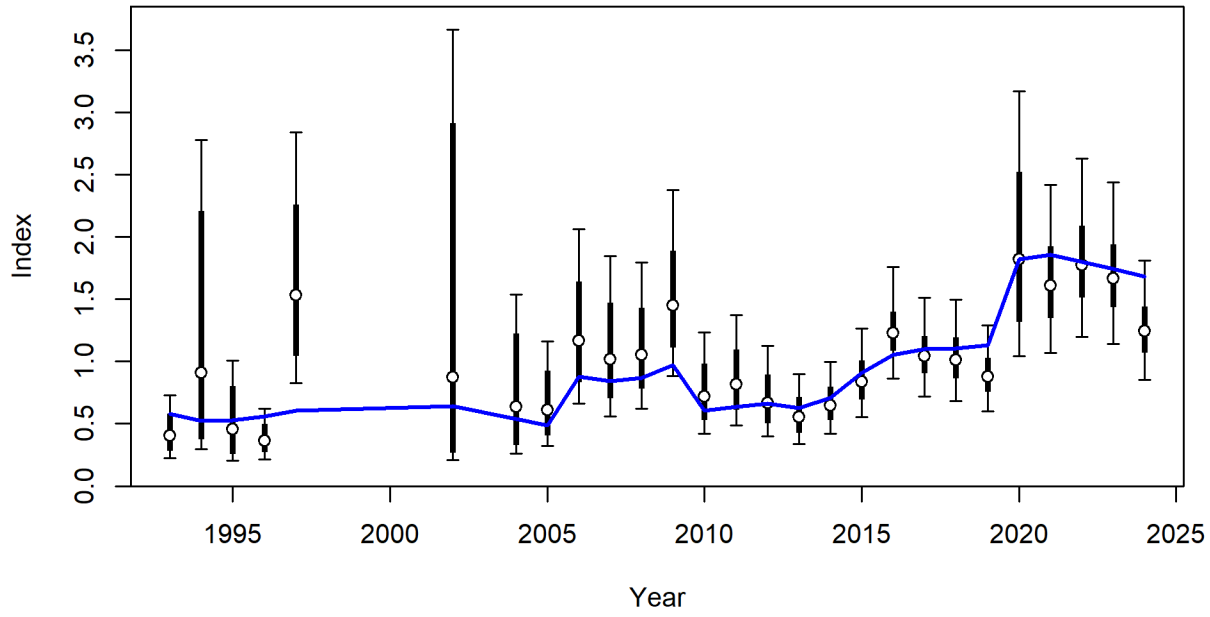


Figure 62. Observed (dots with 95% confidence intervals) and expected (blue lines) indices of relative abundance from the Combined Video Survey. The stock assessment model assumes lognormal error around the standardized index. Thicker lines indicate input uncertainty before addition of the estimated additional uncertainty parameter (0.117).

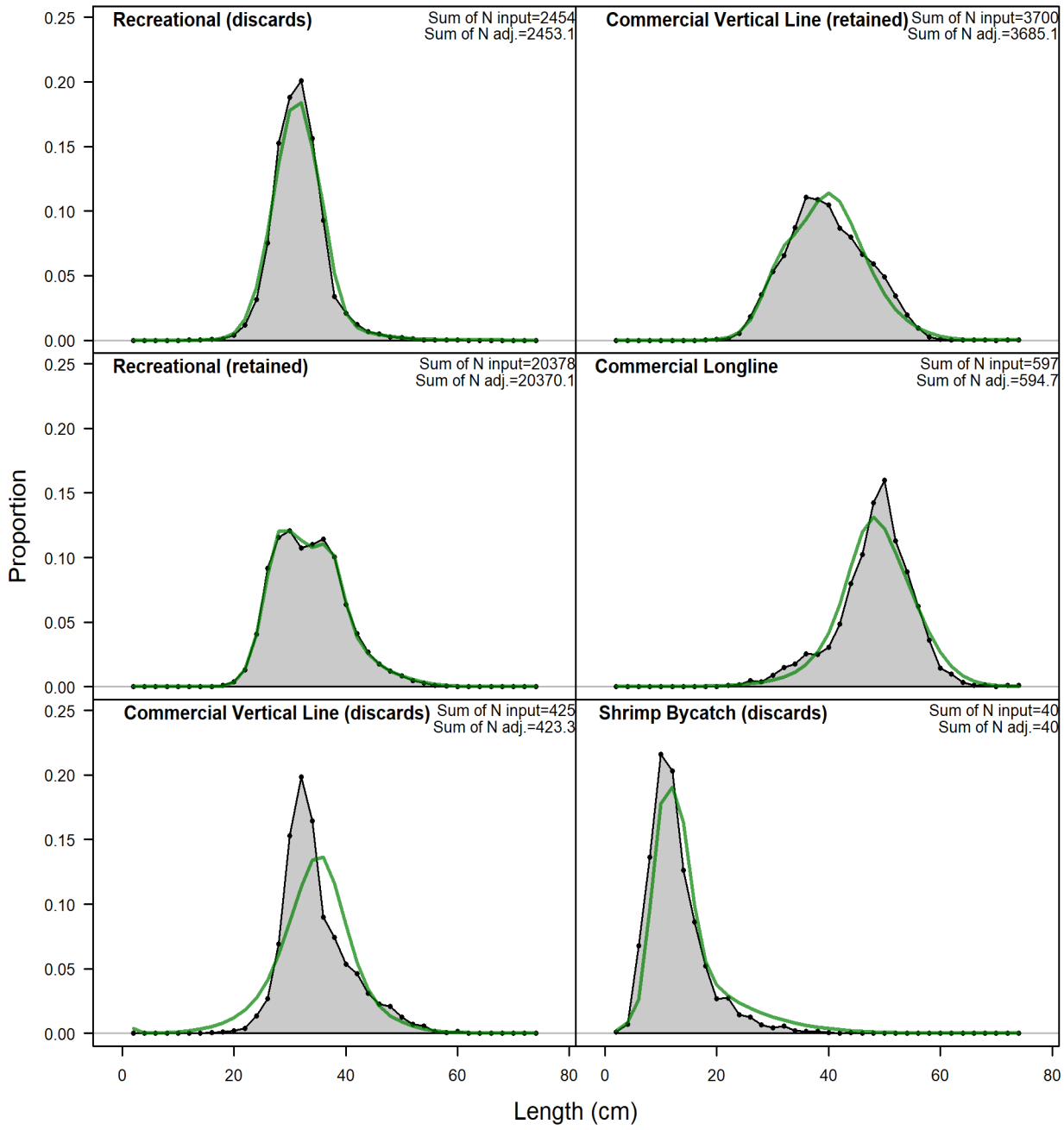


Figure 63. Model fits to the length composition of landed (i.e., retained) or discarded catch aggregated across years for each fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. The input (N input) and adjusted (N adj) sample sizes are provided in the upper right corner of each panel.

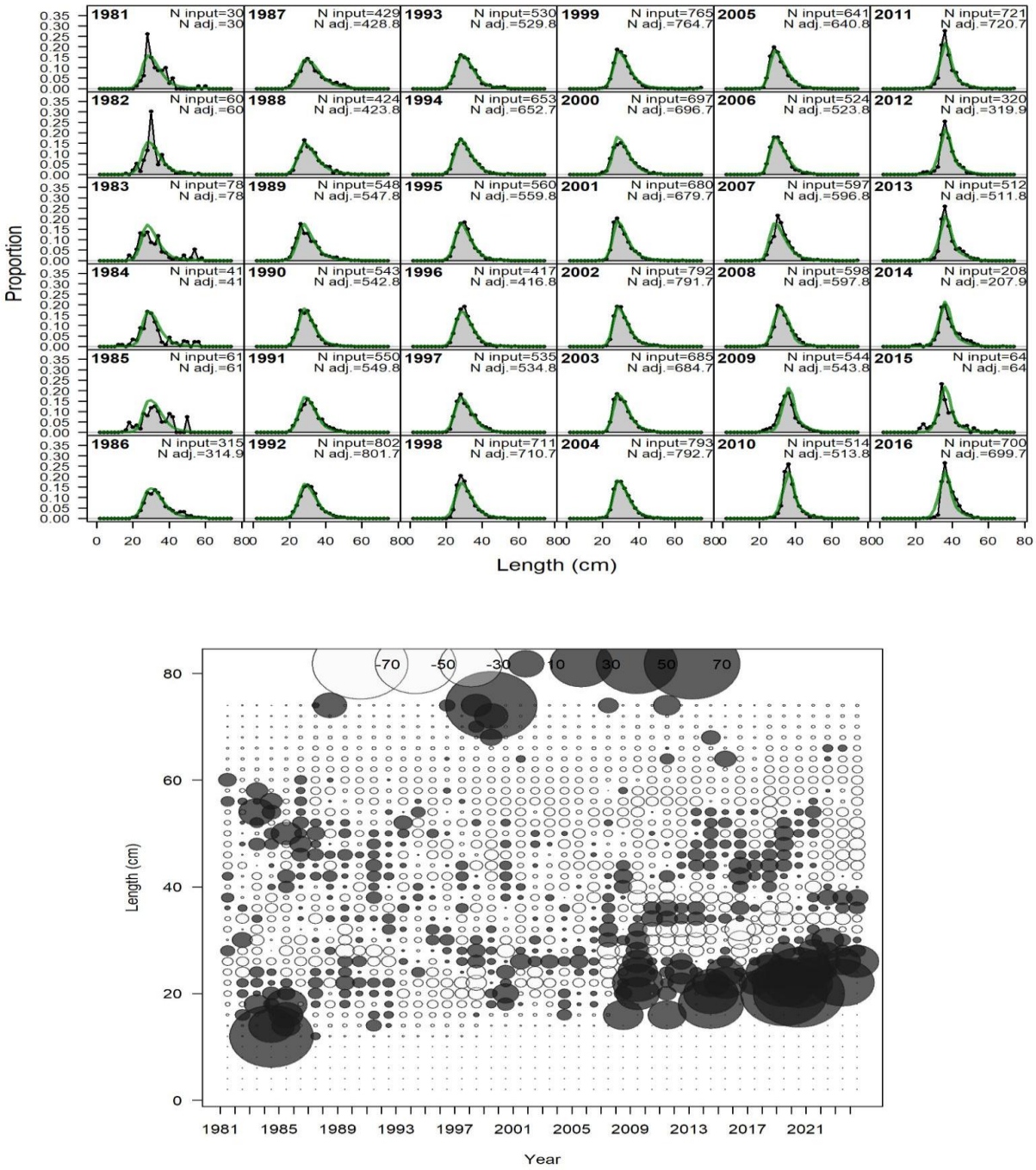
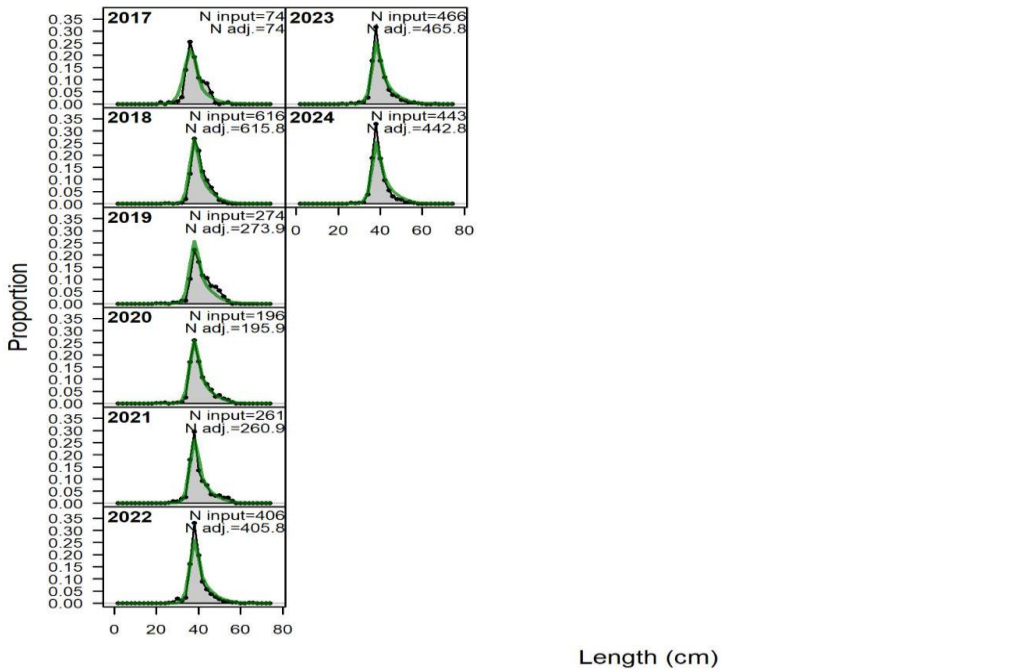


Figure 64. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish landed by the Recreational fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



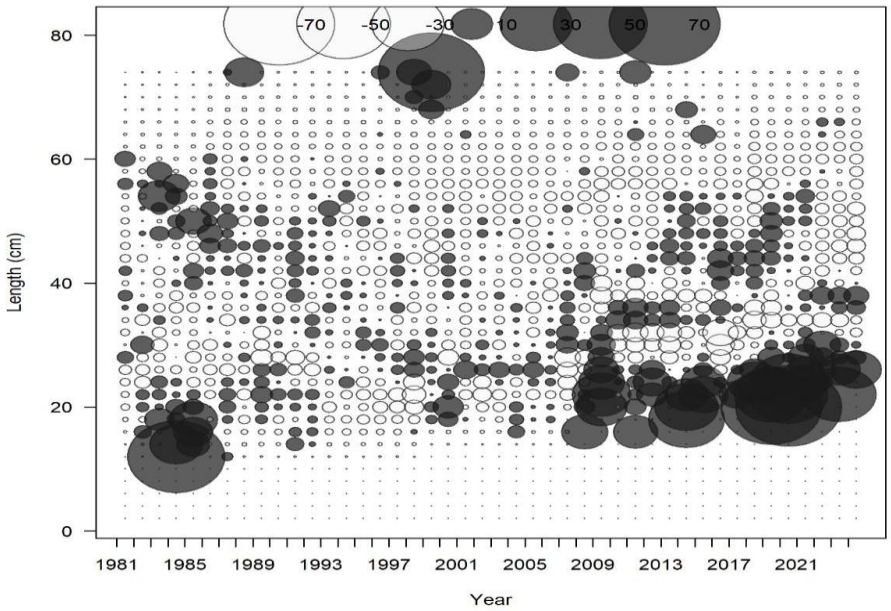
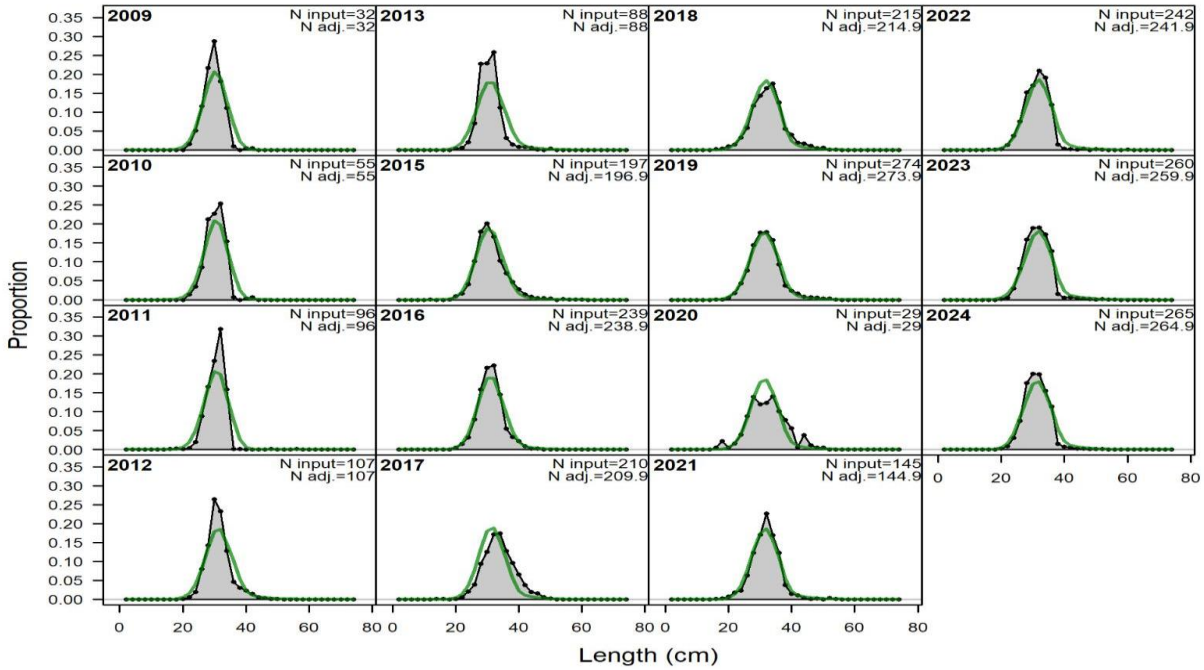


Figure 64 Continued. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish landed by the Recreational fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



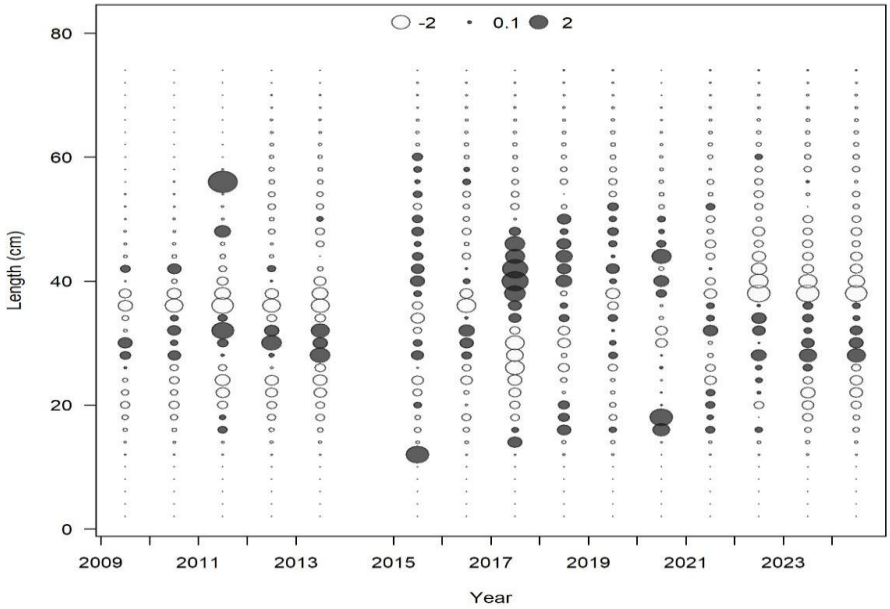
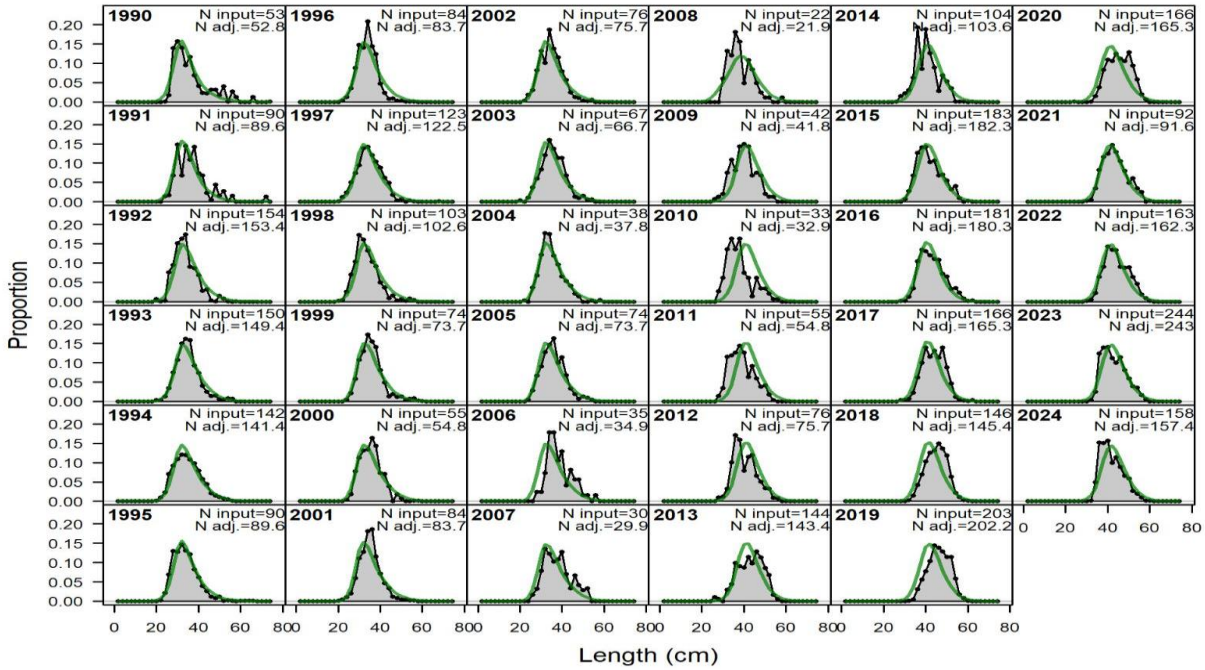


Figure 65. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish discarded by the Recreational fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



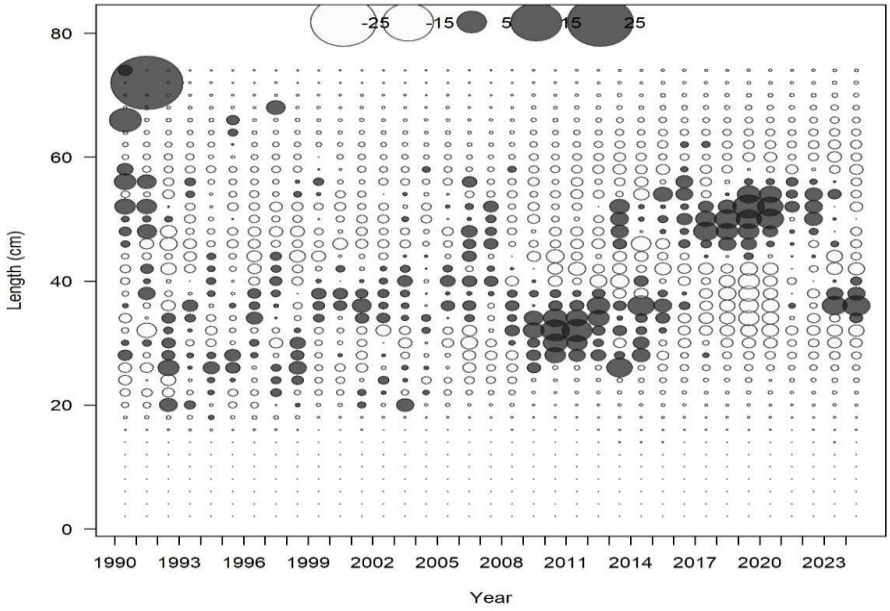


Figure 66. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish landed by the Commercial Vertical Line fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

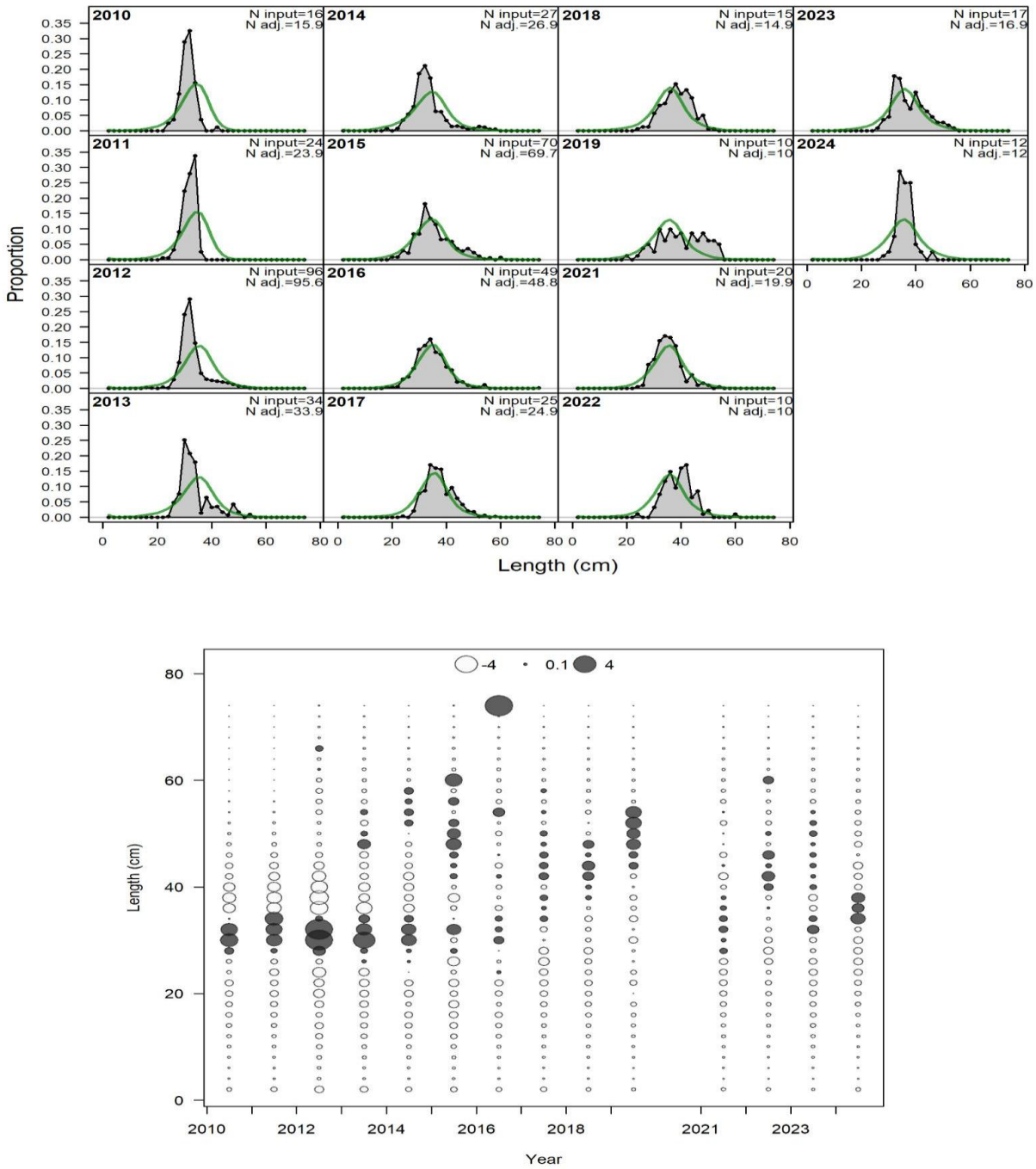
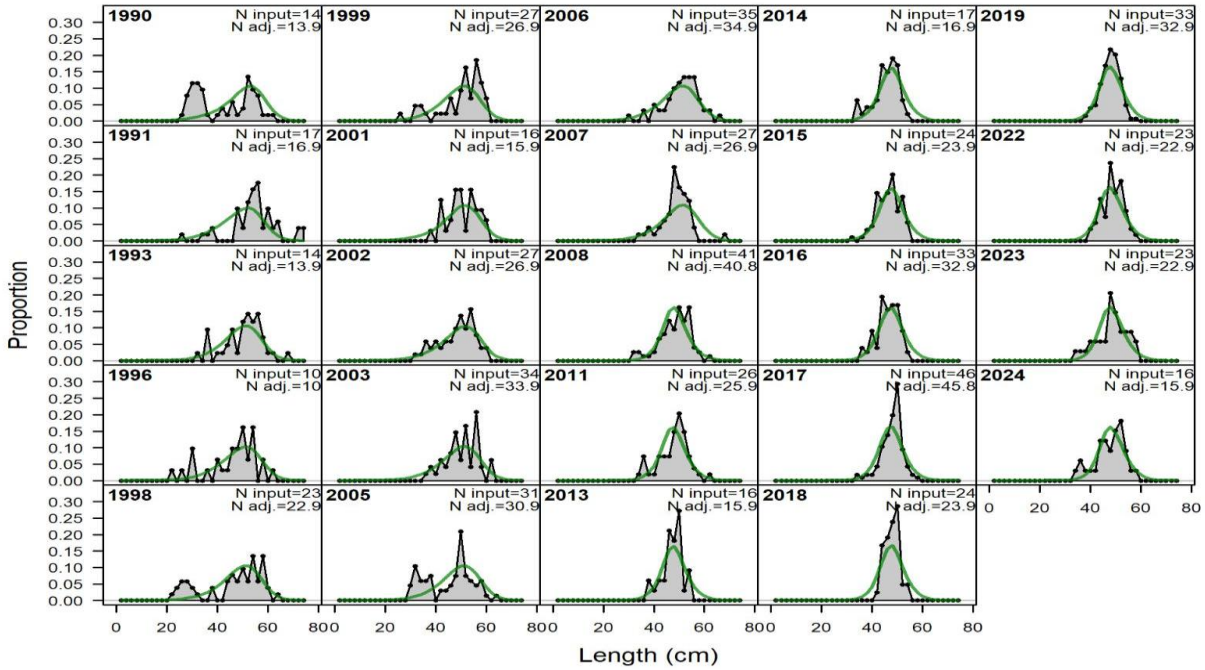


Figure 67. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish discarded by the Commercial Vertical Line fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



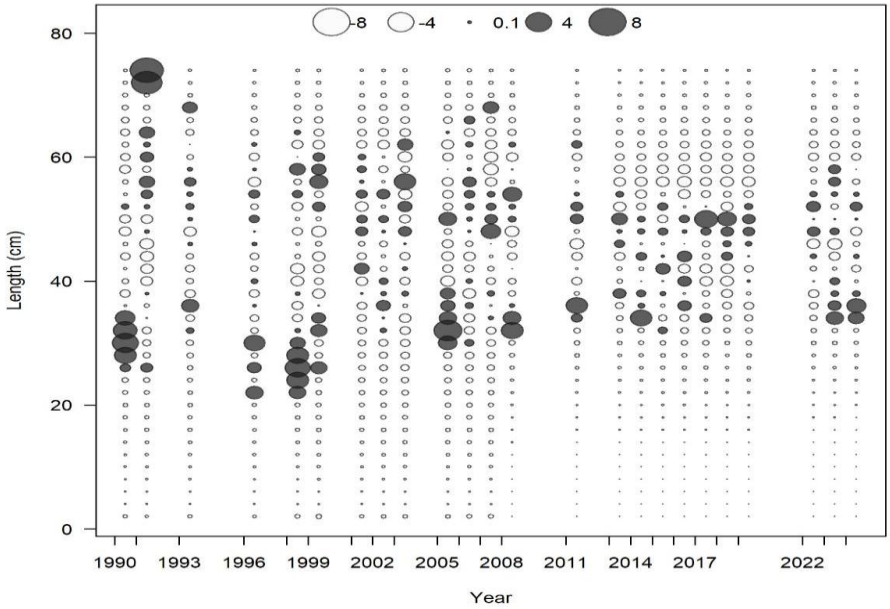
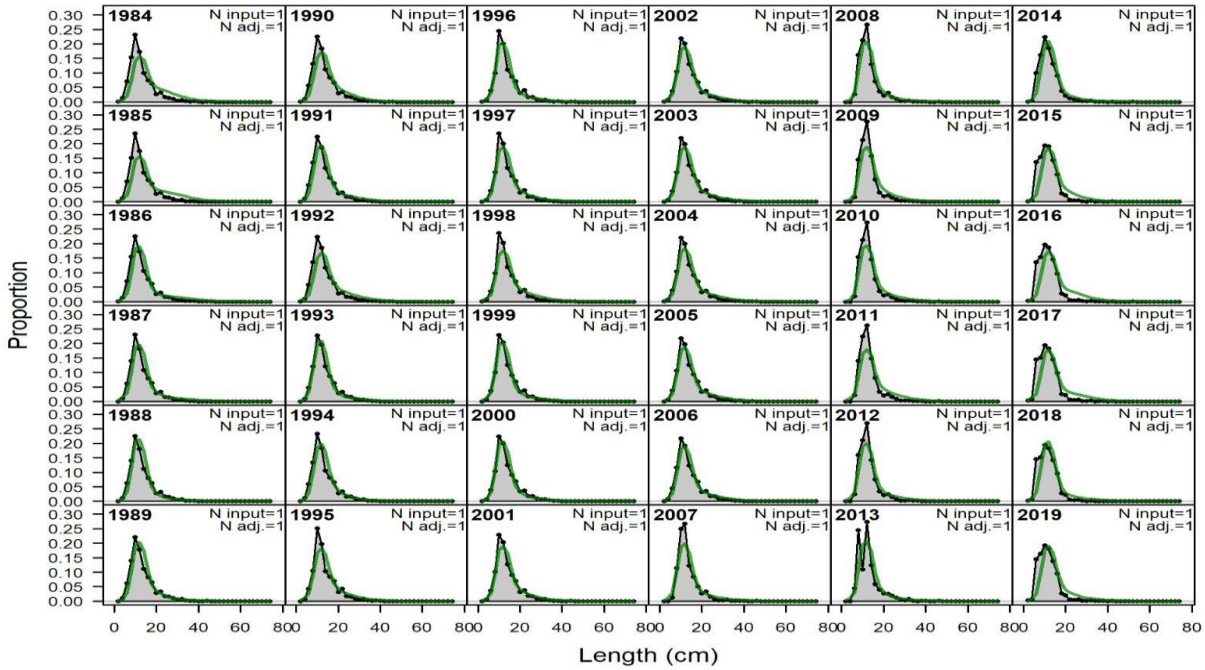


Figure 68. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish landed by the Commercial Longline fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



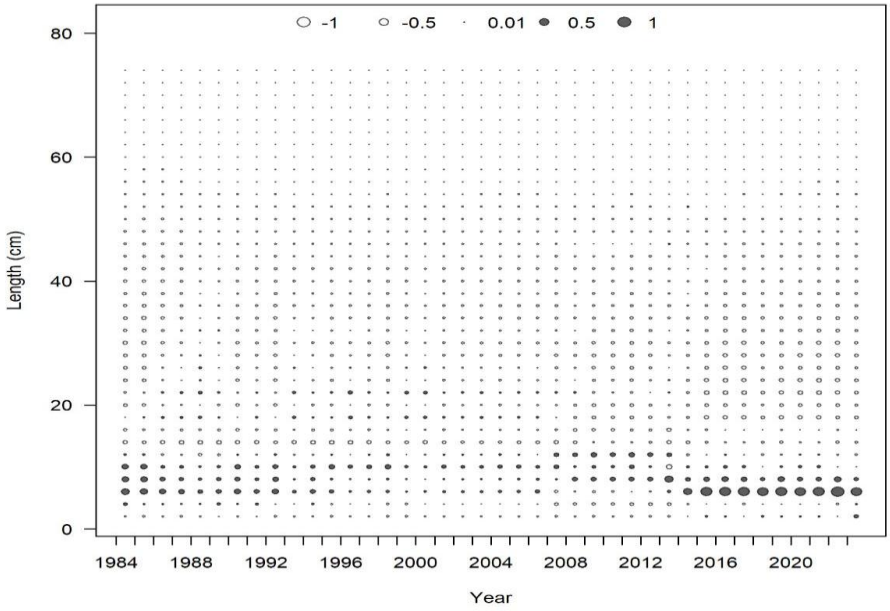
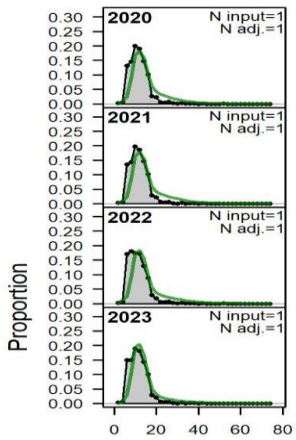


Figure 69. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish discarded by the Shrimp Bycatch fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) are reported but were not adjusted, as this input was not included in the likelihood. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



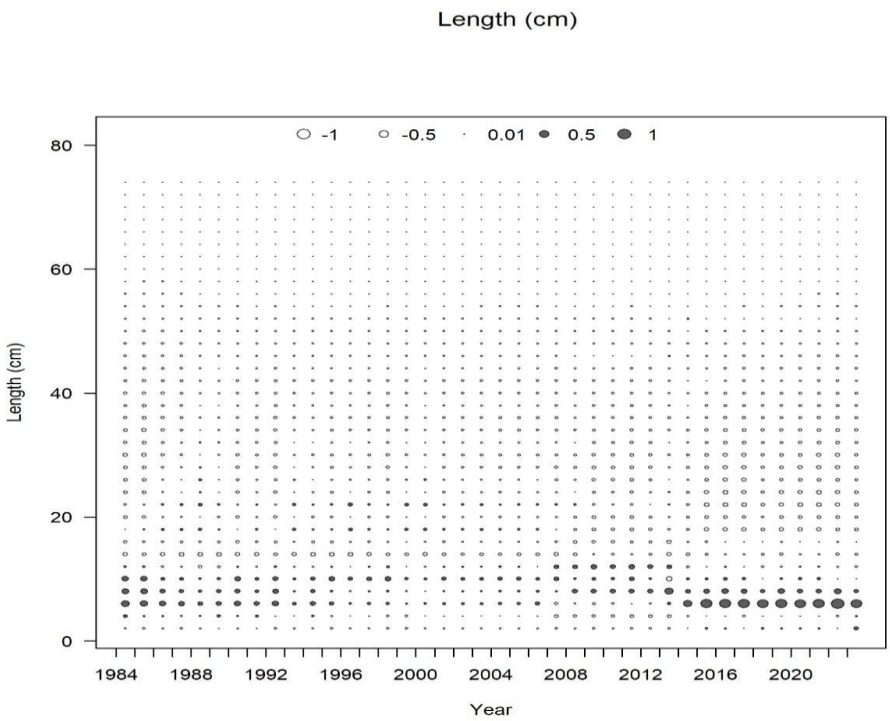


Figure 69 Continued. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish discarded by the Shrimp Bycatch fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) are reported but were not adjusted, as this input was not included in the likelihood. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

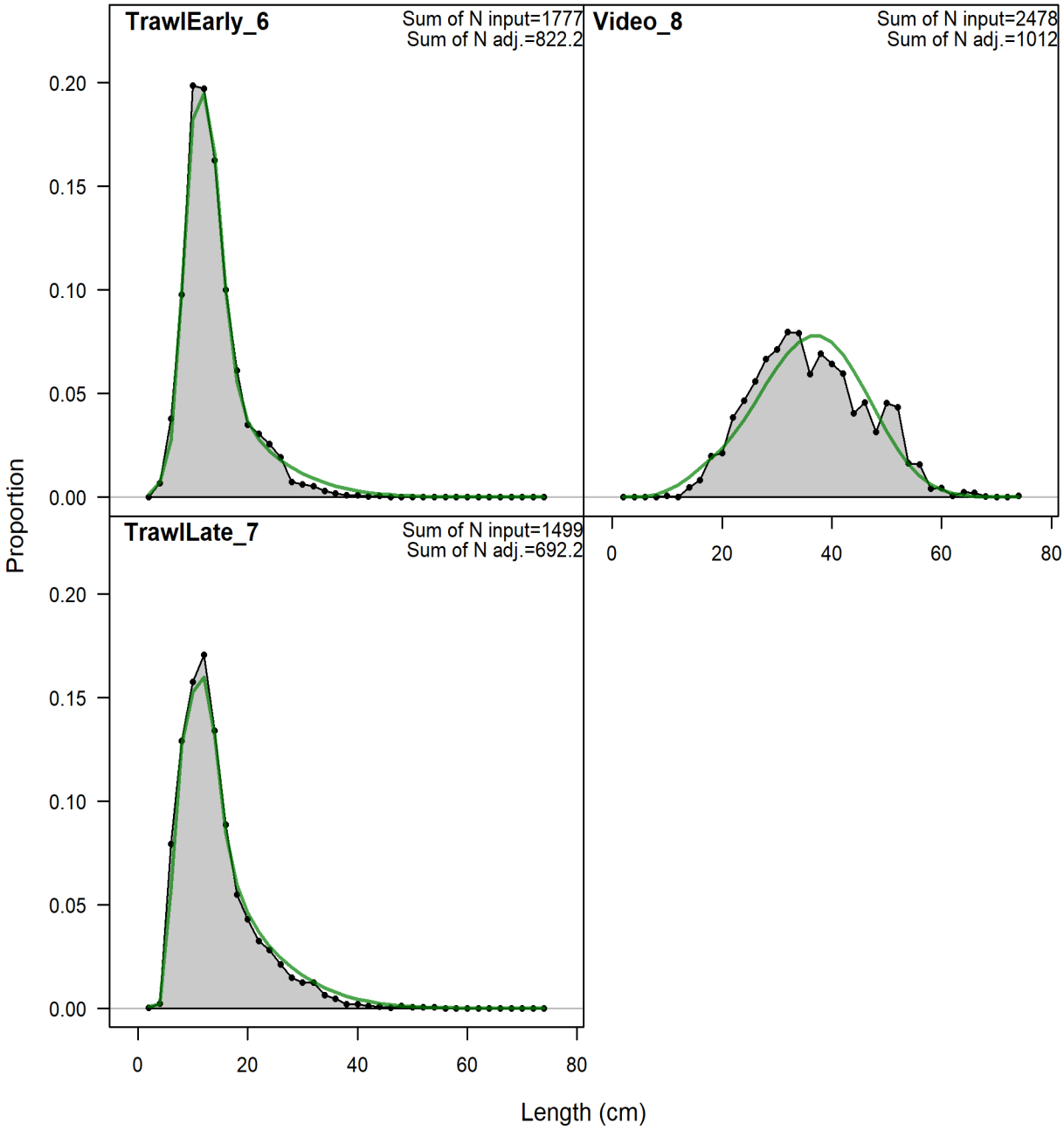


Figure 70. Model fits to the length composition of catch aggregated across years for each survey. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. The input (N input) and adjusted (N adj) sample sizes are provided in the upper right corner of each panel.

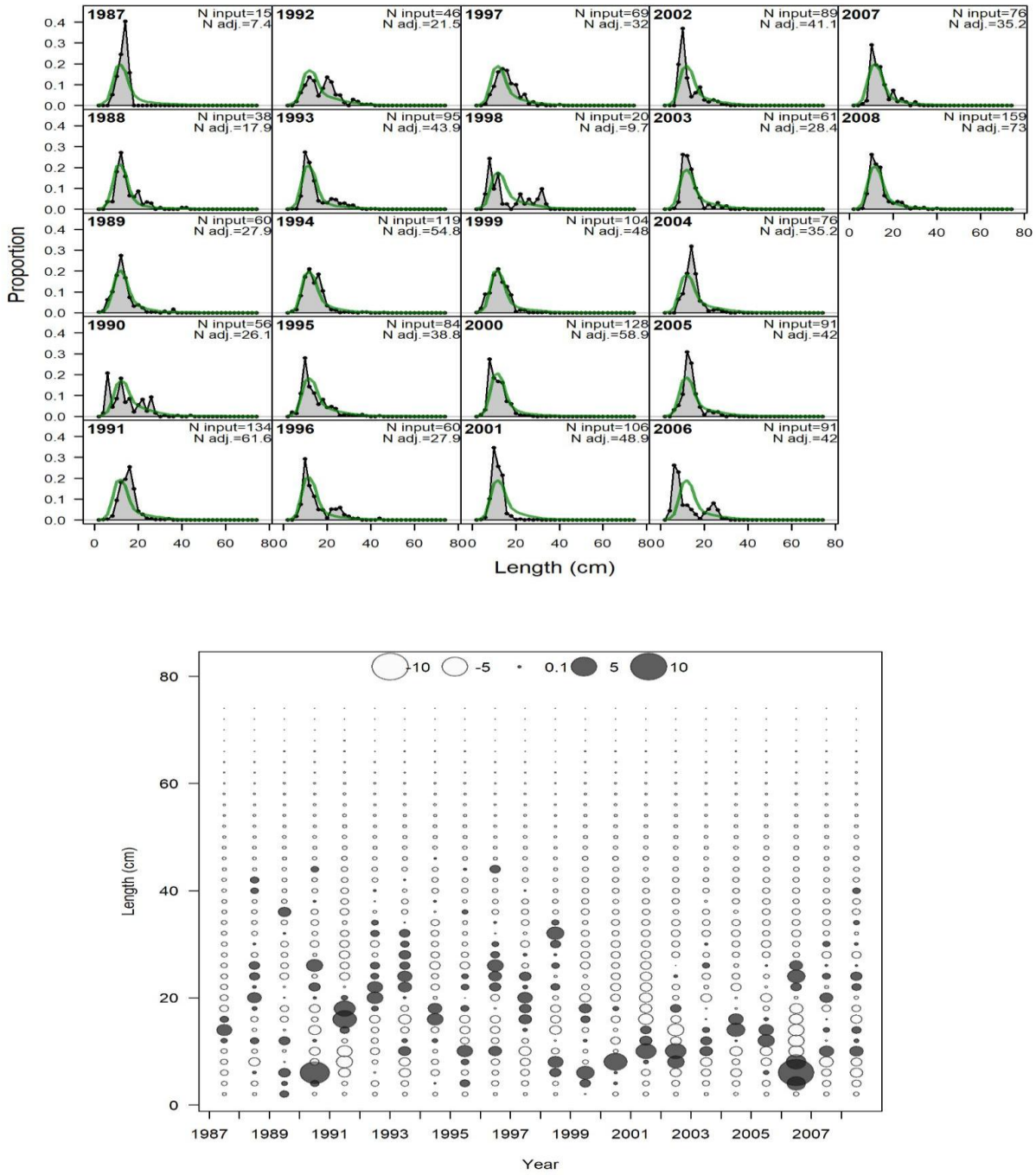


Figure 71. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish in the SEAMAP Trawl Early Survey. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

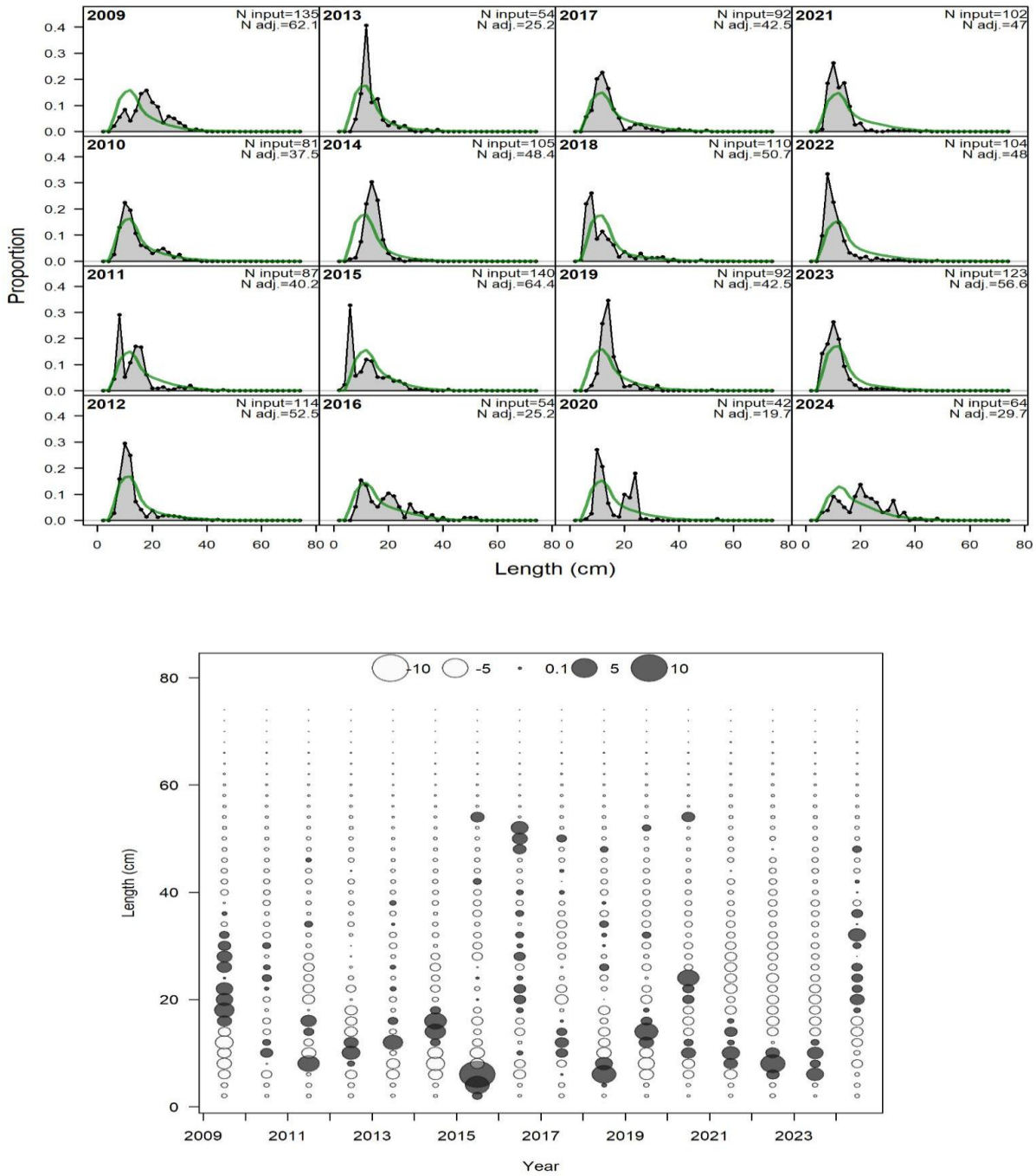
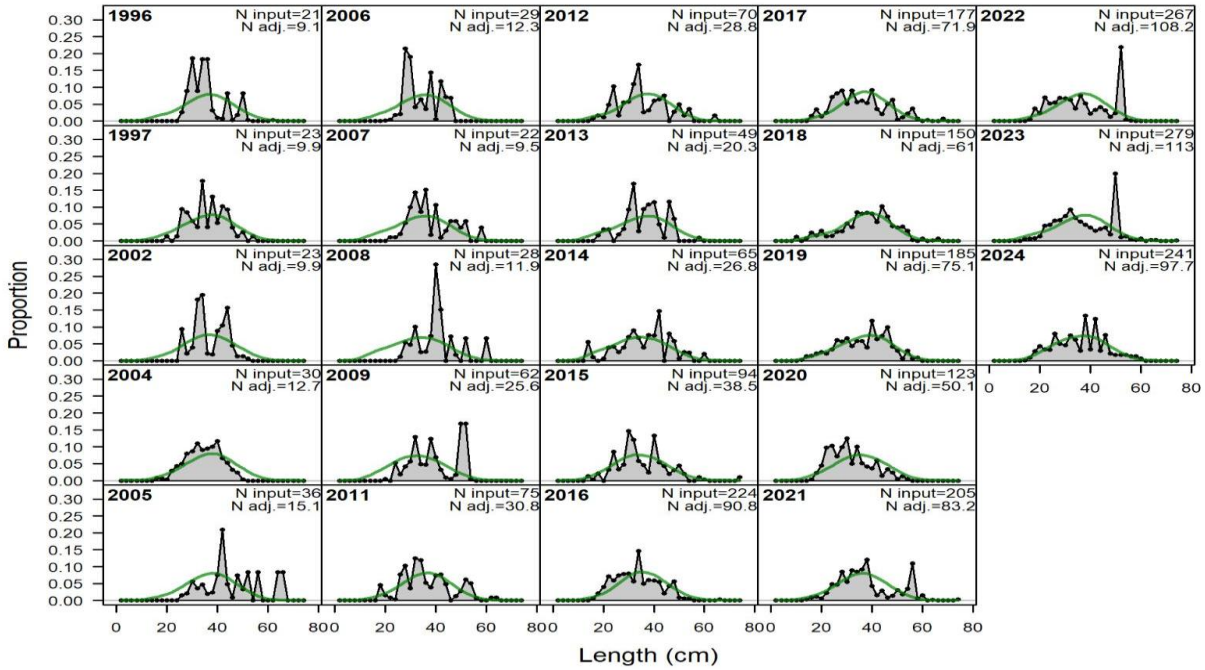


Figure 72. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish in the SEAMAP Trawl Late Survey. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



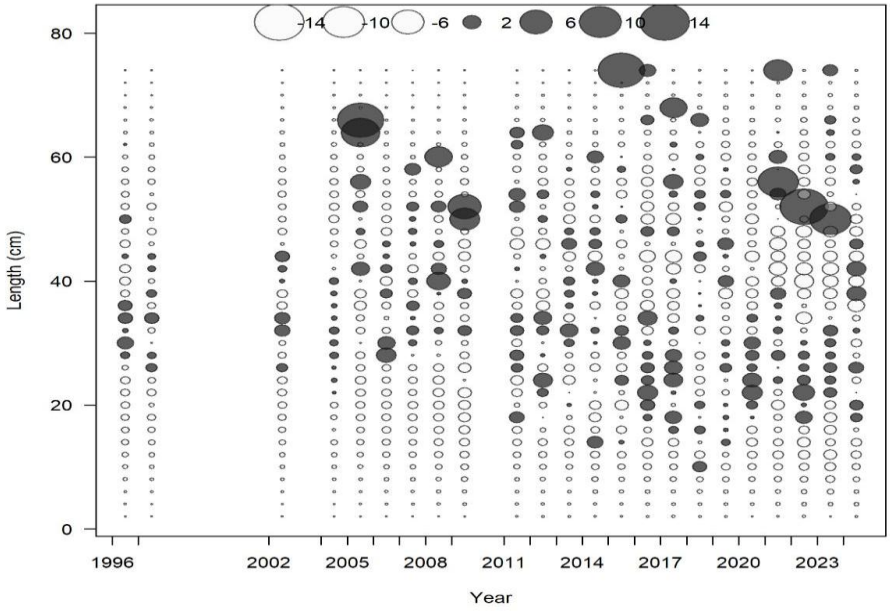


Figure 73. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish in the Combined Video Survey. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

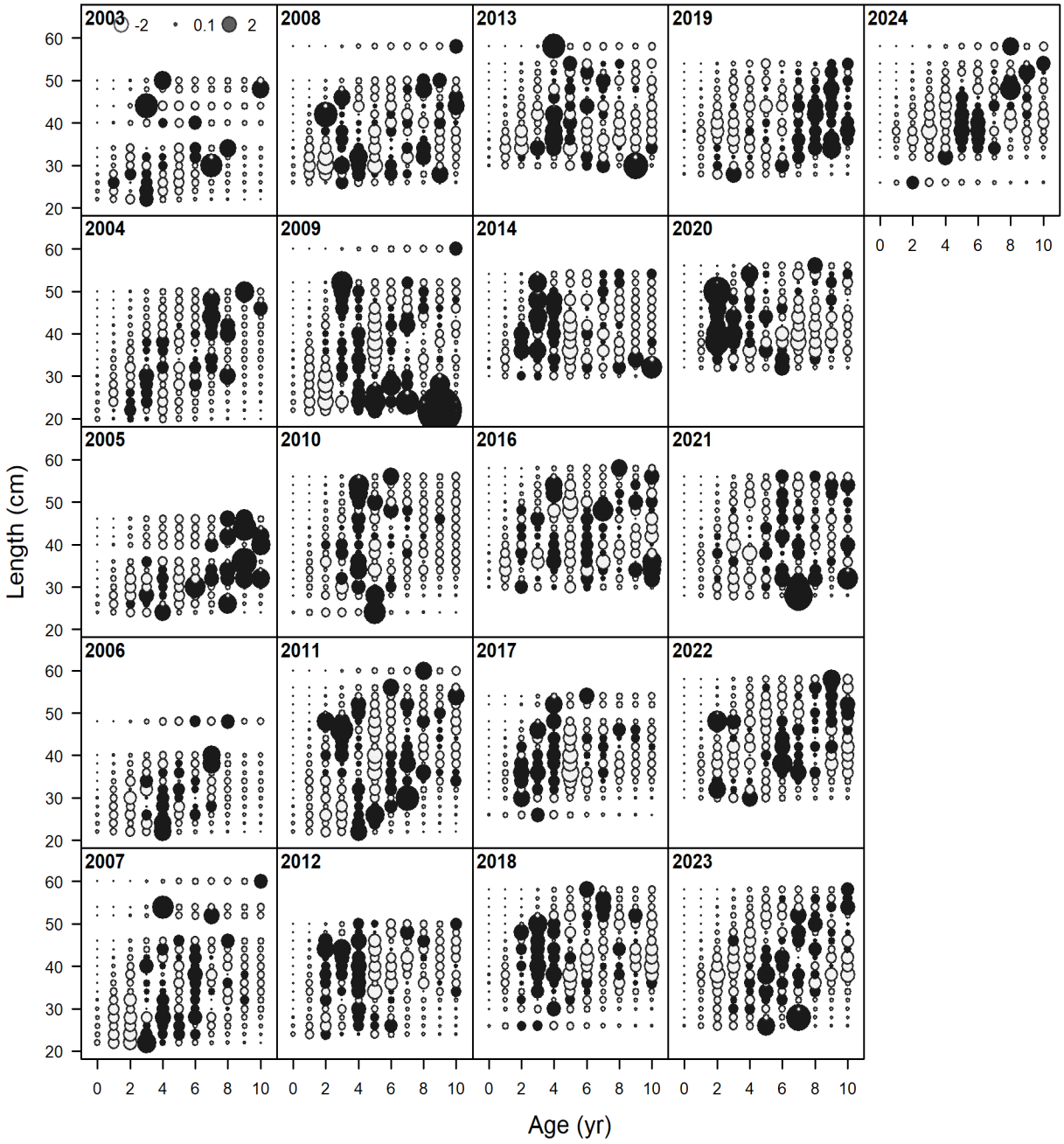


Figure 74. Pearson residuals for the conditional age-at-length compositions for Gray Triggerfish landed by the Recreational fleet. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

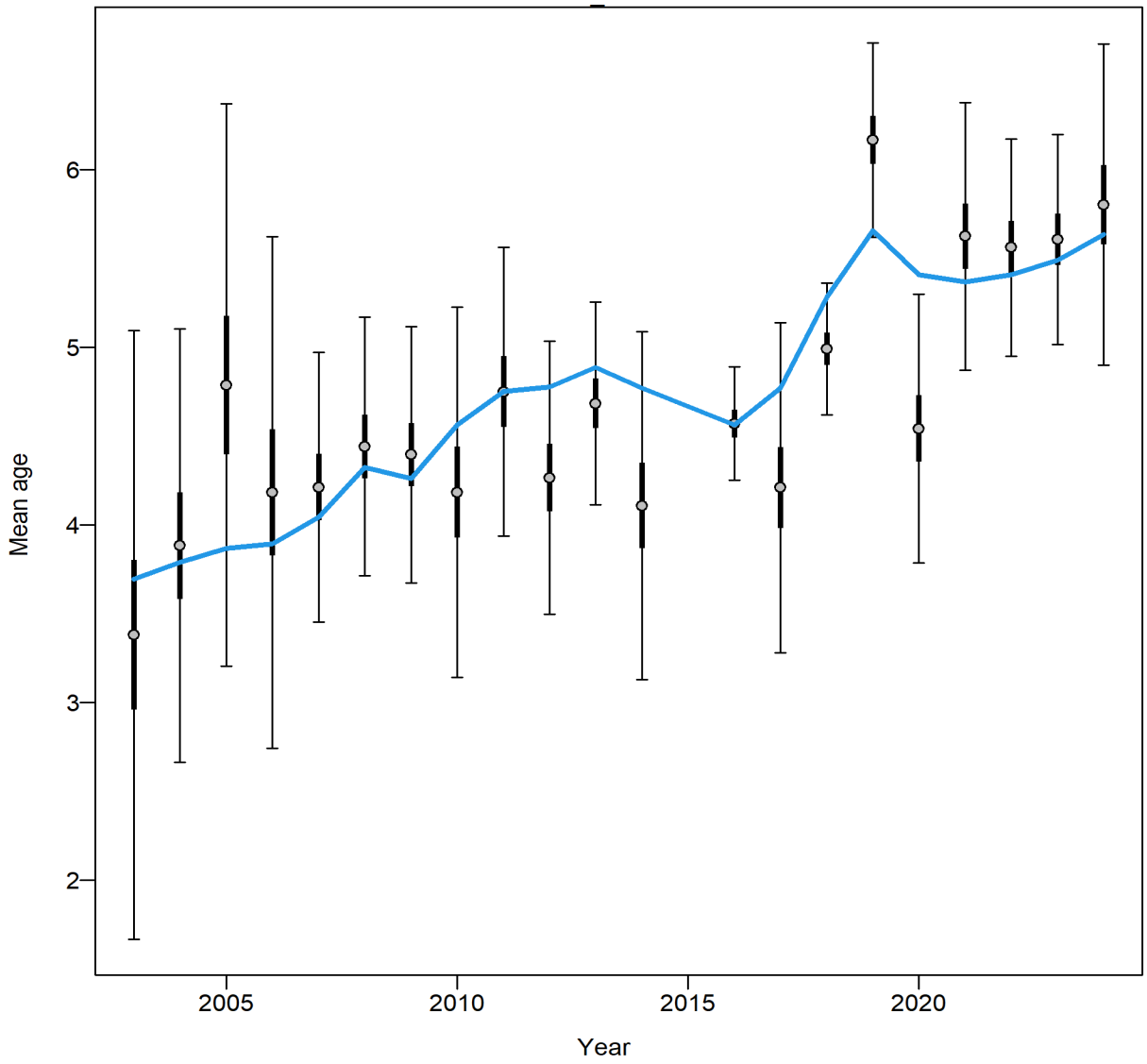


Figure 75. Mean age of Gray Triggerfish landed by the Recreational fleet from conditional data (aggregated across length bins) with 95% confidence intervals (thick bars). Thinner intervals (with capped ends) show the result of further adjusting sample sizes based on the Francis data weighting method, which was not used here.

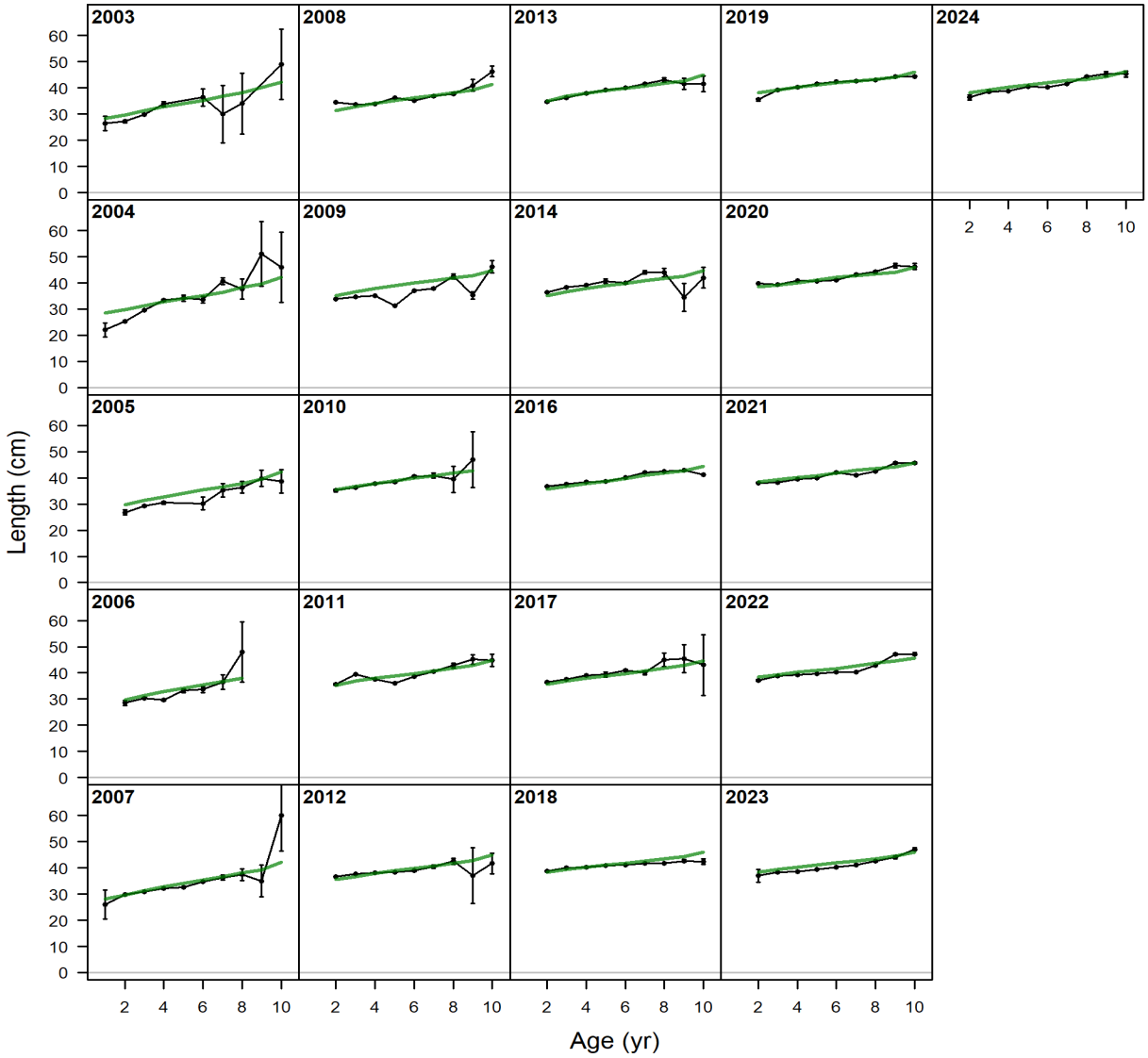


Figure 76. Observed and expected mean length-at-age for Gray Triggerfish landed by the Recreational fleet. Mean length-at-age is provided for comparison of trends and was not included in the likelihood.

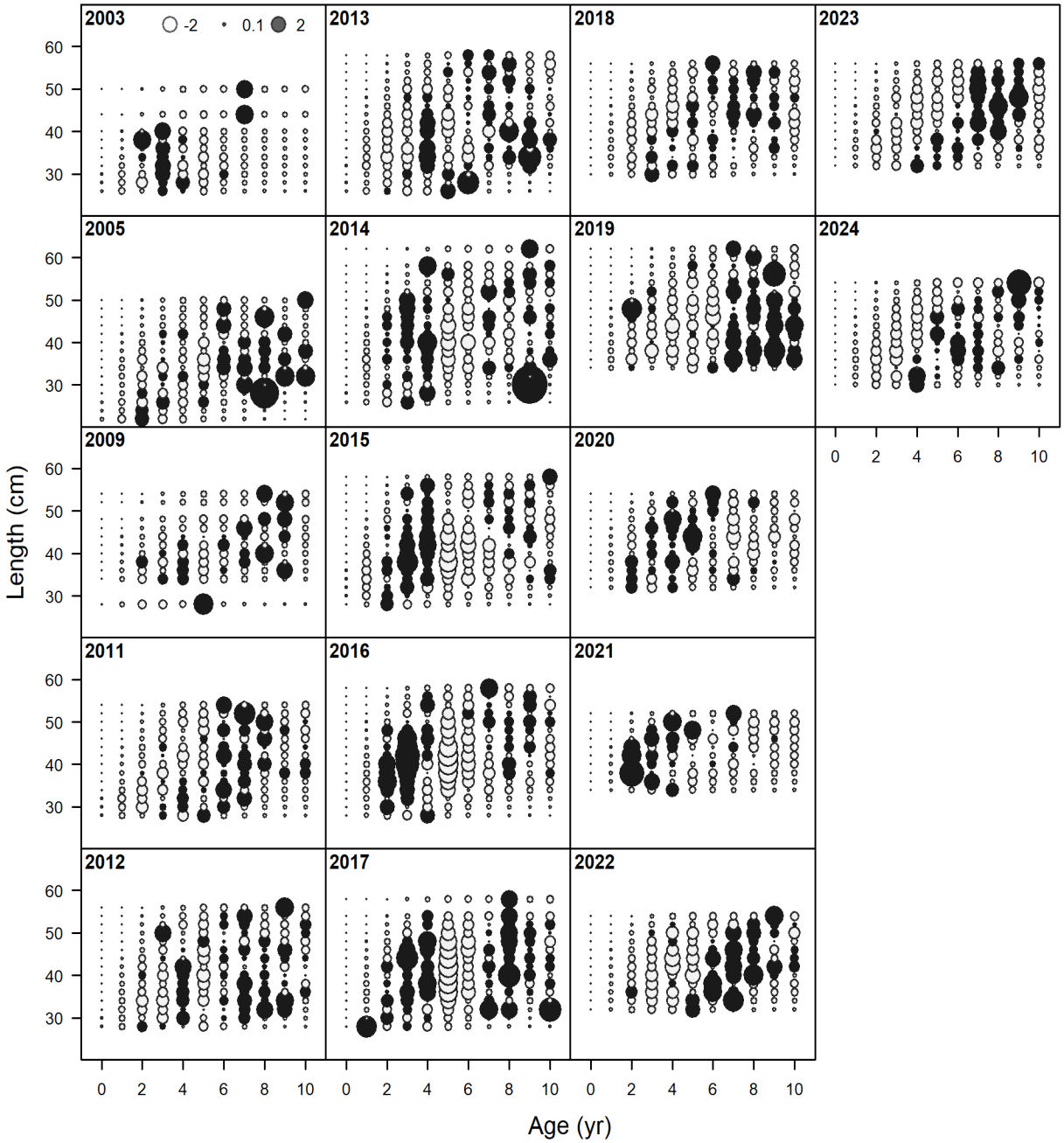


Figure 77. Pearson residuals for the conditional age-at-length compositions for Gray Triggerfish landed by the Commercial Vertical Line fleet. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

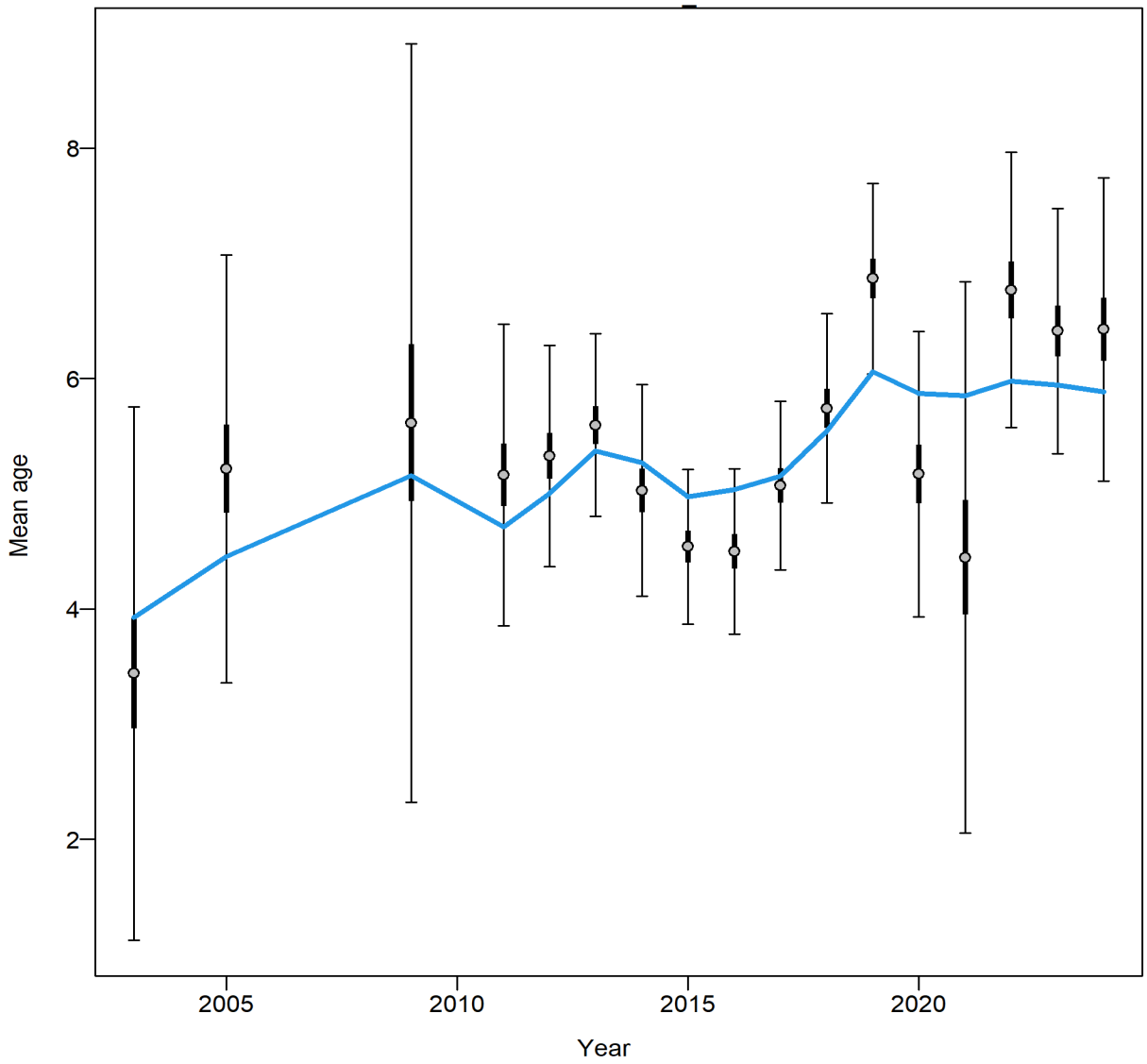


Figure 78. Mean age of Gray Triggerfish landed by the Commercial Vertical Line fleet from conditional data (aggregated across length bins) with 95% confidence intervals (thick bars). Thinner intervals (with capped ends) show the result of further adjusting sample sizes based on the Francis data weighting method, which was not used here.

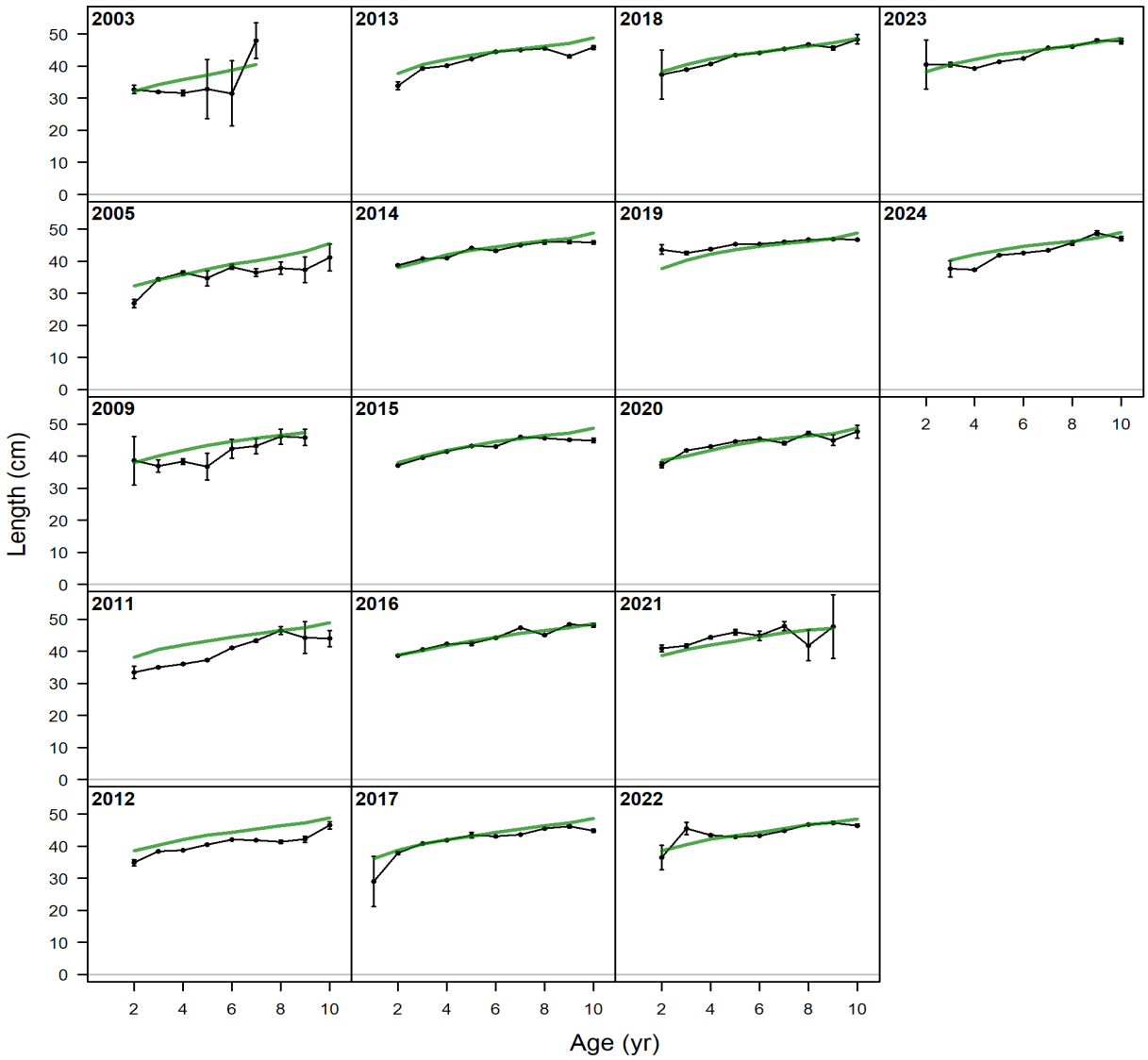


Figure 79. Observed and expected mean length-at-age for Gray Triggerfish landed by the Commercial Vertical Line fleet. Mean length-at-age is provided for comparison of trends and was not included in the likelihood.

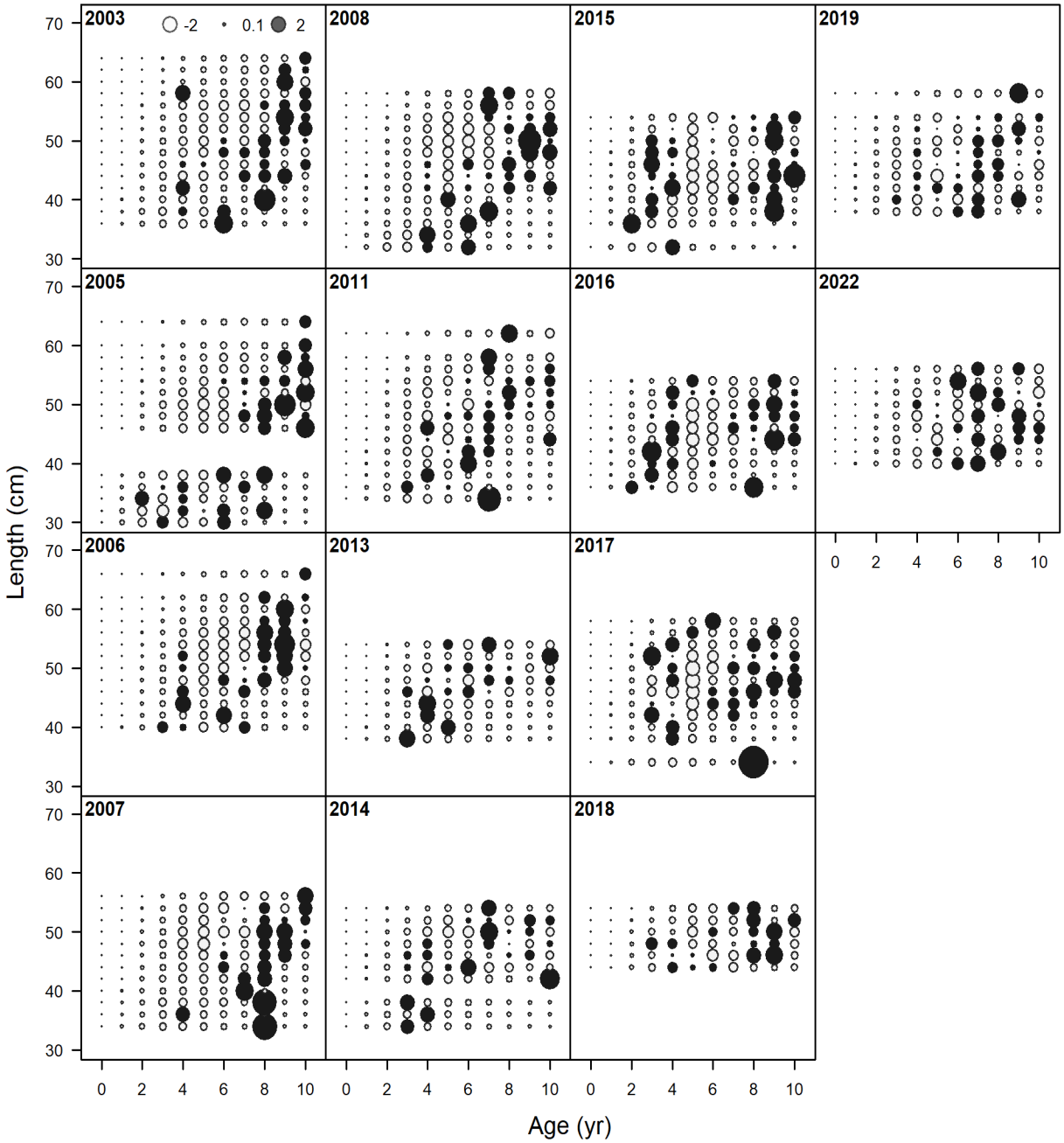


Figure 80. Pearson residuals for the conditional age-at-length compositions for Gray Triggerfish landed by the Commercial Longline fleet. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

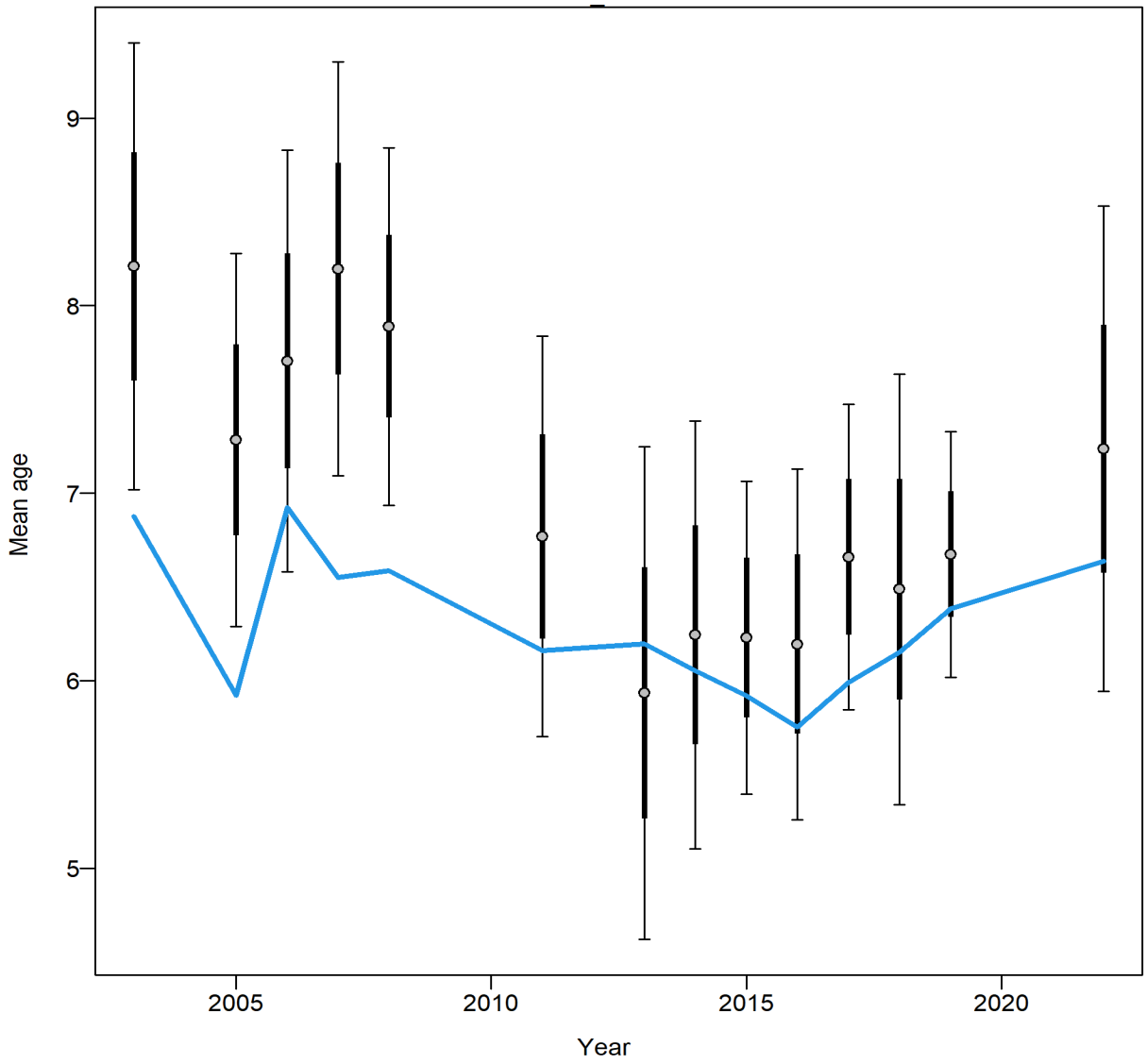


Figure 81. Mean age of Gray Triggerfish landed by the Commercial Longline fleet from conditional data (aggregated across length bins) with 95% confidence intervals (thick bars). Thinner intervals (with capped ends) show the result of further adjusting sample sizes based on the Francis data weighting method, which was not used here.

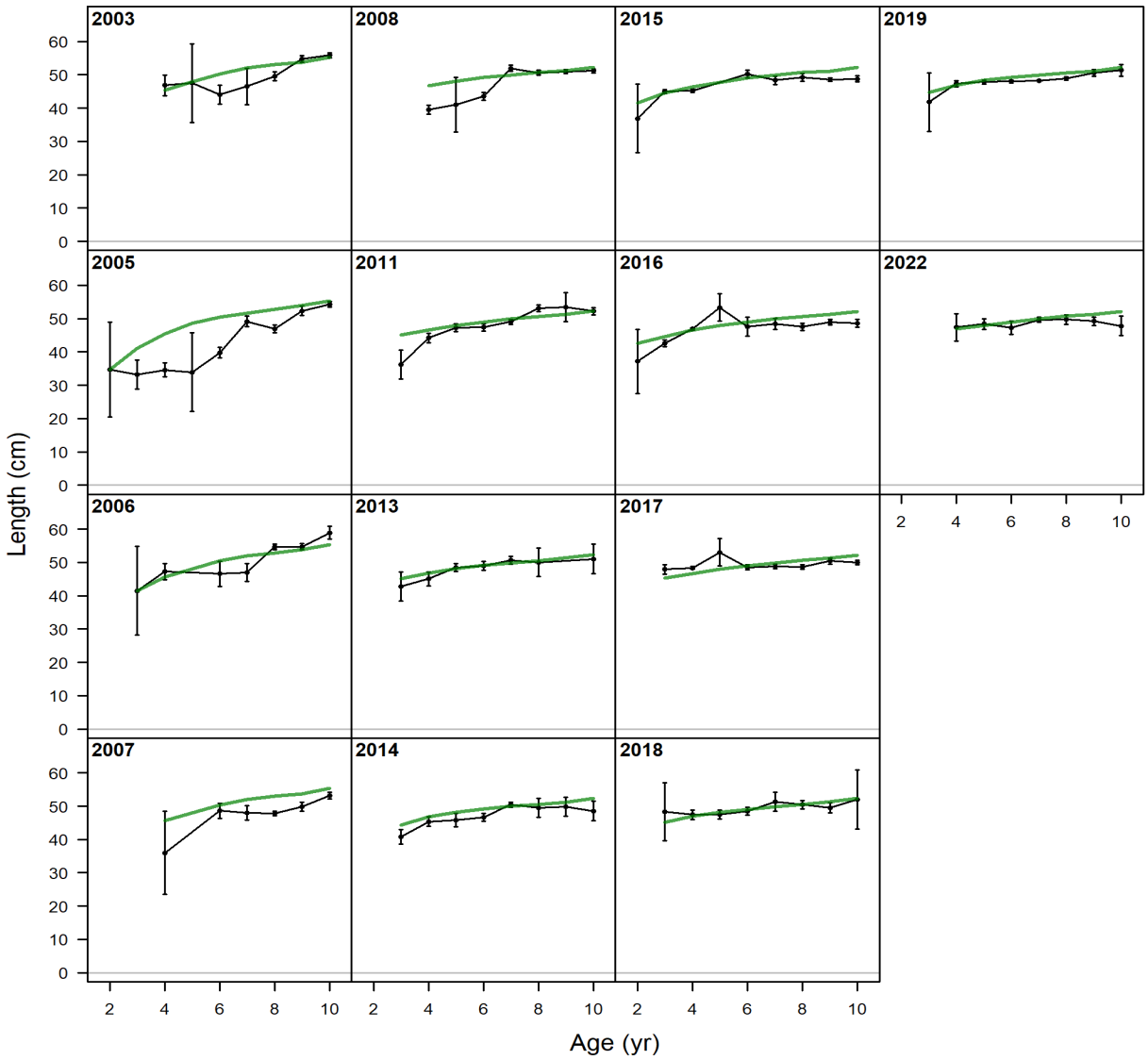


Figure 82. Observed and expected mean length-at-age for Gray Triggerfish landed by the Commercial Longline fleet. Mean length-at-age is provided for comparison of trends and was not included in the likelihood.

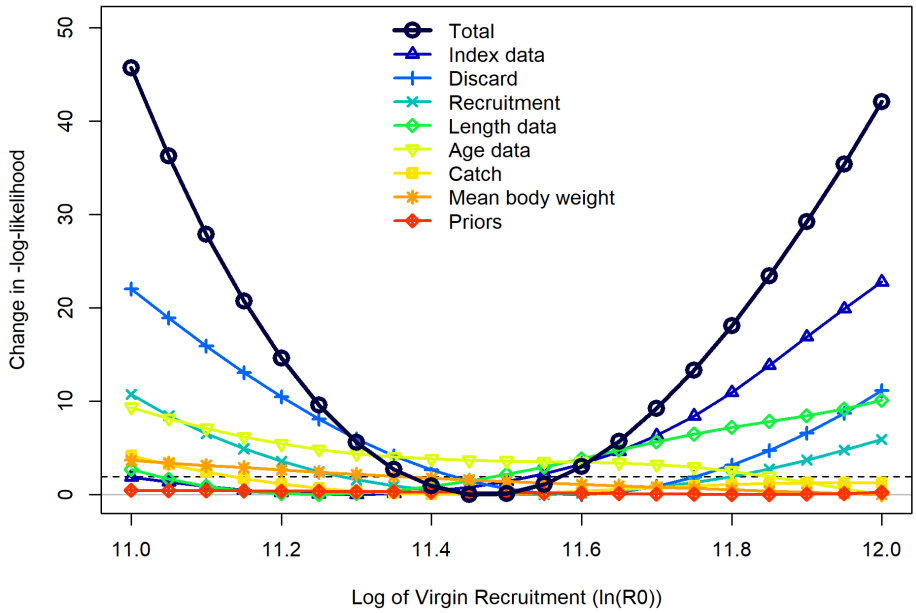


Figure 83. The likelihood profile for the natural log of the virgin recruitment parameter (ln(R_0)) of the Beverton – Holt stock-recruit function. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested. The MLE (CV) for the SEDAR 100 AP Model was 11.469 (0.004). The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

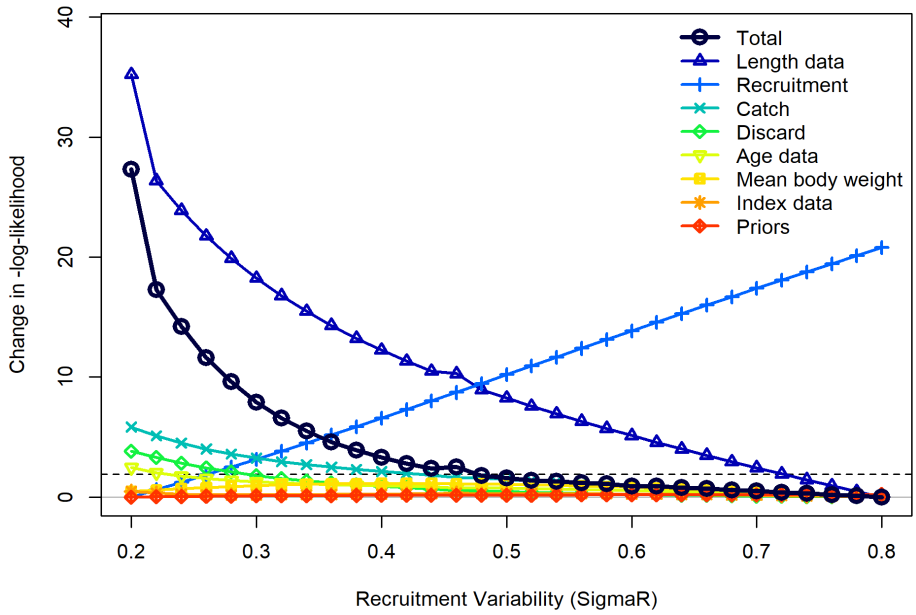


Figure 84. The likelihood profile for the recruitment variability (SigmaR) parameter of the Beverton – Holt stock-recruit function. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested. SigmaR was fixed at 0.6 in the SEDAR 100 AP Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

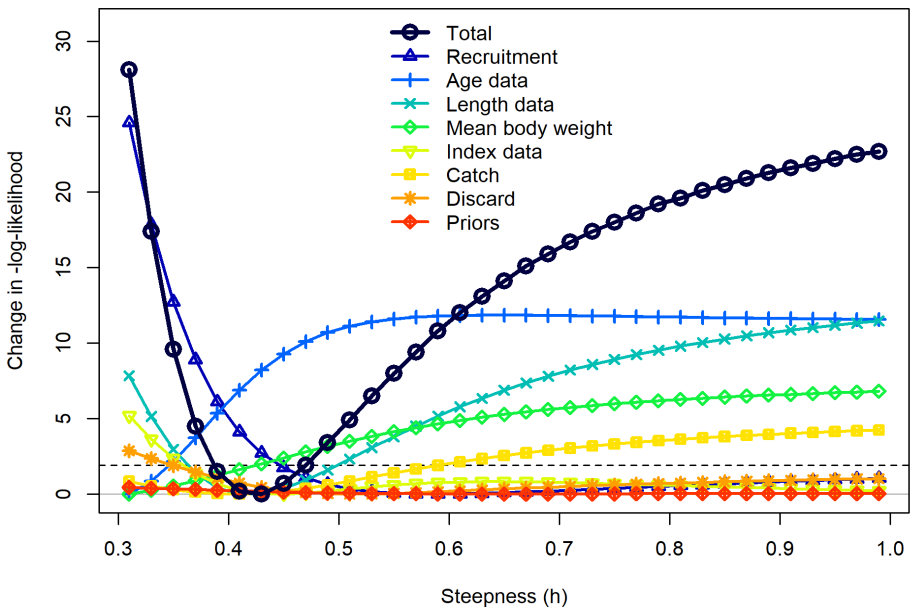


Figure 85. The likelihood profile for the steepness parameter of the Beverton – Holt stock-recruit function. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested. Steepness was fixed at 0.99 in the SEDAR 100 AP Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

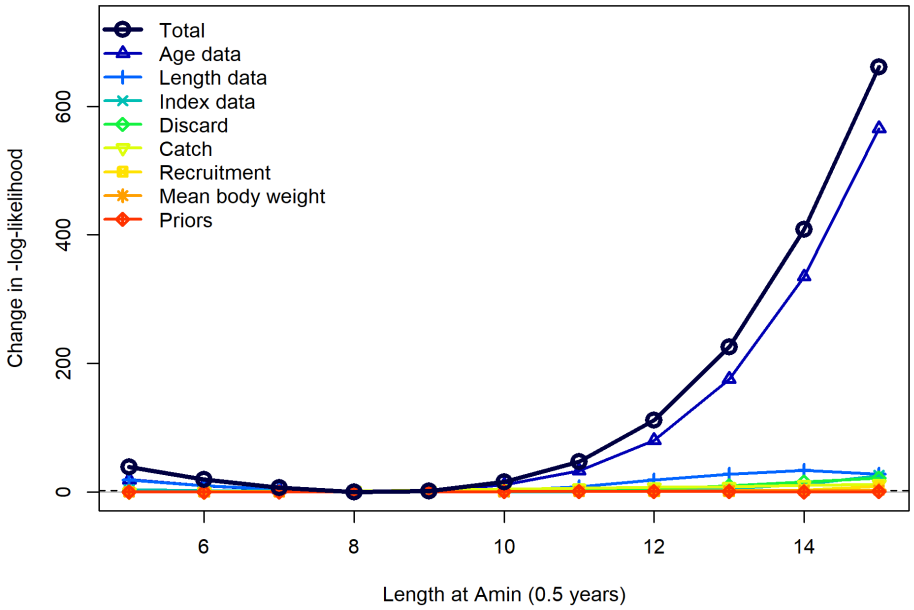


Figure 86. The likelihood profile for the length at the minimum age (0.5 year) parameter (L_{Amin}). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The MLE (CV) for the SEDAR 100 AP Model was 8.353 (0.039). The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

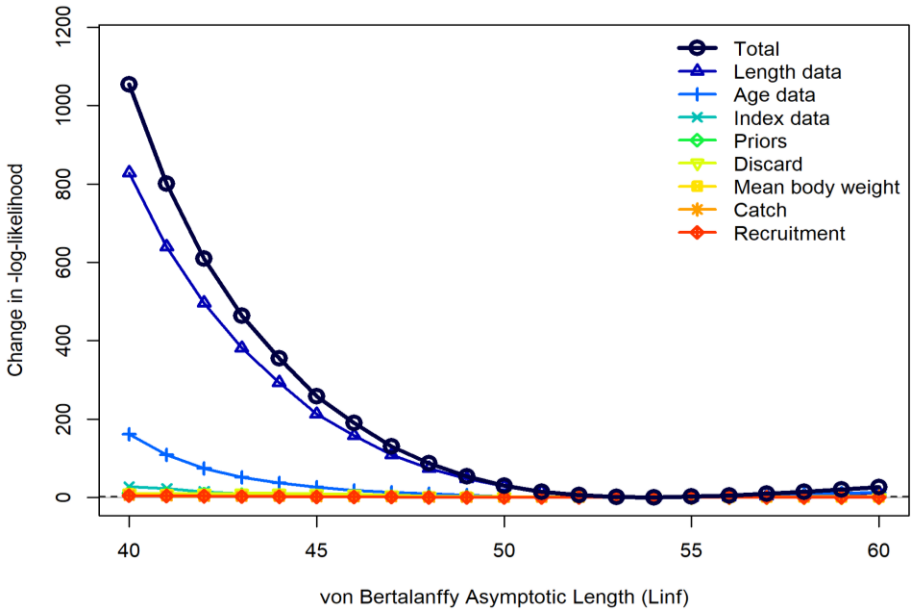


Figure 87. The likelihood profile for the von Bertalanffy asymptotic length parameter (L_{Amax} [i.e., L∞]). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The MLE (CV) for the SEDAR 100 AP Model was 53.804 (0.011). The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

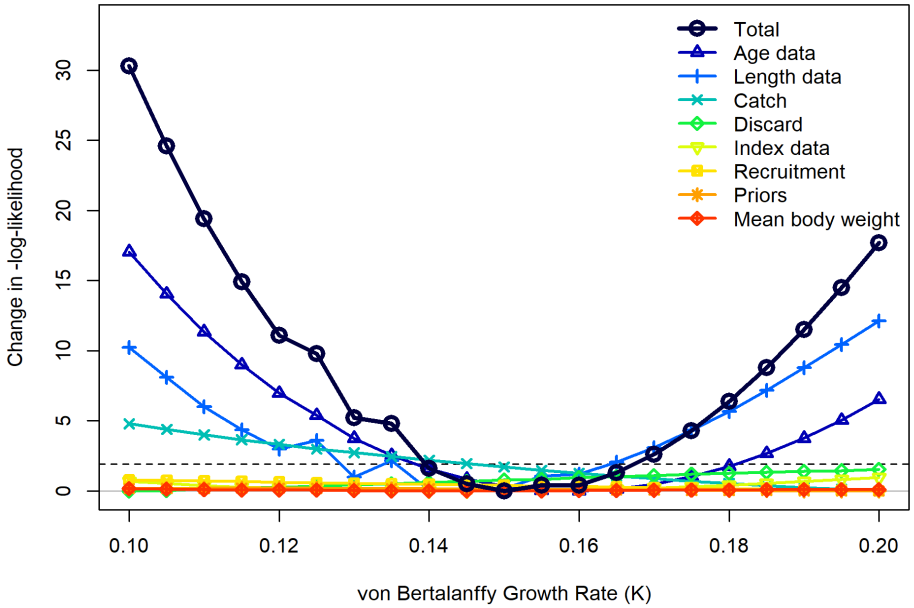


Figure 88. The likelihood profile for the von Bertalanffy growth rate parameter (K). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The MLE (CV) for the SEDAR 100 AP Model was 0.153 (0.048). The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

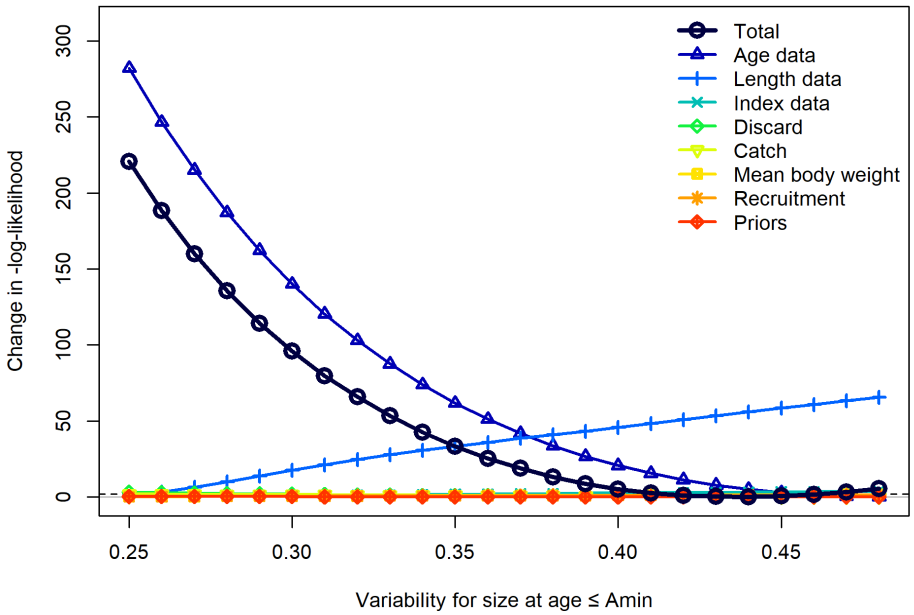


Figure 89. The likelihood profile for the variability for size-at-age ≤ Amin (CV_{Amin}). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The CV_{Amin} parameter was fixed at 0.437 for the SEDAR 100 AP Model after estimating it in an intermediate run. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

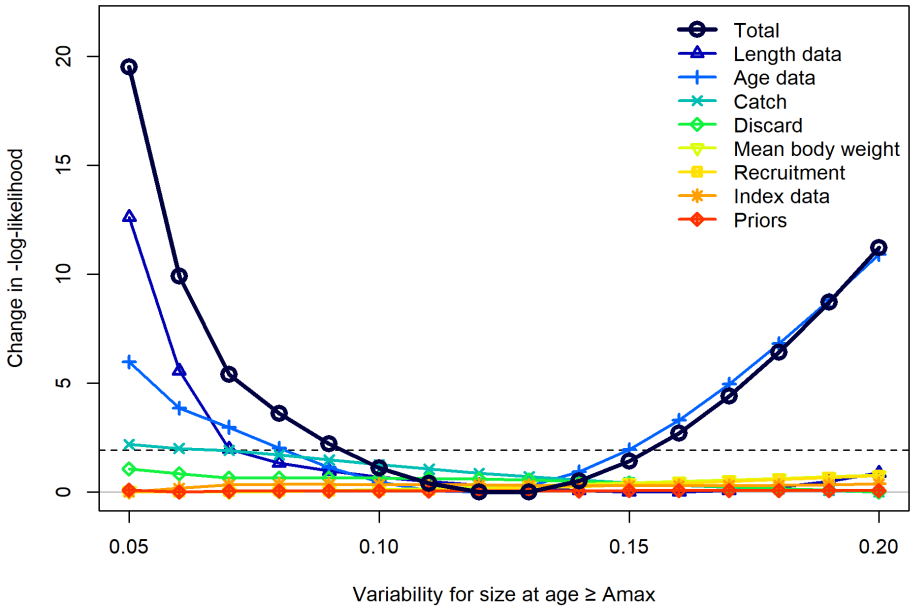


Figure 90. The likelihood profile for the variability for size-at-age ≥ Amax (CV_{Amax}). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The CV_{Amax} parameter was fixed at 0.124 for the SEDAR 100 AP Model after estimating it in an intermediate run. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

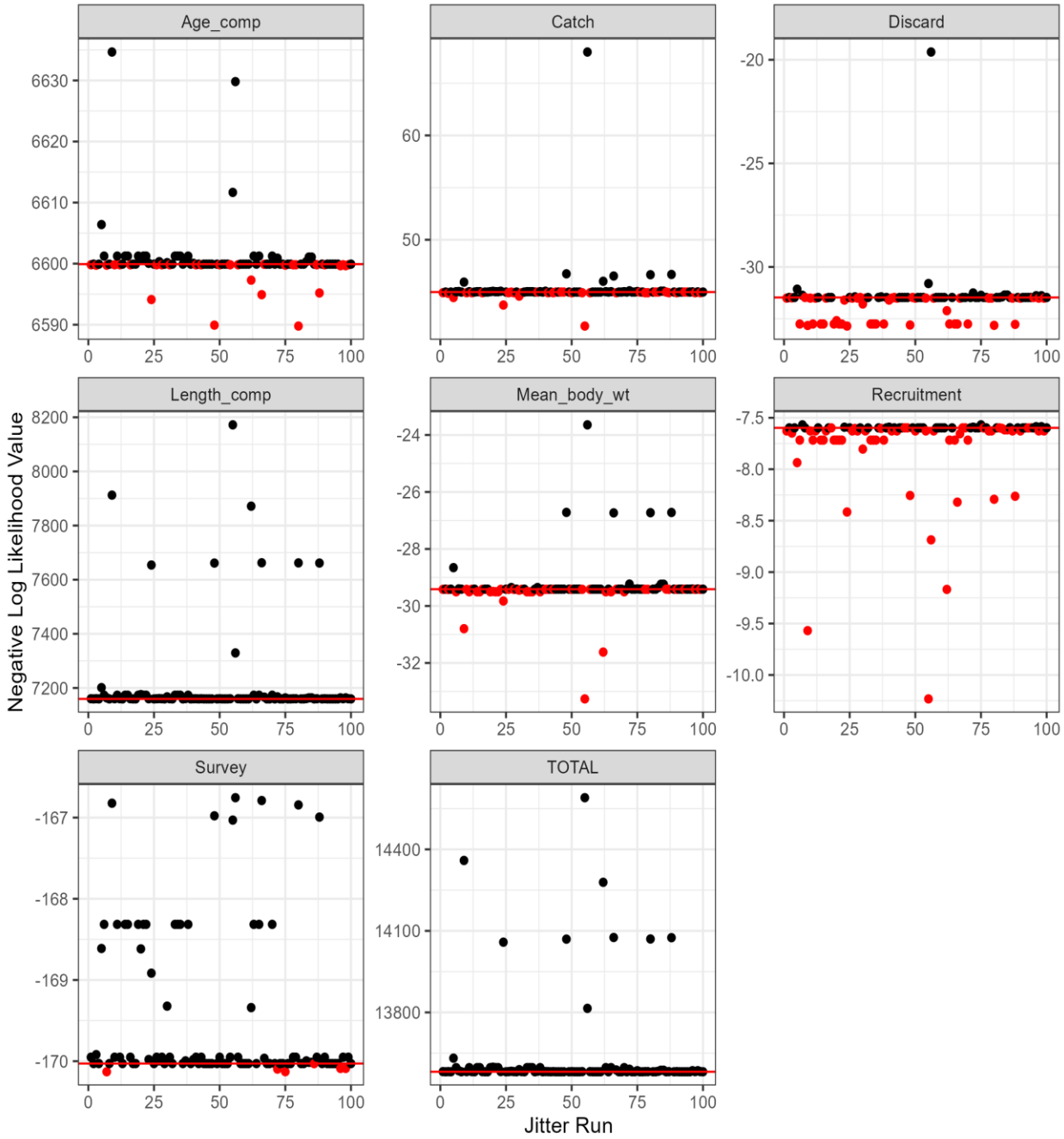


Figure 91. Results of the jitter analysis for various likelihood components for the SEDAR 100 AP Model. Each panel gives the results of 100 model runs where the starting parameter values for each run were randomly changed ('jittered') by 10% from the SEDAR 100 AP Model best fit values. Note that the y-axes differ between panels. Negative log-likelihood components shown from top left through bottom right include: conditional age-at-length (Age_comp), catch, discards, length composition (length_comp), mean weight of landings (Mean_body_wt), recruitment, survey, and total.

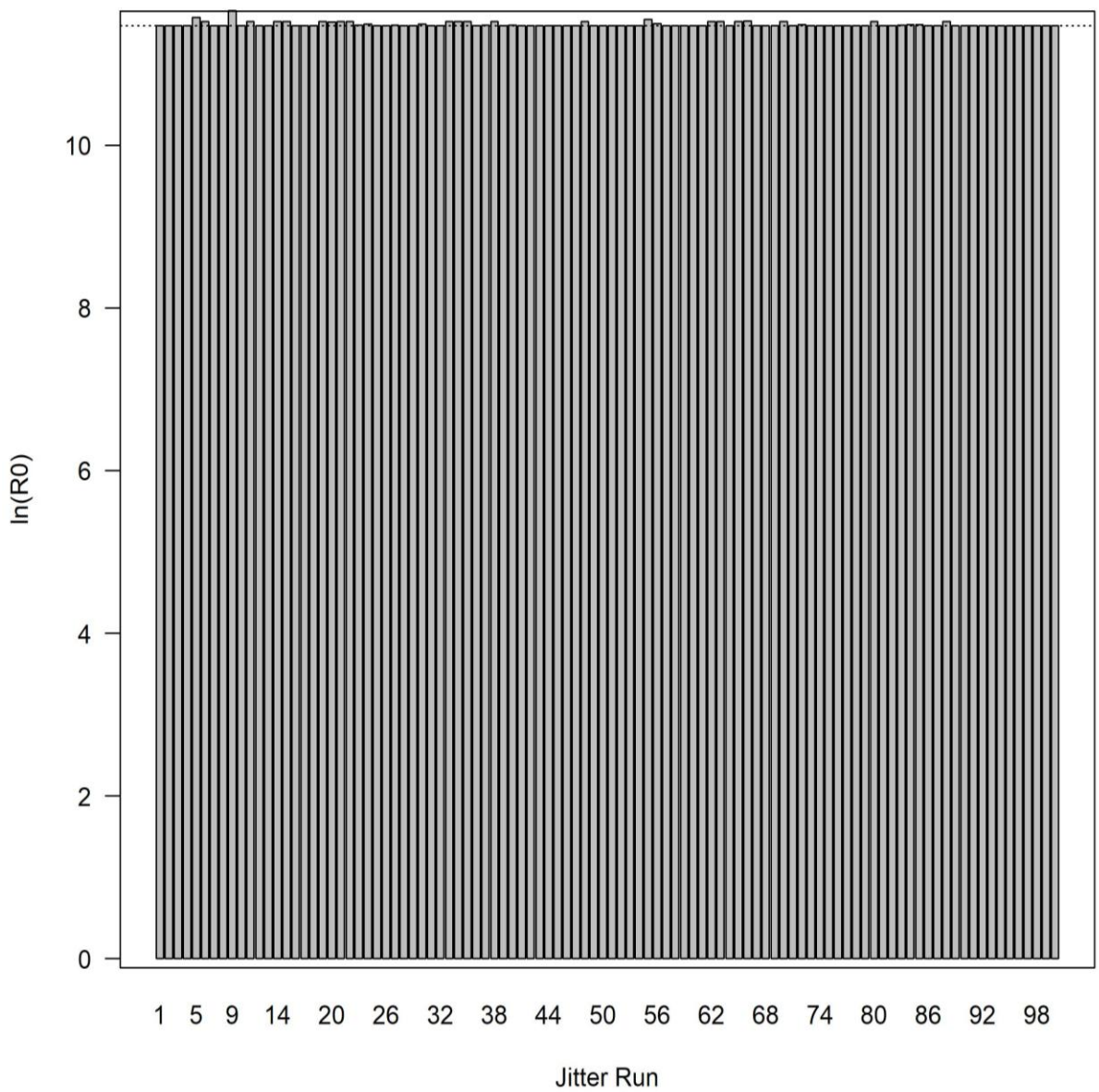


Figure 92. Results of the jitter analysis for the natural log of the virgin recruitment parameter (ln(R_0)) for the SEDAR 100 AP Model from 100 model runs where the starting parameter values for each run were randomly changed ('jittered') by 10% from the SEDAR 100 AP Model best fit value (dashed horizontal line).

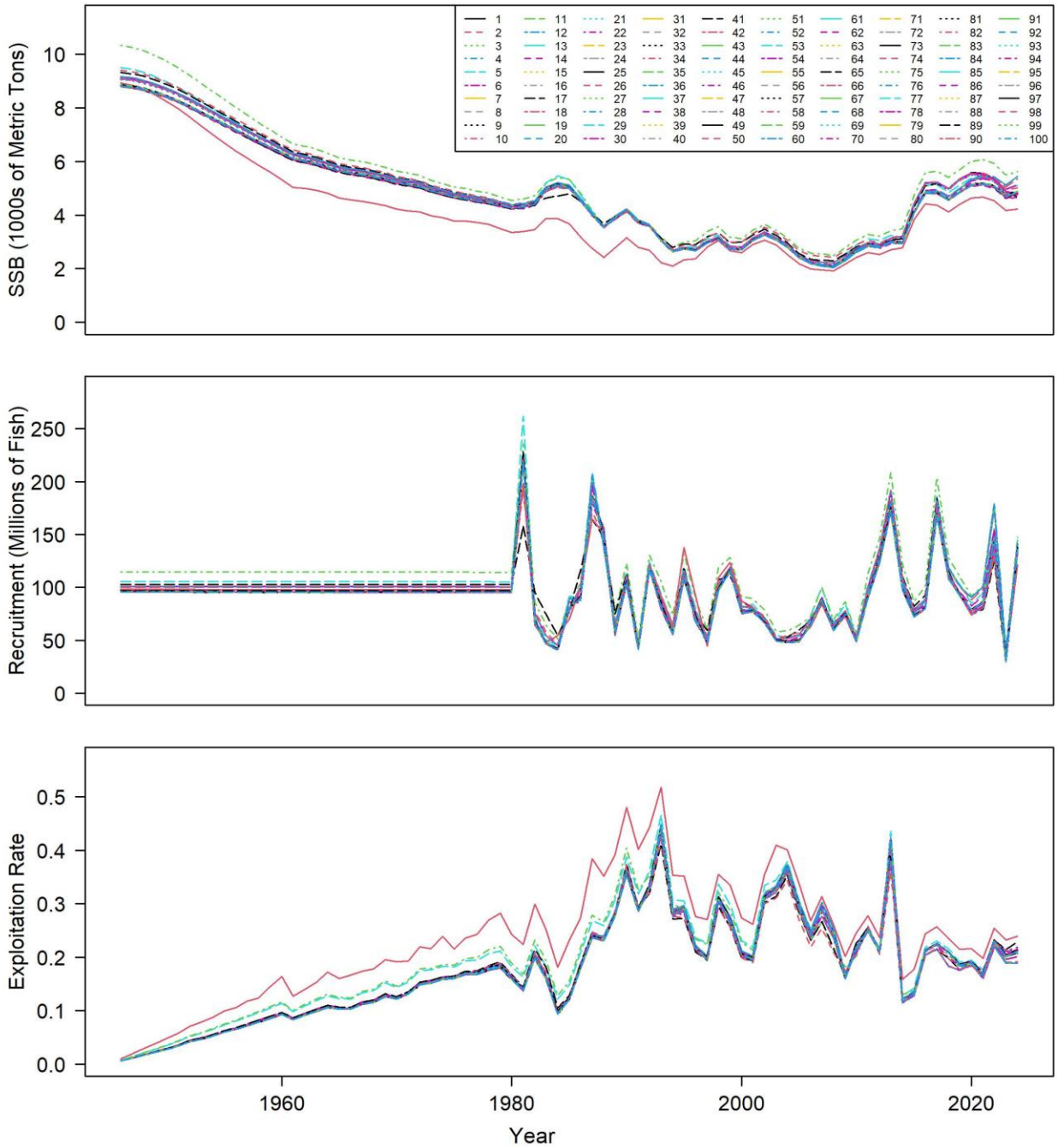


Figure 93. Estimated trajectories in spawning stock biomass (SSB in 1,000s of metric tons; top panel), recruitment (millions of age-0; middle panel), and exploitation rate (total biomass killed all ages / total biomass age 1+; bottom panel) for the SEDAR 100 AP Model.

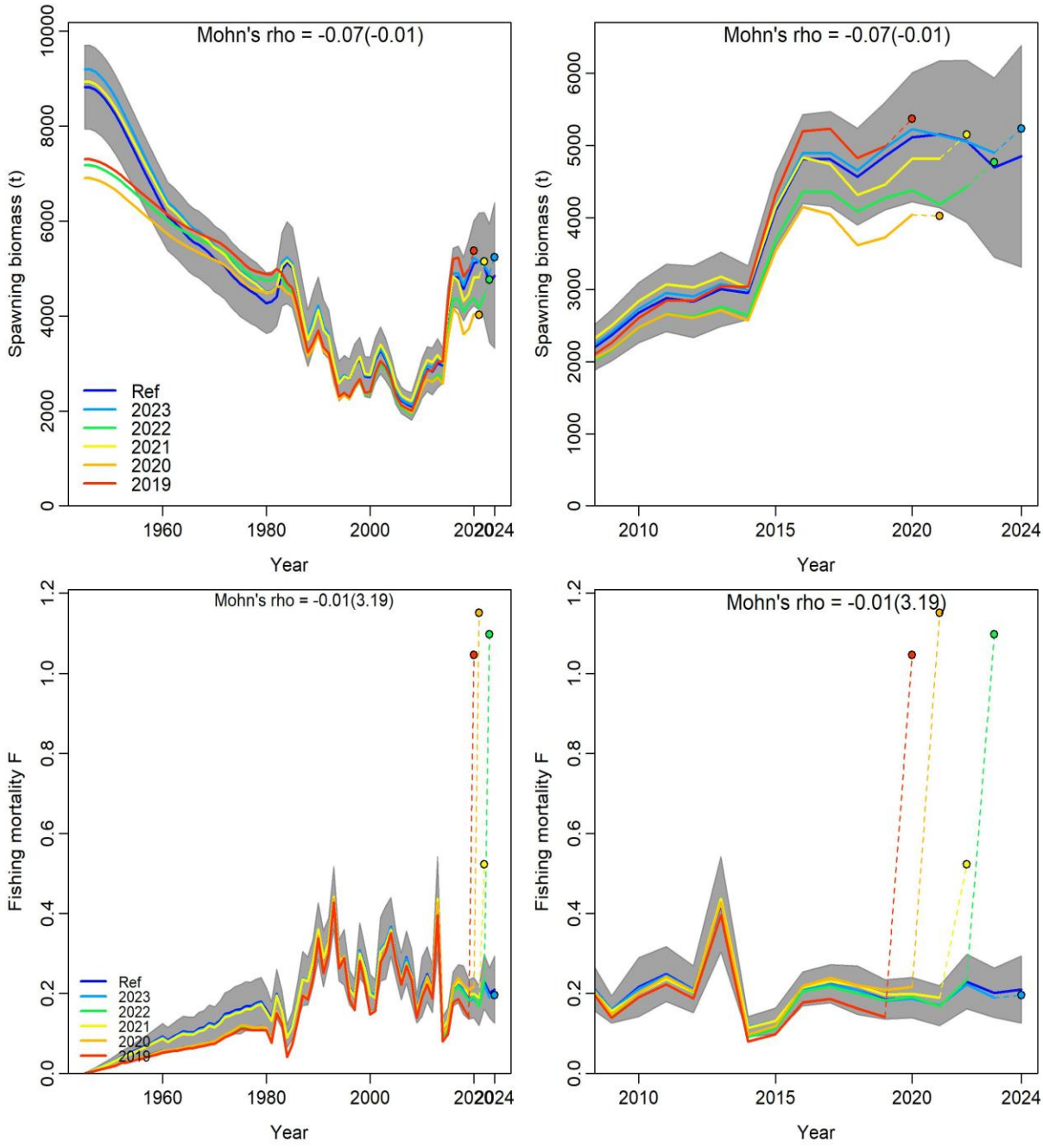


Figure 94. Retrospective analysis of spawning stock biomass (SSB, top panels) and fishing mortality (F, bottom panels) estimates by re-fitting each reference model (Ref) after removing five years of observations, one year at a time sequentially. The retrospective results are shown for the entire time series and for the most recent years only. Mohn's Rho statistic and the corresponding 'hindcast rho' values (in brackets) are printed at the top of each panel. One-year-ahead projections denoted by color-coded dashed lines with terminal points shown for each model. Grey shaded areas are the 95% confidence intervals from the reference model. See Carvalho et al. (2021) for additional details.

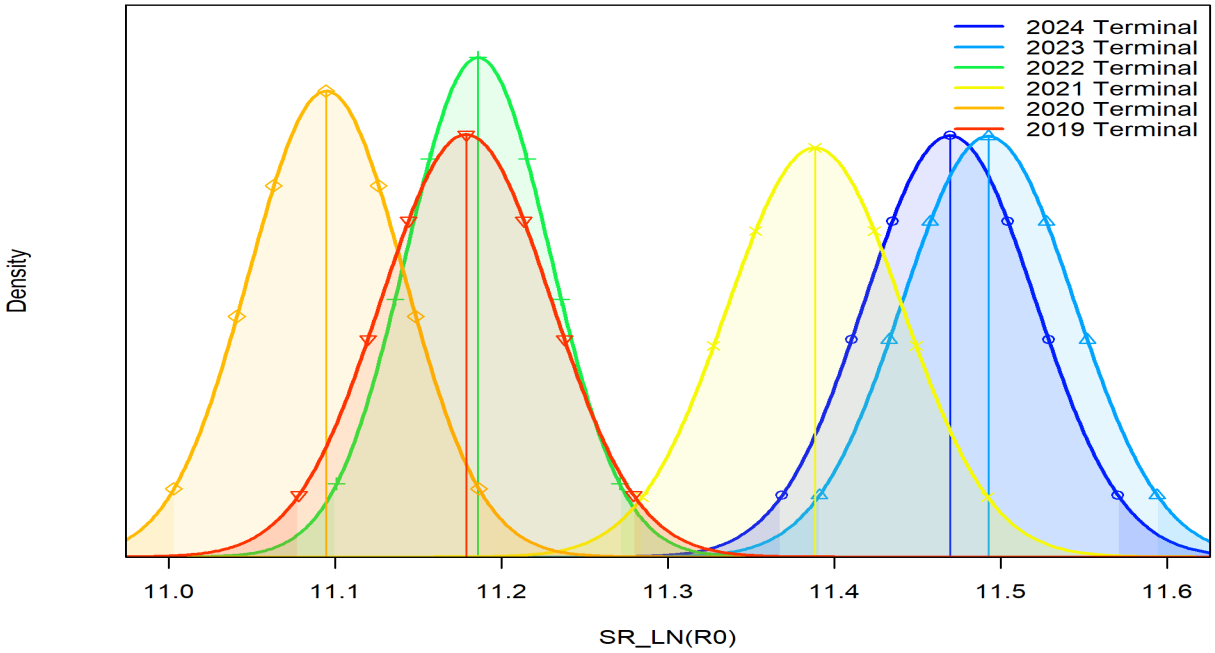


Figure 95. Results of a five year retrospective analysis for the natural log of the virgin recruitment parameter (ln(R_0)) for the SEDAR 100 AP Model.

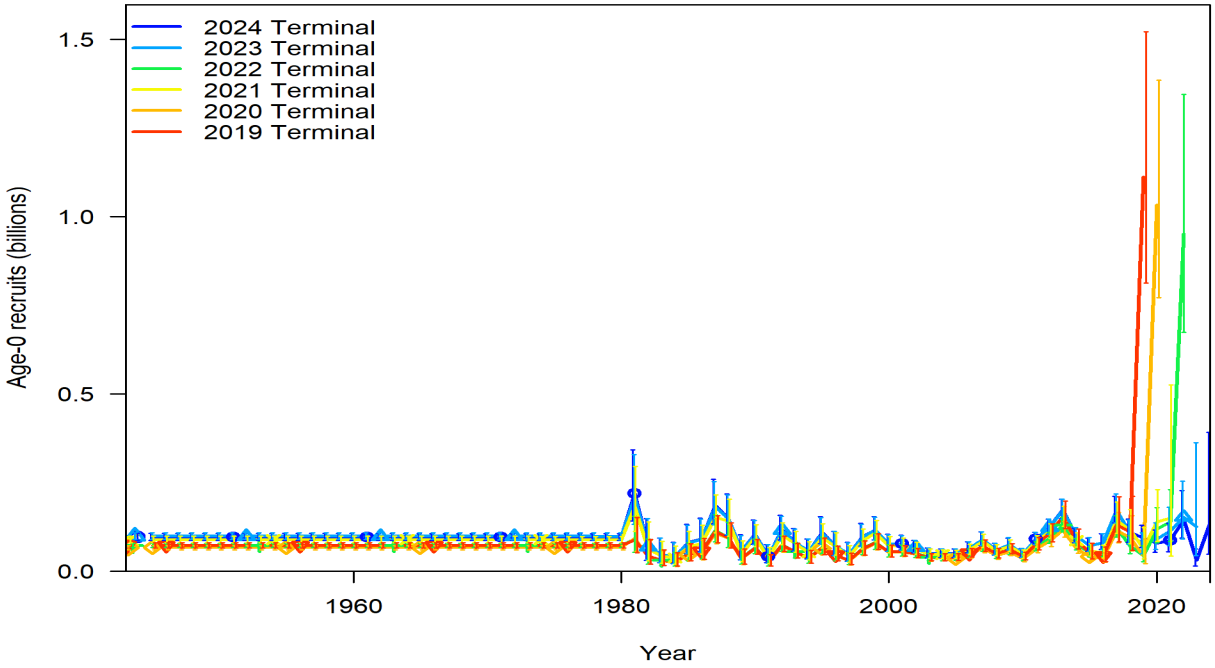


Figure 96. Results of a five year retrospective analysis for recruitment (billions of fish) for the SEDAR 100 AP Model.

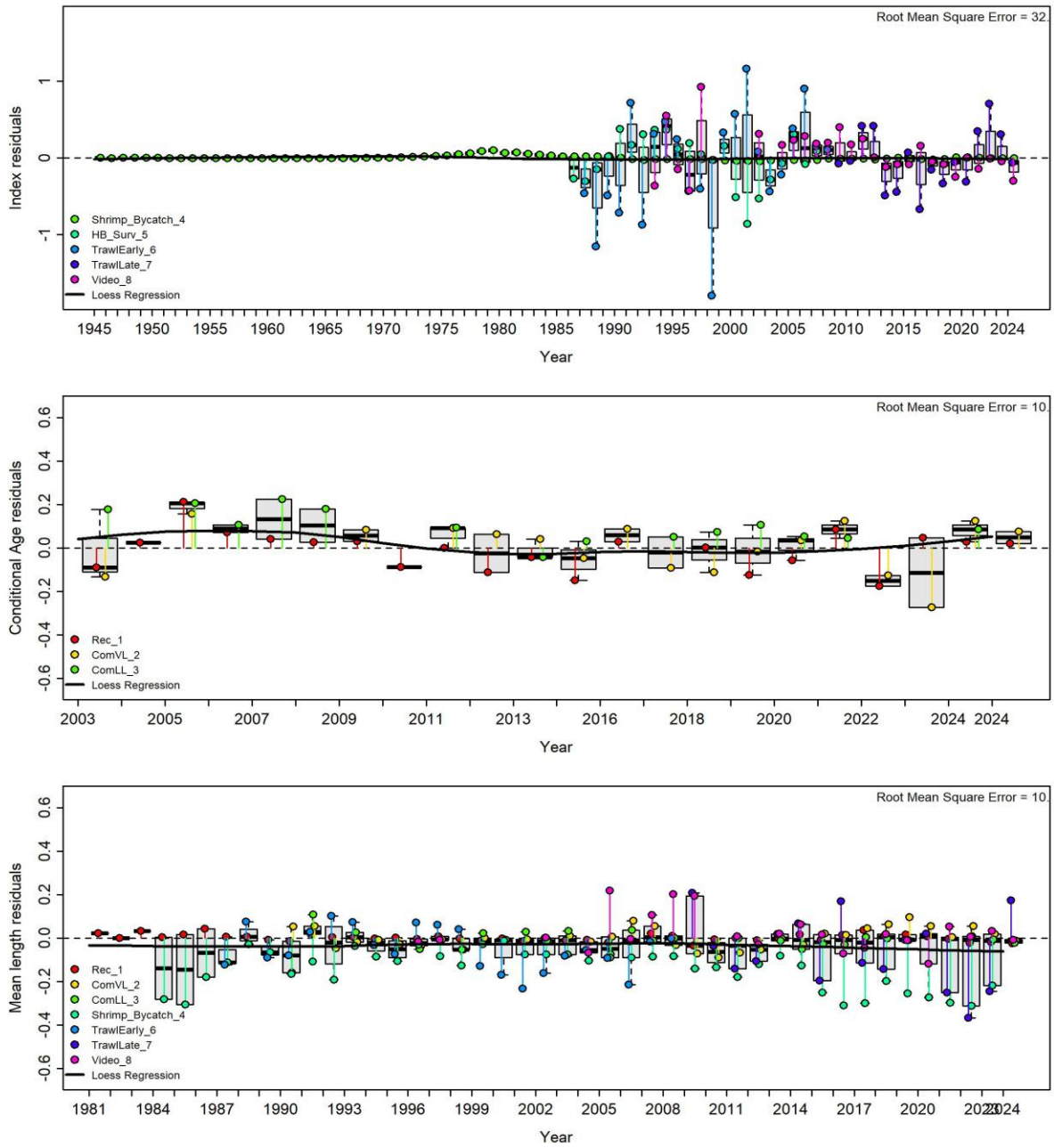


Figure 97. Joint residual plots for indices of abundance fits (top panel), fits to conditional at-age-length (middle panel), and fits to annual mean length estimates (bottom panel). Vertical lines with points show the residuals (in colors by index), and solid black line reflects the loess smoother through all the residuals. Boxplots indicate the median and quantiles in cases where residuals from the multiple indices are available for any given year. Root-mean squared errors (RMSE) are included in the upper right-hand corner of each plot. See Carvalho et al. (2021) for additional details.

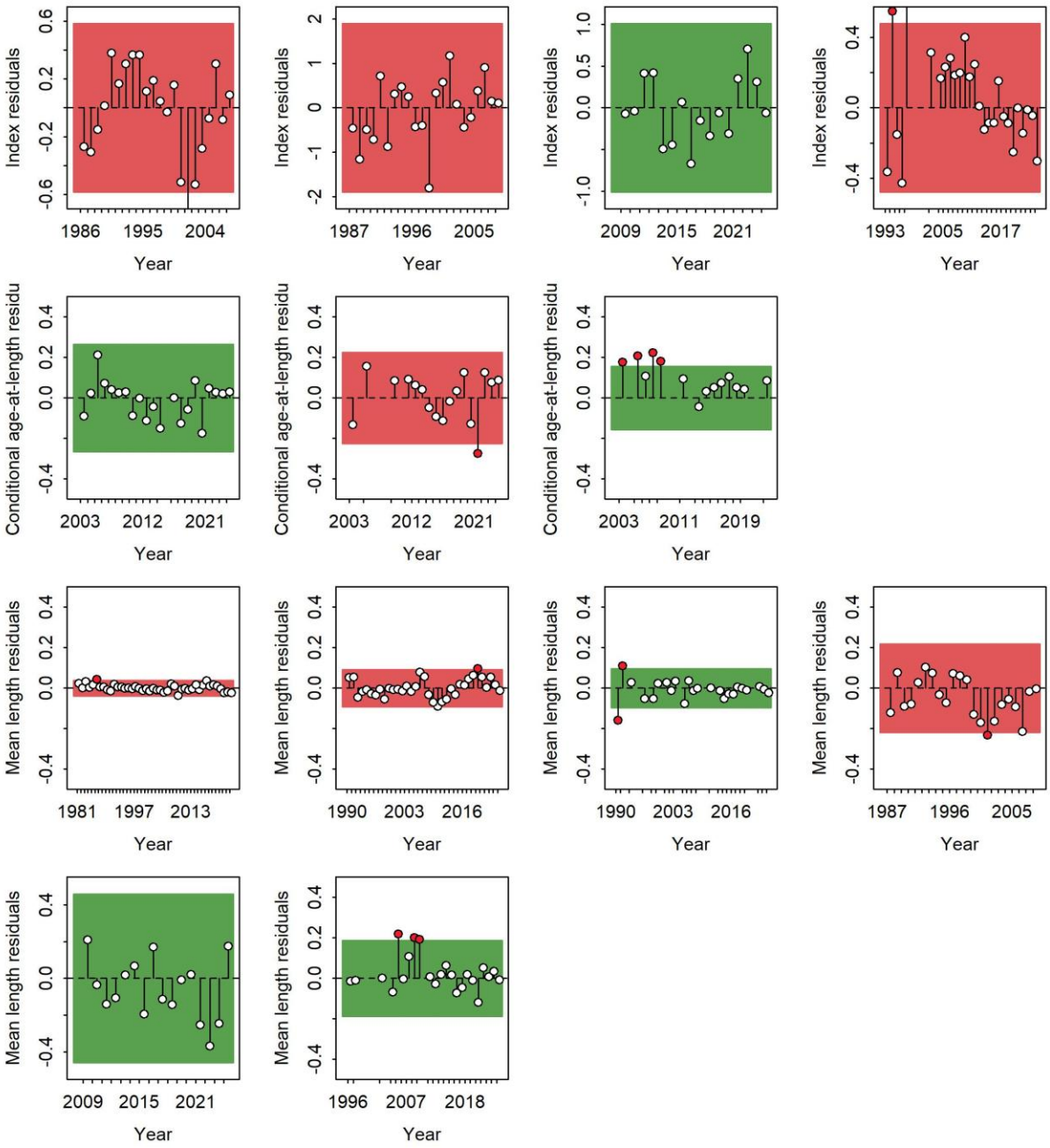


Figure 98. Runs tests results for indices of abundance, conditional age-at-length, and mean length. Green shading indicates no evidence (p >= 0.05) and red shading evidence (p < 0.05) to reject the hypothesis of a randomly distributed time series of residuals, respectively. The shaded (green/red) area spans three residual standard deviations to either side from zero, and the red points outside of the shading violate the 'three-sigma limit' for that series. See Carvalho et al. (2021) for additional details.

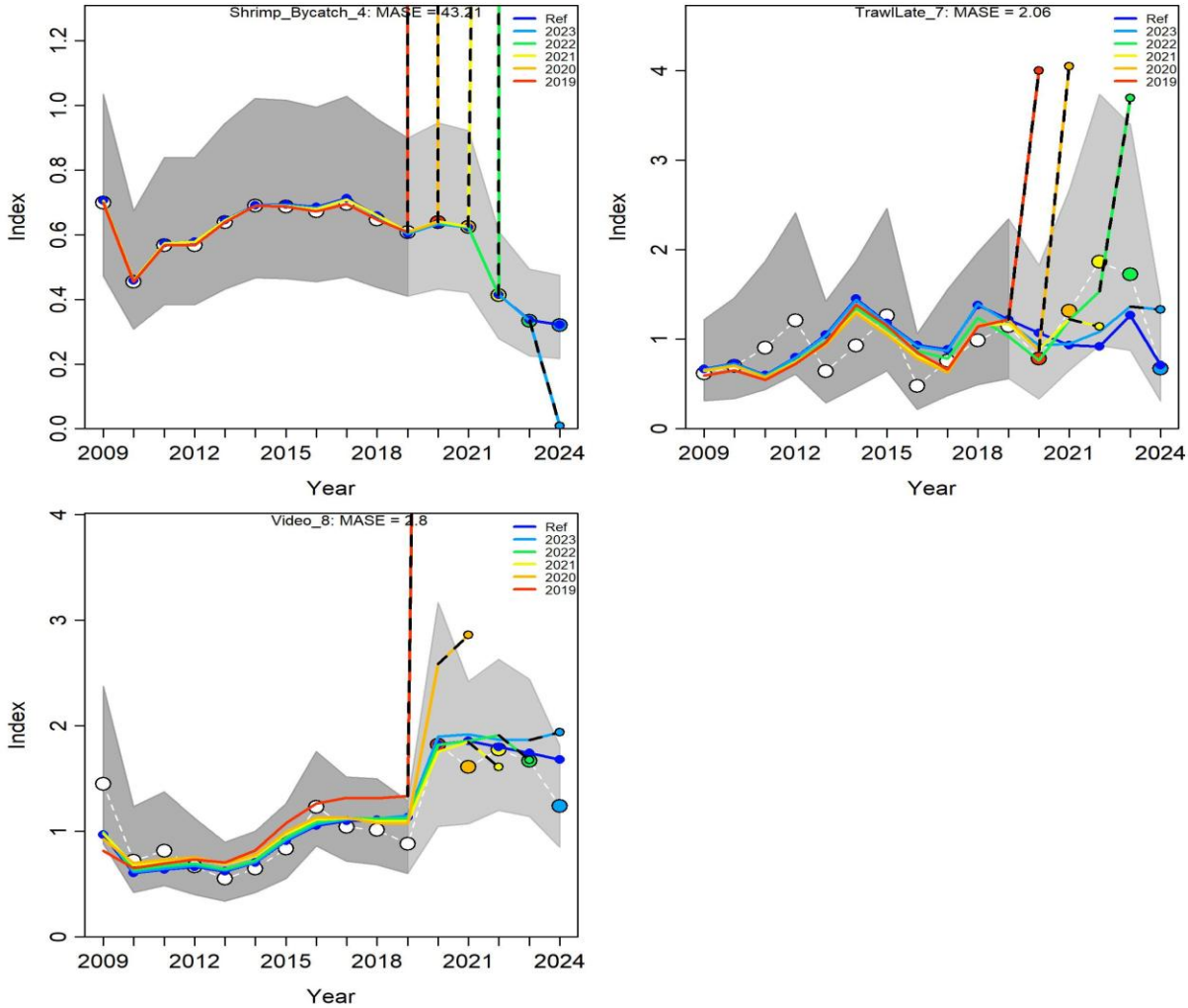


Figure 99. Hindcasting cross-validation (HCxval) results for indices of abundance fits. Shown are observed (large points connected with dashed line), fitted (solid lines) and one-year ahead forecast values (small terminal points). HCxval was performed using one reference model (Ref) and five hindcast model runs (solid lines) relative to the expected index. The observations used for cross validation are highlighted as color-coded solid circles with associated 95% confidence intervals (light-grey shading). The model reference year refers to the endpoints of each one-year-ahead forecast and the corresponding observation (i. e., year of peel + 1). The mean absolute scaled error (MASE) score associated with each index time series is denoted in each panel. See Carvalho et al. (2021) for additional details.

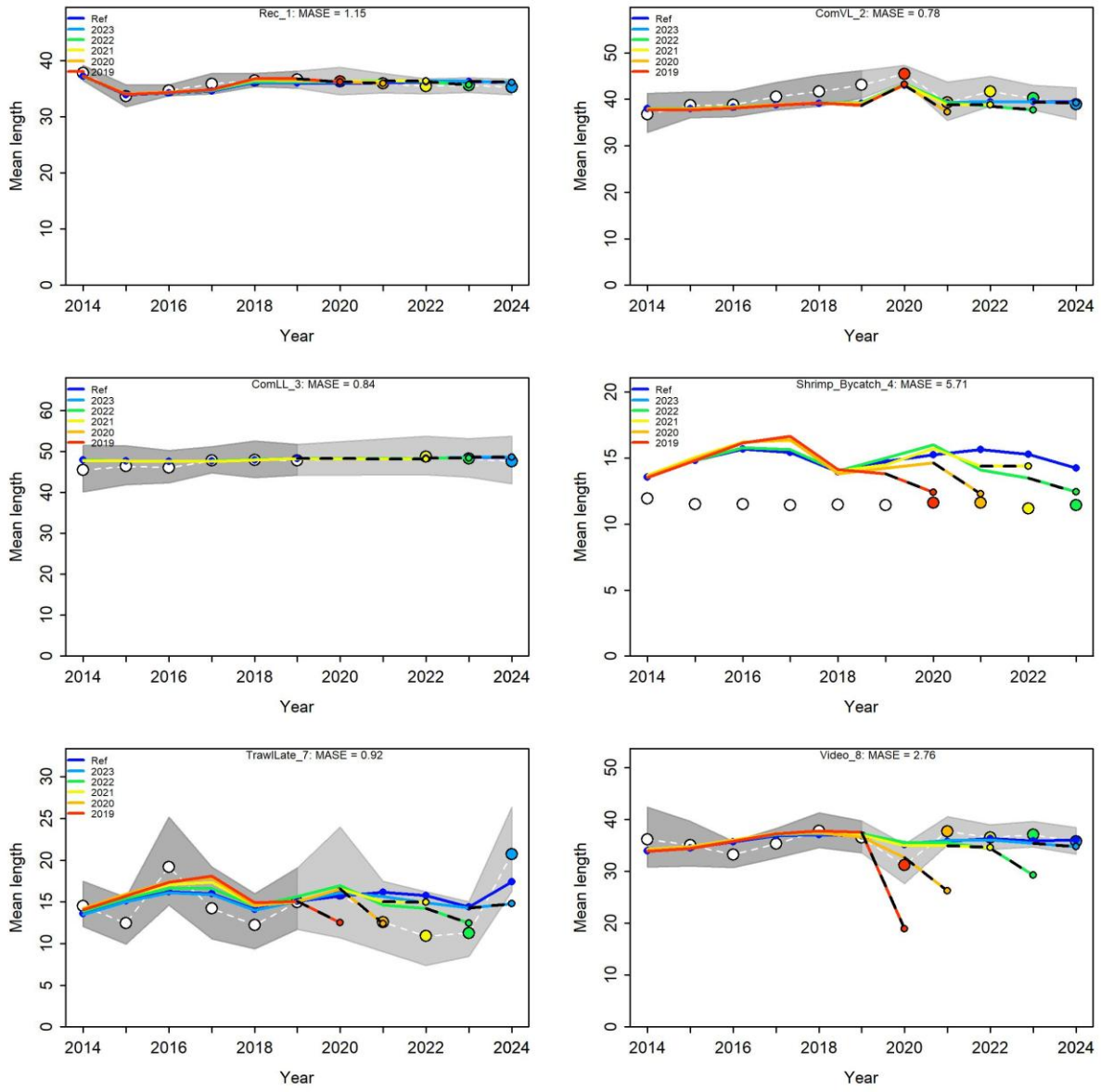


Figure 100. Hindcasting cross-validation (HCxval) results for fits to annual mean length estimates. Shown are observed (large points connected with dashed line), fitted (solid lines) and one-year ahead forecast values (small terminal points). HCxval was performed using one reference model (Ref) and five hindcast model runs (solid lines) relative to the expected mean length. The observations used for cross-validation are highlighted as color-coded solid circles with associated 95% confidence intervals (light-grey shading). The model reference year refers to the endpoints of each one-year-ahead forecast and the corresponding observation (i. e., year of peel + 1). The mean absolute scaled error (MASE) score associated with each size composition time series is denoted in each panel. See Carvalho et al. (2021) for additional details.

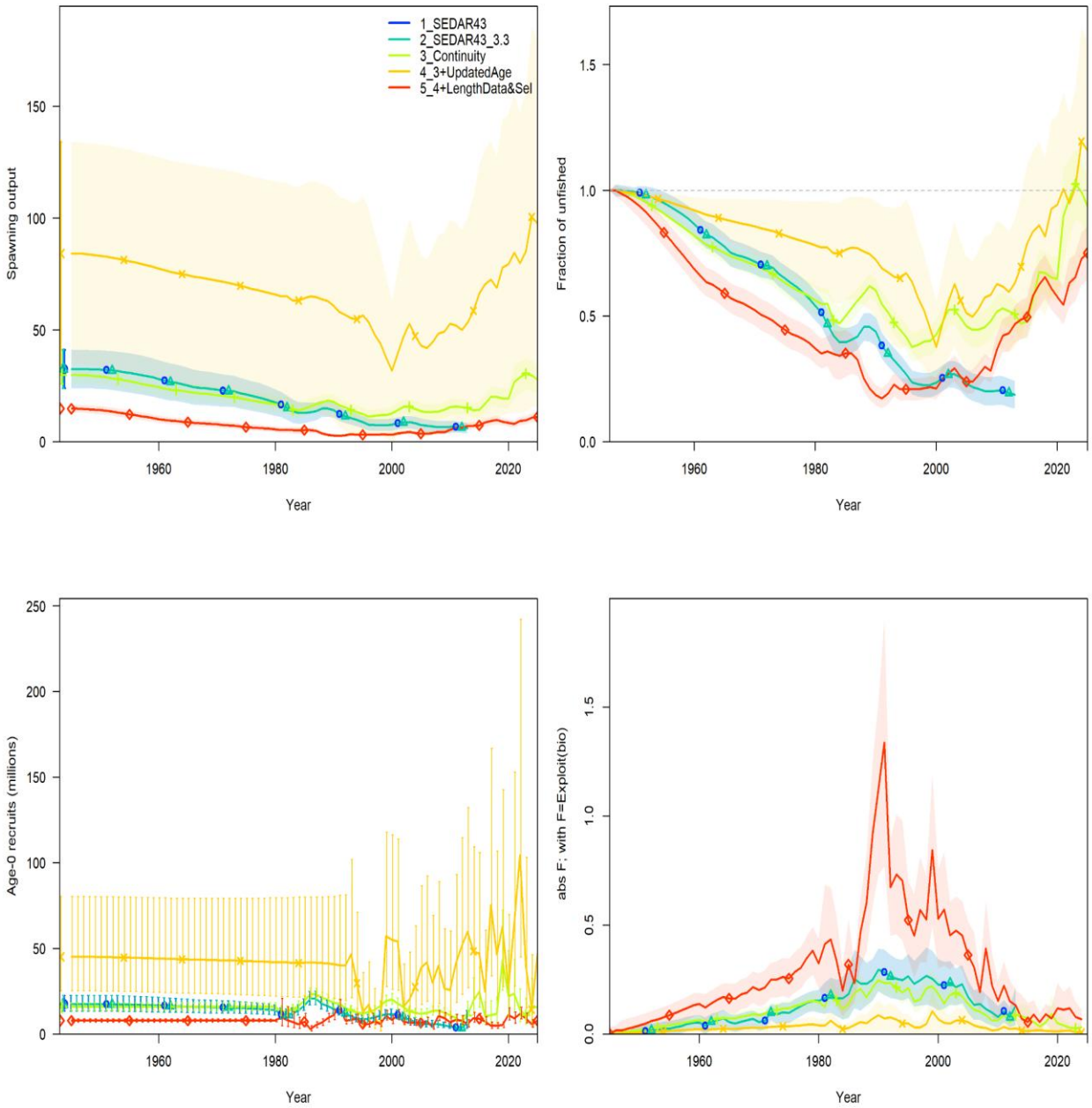


Figure 101. Bridging analysis showing phase 1 changes in estimates of spawning output (eggs; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) and associated uncertainty through each major step of model building between the SEDAR 43 Standard Model (Step 1) and the SEDAR 100 AP Model (Step 28).

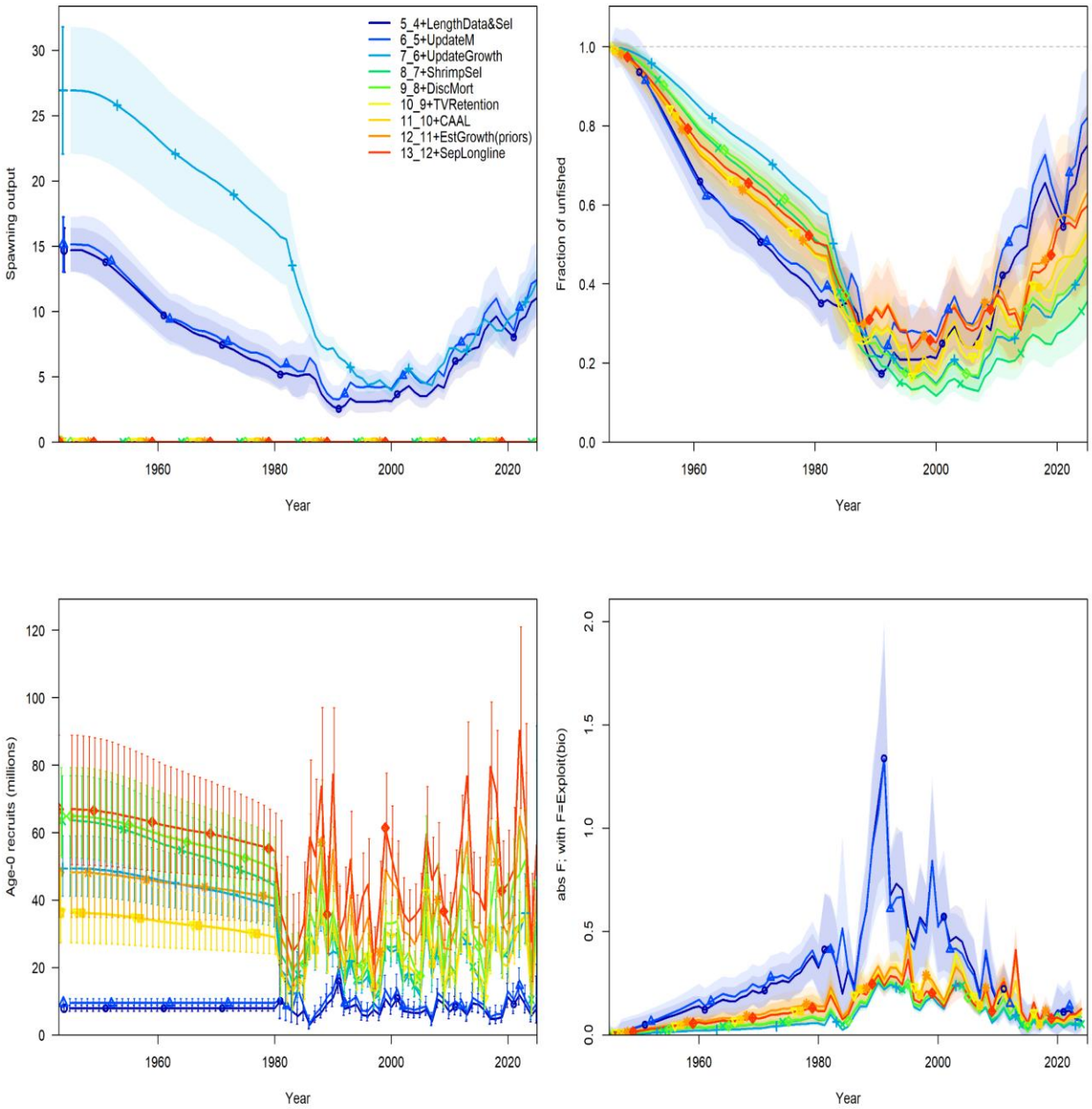


Figure 102. Bridging analysis showing phase 2 changes in estimates of spawning stock biomass (SSB in 1,000s of metric tons except for steps 5-7 which are eggs; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) and associated uncertainty through each major step of model building between the SEDAR 43 Standard Model (Step 1) and the SEDAR 100 AP Model (Step 28).

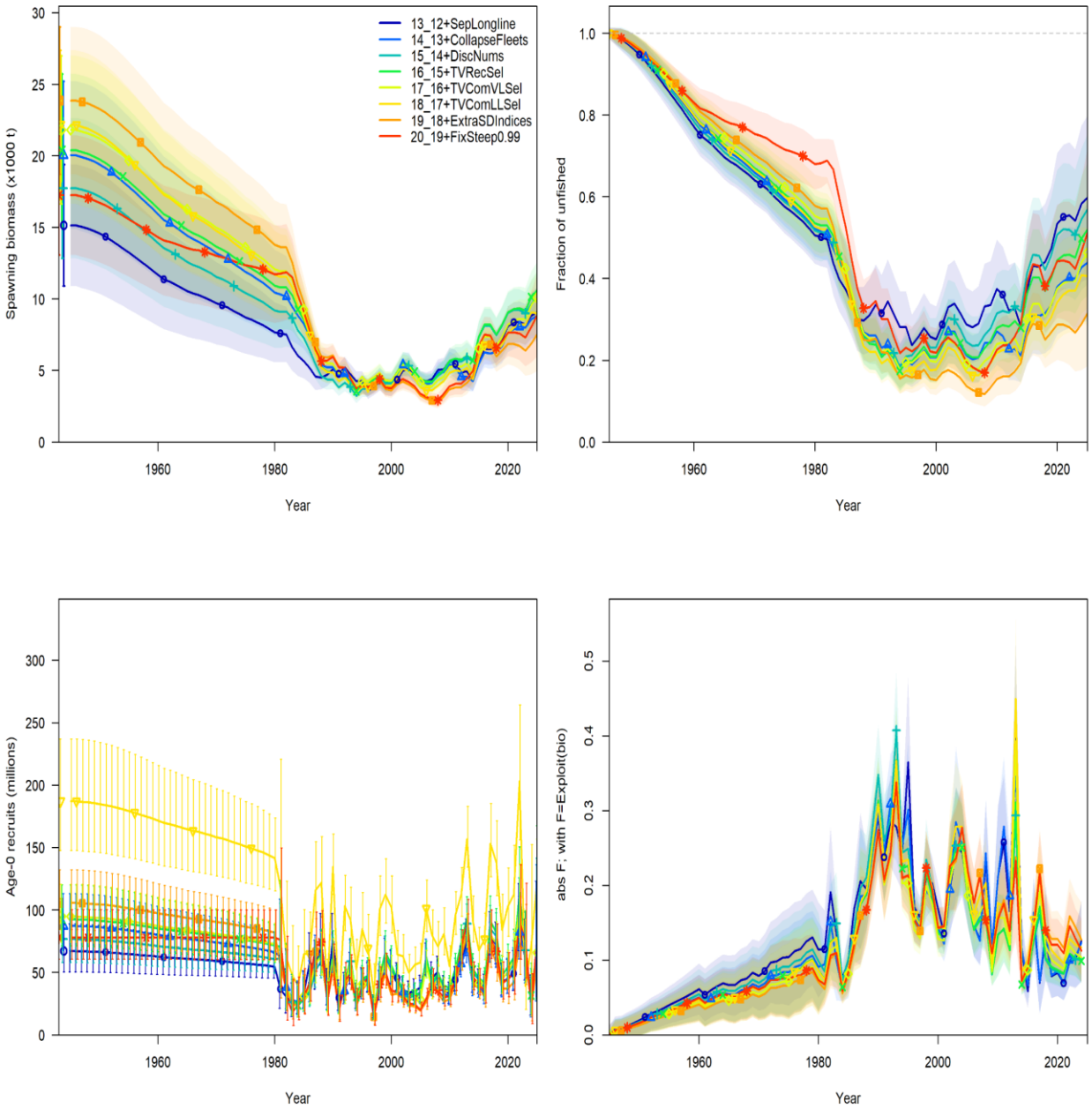


Figure 103. Bridging analysis showing phase 3 changes in estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) and associated uncertainty through each major step of model building between the SEDAR 43 Standard Model (Step 1) and the SEDAR 100 AP Model (Step 28).

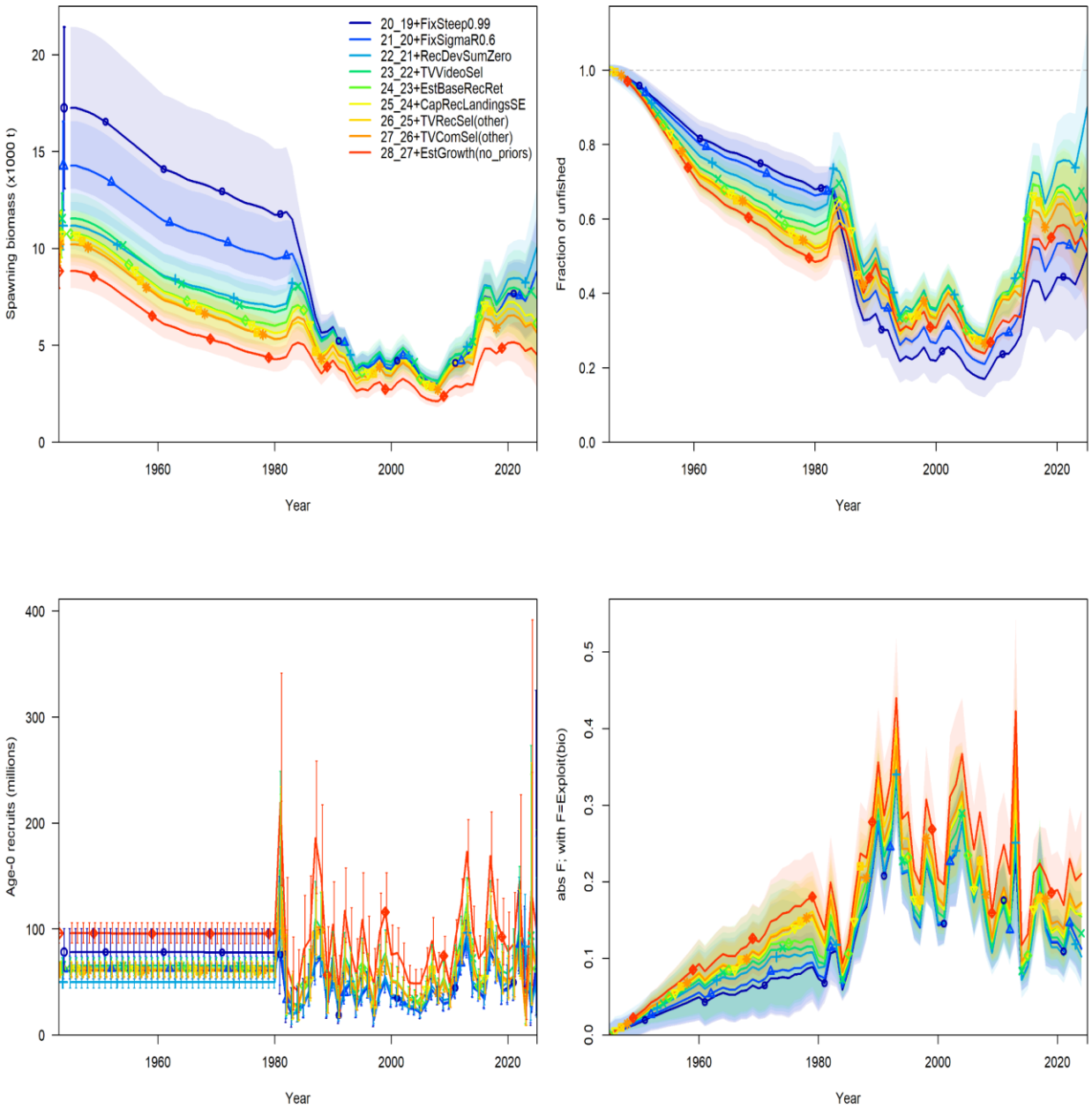


Figure 104. Bridging analysis showing phase 4 changes in estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) and associated uncertainty through each major step of model building between the SEDAR 43 Standard Model (Step 1) and the SEDAR 100 AP Model (Step 28).

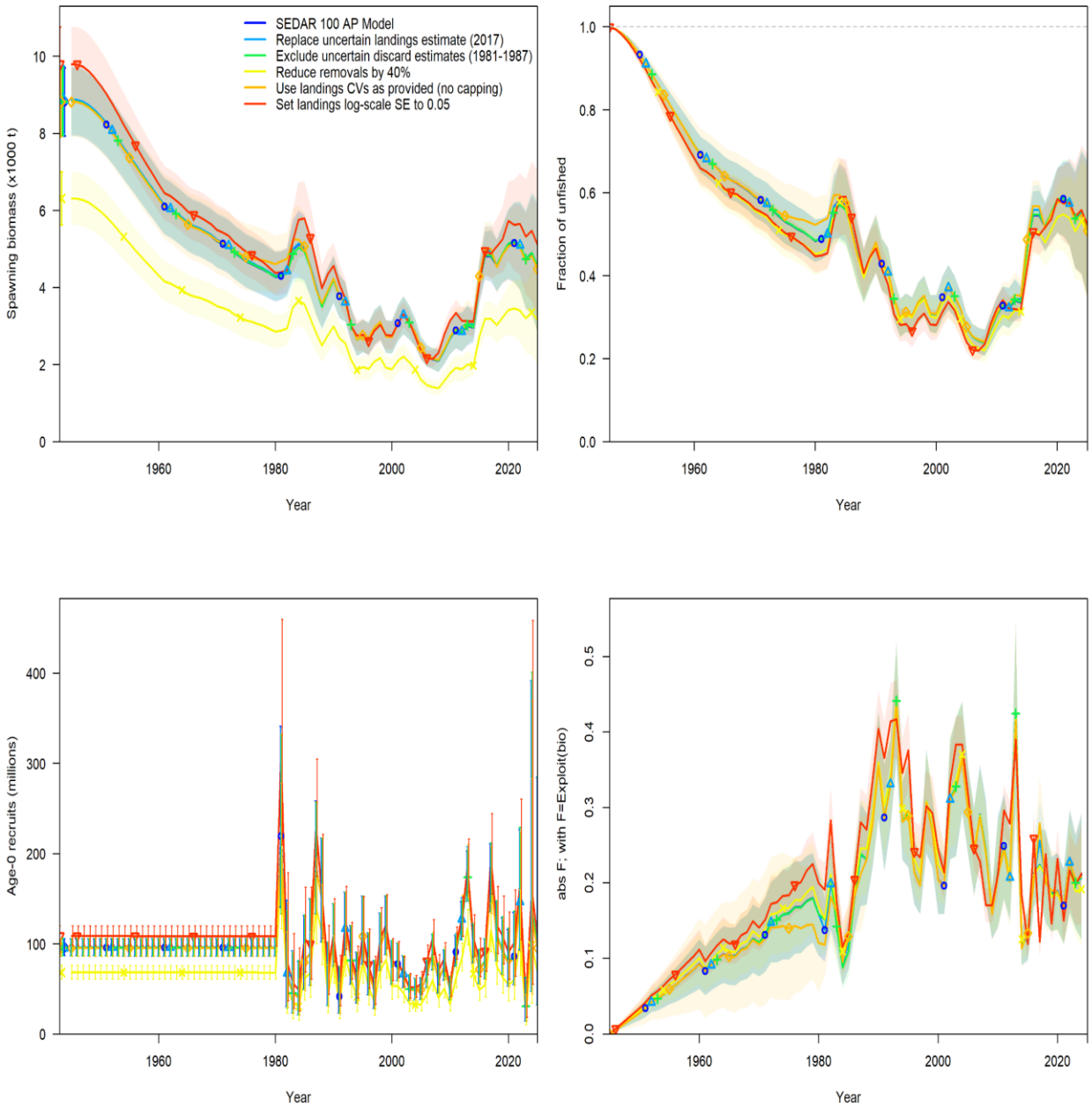


Figure 105. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs exploring recreational data and uncertainty for the SEDAR 100 AP Model.

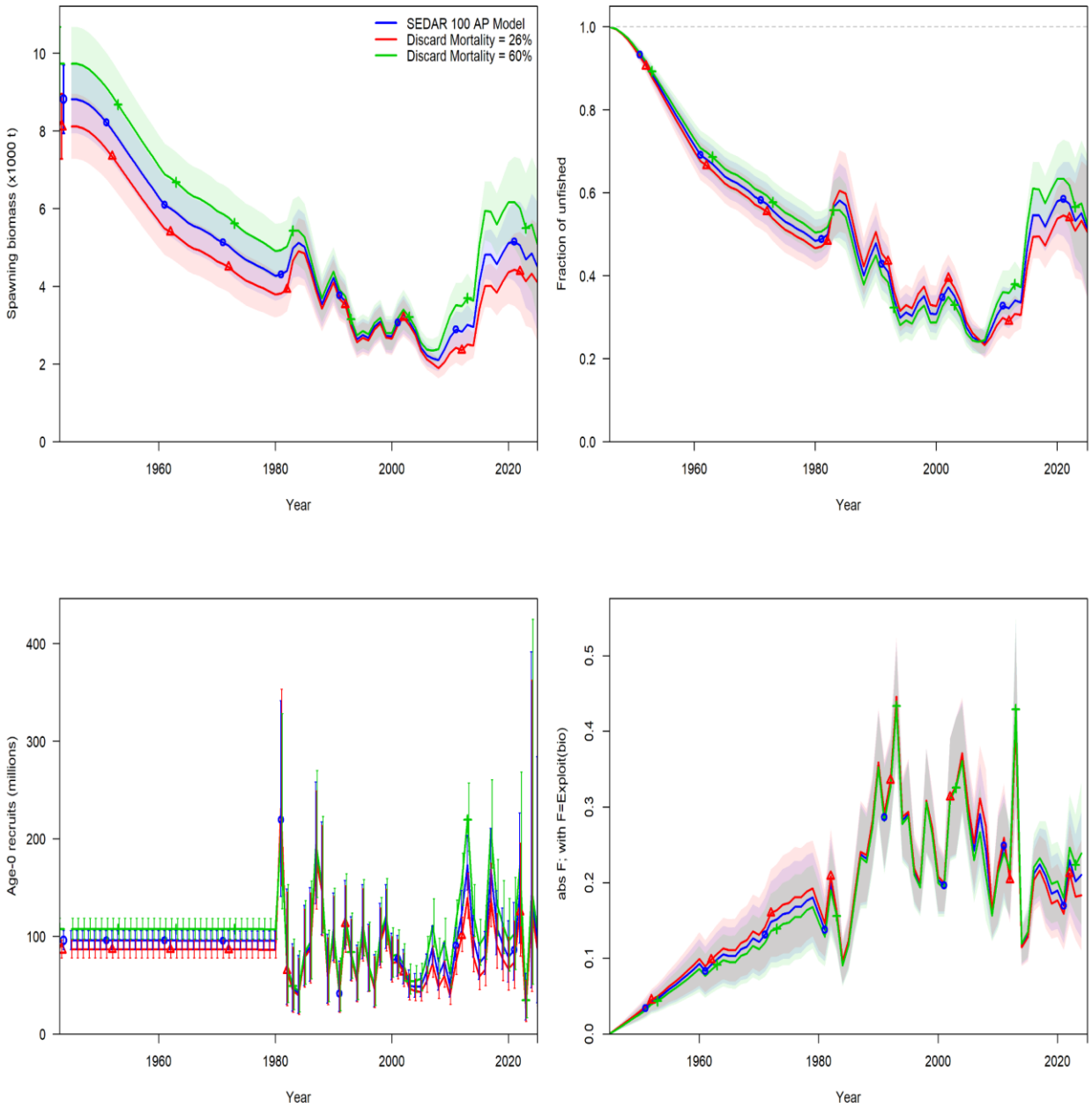


Figure 106. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs exploring alternative values for discard mortality for the SEDAR 100 AP Model.

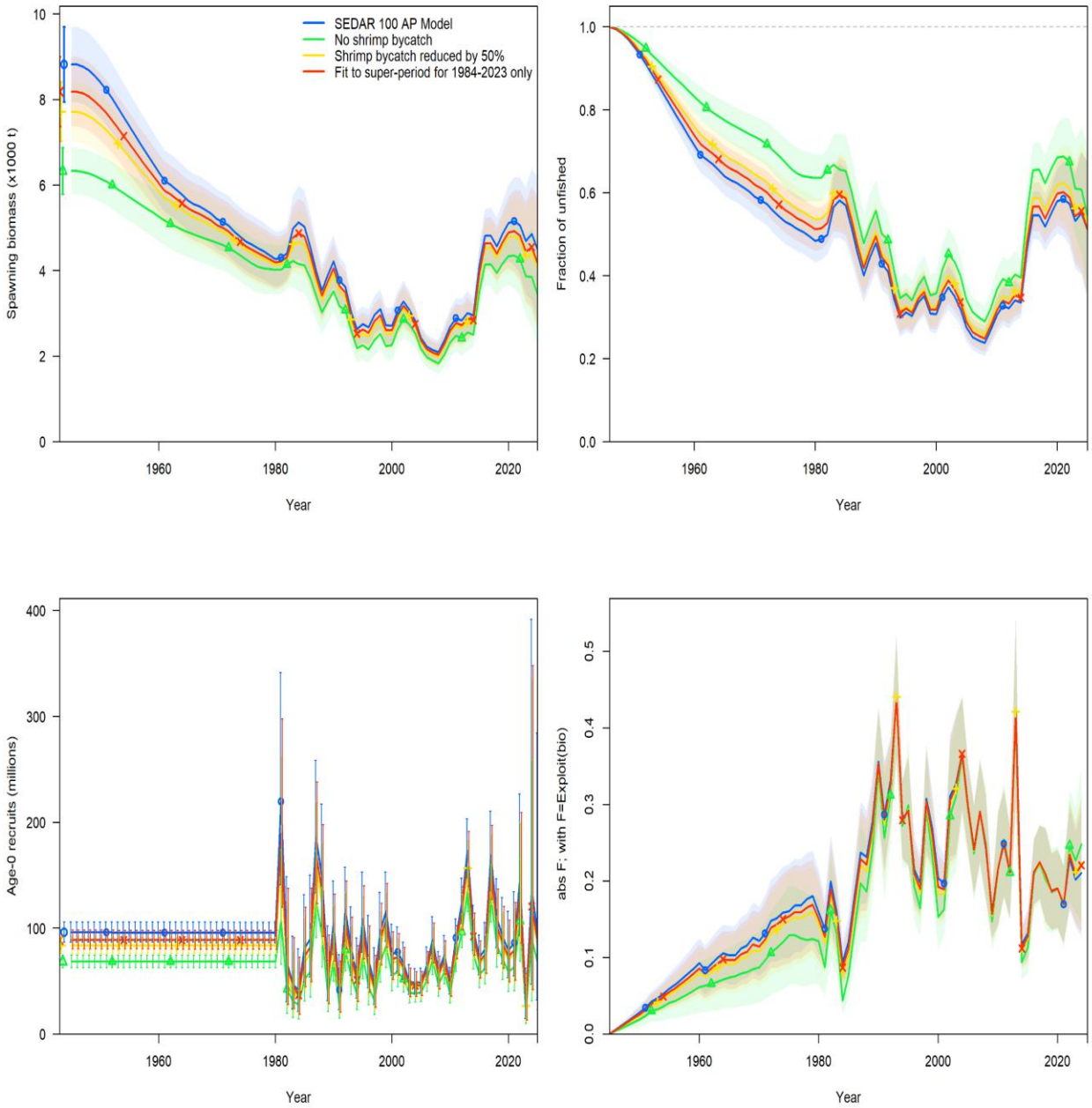


Figure 107. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs exploring different treatments of shrimp bycatch data for the SEDAR 100 AP Model.

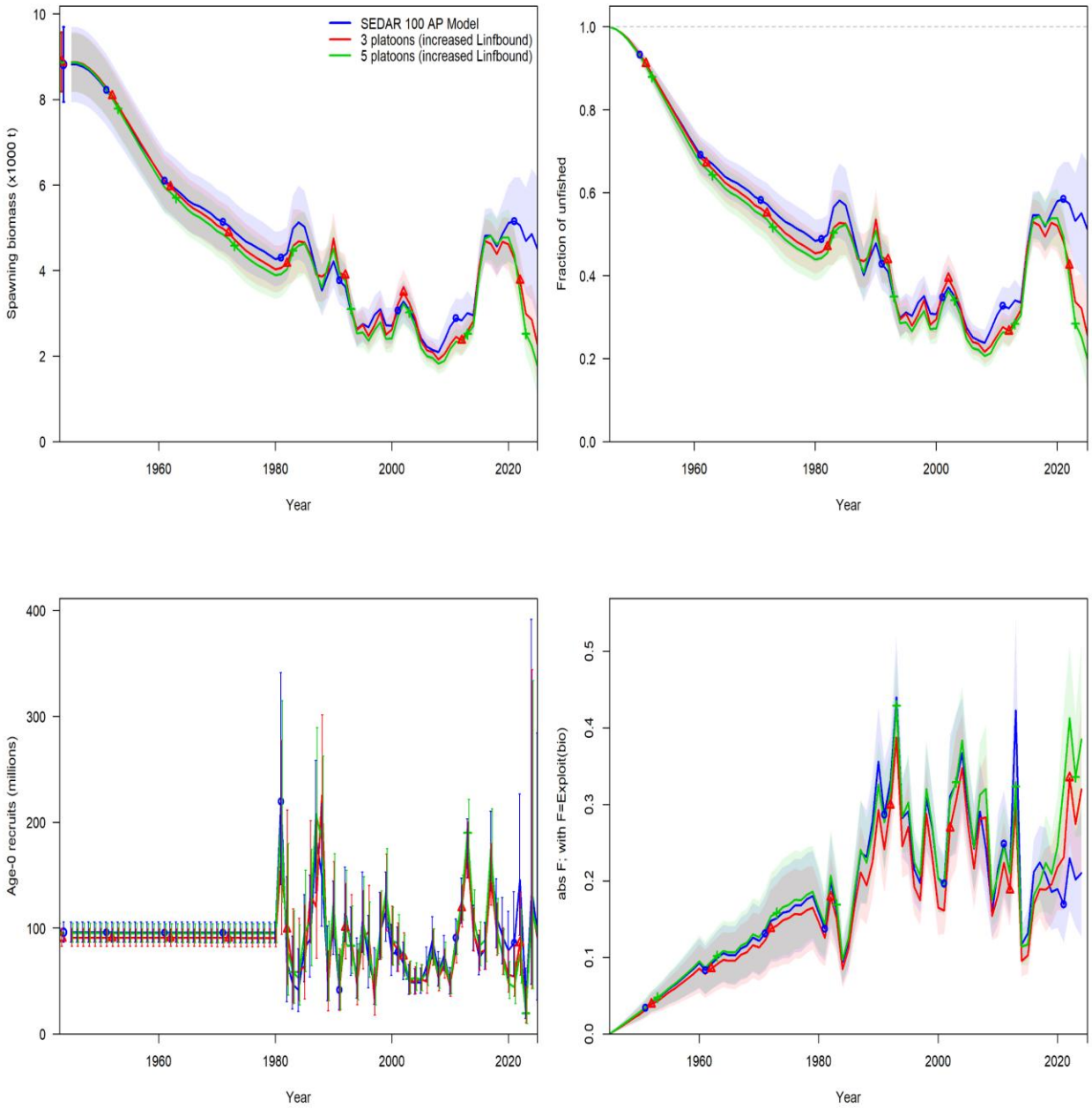


Figure 108. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs exploring growth platoons for the SEDAR 100 AP Model.

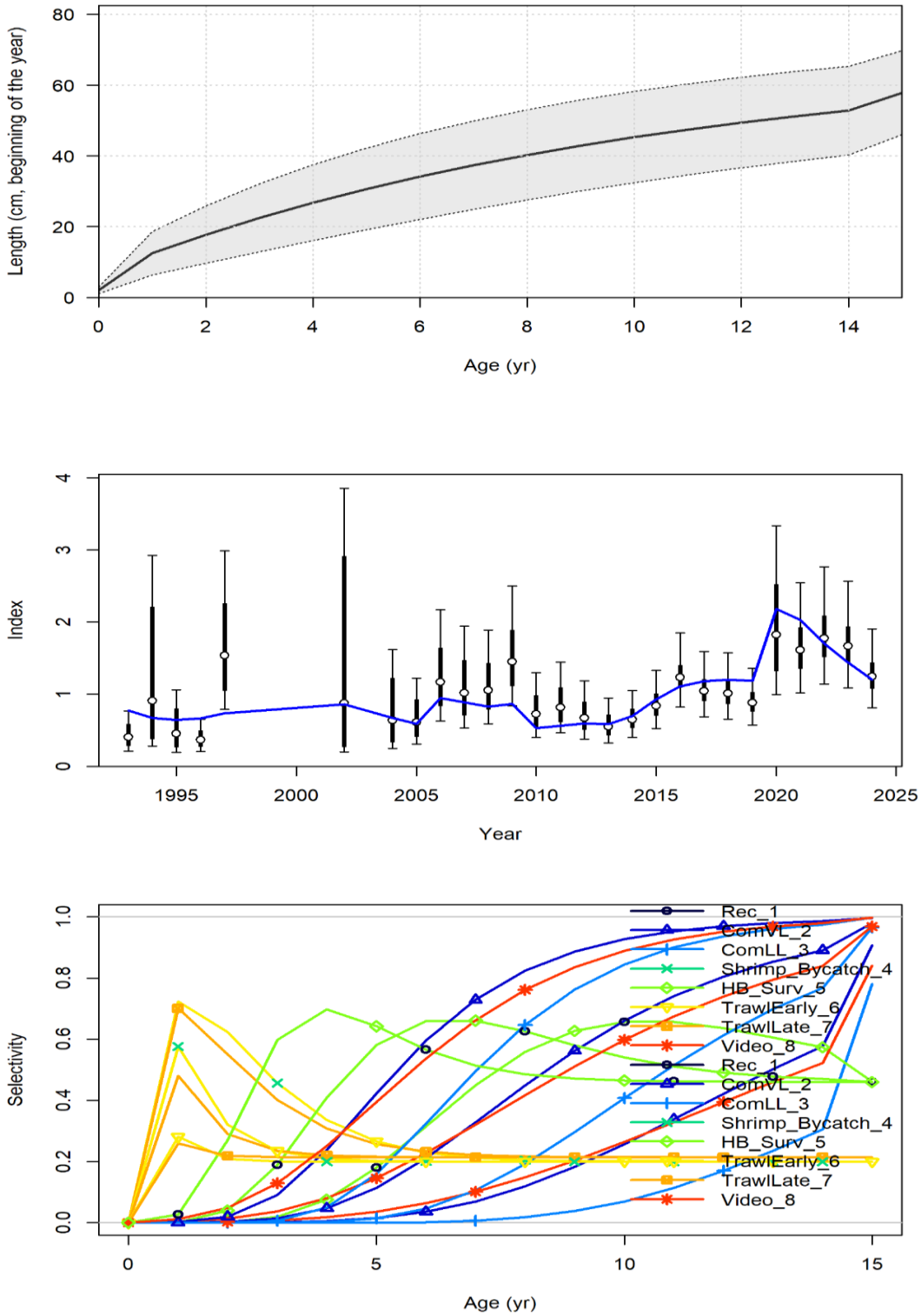


Figure 109. Estimated growth curve with uncertainty (top panel), expected fit to the Combined Video Surveyindex (middle panel), and the derived age-based selectivity patterns for the three platoons for each fishing fleet and survey.

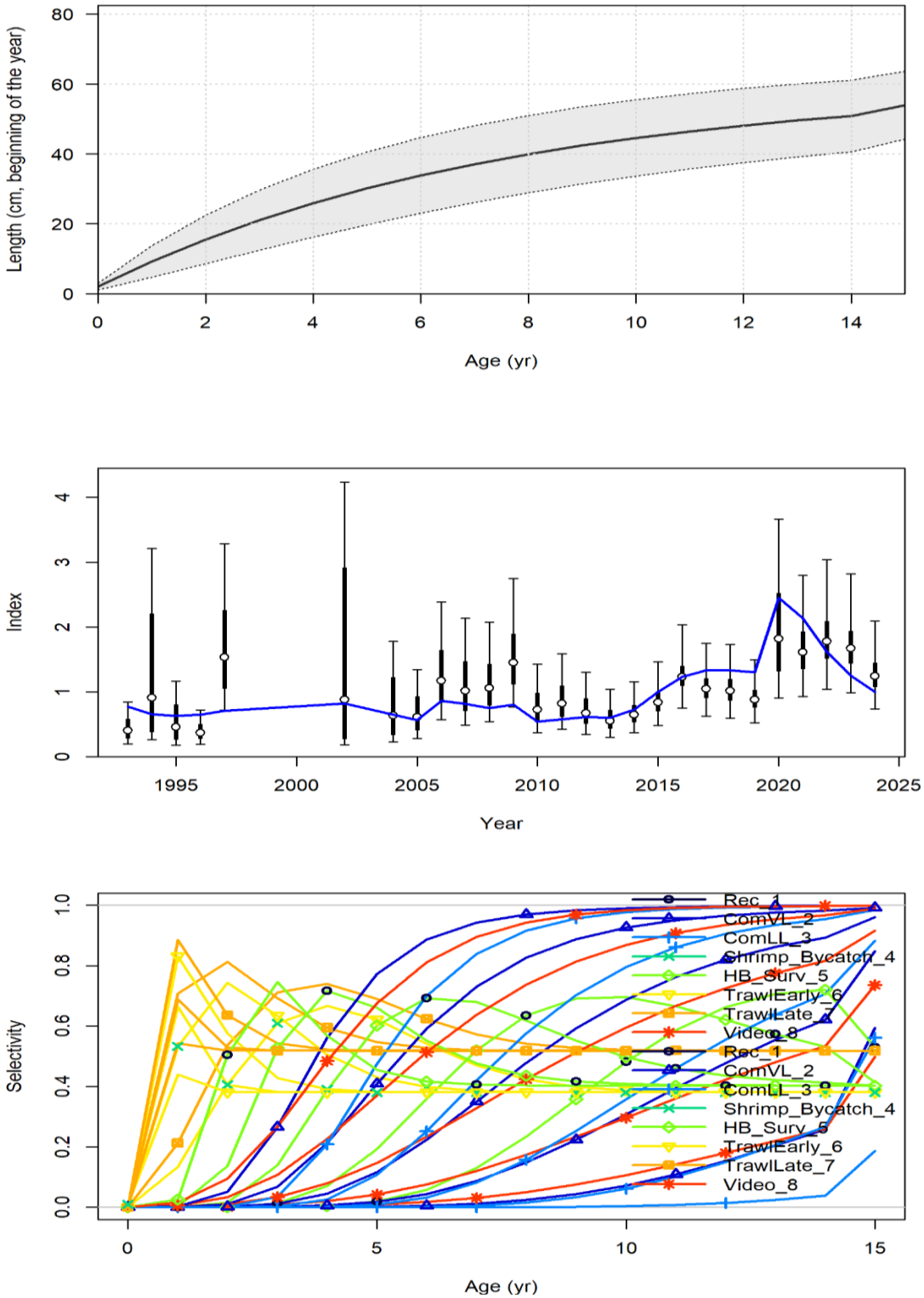


Figure 110. Estimated growth curve with uncertainty (top panel), expected fit to the Combined Video Surveyindex (middle panel), and the derived age-based selectivity patterns for the five platoons for each fishing fleet and survey.

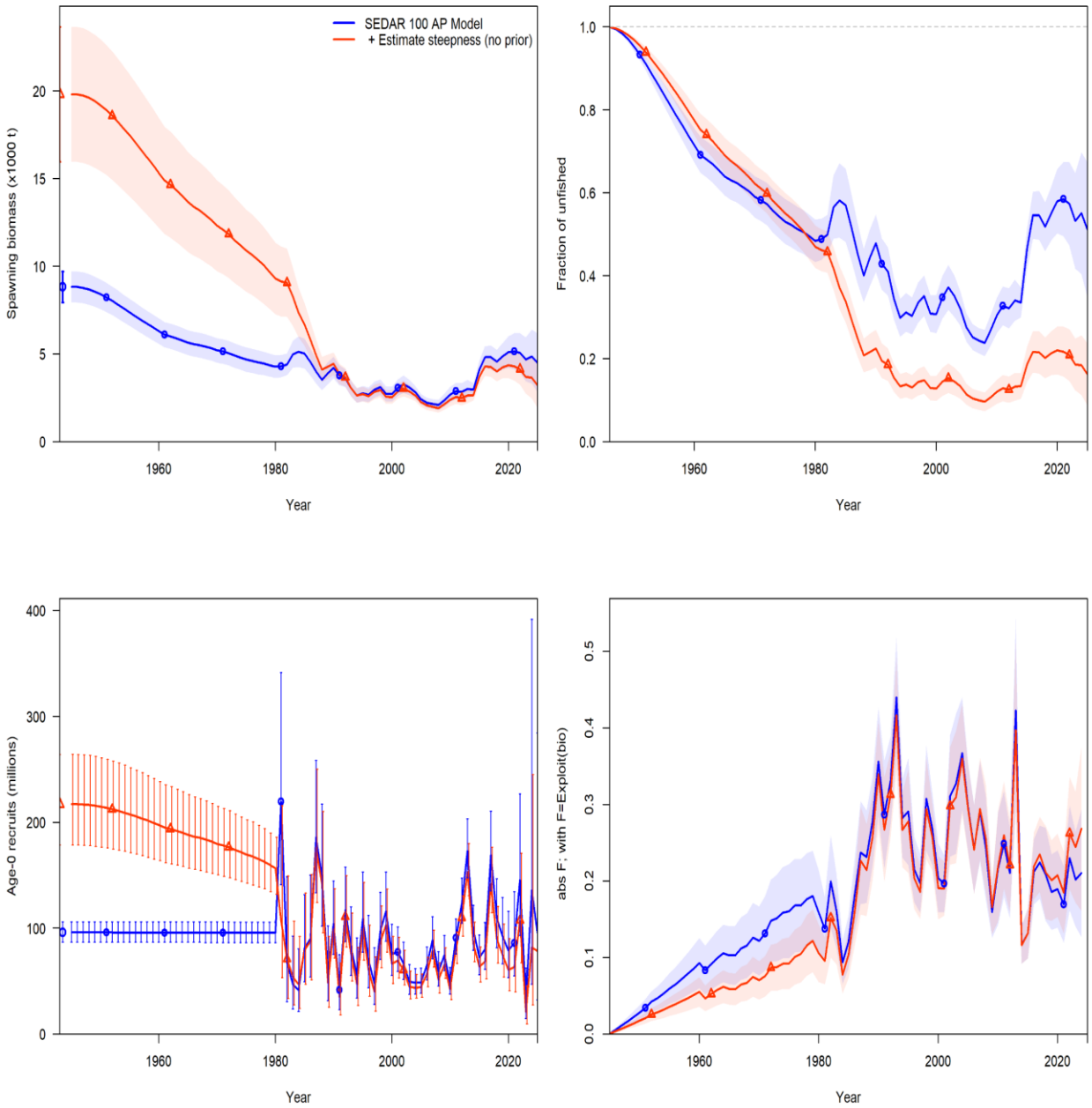


Figure 111. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity run exploring estimation of steepness for the SEDAR 100 AP Model.

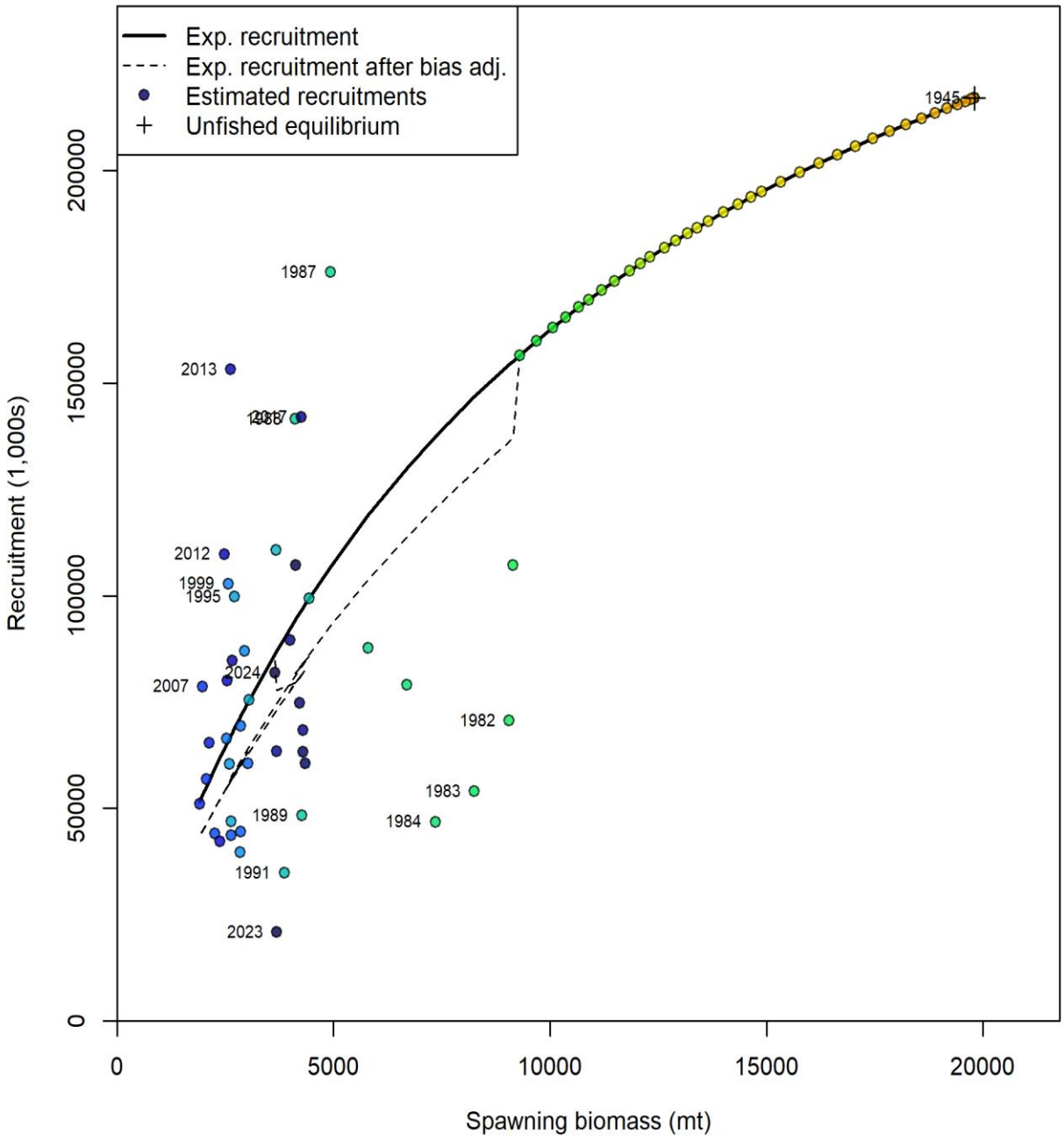


Figure 112. Predicted stock-recruit relationship for the sensitivity run exploring estimation of steepness without a prior. Plotted are predicted annual recruitments from Stock Synthesis (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line).

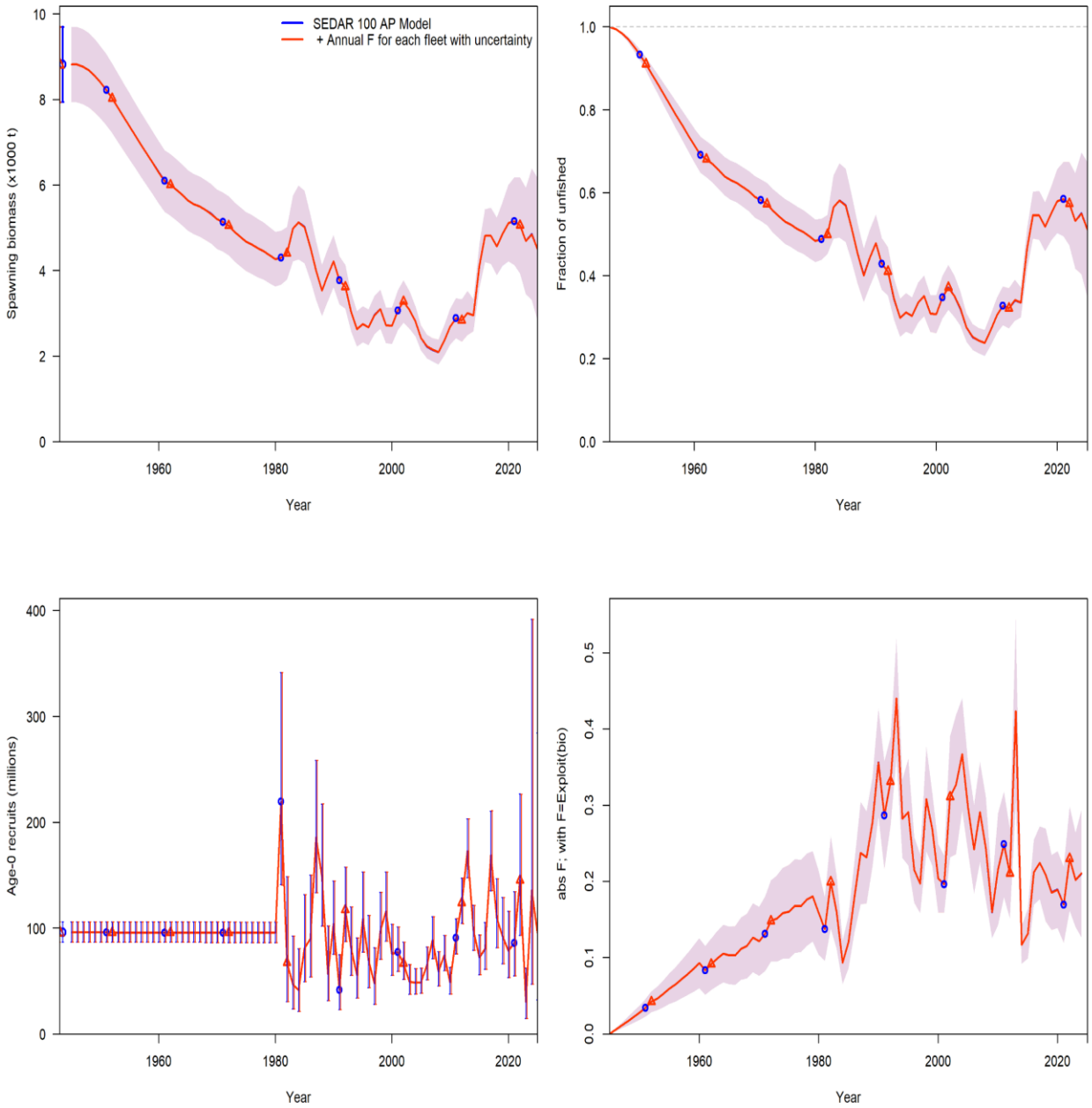


Figure 113. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity run exploring the estimation of annual Fs with landings uncertainty for the SEDAR 100 AP Model.

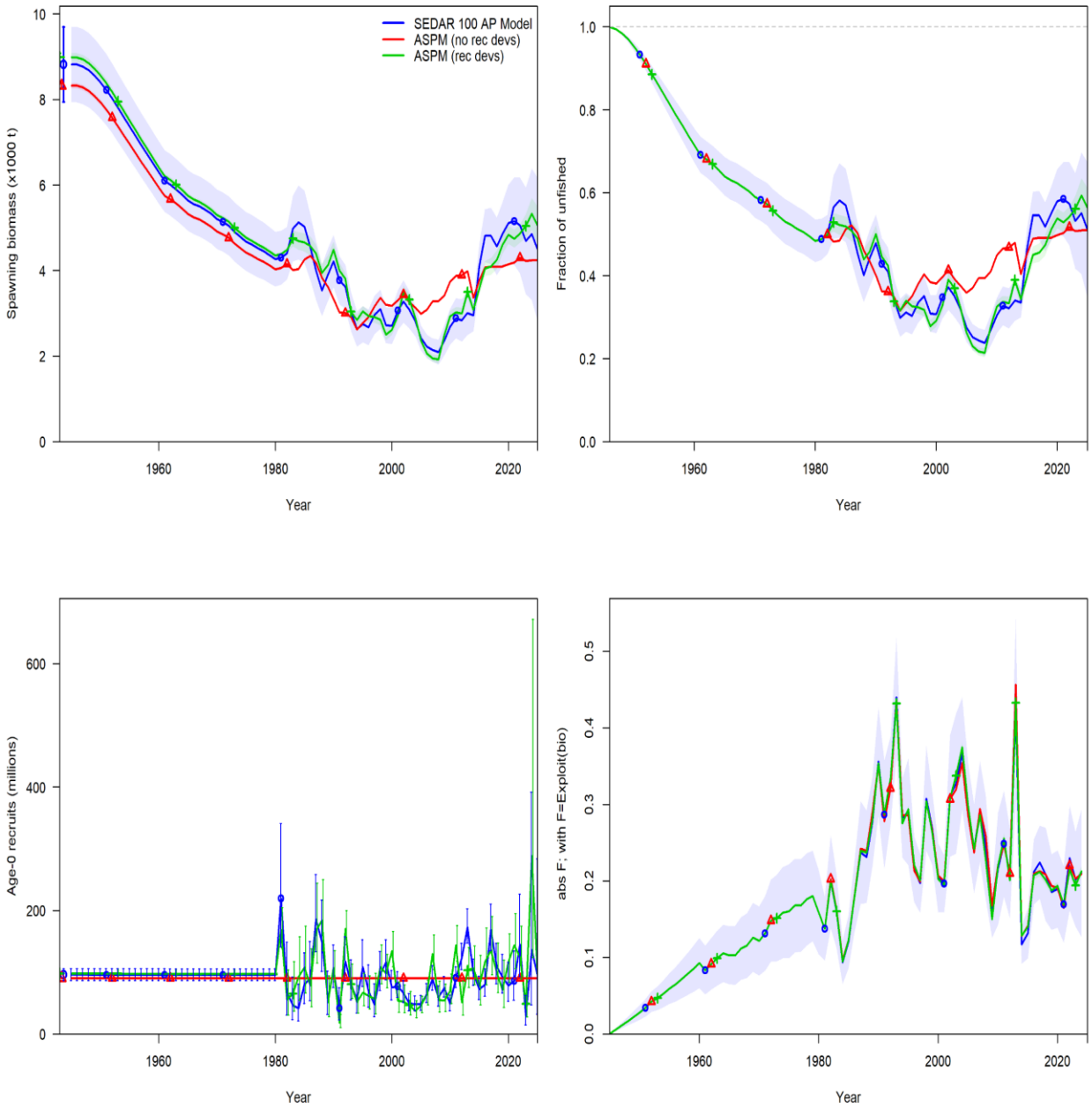


Figure 114. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs exploring simpler age-structured production models for the SEDAR 100 AP Model.

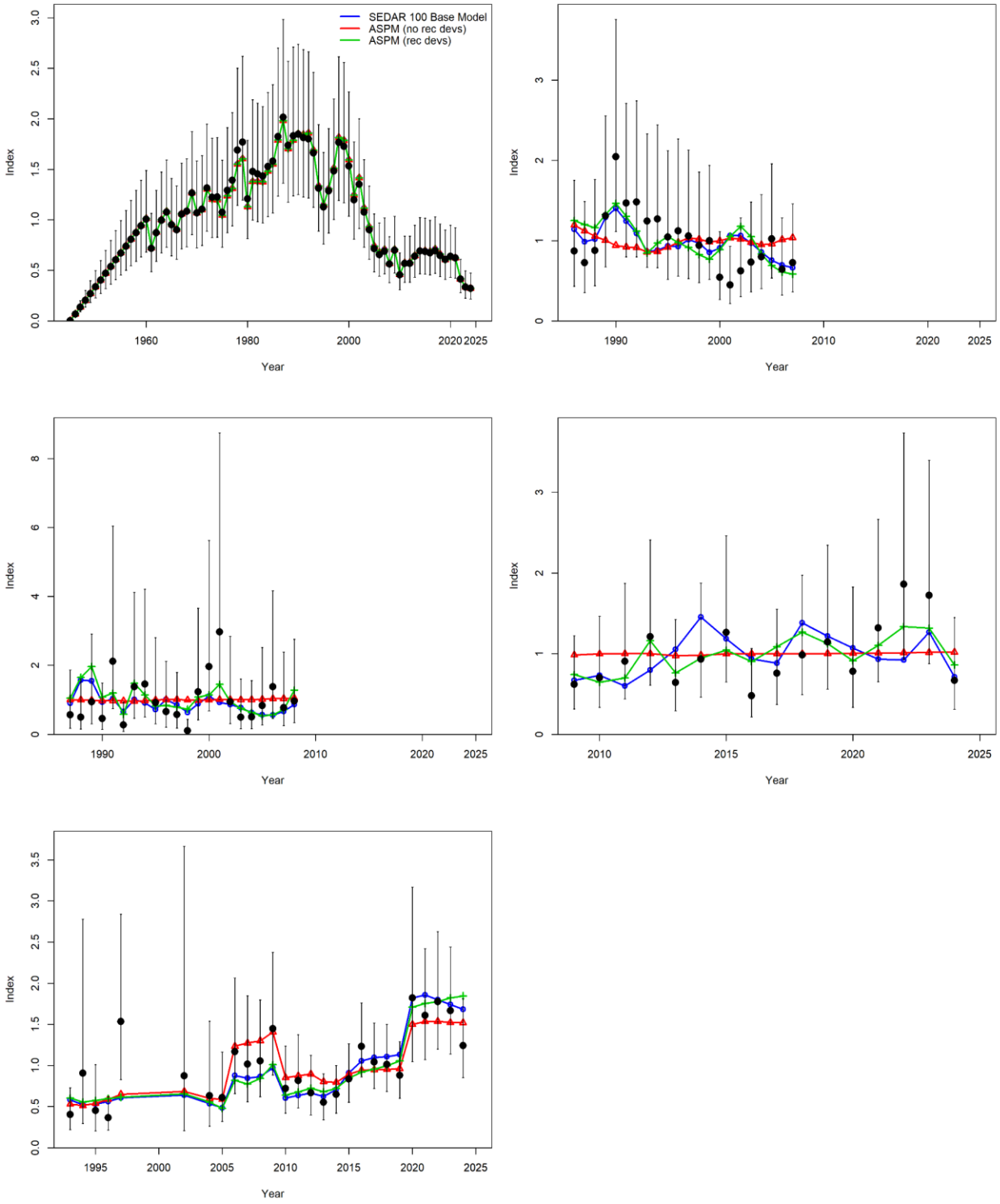


Figure 115. Comparison of fits to the indices of abundance for the sensitivity runs exploring simpler age-structured production models for the SEDAR 100 AP Model.

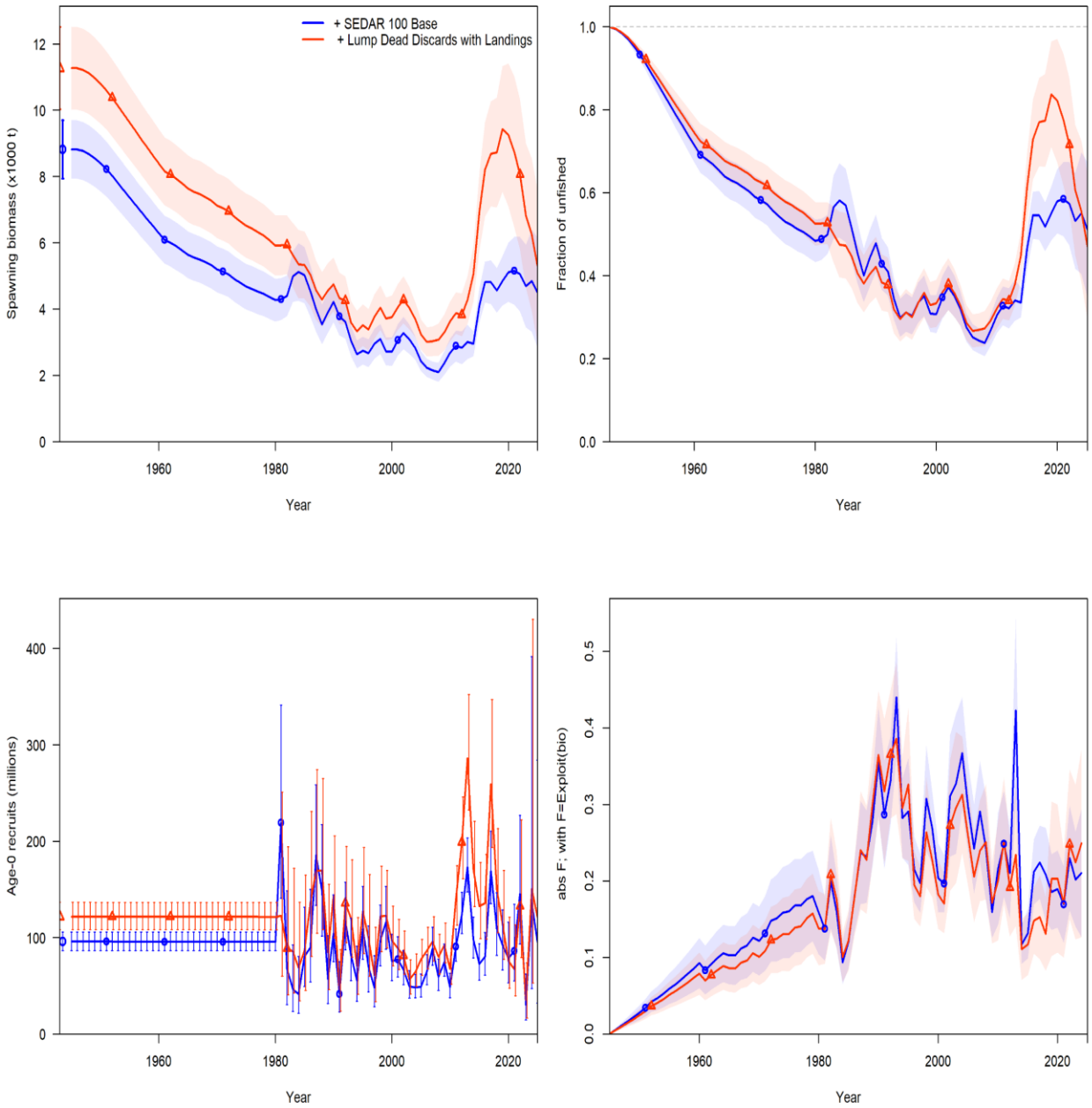


Figure 116. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity run combining dead discards with landings for the SEDAR 100 AP Model.

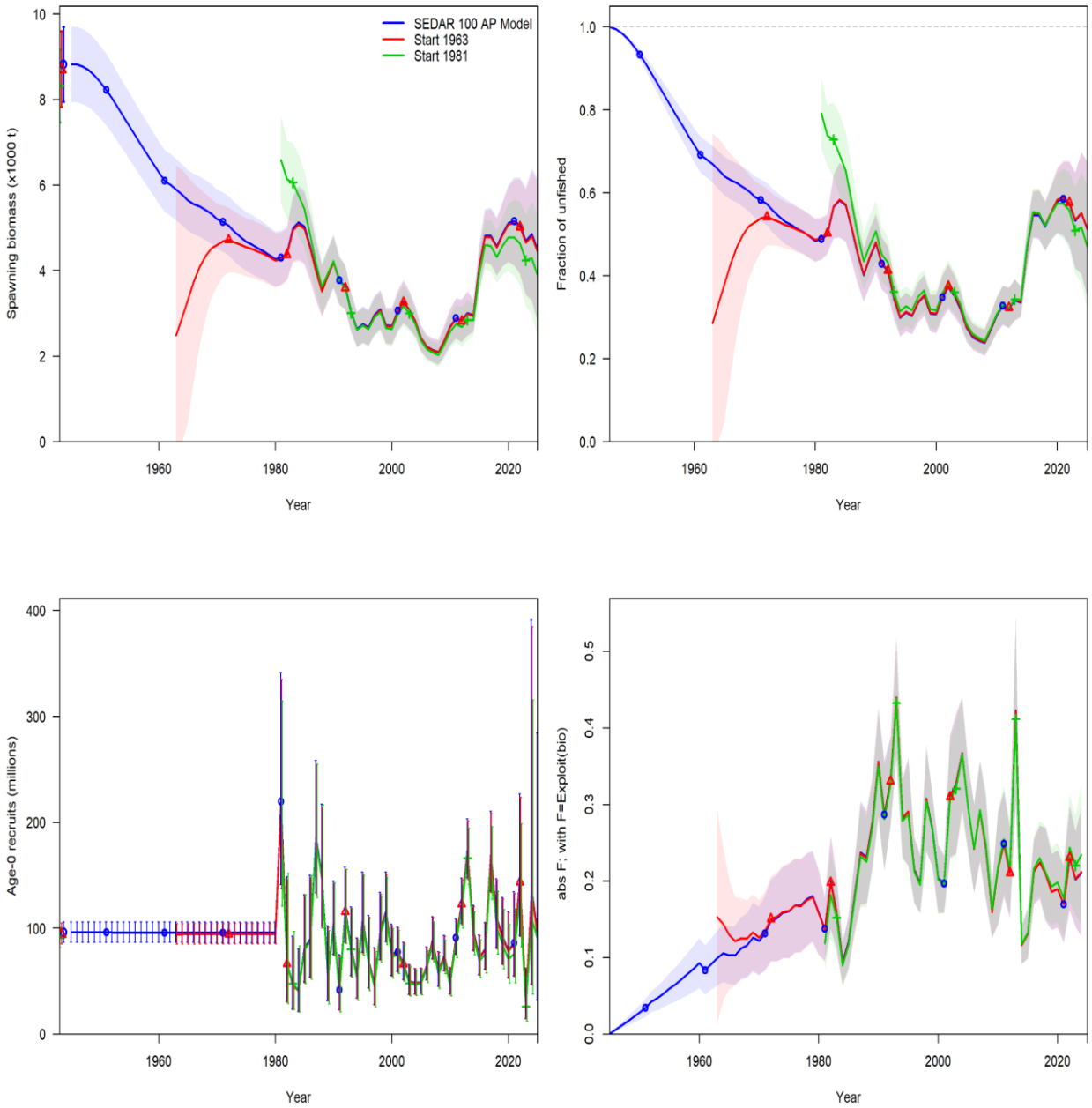


Figure 117. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs exploring different start years for the SEDAR 100 AP Model.

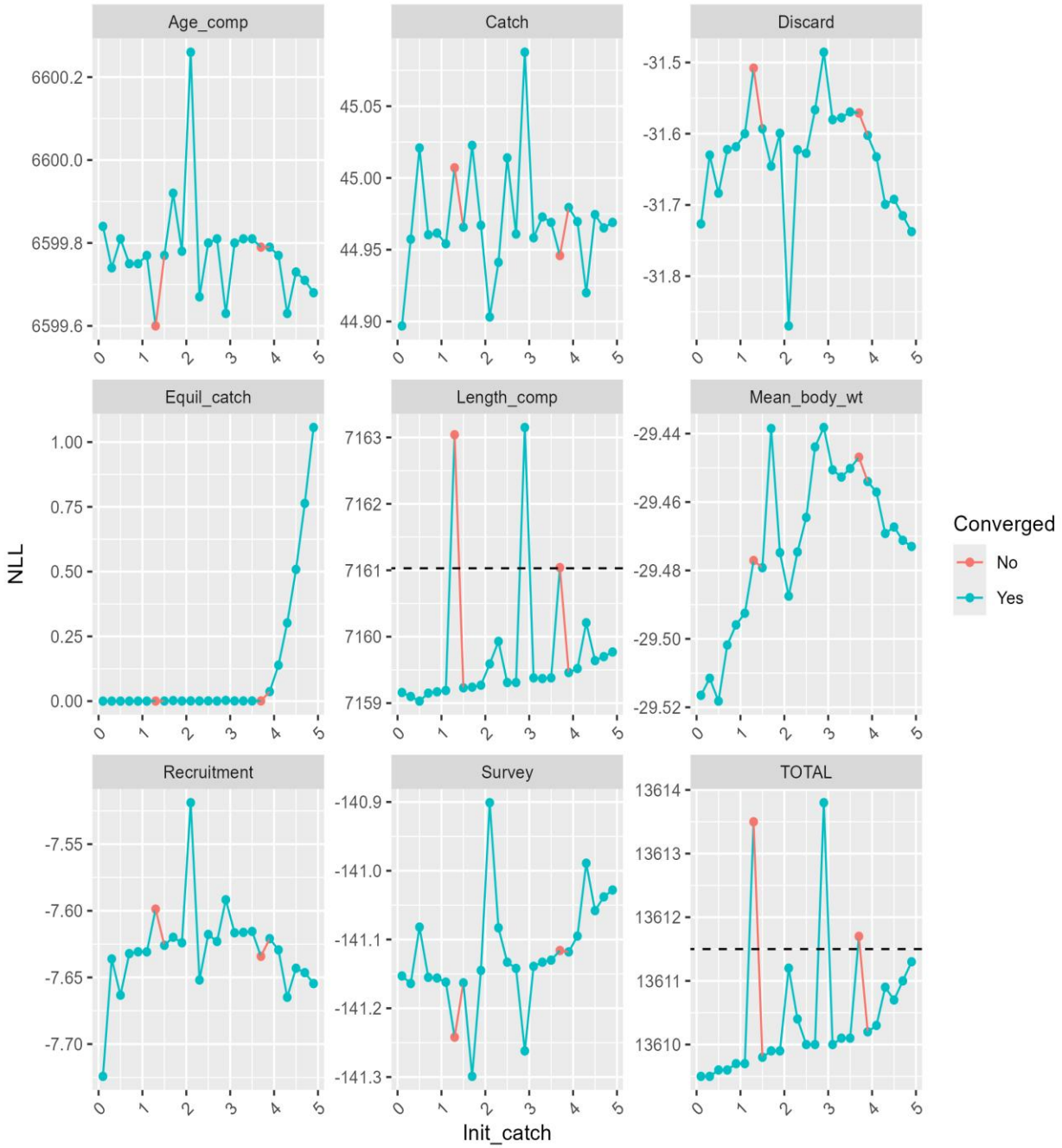


Figure 118. Likelihood profile for the scalar value search for the sensitivity run starting in 1963. Points that fall below the dashed lines are within 2 likelihood units of the minimum. If no dashed line is shown, the y-axis does not range more than 2 likelihood units.

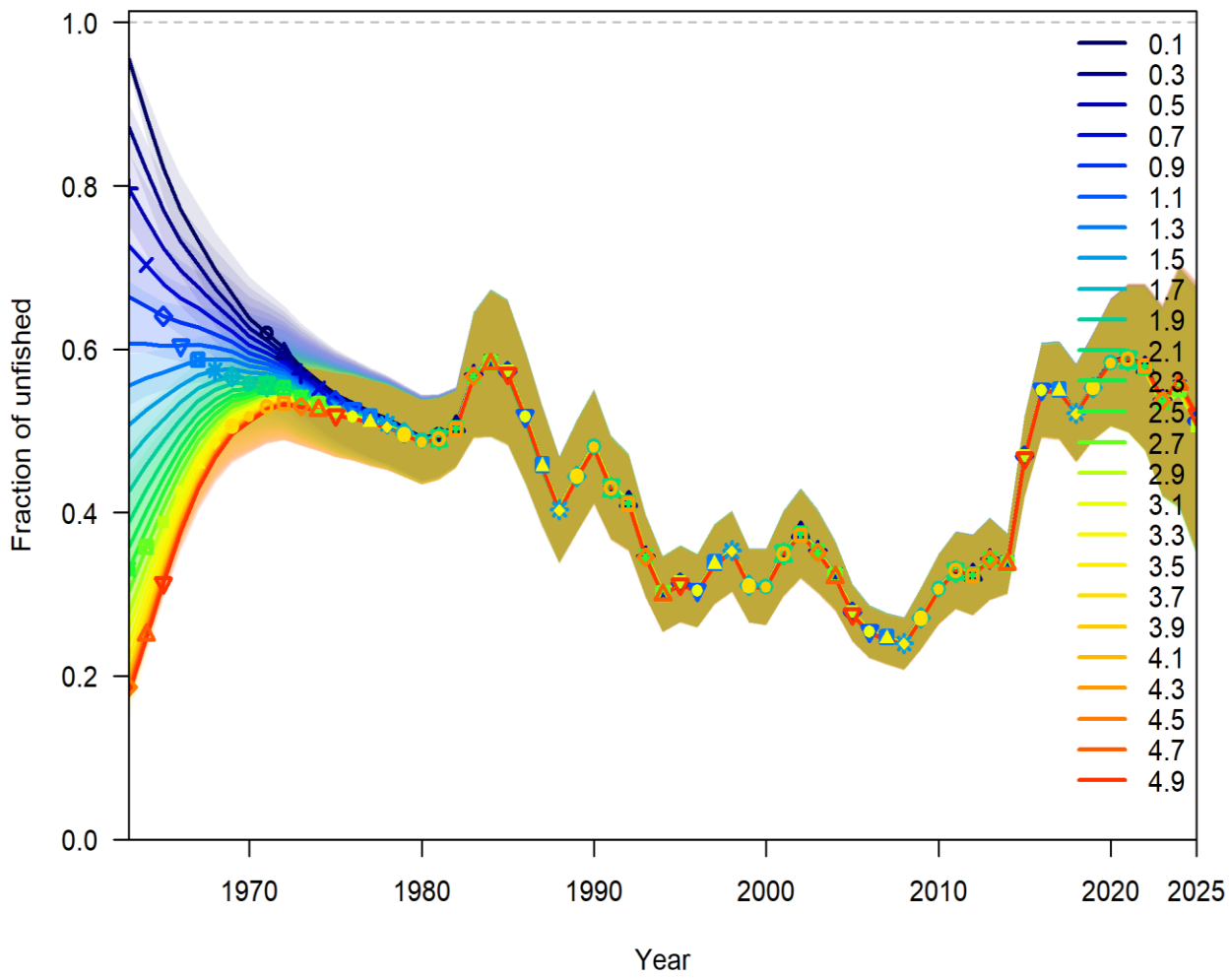


Figure 119. Estimates of the ratio of SSB to virgin SSB for the sensitivity run starting in 1963 and additional runs exploring initial conditions (across scalar values) for the SEDAR 100 AP Model.

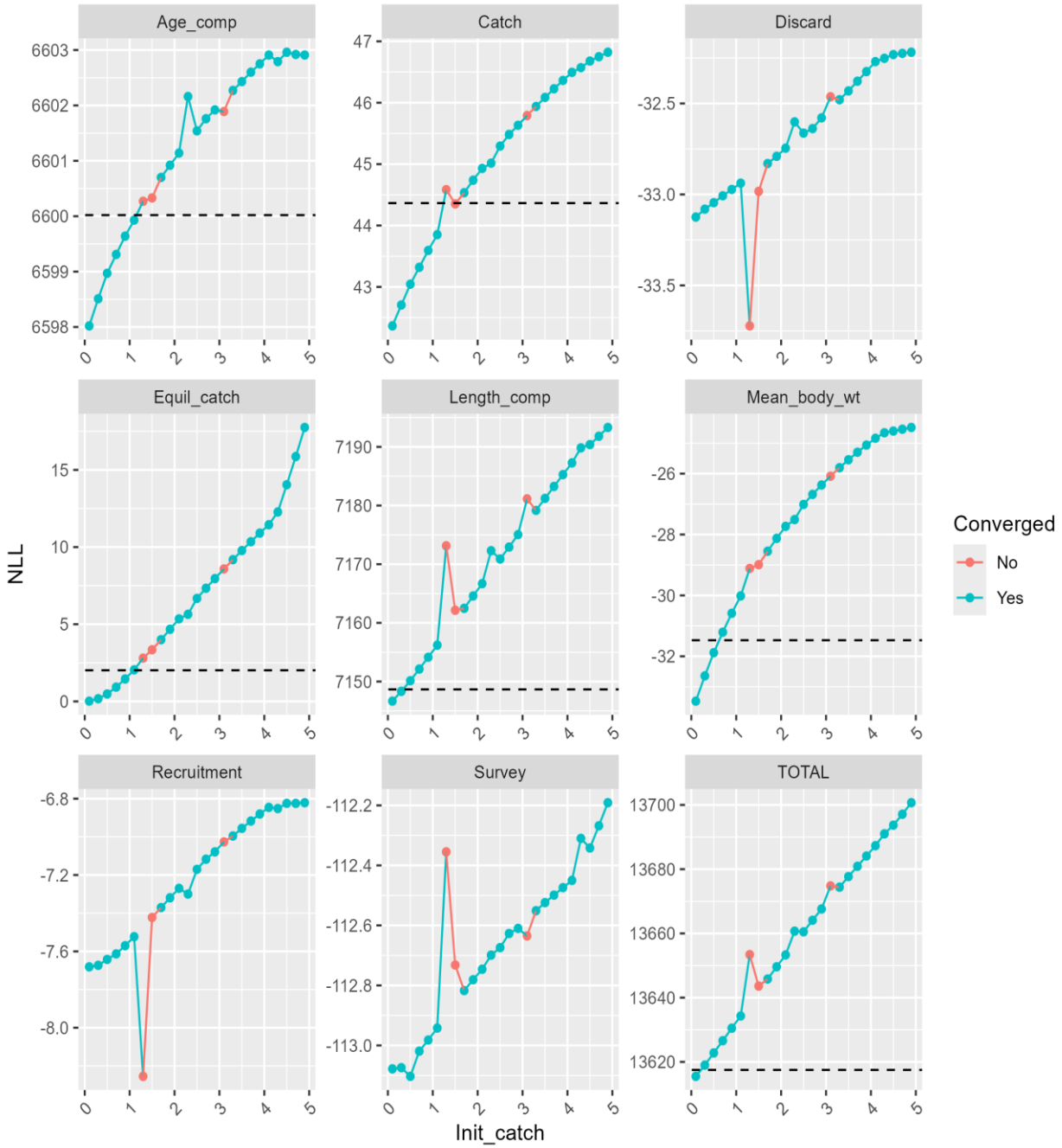


Figure 120. Likelihood profile for the scalar value search for the sensitivity run starting in 1981. Points that fall below the dashed lines are within 2 likelihood units of the minimum. If no dashed line is shown, the y-axis does not range more than 2 likelihood units.

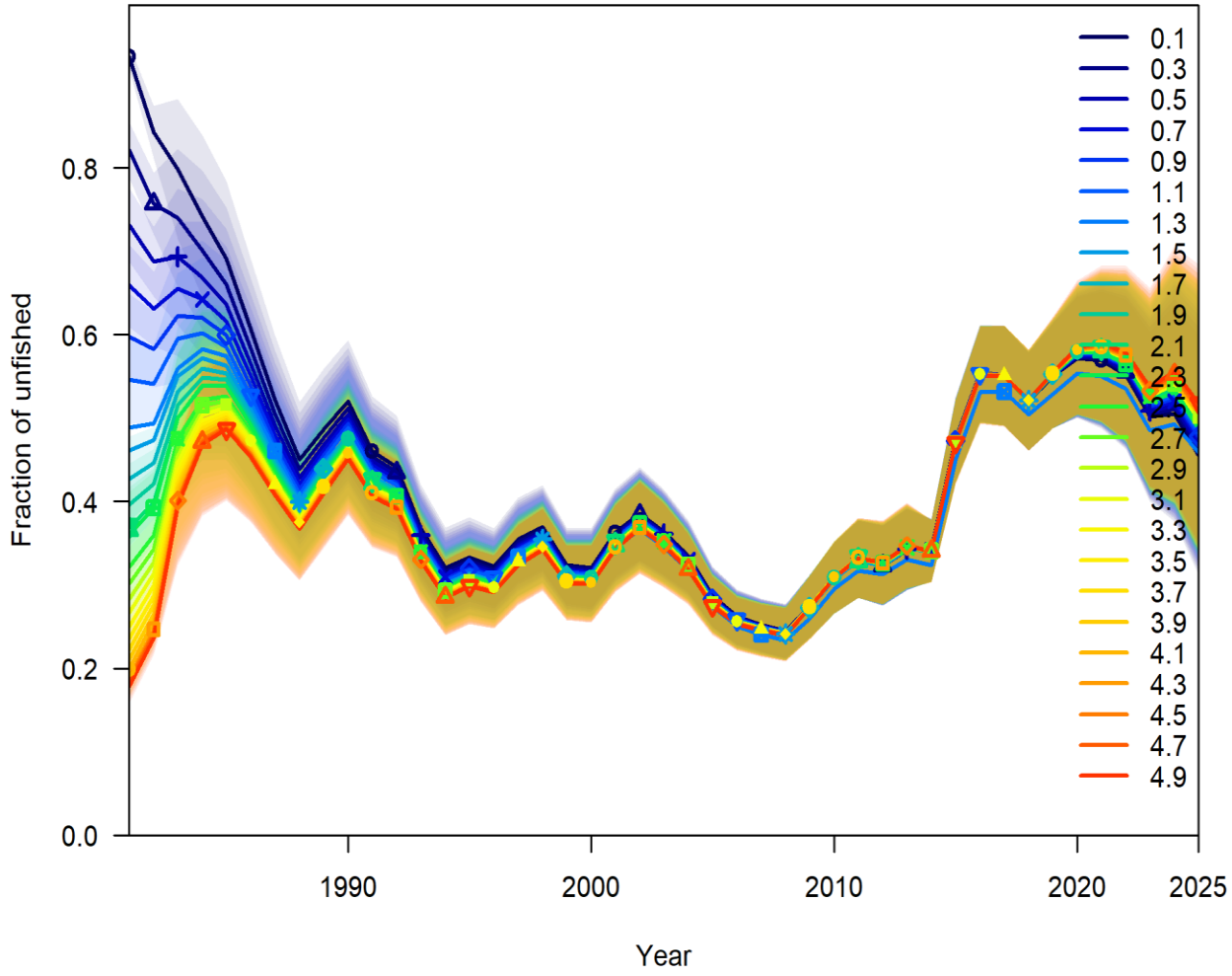


Figure 121. Estimates of the ratio of SSB to virgin SSB for the sensitivity run starting in 1981 and additional runs exploring initial conditions (across scalar values) for the SEDAR 100 AP Model.

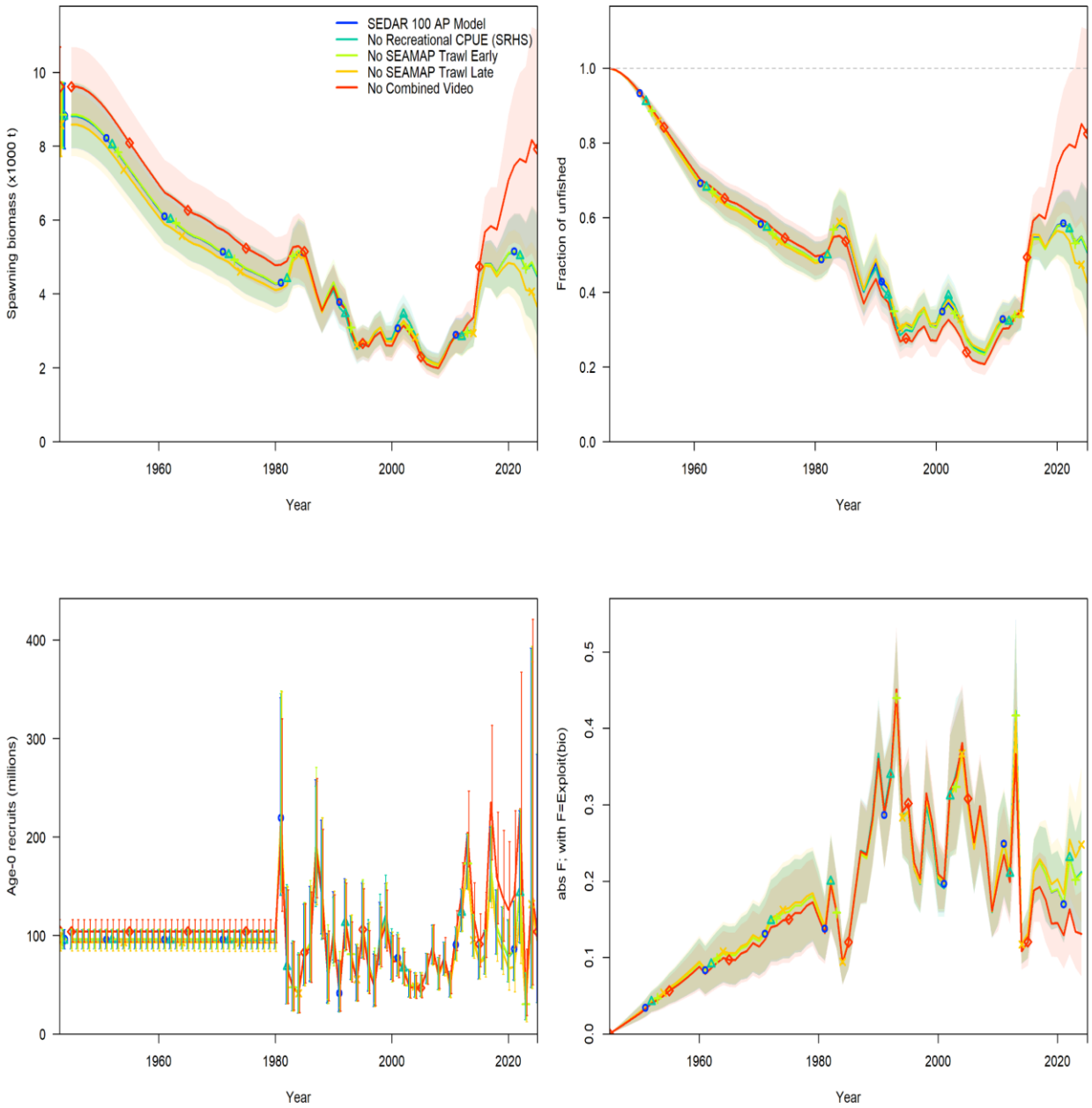


Figure 122. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed all ages / total biomass age 1+; bottom right panel) for the sensitivity runs removing each index of abundance for the SEDAR 100 AP Model.

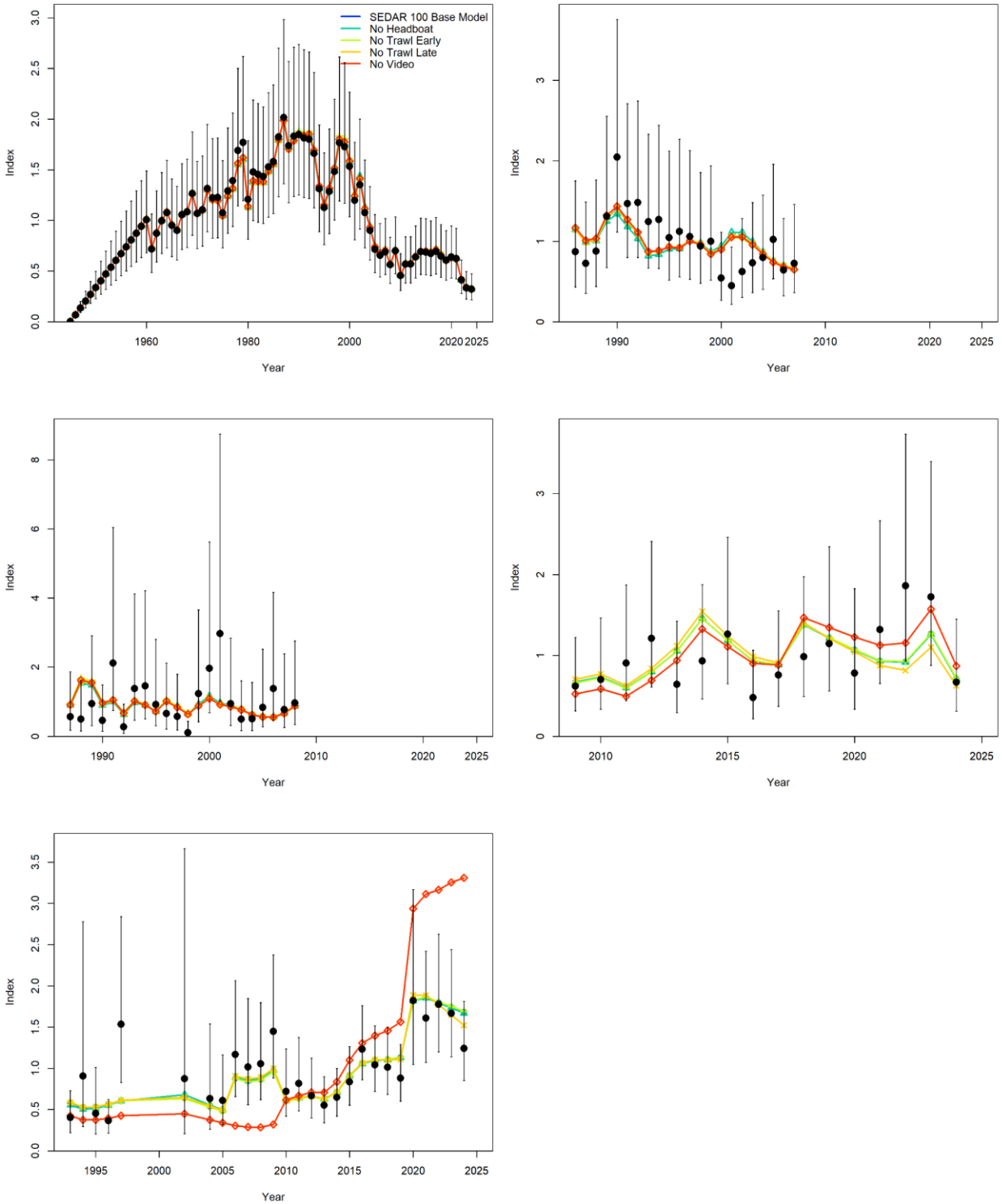


Figure 123. Comparison of fits to the indices of abundance for the sensitivity runs removing each index of abundance for the SEDAR 100 AP Model.

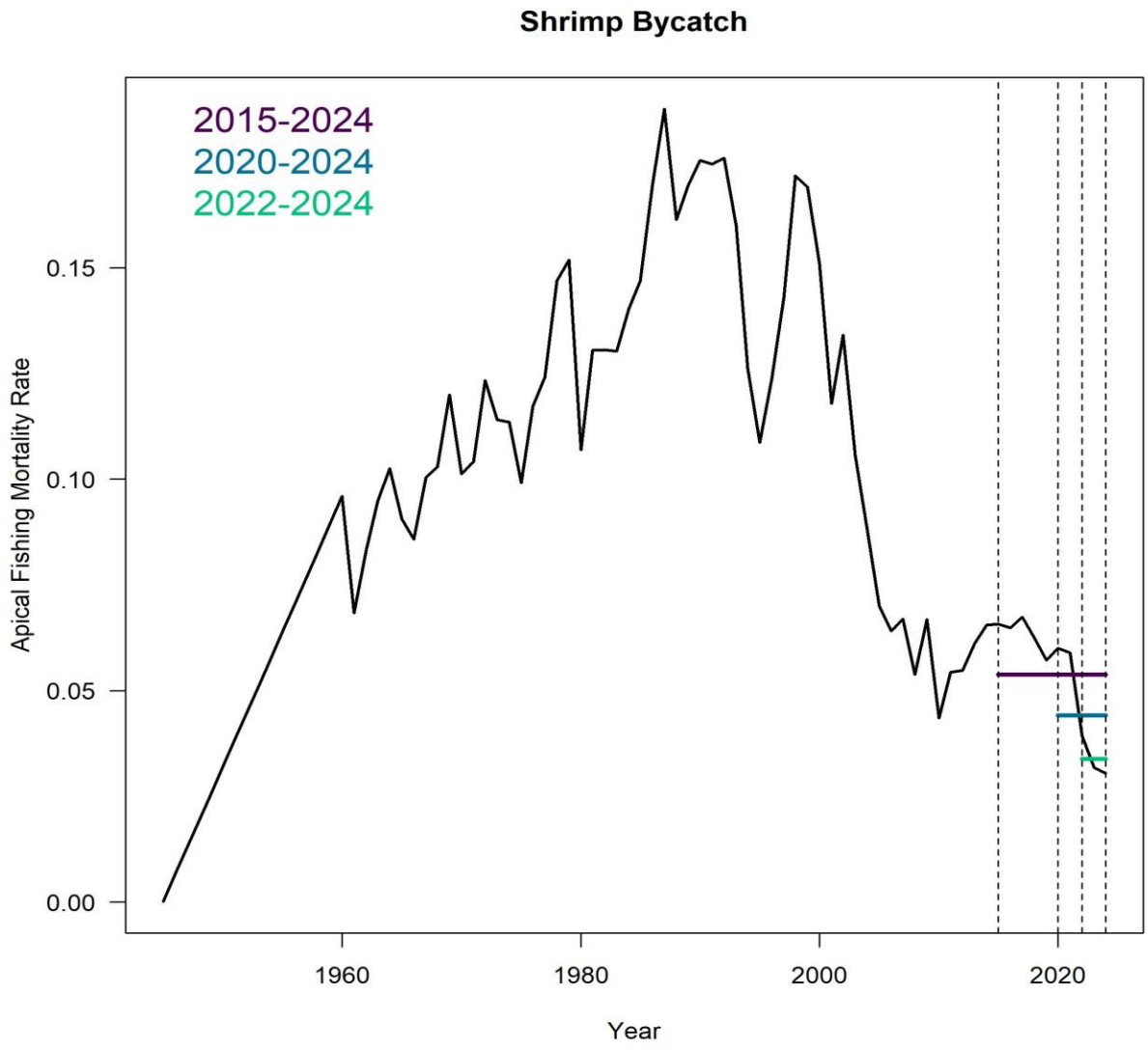


Figure 124. Time series of apical fishing mortality rate for the Shrimp Bycatch fleet. 3, 5 and 10 year averages are shown. The 3-year average was used in projections.

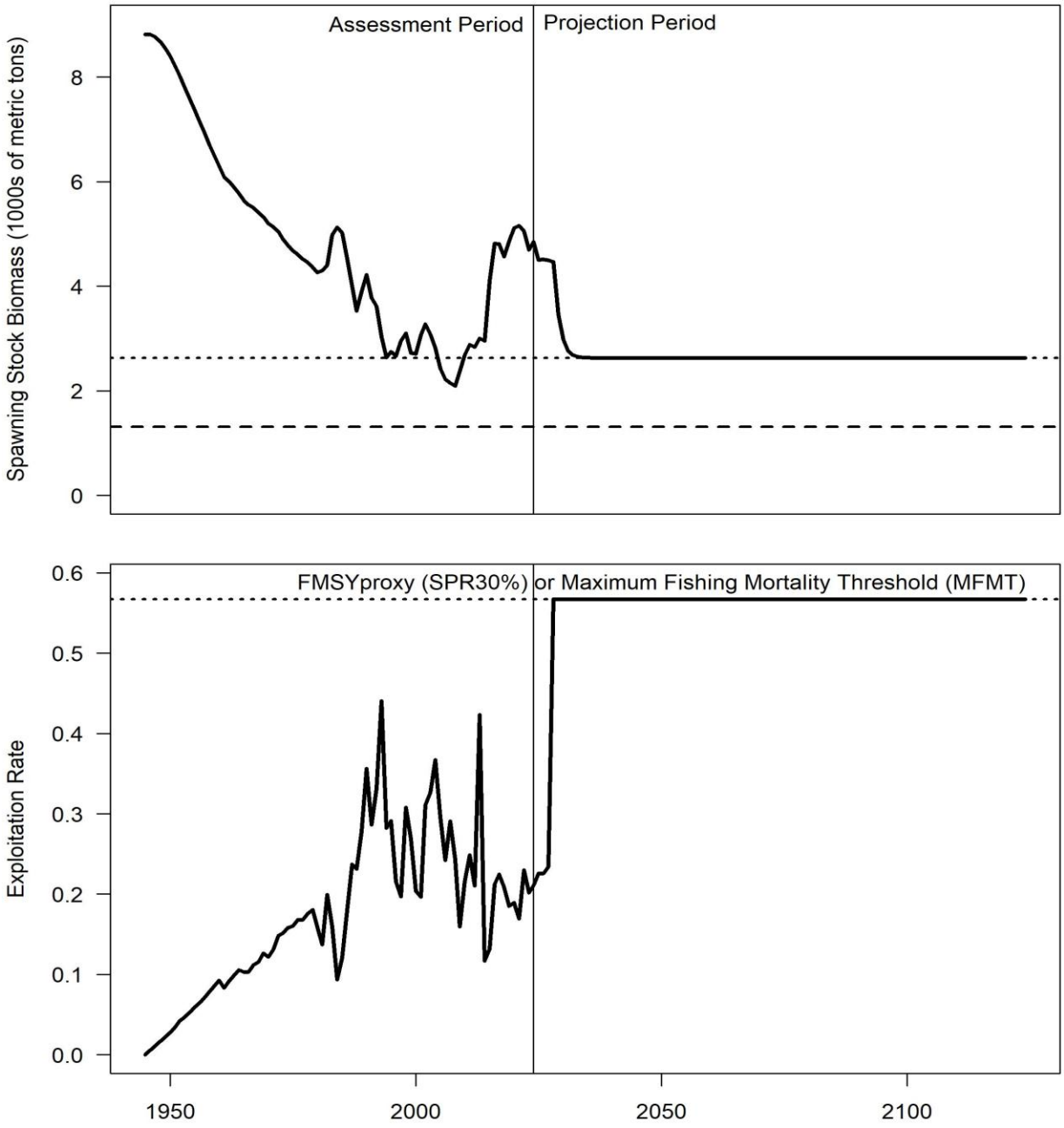


*Figure 125. Time series of SSB (1,000s of SSB) and exploitation rate (total biomass killed all ages / total biomass age 1+) with respect to status determination criteria with mean recruitment (i.e., steepness fixed at 0.99) throughout the projection period. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2**).*

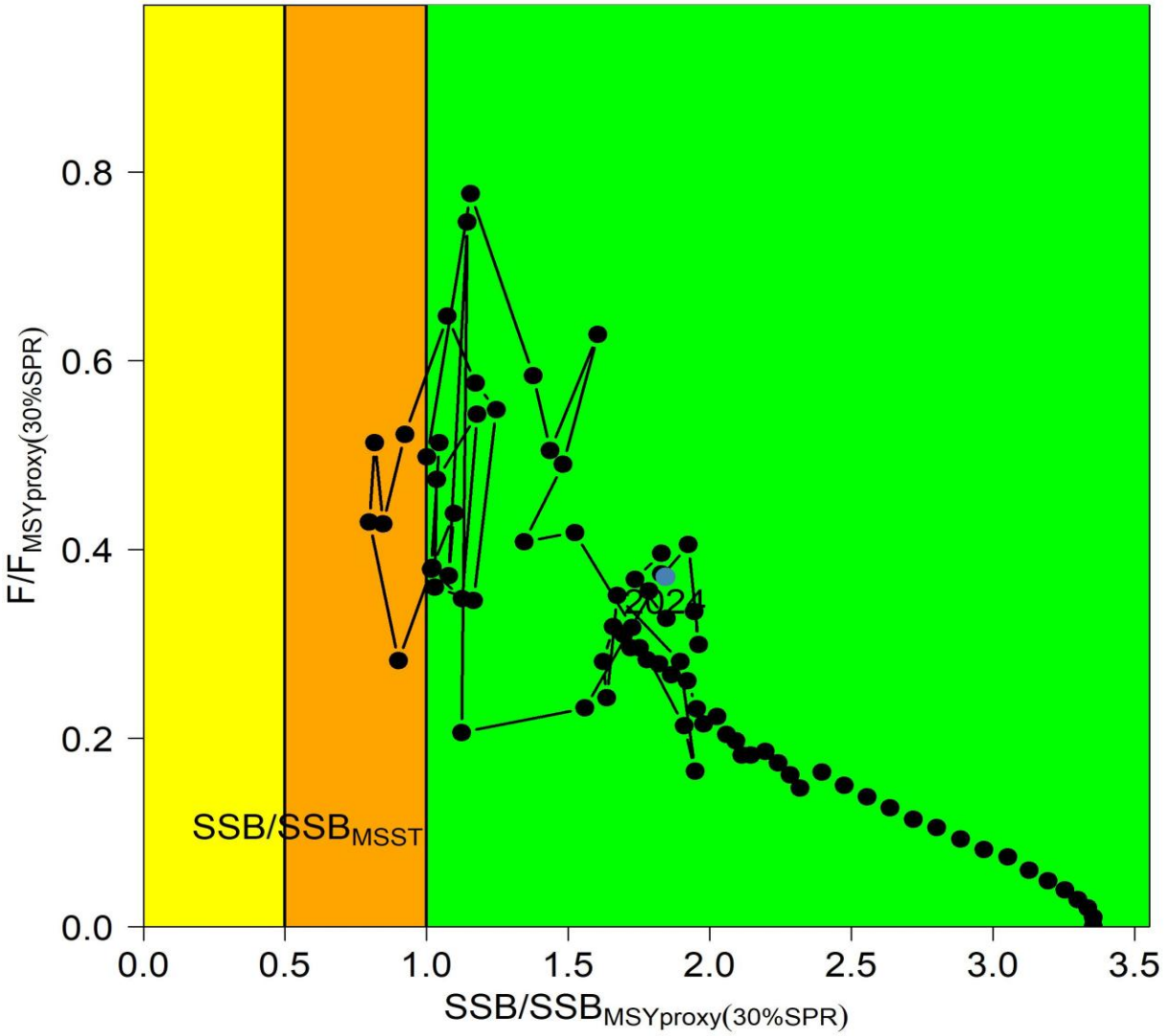


Figure 126. Kobe plot illustrating the trajectory of stock status with mean recruitment (i.e., steepness fixed at 0.99) throughout the projection period. The orange coloring indicates regions where the stock is below the biomass target but above the biomass threshold (MSST = 0.5 x $SSB_{30\%SPR}$). The 2024 terminal year stock status is indicated by the gray dot. See ***Table 42*** *for values. SSB is in metric tons. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (****Section 1.2****).*

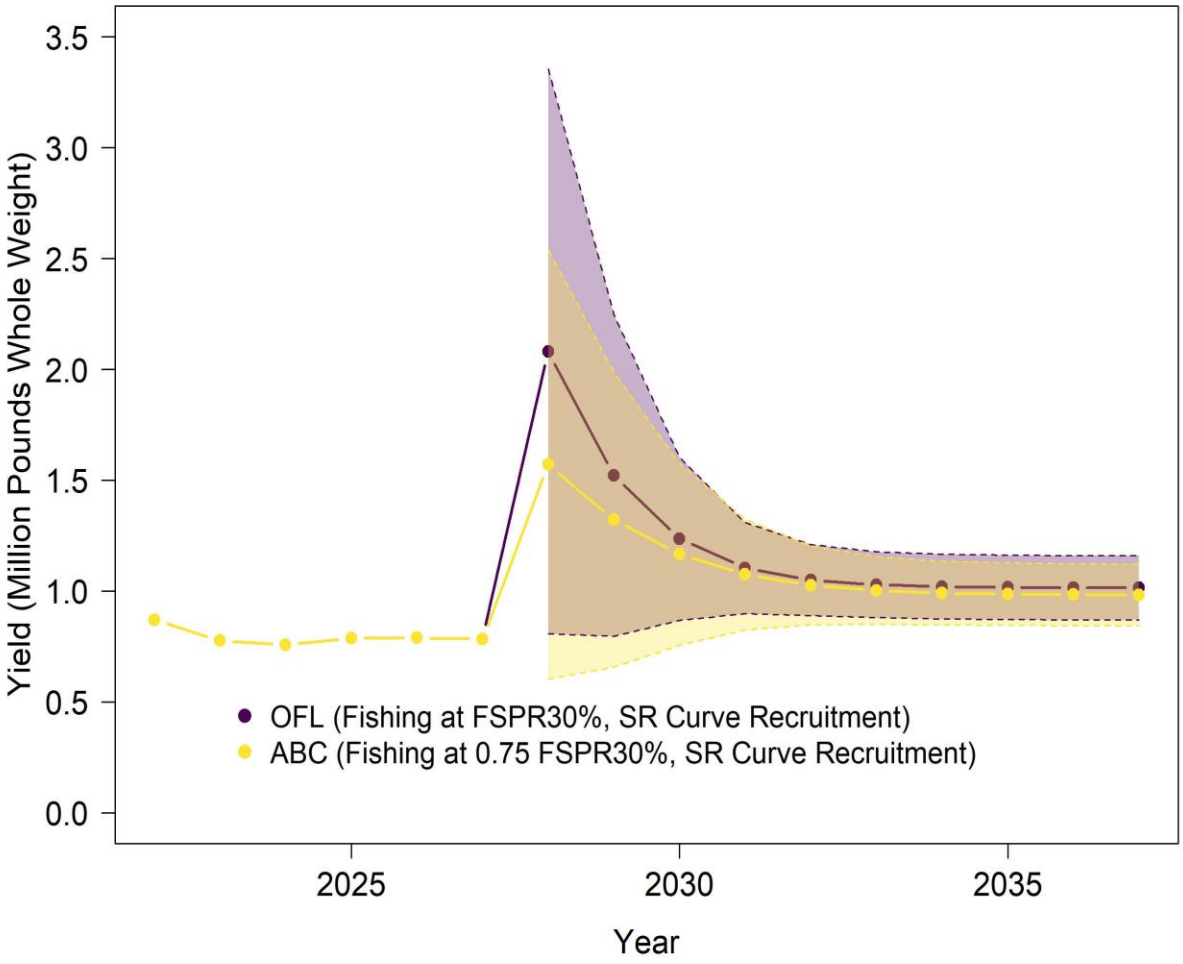


*Figure 127. Historic (2022-2024), interim (2025-2027) and forecasted yields (2028+) for the OFL (fishing set at $F_{30\%SPR}$) and ABC (directed F = 0.75 x Directed F at $F_{30\%SPR}$ (0.567)) projections assuming mean recruitment (i.e., steepness fixed at 0.99) throughout the projection period. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2**).*

12. Appendix

Table A1. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_1_YR_1945_s_1	2.63e-04	(0,4)	7.35e-05	0.280		1
F_fleet_1_YR_1946_s_1	0.005	(0,4)	0.001	0.280		1
F_fleet_1_YR_1947_s_1	0.010	(0,4)	0.003	0.280		1
F_fleet_1_YR_1948_s_1	0.015	(0,4)	0.004	0.281		1
F_fleet_1_YR_1949_s_1	0.021	(0,4)	0.006	0.281		1
F_fleet_1_YR_1950_s_1	0.026	(0,4)	0.007	0.281		1
F_fleet_1_YR_1951_s_1	0.032	(0,4)	0.009	0.282		1
F_fleet_1_YR_1952_s_1	0.038	(0,4)	0.011	0.282		1
F_fleet_1_YR_1953_s_1	0.045	(0,4)	0.013	0.282		1
F_fleet_1_YR_1954_s_1	0.051	(0,4)	0.015	0.283		1
F_fleet_1_YR_1955_s_1	0.058	(0,4)	0.017	0.283		1
F_fleet_1_YR_1956_s_1	0.066	(0,4)	0.019	0.284		1
F_fleet_1_YR_1957_s_1	0.074	(0,4)	0.021	0.284		1
F_fleet_1_YR_1958_s_1	0.083	(0,4)	0.024	0.285		1
F_fleet_1_YR_1959_s_1	0.092	(0,4)	0.026	0.286		1
F_fleet_1_YR_1960_s_1	0.101	(0,4)	0.029	0.286		1
F_fleet_1_YR_1961_s_1	0.106	(0,4)	0.030	0.287		1
F_fleet_1_YR_1962_s_1	0.110	(0,4)	0.031	0.287		1
F_fleet_1_YR_1963_s_1	0.114	(0,4)	0.033	0.287		1
F_fleet_1_YR_1964_s_1	0.119	(0,4)	0.034	0.287		1
F_fleet_1_YR_1965_s_1	0.123	(0,4)	0.036	0.288		1
F_fleet_1_YR_1966_s_1	0.128	(0,4)	0.037	0.288		1
F_fleet_1_YR_1967_s_1	0.133	(0,4)	0.038	0.288		1
F_fleet_1_YR_1968_s_1	0.139	(0,4)	0.040	0.288		1
F_fleet_1_YR_1969_s_1	0.145	(0,4)	0.042	0.289		1
F_fleet_1_YR_1970_s_1	0.151	(0,4)	0.044	0.289		1
F_fleet_1_YR_1971_s_1	0.166	(0,4)	0.048	0.289		1
F_fleet_1_YR_1972_s_1	0.181	(0,4)	0.052	0.289		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_1_YR_1973_s_1	0.198	(0,4)	0.057	0.289		1
F_fleet_1_YR_1974_s_1	0.212	(0,4)	0.061	0.289		1
F_fleet_1_YR_1975_s_1	0.225	(0,4)	0.065	0.287		1
F_fleet_1_YR_1976_s_1	0.223	(0,4)	0.063	0.285		1
F_fleet_1_YR_1977_s_1	0.220	(0,4)	0.062	0.282		1
F_fleet_1_YR_1978_s_1	0.216	(0,4)	0.060	0.278		1
F_fleet_1_YR_1979_s_1	0.213	(0,4)	0.058	0.274		1
F_fleet_1_YR_1980_s_1	0.208	(0,4)	0.056	0.270		1
F_fleet_1_YR_1981_s_1	0.141	(0,4)	0.036	0.253		1
F_fleet_1_YR_1982_s_1	0.283	(0,4)	0.068	0.241		1
F_fleet_1_YR_1983_s_1	0.197	(0,4)	0.047	0.238		1
F_fleet_1_YR_1984_s_1	0.051	(0,4)	0.013	0.257		1
F_fleet_1_YR_1985_s_1	0.097	(0,4)	0.024	0.243		1
F_fleet_1_YR_1986_s_1	0.199	(0,4)	0.041	0.204		1
F_fleet_1_YR_1987_s_1	0.317	(0,4)	0.075	0.237		1
F_fleet_1_YR_1988_s_1	0.315	(0,4)	0.070	0.221		1
F_fleet_1_YR_1989_s_1	0.401	(0,4)	0.067	0.166		1
F_fleet_1_YR_1990_s_1	0.519	(0,4)	0.081	0.156		1
F_fleet_1_YR_1991_s_1	0.338	(0,4)	0.075	0.221		1
F_fleet_1_YR_1992_s_1	0.432	(0,4)	0.060	0.138		1
F_fleet_1_YR_1993_s_1	0.711	(0,4)	0.101	0.143		1
F_fleet_1_YR_1994_s_1	0.379	(0,4)	0.055	0.144		1
F_fleet_1_YR_1995_s_1	0.415	(0,4)	0.079	0.190		1
F_fleet_1_YR_1996_s_1	0.252	(0,4)	0.039	0.156		1
F_fleet_1_YR_1997_s_1	0.223	(0,4)	0.031	0.137		1
F_fleet_1_YR_1998_s_1	0.442	(0,4)	0.075	0.171		1
F_fleet_1_YR_1999_s_1	0.338	(0,4)	0.043	0.127		1
F_fleet_1_YR_2000_s_1	0.238	(0,4)	0.040	0.167		1
F_fleet_1_YR_2001_s_1	0.253	(0,4)	0.034	0.133		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_1_YR_2002_s_1	0.476	(0,4)	0.093	0.196		1
F_fleet_1_YR_2003_s_1	0.530	(0,4)	0.111	0.209		1
F_fleet_1_YR_2004_s_1	0.642	(0,4)	0.091	0.142		1
F_fleet_1_YR_2005_s_1	0.503	(0,4)	0.067	0.134		1
F_fleet_1_YR_2006_s_1	0.407	(0,4)	0.066	0.161		1
F_fleet_1_YR_2007_s_1	0.532	(0,4)	0.080	0.151		1
F_fleet_1_YR_2008_s_1	0.621	(0,4)	0.115	0.185		1
F_fleet_1_YR_2009_s_1	0.501	(0,4)	0.075	0.150		1
F_fleet_1_YR_2010_s_1	0.787	(0,4)	0.170	0.216		1
F_fleet_1_YR_2011_s_1	0.850	(0,4)	0.155	0.183		1
F_fleet_1_YR_2012_s_1	0.873	(0,4)	0.165	0.189		1
F_fleet_1_YR_2013_s_1	2.388	(0,4)	0.445	0.186		1
F_fleet_1_YR_2014_s_1	0.449	(0,4)	0.065	0.144		1
F_fleet_1_YR_2015_s_1	0.513	(0,4)	0.090	0.175		1
F_fleet_1_YR_2016_s_1	0.865	(0,4)	0.114	0.131		1
F_fleet_1_YR_2017_s_1	0.882	(0,4)	0.122	0.138		1
F_fleet_1_YR_2018_s_1	0.924	(0,4)	0.179	0.194		1
F_fleet_1_YR_2019_s_1	0.855	(0,4)	0.148	0.173		1
F_fleet_1_YR_2020_s_1	0.835	(0,4)	0.144	0.172		1
F_fleet_1_YR_2021_s_1	0.696	(0,4)	0.133	0.191		1
F_fleet_1_YR_2022_s_1	1.055	(0,4)	0.190	0.181		1
F_fleet_1_YR_2023_s_1	0.975	(0,4)	0.177	0.182		1
F_fleet_1_YR_2024_s_1	1.012	(0,4)	0.243	0.240		1
F_fleet_4_YR_1945_s_1	1.05e-04	(0,4)	2.39e-05	0.228		1
F_fleet_4_YR_1946_s_1	0.006	(0,4)	0.001	0.225		1
F_fleet_4_YR_1947_s_1	0.013	(0,4)	0.003	0.225		1
F_fleet_4_YR_1948_s_1	0.019	(0,4)	0.004	0.225		1
F_fleet_4_YR_1949_s_1	0.026	(0,4)	0.006	0.225		1
F_fleet_4_YR_1950_s_1	0.032	(0,4)	0.007	0.225		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_4_YR_1951_s_1	0.038	(0,4)	0.009	0.225		1
F_fleet_4_YR_1952_s_1	0.045	(0,4)	0.010	0.225		1
F_fleet_4_YR_1953_s_1	0.051	(0,4)	0.011	0.225		1
F_fleet_4_YR_1954_s_1	0.057	(0,4)	0.013	0.225		1
F_fleet_4_YR_1955_s_1	0.064	(0,4)	0.014	0.225		1
F_fleet_4_YR_1956_s_1	0.070	(0,4)	0.016	0.225		1
F_fleet_4_YR_1957_s_1	0.077	(0,4)	0.017	0.225		1
F_fleet_4_YR_1958_s_1	0.083	(0,4)	0.019	0.225		1
F_fleet_4_YR_1959_s_1	0.090	(0,4)	0.020	0.225		1
F_fleet_4_YR_1960_s_1	0.096	(0,4)	0.022	0.224		1
F_fleet_4_YR_1961_s_1	0.068	(0,4)	0.015	0.225		1
F_fleet_4_YR_1962_s_1	0.083	(0,4)	0.019	0.225		1
F_fleet_4_YR_1963_s_1	0.095	(0,4)	0.021	0.224		1
F_fleet_4_YR_1964_s_1	0.103	(0,4)	0.023	0.224		1
F_fleet_4_YR_1965_s_1	0.091	(0,4)	0.020	0.224		1
F_fleet_4_YR_1966_s_1	0.086	(0,4)	0.019	0.224		1
F_fleet_4_YR_1967_s_1	0.100	(0,4)	0.022	0.224		1
F_fleet_4_YR_1968_s_1	0.103	(0,4)	0.023	0.224		1
F_fleet_4_YR_1969_s_1	0.120	(0,4)	0.027	0.224		1
F_fleet_4_YR_1970_s_1	0.101	(0,4)	0.023	0.224		1
F_fleet_4_YR_1971_s_1	0.104	(0,4)	0.023	0.223		1
F_fleet_4_YR_1972_s_1	0.123	(0,4)	0.027	0.222		1
F_fleet_4_YR_1973_s_1	0.114	(0,4)	0.025	0.222		1
F_fleet_4_YR_1974_s_1	0.113	(0,4)	0.025	0.221		1
F_fleet_4_YR_1975_s_1	0.099	(0,4)	0.022	0.220		1
F_fleet_4_YR_1976_s_1	0.117	(0,4)	0.026	0.218		1
F_fleet_4_YR_1977_s_1	0.124	(0,4)	0.027	0.216		1
F_fleet_4_YR_1978_s_1	0.147	(0,4)	0.031	0.213		1
F_fleet_4_YR_1979_s_1	0.152	(0,4)	0.032	0.211		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_4_YR_1980_s_1	0.107	(0,4)	0.023	0.215		1
F_fleet_4_YR_1981_s_1	0.130	(0,4)	0.028	0.214		1
F_fleet_4_YR_1982_s_1	0.131	(0,4)	0.028	0.214		1
F_fleet_4_YR_1983_s_1	0.130	(0,4)	0.028	0.217		1
F_fleet_4_YR_1984_s_1	0.140	(0,4)	0.031	0.218		1
F_fleet_4_YR_1985_s_1	0.147	(0,4)	0.032	0.220		1
F_fleet_4_YR_1986_s_1	0.169	(0,4)	0.037	0.219		1
F_fleet_4_YR_1987_s_1	0.188	(0,4)	0.041	0.218		1
F_fleet_4_YR_1988_s_1	0.161	(0,4)	0.035	0.216		1
F_fleet_4_YR_1989_s_1	0.169	(0,4)	0.036	0.215		1
F_fleet_4_YR_1990_s_1	0.175	(0,4)	0.039	0.220		1
F_fleet_4_YR_1991_s_1	0.175	(0,4)	0.039	0.222		1
F_fleet_4_YR_1992_s_1	0.176	(0,4)	0.039	0.223		1
F_fleet_4_YR_1993_s_1	0.160	(0,4)	0.036	0.223		1
F_fleet_4_YR_1994_s_1	0.126	(0,4)	0.028	0.224		1
F_fleet_4_YR_1995_s_1	0.109	(0,4)	0.024	0.225		1
F_fleet_4_YR_1996_s_1	0.124	(0,4)	0.028	0.223		1
F_fleet_4_YR_1997_s_1	0.143	(0,4)	0.032	0.222		1
F_fleet_4_YR_1998_s_1	0.172	(0,4)	0.038	0.224		1
F_fleet_4_YR_1999_s_1	0.169	(0,4)	0.038	0.225		1
F_fleet_4_YR_2000_s_1	0.151	(0,4)	0.034	0.226		1
F_fleet_4_YR_2001_s_1	0.118	(0,4)	0.027	0.227		1
F_fleet_4_YR_2002_s_1	0.134	(0,4)	0.031	0.228		1
F_fleet_4_YR_2003_s_1	0.106	(0,4)	0.024	0.227		1
F_fleet_4_YR_2004_s_1	0.088	(0,4)	0.020	0.228		1
F_fleet_4_YR_2005_s_1	0.070	(0,4)	0.016	0.228		1
F_fleet_4_YR_2006_s_1	0.064	(0,4)	0.015	0.229		1
F_fleet_4_YR_2007_s_1	0.067	(0,4)	0.015	0.227		1
F_fleet_4_YR_2008_s_1	0.054	(0,4)	0.012	0.224		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_4_YR_2009_s_1	0.067	(0,4)	0.015	0.225		1
F_fleet_4_YR_2010_s_1	0.043	(0,4)	0.010	0.226		1
F_fleet_4_YR_2011_s_1	0.054	(0,4)	0.012	0.226		1
F_fleet_4_YR_2012_s_1	0.055	(0,4)	0.012	0.227		1
F_fleet_4_YR_2013_s_1	0.061	(0,4)	0.014	0.225		1
F_fleet_4_YR_2014_s_1	0.065	(0,4)	0.015	0.224		1
F_fleet_4_YR_2015_s_1	0.066	(0,4)	0.015	0.225		1
F_fleet_4_YR_2016_s_1	0.065	(0,4)	0.015	0.226		1
F_fleet_4_YR_2017_s_1	0.067	(0,4)	0.015	0.227		1
F_fleet_4_YR_2018_s_1	0.062	(0,4)	0.014	0.226		1
F_fleet_4_YR_2019_s_1	0.057	(0,4)	0.013	0.223		1
F_fleet_4_YR_2020_s_1	0.060	(0,4)	0.013	0.223		1
F_fleet_4_YR_2021_s_1	0.059	(0,4)	0.013	0.224		1
F_fleet_4_YR_2022_s_1	0.039	(0,4)	0.009	0.225		1
F_fleet_4_YR_2023_s_1	0.032	(0,4)	0.007	0.225		1
F_fleet_4_YR_2024_s_1	0.030	(0,4)	0.007	0.226		1

SEDAR

Southeast Data, Assessment, and Review

SEDAR 100

Gulf Gray Triggerfish

SECTION IV: Research Recommendations

SEDAR
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1. DATA WORKSHOP RESEARCH RECOMMENDATIONS

1.1 LIFE HISTORY RESEARCH RECOMMENDATIONS

The LHWG drafted the following recommendations:

- Continue refining ageing algorithms for assigning calendar and fractional ages. This includes further research into the use of edge type, which requires that age readers record narrow versus opaque margin codes to get a better understanding of seasonality of annulus formation.
- Consider evaluating maturity-at-age given the ageing issues identified for ages 0-2
- Continue to examine data for region- and sex-specific differences in growth as data accrue over time.
- Continue to recommend that all age-data providers read the gray triggerfish reference set following the Potts et al. (2023) protocol prior to conducting any production ageing.
- Consider exploring epigenetic ageing as a complementary approach to gain insight into sex-specific growth and to potentially improve confidence in age-class assignments.

1.2 COMMERCIAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

Although the Indices and Bycatch workgroup focused on understanding and evaluating Gray Triggerfish bycatch methods and estimates, the working paper SEDAR100-DW-22 outlines current efforts by SEFSC to improve bycatch estimation in the future. These include:

- Adding Gray Triggerfish to the list of species for which data are currently collected in the Shrimp Observer program.
- Outfitting the commercial shrimp fleet with modern, tamper-proof GPS tracklog devices;
- Applying electronic technologies to enable observers to collect size information on all fish species captured in fish trawls;
- Modifying the allocation of observer sampling effort to better incorporate net configuration and diurnal period;
- The potential for field experiments to improve calibrations of SEAMAP and commercial shrimp trawls.

1.3 RECREATIONAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

1.3.1 Evaluation and Progress of Research Recommendations from Last Assessment Research Recommendations

Task 13: Research recommendations for the improvement of recreational datasets from SEDAR 43 were evaluated and progress on each item is outlined below:

1. *Evaluate existing methods for deriving historical discard numbers and discard rates and improve methods as appropriate*
   - No information on historical (1955-1980) discard rates were presented for consideration at the SEDAR 100 Data Workshop, so hindcasting of historical discards remains unfeasible.
   - As is now the best practice (SEDAR-PW-07), proxy estimates of SRHS discards (1986-2007) for SEDAR 100 were calculated using the Super-Ratio approach, which differs from the MRIP-charter approach applied in SEDAR 43.
   - Conversely, the best practice approach (SEDAR-PW-07) to impute TPWD discards (1981-2024) resulted in highly variable discard rates, and so a modified approach was applied in SEDAR 100 to stabilize those ratios.

1.3.2 Research Recommendations for SEDAR 100

Task 14: The Recreational Working Group provided the following recommendations to improve recreational data in the Gulf of America:

1. Continued evaluation of LA Creel Calibration Ratios for Gulf Gray Triggerfish
2. Additional MRIP Study in TX to include additional year(s) of benchmarking with TPWD
3. Collection of additional biological samples, particularly from the West

4. Continued funding of at-sea observer programs for tagging and estimation of associated discard mortalities
5. Tagging studies to estimate discard mortalities from recreational fisheries as well as additional sources of mortality, including shrimp trawl bycatch

1.4 MEASURES OF POPULTAION ABUNDANCE RESEARCH RECOMMENDATIONS

- Evaluate potential red tide impacts
- Explore incorporating artificial reef / platform data from G-FISHER (short time series)
- Understanding the connection between sargassum habitat and abundance / life history of gray triggerfish
    - Daily aging of sub-age 0 gray triggerfish
    - Is sargassum obligate?

2. ASSESSMENT PROCESS RESEARCH RECOMMENDATIONS

Recommendations for considerations of future research are provided below and do not indicate any particular order of priority.

Age and Growth
- Investigate methods to better collect age structure samples randomly and systematically from all fishing sectors including surveys
- Continue collaboration with ageing facilities throughout the Gulf and South Atlantic. These efforts will include the annual reading of references sets for Gray Triggerfish and other reef fish, and annual meetings to review the interpretation of ageing structures and the timing of annual band deposition
- Explore epigenetic ageing to potentially improve age estimates

Natural Mortality
- Explore more direct approaches to estimating natural mortality (e.g., Mark-recapture approaches (conventional, telemetry, or close-kin))
- Explore ways to better reflect uncertainty around the mortality at age vector

Reproduction
- Continue data collection for maturity and fecundity
- Update maturity-at-age estimates to see whether the age data updates have changed our understanding of maturity

Discard Mortality
- Continue data collection from observer programs or electronic monitoring programs (e.g., Roberts and Neidig 2019 [SEDAR62-WP10]), particularly to get a better handle on discard mortality for the commercial fleets

Shrimp Bycatch
- Estimates of shrimp bycatch are highly uncertain and need further investigation once observer data allow more advanced approaches for estimation

Selectivity and Catchability
- Further investigate and quantify changes in selectivity/catchability through time to improve fit to the length and age composition

Surveys
- Increase collection of length and age information for compositions
- Continue to improve upon standardized indices from the video survey to account for survey design changes through time and space to ensure trends are representative of relative abundance

Sargassum
- Improve our understanding of how sargassum affects Gray Triggerfish recruitment and which life stages are most affected
- Develop indices (with uncertainty estimates) to enable hypothesis testing of environmental linkages within the assessment model

3. REVIEW PANEL RESEARCH RECOMMENDATIONS

The Data and Assessment Process recommendations are appropriate, but the list would be more useful if prioritized by decision relevance. Highest priority should go to work capable of changing status or catch advice: ageing validation and sampling, natural mortality, adult survey continuity, recruitment mechanisms, shrimp bycatch magnitude, and sector-specific discard mortality. Continued collection of maturity/fecundity and western biological samples is also warranted but should be designed to resolve explicit model uncertainties.

- **If applicable, provide recommendations for improvement or for addressing any inadequacies identified in the data or assessment modeling. Describe these recommendations in sufficient detail for application and should be practical for short-term implementation (e.g., achievable within ~6 months). List longer-term recommendations as research recommendations above.**

The RP provide the following research recommendations:

- Future investigation as to why the model is estimating growth differently than external estimations would be beneficial.
- Age information could be improved with more old and young fish.
- A separate tournament fleet might help inform larger, older fish to the growth model and eliminate the need for a 10+ group.
- Explore the ability to estimate sex-specific growth.
- The panel recommends that future assessments produce One step-ahead (OSA) residuals as diagnostics for evaluating fits to the composition datasets (Trijoulet et al., 2023).
- Evaluate alternative empirical-recruitment windows and the *F*30%SPR control rule through management strategy evaluation. The MSE should test whether using recent recruitment to scale SSB at *F*30%SPR and generate forecasts remains robust under recruitment regime shifts, assessment error, retrospective bias, and recreational catch implementation error.
- Develop close-kin, conventional-tag, or telemetry designs capable of informing natural and discard mortality.
- Evaluate sex-specific growth and survivorship with representative sampling; develop a two-sex model only when fleet/survey sex compositions can support it.
- Develop an assessment-independent survey calibration program for combined video components, including habitat, visibility, platform, footprint, and western-Gulf effects.
- Use simulation testing or an operating-model framework to determine whether the current data can identify time-varying selectivity, recruitment, and survey catchability simultaneously.
- Develop a management strategy evaluation that incorporates recruitment regimes, observation error, implementation error, and uncertain productivity.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 100

Gulf Gray Triggerfish

SECTION V: Review Workshop Report

August 2026

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

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1. INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 100 Gulf Gray Triggerfish Review Workshop was held in Tampa, FL August 11-14, 2026.

1.2 TERMS OF REFERENCE

1. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions. Consider the following:
    - The context of the data availability in the region. Are the procedures appropriate for our data limitations?
    - Are data decisions made by the DW and AW justified?
    - Are data uncertainties acknowledged, reported, and within normal or expected levels?
    - Is the appropriate model applied properly to the available data?
    - Are input data series sufficient to support the assessment approach?
2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, considering the available data. Consider the following:
    - Are methods scientifically sound and robust?
    - Are priority modeling issues clearly stated and addressed?
    - Are the methods appropriate for the available data?
    - Are assessment models configured properly and used in a manner consistent with standard practices?
3. Consider how uncertainties are addressed in the assessment, and their potential consequences.
    - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods.

- Comment on the relationship of this variability with ecosystem or climate factors and mechanisms for encompassing this into management reference points.

4. Provide, or comment on, recommendations to improve the assessment.
    - Consider the research recommendations provided by the Data and Assessment workshops in the context of overall improvement to the assessment and make any additional research recommendations warranted.
    - If applicable, provide recommendations for improvement or for addressing any inadequacies identified in the data or assessment modeling. Describe these recommendations in sufficient detail for application and should be practical for short term implementation (e.g., achievable within ~6 months). List longer-term recommendations as research recommendations above.
5. Evaluate the stock projections, including discussing strengths and weaknesses, and consider the following:
    - Are the methods consistent with accepted practices and available data?
    - Are the methods appropriate for the assessment model and outputs?
    - Are the results informative and robust, and are they useful to support inferences of probable future conditions?
    - Are key uncertainties acknowledged, discussed, and reflected in the projection results?
6. Prepare a Review Workshop Summary Report describing the Panel's evaluation of the stock assessment and addressing each Term of Reference.

1.3 LIST OF PARTICIPANTS

Review Panel

Luiz Barbieri (Chair).....GFMC SSC
Jie Cao.....GFMC SSC
Yong Chen .....CIE Reviewer
Nicholas Fisch.....CIE Reviewer
Erik Lang .....GFMC Appointee
Anders Nielsen.....CIE Reviewer

Analytic Team

Skyler Sagarese.....SEFSC
Katie Siegfried .....SEFSC

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Alyssa Clift ..... GFMC Staff
Lisa Hollensead..... GMFC Staff
Matt Freeman..... GMFC Staff

John Froeschke..... GMFC Staff
Jessica Matos ..... GMFC Staff
Ryan Rindone..... GFMC Staff
Carrie Simmons ..... GFMC Staff

Council Representative
Kevin Anson .....Gulf Council

Workshop Observers via Webinar
Lisa Ailloud .....SEFSC
Shanae Allen ..... USF/FWC-FWRI
Jordan Bajema.....FWC-FWRI
Anessa Carter .....FWC-FWRI
Rob Cheshire.....SEFSC
Manuel Coffill-Rivera.....
LaTreese Denson .....SEFSC
Leonardo Eguia ..... GFMC Staff
Alena Figueroa.....FWC-FWRI
Francesca Forrestal .....SEFSC
Sarah Gardiner ..... GFMC Staff
Challen Hyman ..... USF
Tiffany Hopper..... TXPWD
Emily Ott..... SEDAR
Chloe Ramsay .....FWC-FWRI
Seth Leimgruber.....FWC-FWRI
Molly Stevens .....SEFSC
James Swarthout ..... AL DCNR
Nathan Vaughan.....Vaughan Analytics
Kym Walsh .....LAWLF

1.4 LIST OF REVIEW WORKSHOP REFERENCE DOCUMENTS

Reference Documents		
SEDAR100-RD07	A novel habitat-based approach for combining indices of abundance from multiple fishery-independent video surveys: A novel habitat-based approach for combining	Kevin A. Thompson, Theodore S. Switzer, Mary C. Christman, Sean F. Keenan, Christopher L. Gardner, Katherine E. Overly, Matt D. Campbell

	indices of abundance from multiple fishery-independent video surveys	

2. REVIEW PANEL REPORT

Executive Summary

SEDAR 100 developed a stock assessment for the Gulf of America Gray Triggerfish using Stock Synthesis 3 (SS3). The assessment incorporated commercial and recreational removals, fishery-independent indices of abundance, length-composition and conditional age-at-length data, and internally estimated growth. Model performance was evaluated using a broad suite of diagnostics and sensitivity analyses. Although this assessment represents a substantial advancement in the treatment of several important data sources relative to previous Gray Triggerfish assessments, several important data and modeling uncertainties remain. Despite these limitations, the Review Panel (RP) concluded that the available data were sufficient to support the integrated assessment approach and that the model was generally appropriately configured and scientifically sound. A principal issue identified during the review was the treatment of stock productivity. Natural mortality (*M*) was considered appropriately fixed at 0.36, but the Panel concluded that steepness (*h*) should be estimated rather than fixed at 0.99. The revised model estimated *h* at approximately 0.42 and produced improved model fits, retrospective diagnostics, and robustness to alternative recruitment assumptions. However, the RP concluded that the estimated stock-recruitment relationship was not sufficiently informed across the full range of spawning biomass (i.e., beyond the observed range) to support extrapolation for equilibrium reference points or projections. Accordingly, the estimated *h* was considered appropriate for reconstructing the historical population but should not be used directly to generate future recruitment. Instead, the RP recommended recalculating reference points and projections using empirical recruitment from recent, well-estimated cohorts, with sensitivity analyses examining alternative 5-, 10-, and 15-year recruitment periods and stochastic projections incorporating observed recruitment variability. The RP also identified research priorities related to ageing, collection of older and younger fish, shrimp-trawl bycatch, commercial discard mortality, composition diagnostics, and improved characterization of recruitment and assessment uncertainty. Overall, the RP concluded that SEDAR 100 provides a scientifically defensible assessment framework for Gulf Gray Triggerfish and uses the available data appropriately. However, because stock-status reference points and projections require recalculation using the recommended empirical-recruitment approach, the final management quantities should be based on those revised analyses rather than projections that extrapolate the estimated stock-recruitment relationship beyond the range supported by the available data.

The Review Panel discussions and deliberations are summarized below for each of the Terms of Reference

1. **Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions.**

The input data are sufficient to support an integrated, length-focused assessment, and the Data and Assessment Process decisions are generally well justified. SEDAR 100 made notable advances in age re-reading, ageing error, fishery catch reconstruction, direct fitting of discards in numbers, length compositions, conditional age-at-length, survey standardization, and observation-error treatment. Nevertheless, data informativeness is not uniform. The assessment is much stronger for recent catch magnitude and size structure than for historical scale, cohort tracking, recruitment, or continuous adult abundance.

- **The context of the data availability in the region. Are the procedures appropriate for our data limitations?**

Data limitations include a truncated length distribution due to fleet selectivity, lack of sex-specific age at length compositions, lack of bycatch information for the commercial bottom longline fleet, lack of discard mortality estimate for commercial vertical line fleet, lack of direct observations of Gray Triggerfish bycatch in the shrimp trawl fleet, lack of recreational discard length compositions from Texas and Louisiana, and lack of empirical age at length information from the camera survey.

In previous Gray Triggerfish stock assessments, the methodology, precision, and accuracy of age determination were questioned, and ageing error was identified as a potentially important source of observation error. Recent studies have validated Gray Triggerfish age estimates using bomb radiocarbon and demonstrated that the historical dorsal-spine aging protocol systematically underestimated age, particularly for fish aged 5 years and older. Consequently, historical samples aged 5 years and older were re-aged using the updated dorsal-spine protocol to improve accuracy and precision. Additionally, age 0 and 1 fish were re-aged during development of the SEDAR 100 age at length data to reduce the variance in length within these age classes. Age at length data were not separated by sex, although sex-specific growth and age at length data could be advantageous for Gray Triggerfish given evidence of sex-specific growth differences. The absence of sex-specific age at length compositions does not preclude the current Stock Synthesis configuration.

The understanding of recreational discard mortality has significantly improved since the assumed 5% with a 10% sensitivity of the SEDAR 43 assessment. A synthesis of peer-reviewed documentation and reports resulted in a base model recreational discard mortality of 40% with 26% and 60% sensitivity runs. The MRIP survey provides estimates of recreational discards from 1981 to the terminal year of the assessment with discards before 1981 assumed to be negligible. Commercial vertical line discard inputs began in 2000 with all other commercial

discards assumed to be negligible. Due to similarities in gear characteristics, commercial vertical line discard mortality was assumed to be equivalent to recreational discard mortality. In contrast, the commercial bottom longline fleet was assumed to have no discards. The review panel agrees that these assumptions are valid and necessary, but it would be beneficial to ground truth the similarity of commercial vertical line discard mortality to the recreational fishery and the lack of discards in the commercial bottom longline fishery.

Currently, the median of the estimated Gray Triggerfish discards from the shrimp fishery across the time series is used for fitting within the stock assessment model. This method was used due to the uncertainty regarding the bycatch estimation. The bottom trawl fishery observer program does not count or sample Gray Triggerfish bycatch. Therefore, a proxy species was determined from the SEAMAP trawl survey after stations were restricted to shrimping areas. The bycatch estimated from the fleet varied greatly across years, thus the assessment authors chose to use the median across the time series, scaled with the annual shrimp effort to fit the data in the stock assessment. The review panel finds the current stock assessment model incorporated Gray Triggerfish bycatch from the shrimp fleet using the best possible practices, given the data limitations. Regardless, these estimates will be vastly improved when observers account for Gray Triggerfish bycatch explicitly.

The use of the Combined Video Survey as an index of adult Gray Triggerfish abundance is appropriate because it provides information on a portion of the population that is not adequately represented by other fishery-dependent or fishery-independent data sources. However, because video observations do not provide empirical ages, the age composition attributed to this survey is dependent on the growth relationship estimated within the integrated assessment. This is particularly relevant because the age at length data used to estimate growth are truncated at age 10+, while the video survey provides information on larger individuals that may represent older age classes. The review panel considers the current approach appropriate given the available data, but additional empirical age-at-length observations from fleets or surveys sampling larger and older Gray Triggerfish would substantially improve the internally estimated growth model and the ability of the assessment to validate the age structure attributed to the Combined Video Survey.

- **Are data decisions made by the DW and AW justified?**

The review panel finds the decision to initiate the model in 1945 is justified as it provides a sufficiently long period for the population to approach equilibrium under relatively low exploitation before substantial development of the fishery. Starting the model later requires the estimation of equilibrium fishing mortalities prior to the model starting year, parameters that are difficult to estimate. Extending the model back to 1945 provides a more appropriate representation of the historical development of the fishery and reduces the amount of early exploitation that must be captured through initial conditions.

Estimating growth internally within the stock assessment is justified by the substantial amount of available age at length information across multiple fleets. This approach allows uncertainty in growth to be propagated through the integrated assessment rather than treating growth parameters as known. The available data appear particularly informative over the middle portion of the size distribution, but additional age at length observations for fish smaller than 20 cm and larger than 40 cm would improve growth estimation. Additionally, age at length information was used to estimate a single growth curve given limited availability of sex-specific age data from various fleets that yielded similar growth between the two sexes. If sex-specific age at length data becomes more available, particularly across the full-length range, sex-specific growth relationships should be considered in future assessments. Regardless, a combined-sex growth model represents a reasonable balance between biological realism and the information available from the data.

The mean natural mortality at age in the assessment was determined using the longevity-based methods of Hamel and Cope (2022), while a Lorenzen function was used to scale natural mortality at age through age 15. In contrast, the age-at-length data were truncated to a 10+ age group. Reviewers identified the difference between the age range of the natural mortality schedule and the age range represented in the age at length data as a potential area of concern. Assessment analysts explained that observations above age 10 were sparse and that retaining these observations as separate age classes could add unnecessary complexity and potentially influence model estimates without providing substantial additional information.

Estimating maturity as a function of length is justified and is likely more appropriate than estimating maturity solely as a function of age given the uncertainty associated with assigning age and the biological importance of body size to reproductive capability. The maturity at length relationship informs maturity at age, which is used to calculate spawning stock biomass assuming a 50:50 sex ratio. Using spawning stock biomass as a proxy for fecundity is justified in this assessment given the small amount of fecundity information available, which also indicates batch fecundity values that may be directly proportional to body size.

The use of a 40% discard-mortality rate for the commercial vertical-line fleet is justified due to its similarities in gear characteristics to the recreational fleet. A synthesis of peer-reviewed documentation and reports resulted in a base model recreational discard mortality of 40% with 26% and 60% sensitivity runs.

The decision to exclude the commercial vertical line index from the assessment is justified given the relationship between catch rate and population abundance has likely been substantially affected by changes in regulations and fishing practices over the recent time series. Similarly, exclusion of the MRIP recreational index is justified by the substantial changes in the recreational fishery over the period represented by the index. Under these circumstances, relative catch rates from both the commercial and recreational fleets no longer provide a consistent measure of abundance.

The decision to combine the SEAMAP summer and fall survey indices is justified by the substantial overlap in the size distributions observed in the two surveys and the inability to reliably distinguish age-0 and age-1 fish based solely on length. Because both surveys provide information on young fish and their size distributions overlap, treating them as separate indices could potentially imply a degree of age or population-structure separation that is not supported by the data. Combining the surveys therefore provides a more comprehensive measure of recruitment and juvenile abundance while avoiding an artificial distinction between age classes that cannot be reliably identified from the observed length distributions.

The use of a random forest modeling approach to combine multiple video surveys is justified given the complementary nature of their information regardless of slight differences in sampling techniques that are accounted for in the averaging of multiple classification and regression trees (CARTs).

- **Are data uncertainties acknowledged, reported, and within normal or expected levels?**

The assessment appropriately acknowledges and incorporates uncertainty associated with the major data inputs, including landings, discards, relative abundance indices, growth, and composition data. A constant growth coefficient of variation of 0.14 was recommended by the data workshop as a fixed input. The recreational fleet uncertainties associated with landings and discards are derived directly from the MRIP estimation and landings previous to the MRIP time series had a pre-determined large associated uncertainty (0.536). Commercial landings uncertainty inputs were calculated as averages of the recommended uncertainty by state, weighted by state landings. This is an improvement from SEDAR 43, where commercial landings uncertainty were assumed to be 0.05. Commercial discards annual estimates were input with their associated log-scale standard errors. Measures of relative abundance were also input with their associated log-scale standard errors. The review panel agreed that all input values had appropriate values of uncertainty.

However, the reviewers noted that shrimp trawl bycatch sampling errors are estimated using a proxy species because Gray Triggerfish are not directly enumerated or measured by the observer program. Overall, necessary assumptions were made in order to incorporate all removals in the stock assessment, but elevating the priority level of Gray Triggerfish for documentation in shrimp bycatch will aid in the explicit estimation of observation error.

The assessment utilizes the number of trips sampled or the number of fish sampled as the input sample size for the composition data sets. Although a simple heuristic, the input sample sizes could be more objectively developed using a bootstrapping approach such as that presented in Stewart and Hamel (2014). Using bootstrapping (resampling the trips, then the specimen within trips) allows for an input sample size estimate for compositions that can serve as a good theoretical upper bound where the Dirichlet-Multinomial can further down-weight if deemed

necessary. Another suitable alternative would be to employ a spatial and spatiotemporal standardization of the different composition data sets such as that presented in Thorson and Haltuch (2019), which also results in estimates of input sample sizes.

- **Is the appropriate model applied properly to the available data?**

The integrated Stock Synthesis framework is appropriate for the available data because the assessment contains the primary data types required to estimate an age-structured population model, including removals, length compositions, conditional age at length compositions, and relative abundance information. The integration of growth estimation within the assessment is also appropriate because it allows uncertainty in the age at length relationship to be propagated through the population dynamics rather than treating growth parameters as known inputs.

The abundance index time series are generally standardized using common methods for the region (delta-lognormal generalized linear models). However, spatial and spatiotemporal standardizations of abundance index time series have become more common across many other regions and have been shown to outperform design-based indices (Thorson et al., 2015). Where possible, i.e., where the data allow, future assessments should consider developing spatial and spatiotemporal standardizations of abundance index time series.

- **Are input data series sufficient to support the assessment approach?**

The available input data series are sufficient to support the integrated Stock Synthesis approach. The assessment contains the standard data inputs required for an age-structured model, including landings, discards, relative abundance indices, length compositions, and conditional age-at-length compositions. In addition, relative abundance information is available across multiple life stages, while the integrated growth model provides a mechanism for linking length observations to age when direct age observations are unavailable.

However, the reviewers recognize that potential for data improvement varies among components of the assessment. Several important processes are informed indirectly because direct observations are unavailable. These include shrimp-fishery Gray Triggerfish bycatch, commercial vertical-line discard mortality, commercial bottom-longline discards, and age at length information for a wider array of lengths. These limitations do not prevent application of the integrated assessment model, but they reduce the amount of direct information available to independently estimate some population and fishery processes. Consequently, the reviewers consider the data sufficient to support the assessment approach, while recognizing that additional observations of older fish, shrimp-fishery bycatch, commercial discard mortality, and the age structure of the adult population would substantially strengthen future assessments.

2. **Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, considering the available data. Consider the following:**

- **Are methods scientifically sound and robust?**

The methods used to assess the stock of Gulf of America Gray Triggerfish for SEDAR 100 are largely sound. The stock assessment used an assessment program commonly used in the US, Stock Synthesis 3, to fit an age-structured assessment to catches, discards, indices of abundance, length compositions, and conditional age-at-length compositions. The authors examined a broad suite of model diagnostics including examining fits to data, retrospective analyses, hindcasting, likelihood profiles, jitter analysis, and jackknife analyses in common with many assessments in the region and the US. Although some model diagnostics were suboptimal, such as fits to the composition data, they were deemed largely acceptable by the review panel in context of the data quality and similar assessments in the region.

The review panel did, however, note some concerns in the methodology for the assessment. Primarily, the group made note that both steepness (h) and natural mortality (M) were fixed, and this in essence "fixes" the productivity of the stock. When h is fixed at 0.99 and M is estimated, the model converges on a value of 0.076 without a prior and 0.128 with a prior from Hamel and Cope (2022), each of which appear biologically implausible given the observed longevity of the species. In light of this, the review panel found that fixing M at 0.36 (the Hamel and Cope (2022) estimate) to be a defensible assumption. However, when h was estimated and M fixed at 0.36, the assessment converges on a value of $h = 0.422$ at a lower negative log likelihood solution of approximately 22 units. The review panel discussed this topic at length, reviewing model diagnostics and sensitivity to key assumptions of each assessment configuration. The model with estimated steepness exhibited improved retrospective diagnostics, fits to data, and largely similar hindcast predictions and jitter stability. Notably, the model that estimated h exhibited increased robustness to some key recruitment assumptions, such as applying the sum-to-zero constraint for recruitment deviations. In the SEDAR 100 AP model with h fixed at 0.99, the assessment was highly sensitive to relaxing the sum-to-zero constraint, estimating markedly different recruitment deviations (and summing to -14) in relation to when the constraint was applied. The review panel remarked that this suggests the recruitment deviations, when unconstrained, are accounting for some process error unaccounted for in the model rather than conforming to their specified lognormal distribution (with mean 1). In contrast, the assessment model that estimated h did not exhibit sensitivity to the sum-to-zero constraint.

In light of the improved diagnostics and robustness, the review panel recommends the assessment adopt a base model where h is estimated internally (RW model). The review panel notes, however, that the paired SSB-recruitment estimates from the RW model occur only over a very small range of SSB regarding the stock-recruitment curve in the time period when recruitment deviations are estimated, and in particular when SSB is low. This suggests the part of the stock-recruit curve at higher levels of SSB is not well defined. Thus, the RP does not consider this h estimate useful for management benchmarks or projections. Rather, the Panel finds the estimate of h to be a computational convenience leading to a more stable model that better fits the observed data and consequentially estimates a more likely historical time series.

The review panel also remarked that the provided diagnostics for the assessment model included Pearson residuals for the composition datasets. The panel stressed that these residuals are improper for composition datasets due to the fact that compositions must sum to 1 (thus each observation is correlated and violates Pearson assumptions). The panel recommends that future assessments produce One step-ahead (OSA) residuals as diagnostics for evaluating fits to the composition datasets (Trijoulet et al., 2023).

- **Are priority modeling issues clearly stated and addressed?**

Several priority modeling issues were identified and addressed. Firstly, the assessment authors did address the priority modeling issue of when to begin the assessment model. They examined a start date in 1945 in an unfished state, and two others in fished states: one in 1963 and another in 1981. Although the models had different starting estimates their SSB time series converged to be very similar to the model that started in 1945 (and thus were largely insensitive to this assumption). In addition, when the models with different start dates attempted to estimate h, the resulting estimates were largely similar. The review panel noted that given the constraints of Stock Synthesis, the start date of 1945 in an unfished state was the most defensible given the other two start dates required estimating highly uncertain equilibrium initial F parameters. The RP noted that an alternative approach in another assessment program such as State-space Assessment Model (SAM) would be able to utilize random effects to aid the model in estimating fishing mortalities and recruitment estimates for early years where data interpolation was necessary (for Fs) or recruitment estimates needed to be assumed at the mean stock recruit value. This may also be built into the Fisheries Integrated Modeling System (FIMS) in the future.

Secondly, the assessment authors re-evaluated multiple assumptions that were made in SEDAR 43. The previous assessment (SEDAR 43) assumed a fleets-as-areas (East/West) structure. The authors noted the data imbalance by region (composition data overwhelmingly from the East) however presented evidence that growth and selectivity did not differ between the regions, supporting the modeling choice in SEDAR 100 of a single, Gulf-wide model (and Gulf-wide data sources from each fleet). The authors also showed, in contrast to previous studies (Chamberlin et al., 2025), that there was no sexual dimorphism evident in growth of Gulf Gray Triggerfish. In light of this, a single sex-structure was used in the assessment. The review panel found each of these modeling decisions to be defensible given the evidence presented.

The assessment authors chose to model length-based selectivity, maturity, and fecundity in contrast to the previous assessment. This decision was largely on account of the sizable level of ageing error expected from the age data. The authors noted that although a new protocol was implemented for ageing triggerfish that greatly reduced bias, uncertainty in ageing remains a key challenge. The RP supports the decision to model length-based processes when possible in the assessment and recommends improvements in ageing remain a key research priority for Gray Triggerfish.

The assessment authors also chose to fix the standard deviation of recruitment at 0.6, under the rationale that it could not be estimated and that 0.6 reflected realistic standard deviation in recruitment estimates. The RP discussed this, remarking that meta-analyses of recruitment variation (Thorson et al., 2014) typically show the parameter above 0.6. In addition, the likelihood profile suggests more support for the parameter at higher values. The RP recommends future additional sensitivity evaluation to this parameter at higher levels.

- **Are the methods appropriate for the available data?**

The review panel found that the methodology was largely appropriate for the available data. The review panel did note that moving from a penalized maximum likelihood framework such as Stock Synthesis to a state-space assessment framework such as the Woods Hole Assessment Model (WHAM), State-space Assessment Model (SAM), or the Fisheries Integrated Modeling System (FIMS), may help in multiple aspects of the assessment. These include, but are not confined to, limiting concerns regarding the model starting year (e.g., estimating initial numbers at age, or initial recruitment deviations), incorporating environmental linkages, and estimating variance terms (e.g., standard deviation in recruitment).

There was concern among the RP about the jitter analysis. Many jitter iterations came to local minima suggesting the model is sensitive to starting parameters, and thus not as robust as would be ideal. The RP did remark however that it was encouraging that of the 100 jitter iterations, the chosen AP model did come to the solution with the lowest negative log likelihood (when *h* was fixed). The RP recommends the authors explore conducting self-test simulations for assessments in the future to ensure the model can reproduce parameter estimates in a correctly specified scenario.

- **Are assessment models configured properly and used in a manner consistent with standard practices?**

For the most part, the assessment models are configured properly and used in a manner consistent with standard practices for the region and the US. The review panel did note some aspects that could be improved, such as:

- Incorporating ageing error bias into the stock synthesis assessment model. The data workshop recommended utilizing an ageing error matrix that includes both ageing imprecision in terms of standard deviations at age and also a slight positive bias in ageing. The AP assessment model included in the report incorporated the imprecision into the Stock Synthesis assessment program however not the bias. The Panel recommends future assessments consider incorporating the bias in age reading as well into their definition of ageing error in the stock assessment.

- Use of the bias ramp adjustment for recruitment variation in Stock Synthesis. Although a common assumption in Stock Synthesis, the review panel remarked that the use of a bias

ramp in adjusting the variation of the recruitment deviates may produce some undesirable consequences. Namely, in periods without a bias ramp, the recruitment will tend to the median whereas with a full bias adjustment the recruitment estimates will tend to the mean. In highly skewed distributions such as lognormal recruitment the median may be preferred.

3. **Consider how uncertainties are addressed in the assessment, and their potential consequences.**

- **Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods.**

The method used to evaluate uncertainties is the default in Stock Synthesis and the standard across many integrated assessments. The RP recommends that the default method be extended to include other standard methods, which may be better suited to capture uncertainties in such complex assessment models.

The assessment model almost exclusively quantifies uncertainty using the asymptotic normality of the maximum likelihood estimates. The standard deviations are derived from the inverted Hessian matrix, and hence from a second-order Taylor approximation. There are a few things to note about this approach in this context:

- This approach is asymptotic, so only valid when the number of observations informing each parameter is `large'. It is not demonstrated that the asymptotics is valid, and since there are year-specific parameters (recruitment deviations, *F* for recreational, and *F* for shrimp bycatch), which increase in number every time a new year of data is added, it is implausible.

- Priors are included on many parameters (Dirichlet-multinomial parameters, recruitment deviations, and `weak' penalties to avoid bounds) hence, the reported standard deviations are not cleanly frequentist standard deviations.

- Multiple key parameters are fixed (CV of young, CV of old, sigma R, *h*, *M* Lorenzen, maturity parameters, and more). Fixing a parameter, even at the model's own estimate, deletes a dimension from the Hessian and understates the true uncertainty.

- The Dirichlet-multinomial distribution does not describe the compositional observations in the most appropriate manner. It is evident from the Pearson and one-step-ahead (OSA) residuals that most compositions are positively correlated with neighboring classes, and the runs test rejects randomness. This is in contradiction with the negative correlations in the Dirichlet-multinomial. Ignoring positive correlations artificially increases the weight

of the observations (and artificially shrinks the uncertainties), as it ignores that each observation is partially explained by other observations.

Alternatives to the asymptotic standard deviations, which are often used in assessments, are Markov Chain Monte Carlo (MCMC) methods and simulation studies (a.k.a. parametric bootstrap or self-tests). MCMC techniques set up Markov chains with an equilibrium distribution, which is the posterior distribution of the joint parameter vector (assuming a uniform prior on previously prior-free parameters). This can be used to quantify the uncertainty, and does not rely on any asymptotics with respect to the number of observations (it does require the Markov chains to be run for a long time, but that is a technicality). Full simulation studies are the `gold standard' for uncertainty quantification, where a large number of data sets are simulated forward from the model, then each data is used to estimate all parameters, and the distribution of the estimates are used to quantify the uncertainty. Again, this approach does not rely on any asymptotics with respect to the number of observations. It is recommended that these approaches be explored.

In addition to the model based asymptotic uncertainty estimates, a broad and well selected set of sensitivity runs were presented (including scenarios on recreational removals, discard mortality, bycatch in shrimp fishery, growth platoons, steepness, start year, and leaving out indices). Most sensitivity runs showed similar overall trends, but estimating *h* (and to a lesser extent using growth platoons) exhibited a considerable axis of uncertainty. Estimating *h* decreased recent SSB-ratio estimates (mainly by increasing absolute SSB in the past). Per the request of the reviewers, these sensitivities were further explored.

Profile likelihoods were investigated for key fixed parameters, and for *h* the profile appeared to contradict fixing it at 0.99. This was investigated further per the request of the reviewers. It is often not possible to estimate *h*, but it appeared possible in this assessment. Partial profiles (for different data parts) agreed that *h* could be estimated, and the overall estimate was 0.42. To further validate this conclusion the data series were started later in two steps (to investigate if the ability to estimate was an artifact of earlier uncertain data series). Further, it was investigated if excluding the composition data from the recreational observations. However, the estimation of *h* was robust to all these experiments. Furthermore, the model with estimated *h* improved the overall model fit, improved the retrospective pattern for recruitment, and resolved an important issue with tension in the model between estimated recruitment deviances and the previous period. The RP concluded that the model where *h* is estimated is the preferred model candidate.

The retrospective diagnostics are good for fishing mortality and spawning stock biomass, but problematic for recruitment.

- **Comment on the relationship of this variability with ecosystem or climate factors and mechanisms for encompassing this into management reference points.**

The projections and management reference points are deterministic, and do not directly include ecosystem or climate factors. This is listed as a research recommendation from the assessment panel to improve the understanding of how sargassum affects Gray Triggerfish recruitment, and to build such an index into the assessment model and model consistent projections.

4. **Provide, or comment on, recommendations to improve the assessment.**

- **Consider the research recommendations provided by the Data and Assessment workshops in the context of overall improvement to the assessment and make any additional research recommendations warranted.**

The Data and Assessment Process recommendations are appropriate, but the list would be more useful if prioritized by decision relevance. Highest priority should go to work capable of changing status or catch advice: ageing validation and sampling, natural mortality, adult survey continuity, recruitment mechanisms, shrimp bycatch magnitude, and sector-specific discard mortality. Continued collection of maturity/fecundity and western biological samples is also warranted but should be designed to resolve explicit model uncertainties.

- **If applicable, provide recommendations for improvement or for addressing any inadequacies identified in the data or assessment modeling. Describe these recommendations in sufficient detail for application and should be practical for short-term implementation (e.g., achievable within ~6 months). List longer-term recommendations as research recommendations above.**

The RP provide the following research recommendations:

- Future investigation as to why the model is estimating growth differently than external estimations would be beneficial.
- Age information could be improved with more old and young fish.
- A separate tournament fleet might help inform larger, older fish to the growth model and eliminate the need for a 10+ group.
- Explore the ability to estimate sex-specific growth.
- The panel recommends that future assessments produce One step-ahead (OSA) residuals as diagnostics for evaluating fits to the composition datasets (Trijoulet et al., 2023).
- Evaluate alternative empirical-recruitment windows and the *F*30%SPR control rule through management strategy evaluation. The MSE should test whether using recent recruitment to scale SSB at *F*30%SPR and generate forecasts remains robust under recruitment regime shifts, assessment error, retrospective bias, and recreational catch implementation error.

- Develop close-kin, conventional-tag, or telemetry designs capable of informing natural and discard mortality.
- Evaluate sex-specific growth and survivorship with representative sampling; develop a two-sex model only when fleet/survey sex compositions can support it.
- Develop an assessment-independent survey calibration program for combined video components, including habitat, visibility, platform, footprint, and western-Gulf effects.
- Use simulation testing or an operating-model framework to determine whether the current data can identify time-varying selectivity, recruitment, and survey catchability simultaneously.
- Develop a management strategy evaluation that incorporates recruitment regimes, observation error, implementation error, and uncertain productivity.

5. **Evaluate the stock projections, including discussing strengths and weaknesses, and consider the following:**

After reviewing the additional analyses, the RP supported a revised base model in which natural mortality is fixed at (M = 0.36) and h is estimated rather than fixed at 0.99. The additional analyses consistently supported a substantially lower h, with the revised model estimating h at approximately 0.42. This change improves the historical assessment because it allows the stock–recruitment relationship to be informed by the data instead of imposing an assumption of nearly constant recruitment.

However, the Panel does not recommend using the estimated h directly in projections or equilibrium reference-point calculations. The assessment contains observations over a relatively limited range of SSB, whereas projections based on the fitted Beverton–Holt relationship would extend well beyond that observed range. Such extrapolation produced biologically and operationally problematic results, including very low predicted recruitment and failure of the projected stock to sustain the intended SPR equilibrium (SPR30%).

The additional analyses provided by the analytical team clarified several important results to inform the RP of revising the initial use of h fixed at 0.99:

- Estimating h with (M = 0.36) produced a value near 0.42.
- The h profile had a minimum near 0.43, with an approximate two-likelihood-unit range of 0.39–0.47.
- The model beginning in 1963 estimated h = 0.42, and the later-start model produced h near 0.51.
- Removing recreational compositions produced an h estimate near 0.45.

- Joint estimation of *M* and *h* produced estimates of *M* near 0.366 and *h* = 0.431.
- Estimating *h* reduced the negative log-likelihood relative to fixing it at 0.99.
- The estimated-*h* model substantially improved the recruitment retrospective pattern relative to the original assessment-proposed model.
- Reference points and stock status changed substantially when the estimated stock–recruitment relationship was extrapolated to equilibrium.
- The estimated-*h* equilibrium calculation could not maintain the intended 30% SPR condition because projected recruitment became too low as SSB moved outside the historically informed range.

Collectively, these results support estimating *h* in the historical model but do not demonstrate that the resulting stock–recruitment curve can be projected reliably outside the observed SSB range.

The RP finds that the projection framework is technically appropriate and internally consistent with the accepted Stock Synthesis model. The projections are informative for comparing management scenarios, but they are conditional on several influential assumptions and should not be interpreted as precise forecasts. The RP supports use of the projection framework for management, provided that alternative recruitment scenarios, stochastic uncertainty, and major structural sensitivities are presented.

- **Are the methods consistent with accepted practices and available data?**

The projection procedures are generally consistent with accepted Stock Synthesis practices. Use of recent selectivity, retention, discard mortality, interim catches, sector allocation, and an SPR-based fishing-mortality target is transparent and operationally reasonable. However, the primary projections are deterministic and do not fully represent the uncertainty evident in the assessment. The RP recommends verifying that the 21:79 commercial–recreational allocation is compatible with current MRIP-FES catch accounting and evaluating alternatives to the assumed 2025–2027 catches, fixed shrimp-bycatch mortality, and constant future fishery patterns.

The RP concludes that the projection mechanics are acceptable, but recruitment should not be generated from either the former fixed *h* relationship or an extrapolation of the newly estimated *h*. Projections should use an empirical recent-recruitment distribution. The RP concluded that the methods are acceptable as standard deterministic projection procedures but require additional uncertainty analysis for risk-based management advice.

- **Are the methods appropriate for the assessment model and outputs?**

The Stock Synthesis forecast module is appropriate and maintains consistency with the population structure, biological parameters, fleets, and selectivity estimated by the assessment. The *F*30%SPR framework is a reasonable provisional basis for projections. The principal concern is the recruitment specification. Initial steepness was fixed at 0.99 despite a likelihood profile favoring a substantially lower value, and recent recruitment estimates show severe retrospective instability. The $h = 0.99$ value should therefore be considered as a projection convention rather than an empirically supported biological estimate. The RP concluded that the framework is appropriate, but a single recruitment specification may be insufficient. Alternative h values, long-term mean, recent mean and low-recruitment scenarios should be explored.

- **Are the results informative and robust, and are they useful to support inferences of probable future conditions?**

The additional analyses demonstrate that projected stock conditions and reference points are highly sensitive to how recruitment is specified.

The estimated steepness produced substantially different reference points and status results when the fitted stock–recruitment curve was extrapolated. These results should not be interpreted as reliable evidence of future conditions because they depend on recruitment predictions outside the historically informed SSB range.

Projections based on recent empirical recruitment would be more informative about probable near-term conditions, provided that:

- The recruitment averaging period is justified;
- Only sufficiently estimated cohorts are included;
- Recruitment variability is retained; and
- Projected SSB is monitored relative to the SSB range used to estimate the historical relationship.

The most recent 10-year period is a reasonable starting choice because it balances relevance to current productivity against sensitivity to a few anomalous cohorts. Nevertheless, the team should compare alternative windows, such as recent 5-, 10-, and 15-year periods, and select the period using objective criteria.

The RP concludes that projections can be useful for management, but only after recruitment is reformulated empirically. Results based on extrapolating the estimated steepness should not be used as the principal basis for catch advice.

- **Are key uncertainties acknowledged, discussed, and reflected in the projection results?**

The assessment acknowledges many important uncertainties, particularly those related to recruitment and alternative catch assumptions. However, these uncertainties are not adequately reflected in the numerical projection results. The primary projections do not fully incorporate recruitment process variation, retrospective bias, parameter covariance, natural mortality, growth, catch calibration, discard mortality, shrimp bycatch, video-index structure, model selection, or catch implementation error.

The additional analyses substantially improved understanding of recruitment uncertainty. They demonstrated that:

- Fixing h at 0.99 was inconsistent with the likelihood information;
- h can be estimated within the revised historical model;
- The estimate is reasonably consistent across several sensitivity runs;
- h and natural mortality can be confounded; and
- The fitted relationship is unreliable when extrapolated outside the observed SSB range.

These uncertainties must now be reflected directly in the projection design. Using a single deterministic recent mean would avoid stock–recruit extrapolation but would still understate recruitment variability. The preferred forecasts should draw recruitment from an empirical distribution of recent, well-estimated cohorts.

The projection report should show:

- The years and cohorts included in the recruitment period;
- Arithmetic, geometric mean and median recruitment used;
- Variability among years;
- Sensitivity to alternative recruitment windows; and
- Annual projection intervals.

Priority recommendations

1. Recalculate reference points using empirical recruitment. Estimate F30%SPR through per-recruit analysis and calculate SSB at F30%SPR using the mean or other justified central recruitment measure from the most recent 10 well-estimated cohorts, without applying the estimated Beverton–Holt relationship outside the observed SSB range.

2. Rerun projections using recent empirical recruitment. Use the selected 10-year recruitment measure for the deterministic projection and resample recruitment from those cohorts for the stochastic projection.

3. Evaluate recruitment-window sensitivity. Compare recent 5-, 10-, and 15-year recruitment periods and report their effects on B at *F*30%SPR, OFL, ABC, and projected SSB.

Long-term research recommendation

Evaluate alternative empirical-recruitment windows and the *F*30%SPR control rule through management strategy evaluation. The MSE should test whether using recent recruitment to scale SSB at *F*30%SPR and generate forecasts remains robust under recruitment regime shifts, assessment error, retrospective bias, and recreational catch implementation error.

6. **Prepare a Review Workshop Summary Report describing the Panel's evaluation of the stock assessment and addressing each Term of Reference.**

This report represents the Peer Review Summary summarizing the Panel's evaluation of the SEDAR 100 Gulf of America Gray Triggerfish stock assessment and addressing each Term of Reference.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 100

Gulf Gray Triggerfish

SECTION VI: Post Review Workshop Addendum

August 2026

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SEDAR 100 Gulf of America Gray Triggerfish Stock Assessment - Addendum

Gulf Fisheries Branch
Sustainable Fisheries Division
NOAA Fisheries - Southeast Fisheries Science Center

August 2026

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1. Introduction

The SEDAR 100 Gray Triggerfish Stock Assessment Review Workshop (RW) took place August 11-14, 2026 in Tampa, Florida. During the RW, the RW Panel revisited discussions and decisions made during the Assessment Process (AP) led internally by the Southeast Fisheries Science Center (SEFSC) and requested additional details or analyses from the analytical team. Below is a summary of those requests.

2. AP Model Requests

2.1 Distribution of Correlation Coefficients

While reviewing the AP Model jitter results, the RW requested a histogram of the correlation coefficients to confirm that their distribution was centered around zero (**Figure 1**).

2.2 Natural Mortality

The RW Panel requested additional details, including how the maximum age (t_{max}) was obtained for SEDAR 100 and what Hamel and Cope (2022) interpret as t_{max}. While a single Gray Triggerfish was aged at 16 years, the SEDAR 100 Life History Working Group specified the maximum age as 15 years based on 5 individuals caught in 2005 (x2), 2016, 2017, and 2020 (first year of data was 2003). Hamel and Cope (2022) interpret t_{max} as the maximum observed age, which was assumed here to be 15 years.

To evaluate whether natural mortality (*M*) was estimable in the AP Model, the RW Panel requested a likelihood profile for this parameter. The first likelihood profile presented at the RW spanned the range of 0.25-0.5, which was roughly derived from the SEDAR 43 (M = 0.27) and SEDAR 100 (M = 0.36) estimates along with higher *M* values based on lower maximum age estimates. Across this range, the likelihood profile showed a total minimum at 0.25, but indices, landings, and discards supported higher estimates between 0.42 and 0.5 (**Figure 2**). After running AP Model sensitivity runs estimating *M* requested by the RW Panel (**Section 3.4**), which revealed much lower *M* estimates, a wider range of *M* from 0.05 to 0.4 was profiled. Across this range, the likelihood profile identified values between 0.06 and 0.1 within 2 negative log-likelihood (NLL) units, with the lowest NLL identified for M = 0.07 (**Figure 3**). Conflicts were again evident between data streams, with the landings and indices similarly favoring higher *M* around 0.4.

2.3 One-Step-Ahead Residuals for Length Compositions

The RW Panel requested one-step ahead (OSA) residuals for the composition plots as a more appropriate metric to evaluate goodness of fit than evaluating Pearson residuals. Using the Dirichlet-Multinomial likelihood creates correlations between observations that render Pearson residuals inaccurate. OSA residuals specifically de-correlate compositional observations for multivariate distributions such as the Dirichlet-Multinomial distribution (Trijoulet et al. 2023).

One-step ahead residuals for the length compositions were calculated from the Stock Synthesis output using the afscOSA package in R (*https://github.com/noaa-afsc/afscOSA*).

Overall, the one-step ahead residual plots revealed undesirable patterns for most length compositions, evidenced by clusters of positive or negative residuals (**Figures 4-12**). This was especially true for the length compositions of landings by the Recreational fleet.

2.4 Platoons

While reviewing the AP Model sensitivity runs which enabled the use of platoons to estimate size-dependent survivorship, the RW Panel requested a comparison plot of the scattered age-length data points with the estimated growth curves for each platoon overlaid. This plot revealed how disparate the growth curves were compared to the input data. For both the three platoons (**Figure 13**) and five platoons (**Figure 14**), poor correspondence between the size-dependent growth curves and the input age-length data were evident, further raising concerns over the AP Model's ability to estimate growth for individual platoons. However, it was noted by the RW Panel that the AP Model's estimated growth curve was also fitting poorly at young ages.

3. AP Model Sensitivity Runs

The RW Panel requested sensitivity runs on high priority issues discussed below.

3.1 Fix Growth Parameters at Values Recommended at the Data Workshop

The RW Panel requested that the analytical team fix the growth parameters at the estimates provided at the Data Workshop (**Table 2 in the Assessment Process Report**).

Results: The model did not converge and had multiple parameters on bounds (**Table 1**). Parameters hitting their upper bound included the parameter defining the base asymptote of the Commercial Vertical Line retention curve and the parameter defining the inflection point of the Commercial Longline selectivity curve. Parameters hitting their lower bound included the parameter defining the peak of the dome-shaped selectivity curve for both the SEAMAP Trawl Early Survey/Shrimp Bycatch and SEAMAP Trawl Late Survey. The high gradient was primarily due to the gradient for the 1945 instantaneous fishing mortality rate for the Recreational fleet.

3.2 Fixed Parameters for Consistency in Jitter Analysis

The RW Panel expressed concerns over the AP Model jitter results, which showed that some model runs resulted in different NLL values, indicative of model instability where the model may be getting trapped in a local minimum. To reduce the flexibility of the model, the analytical team conducted a sensitivity run where they fixed the following parameters at the AP Model estimates: Dirichlet-Multinomial parameters for the Recreational and Commercial length compositions; top-logit and ascending limb parameters for the Recreational fleet selectivity, and top-logit parameter for both the SEAMAP Trawl Early Survey/Shrimp Bycatch and SEAMAP Trawl Late Survey selectivities.

Results: Model fits and key parameter estimates were nearly identical (**Tables 1-2**), as were the derived quantities including spawning stock biomass (SSB), SSB ratio (SSB/SSB_0 where SSB_0 is SSB at unfished conditions), recruitment, and fishing mortality (*F*; as an exploitation rate of total biomass killed / total biomass age 1+) (**Figure 15**). The jitter results showed more consistency, with 79% of runs having the same NLL and no runs finding a lower NLL (**Figure 16**). While some runs still found different NLL estimates, overall the estimated $\ln(R_0)$ (**Figure 17**) and trajectories of SSB, recruitment, and *F* were generally similar (**Figure 18**).

3.3 Exclude Fitting to Recreational Length Compositions

The RW Panel extensively discussed the drivers of recent population trends and the causes of poor retrospective patterns in recruitment estimates. The RW Panel requested a sensitivity run which down weighted the importance of the Recreational length compositions, given concerns over their data quality and representativeness of the fishery as a whole. It was hypothesized that down-weighting the Recreational data would potentially increase the importance of the trawl data for informing recruitment.

Results: Model performance was poor for this run with more uncertain parameters and bounded parameters (**Table 1**). Not fitting to the Recreational length compositions had a noticeable impact on the derived quantities (**Figure 19**), as this data stream was partly responsible for the higher SSB ratio in recent years (SSB ratio in 2024 dropped from 55% to 43%; **Table 2**). The fits to the indices got worse (**Figure 20**) for the SEAMAP Trawl Early Survey (RMSE = 0.701; AP Model RMSE = 0.693) and the SEAMAP Trawl Late Survey (RMSE = 0.474; AP Model RMSE = 0.371). Likelihood profiles for *M* (**Figure 21**) and steepness (*H*; **Figure 22**) revealed similar patterns to the AP Model, showing lower total NLL at lower *M* estimates but variable minimums for *H* between 0.4 and 0.77. The jagged profiles were likely the result of poorly estimated selectivity parameters for the Recreational fleet given the lack of length composition data to inform their estimation.

A further sensitivity run was conducted for this model which estimated *H* to determine whether this data stream was influencing this parameter. *H* was estimated at 0.448 (0.086), which was similar to the value estimated in the AP Model sensitivity run where it was estimated (*H* = 0.422; **Table 2**). Estimated trajectories of SSB, recruitment and *F* were very different when *H* was estimated, particularly in the early part of the time series where SSB and recruitment estimates were higher and annual *F* estimates were lower (**Figure 23**). The SSB ratio in 2024 was estimated at 20% (**Table 2**).

3.4 Natural Mortality and Steepness Explorations

The RW Panel spent a majority of the Review Workshop discussing the AP Model's ability to estimate *M* and *H*, either independently or simultaneously. Sensitivity runs were requested first estimating *M* with or without a prior and second while also estimating *H* (without a prior). In addition, the analytical team conducted a bivariate likelihood profile analysis which tested combinations of fixed values of *M* (0.06-0.48 in 0.03 intervals) and *H* (0.34-0.99 in 0.05 intervals). Piner plots for *M* and *H* were also produced to provide insight into which data types and data sources (fleets/surveys) were driving the AP Model estimates of *M* and *H*.

3.4.1 Estimate Natural Mortality Without a Prior

The RW Panel requested a sensitivity run that estimated *M* without a prior to see what value the data supported.

Results: When estimated freely, the model estimated an *M* (CV) of 0.076 (0.171), which was substantially lower than recommended estimates for SEDAR 100 or prior assessments (**Table 2**). This low *M* was also supported by the likelihood profile conducted for the AP Model (**Figure 3**). Because the estimated *M* vector was much lower than in the AP Model (**Figure 24**), the estimated trajectories for SSB and recruitment differed drastically (**Figure 25**). This resulted in a substantially larger historical SSB and much lower recent SSB ratios, dropping to just 3% in 2024 (**Table 2**). Recruitment estimates were substantially lower throughout the time series whereas *F* estimates were much larger beginning in the late 1970s. The NLL was reduced by 34 units (**Table 1**), largely due to lower NLL for Recreational discards, mean weight of Recreational landings, and Recreational and Commercial Vertical Line length composition and conditional age-at-length (**Table 3**). However, degraded fits to length compositions were noted for both SEAMAP Trawl Surveys and to the SEAMAP Trawl Early index. Similar trends in diagnostics were observed for RMSE (**Table 4**), whereas runs tests revealed an improvement for the Combined Video Survey index but at the expense of Recreational conditional age-at-length (**Table 5**). The retrospective analysis revealed strong biases for most years for *F* and SSB (**Table 6**), and a similarly high bias in recruitment as observed in the AP Model (> 6). The retrospective model ending in 2022 resulted in very different trajectories compared to the other retrospective peels, and surprisingly looked similar to the AP Model results (**Figure 26**). The hindcast analysis revealed better prediction skill for the Combined Video Survey length composition but at the expense of poorer prediction skill of the Trawl Late Survey length composition (**Table 7**).

3.4.2 Estimate Both Natural Mortality and Steepness Without Priors

The RW Panel requested a sensitivity run that estimated both *M* and *H* without priors to see what values the data supported.

Results: When both *M* and *H* were estimated freely, the model estimated an *M* (CV) of 0.366 (0.063) and an *H* (CV) of 0.431 (0.106). Surprisingly, *M* was close to the SEDAR 100 recommended value of 0.36, which led to nearly identical age-specific *M* estimates (**Figure 24**). The *H* estimate was also similar to the value estimated by the AP Model sensitivity run where *H* was estimated (*H* = 0.422; **Table 2**). The estimated trajectories for SSB and recruitment differed considerably (**Figure 27**), with much larger historical SSB and much lower recent SSB ratios, with the SSB ratio in 2024 at 22% (**Table 2**). In the early part of the time series, estimates of recruitment were substantially higher whereas *F* estimates remained lower. The stock-recruit curve showed some relationship between recruits and SSB but lacked any SSB estimates above 10,000 metric tons, leaving a large gap in the data informing the asymptote of the curve (**Figure 28**). The NLL was reduced by only 5 units, because any improvements to data such as Recreational landings (and mean weight), length composition, and conditional age-at-length were cancelled out by worse fits to Trawl Survey length compositions and Commercial Vertical Line conditional age-at-length (**Table 3**). Trends in diagnostics were similar for RMSE (**Table 4**) and runs tests (**Table 5**). The retrospective analysis revealed strong biases for all years for *F* and SSB (**Table 6**). The bias in recruitment was not as pronounced as in the AP Model, but still remained undesirably high at -0.89 (**Table 6**). The retrospective model ending in 2024 resulted in

very different trajectories compared to the other retrospective peels, all of which estimated much lower recent SSB ratios (**Figure 29**). The hindcast analysis revealed better prediction skill for the SEAMAP Trawl Late Survey index but worse prediction skill for the Trawl Late Survey length composition (**Table 7**).

3.4.3 Estimate Natural Mortality With a Prior

The RW Panel requested a sensitivity run that estimated *M* using a prior to see what value the data supported given additional information. A log-normal prior (**Figure 30**) was derived as recommended by Hamel and Cope (2022) based on the target *M* (initial value = 0.36, prior value = ln(0.36), SD in log-space = 0.31).

Results: Using a prior, the model estimated an *M* (CV) of 0.128 (0.193), which diverged considerably from the prior distribution (**Figure 30**) and was still lower than any of the estimates recommended for SEDAR 100 or prior assessments (**Figure 24**). The estimated trajectories for SSB, recruitment, and *F* were drastically different from the AP Model (**Figure 31**), with much larger historical SSB and much lower recent SSB ratios, with the SSB ratio in 2024 at 8% (**Table 2**). The NLL was reduced by 22 units (**Table 1**), largely due to lower NLL for the mean weight of Recreational landings and for length composition and conditional age-at-length for the Recreational and Commercial Vertical Line fleets (**Table 3**). Fits to the SEAMAP Trawl Survey length compositions and Recreational landings got worse. Similar trends in diagnostics were observed for RMSE (**Table 4**), whereas runs tests revealed an improvement for the Combined Video Survey index but at the expense of Recreational conditional age-at-length (**Table 5**). The retrospective analysis revealed results similar to the AP Model, but with much less forecast bias in *F* and lower but still unacceptable bias in recruitment at 0.5 (**Table 6**). Similar trajectories were observed each retrospective peel (**Figure 32**). The hindcast analysis revealed better prediction skill for the SEAMAP Trawl Late Survey index but worse prediction skill for the Trawl Late Survey length composition (**Table 7**).

3.4.4 Estimate Natural Mortality With a Prior and Steepness Without a Prior

The RW Panel requested a sensitivity run that estimated *M* using a prior and *H* without a prior to see what values the data supported.

Results: Using a prior on *M* while freely estimating *H*, the model estimated an *M* (CV) of 0.223 (0.142) and an *H* (CV) of 0.73 (0.11). *M* was still estimated lower than previous estimates (**Figure 24**), whereas *H* was estimated at a higher value than the AP Model sensitivity run where *H* was estimated (*H* = 0.422; **Table 2**). The estimated trajectories for SSB, recruitment, and *F* differed considerably from the AP Model (**Figure 33**), with much larger historical SSB and much lower recent SSB ratios, with the SSB ratio in 2024 at 11% (**Table 2**). Recruitment estimates remained substantially lower throughout the time series whereas *F* estimates remained higher starting in the 1980s. The stock-recruit curve showed some relationship between recruits and SSB but lacked any SSB estimates above 10,000 metric tons, leaving a similar large gap as discussed above in the data informing the asymptote of the curve (**Figure 34**). The NLL was reduced by 28 units (**Table 1**), largely due to lower NLL for the Recreational mean weight of landings, length compositions and conditional age-at-length (**Table 3**). Trends in diagnostics were similar for RMSE (**Table 4**) and runs tests (**Table 5**). The retrospective analysis revealed slightly more bias for *F* and SSB compared to the AP Model (**Table 6**), but those biases

remained within the acceptable range as did the bias in recruitment at 0.05 (**Table 6**). Similar trajectories were observed for each retrospective peel (**Figure 35**). The hindcast analysis revealed worse prediction skill for the Trawl Late Survey length composition (**Table 7**).

3.4.5 Estimate Natural Mortality and Steepness - Further Investigation

3.4.5.1 Bivariate Likelihood Profiles

The bivariate likelihood profile revealed apparent areas of lower NLL for H = 0.99 and M = 0.21 (**Figure 36**). After reviewing these results, the RW Panel requested additional sensitivity runs for three fixed M and H scenarios which spanned the contours of the lowest NLL values: (1) M = 0.21 and H = 0.99, (2) M = 0.36 and H = 0.5, and (3) M = 0.3 and H = 0.75. While these runs were completed during the RW (**Tables 1-2**), ultimately these results were not reviewed by the RW Panel for the reasons discussed below.

Further review of the contour plot raised concerns over the validity of these results because the univariate H likelihood profile conducted for the AP Model did not match the corresponding line in the bivariate plot for H = 0.99, an unexpected outcome. Since this analysis was conducted "on-the-fly", additional review by the analytical team was needed to determine why the results from the bivariate likelihood profiles differed from the univariate likelihood profile results.

Further investigation identified two issues: (1) the starting values and (2) plotting limitations. First, the starting values were modified in the bivariate profile runs to start from the AP Model's Maximum Likelihood Estimates with the exception of M and H which were fixed at their specified values. A few M-H combinations were tested to explore these results (**Tables 1-2**), and it was confirmed that the starting values did change the model results for many of the M-H combinations (delta NLL up to 10; **Table 8**). Second, a potential plotting issue was also discussed regarding the actual M and H values and the method of smoothing used in the contour plot. This issue was alleviated by reviewing the raw NLL values (**Figure 37**) for each bivariate run as opposed to figures smoothing over the values (i.e., **Figure 36**). Review of the actual NLL values also allowed the quick identification of the combination with the lowest NLL, which was observed for M = 0.18 and H = 0.84.

A re-analysis of the bivariate likelihood profile results also highlighted an important trade-off identified between M and H parameterizations and the estimated SSB ratio in 2024 (**Figure 38**). Similar SSB ratios in 2024 could be achieved by different combinations of M and H, such as combinations of H = 0.99 and M = 0.12 or H = 0.54 and M = 0.27 resulting in SSB ratios in 2024 between 5% and 10%. Different levels of fixed M caused very different SSB ratios in 2024 while maintaining H fixed at 0.99, as in the AP Model. Overall, these results caution the difficulty of the model determining both productivity and H.

3.4.5.2 Piner Plots

The Piner plots for M revealed that the lower estimates (0.7-0.12) were largely driven by the Recreational landings (and mean weight), the Combined Video Survey index, Recreational and Shrimp Bycatch discards, and Recreational and Commercial Vertical Line conditional age-at-length (**Figure 39**).

The Piner plots for *H* revealed that the lower estimates (~0.4) were being driven by Recreational landings, the Combined video Survey index, Shrimp Bycatch discards, and Recreational length compositions (**Figure 40**).

3.4.6 Estimate Steepness (RW Model)

Ultimately, the RW Panel recommended estimating *H* while keeping *M* fixed at the value recommended by the Data Workshop. The RW Panel did not support estimating both *H* and *M* simultaneously, and deemed *H* more estimable than *M*. This decision was based on improved fits to the data, the *H* likelihood profile, and consistency in *H* estimates (range: 0.4-0.5) in AP Model sensitivity runs with different start years (**Section 3.4.7**) and excluding fitting to Recreational length compositions (**Section 3.3**). A similar *H* was estimated in the SEDAR 43 Model and its plausibility was supported due to their unique life history (e.g., nest-guarding behavior). Notably, estimating *H* in the RW Model reduced the tension in the recruitment deviations in the historic versus recent period (discussed below in the RW Model sensitivity run) and resulted in less retrospective bias in recruitment (also discussed below). While the RW Panel supported estimation of *H*, they did express concerns over its utility for projections because the estimated SSB trajectory seemed implausible, particularly virgin SSB.

Results: When freely estimated, the model estimated an *H* (CV) of 0.422 (0.049; **Table 2**). The NLL was reduced by 23 units (**Table 1**), largely due to lower NLL for Recreational landings (and mean weight) and length compositions and Commercial Longline conditional age-at-length (**Table 3**). The estimated trajectories for SSB and recruitment were drastically different from the AP Model (**Figure 41**), with much larger virgin and historical SSB and much lower recent SSB ratios, with the SSB ratio in 2024 at 18% (**Table 2**). In the early part of the time series, recruitment estimates were substantially higher whereas *F* estimates remained lower, until the last few years where *F* estimates increased beyond the AP Model estimates. The stock-recruit curve showed some relationship between recruits and SSB but lacked any SSB estimates above 10,000 metric tons, leaving a large gap in the data informing the asymptote of the curve (**Figure 42**).

Tables and Figures for the RW Model outputs are provided in the **Appendix** and follow the same structure as those reported in the Assessment Process Report for ease of comparison to the AP Model results. In general, most model fits remained similar to those for the AP Model with a few notable exceptions. Better fits in the late 1970s and early 1980s were observed for the Recreational landings (**Figure RW46**) and Shrimp Effort index (**Figure RW58**). While the 2013 Recreational discard estimate is still expected to be higher than observed, it is closer to the uncertainty bounds (**Figure RW53**). The expected median Shrimp Bycatch estimate is also closer to the input value (**Figure RW57**). Lastly, the recent decline in the Combined Video Survey index is better captured in the RW Model (**Figure RW62**), but at the expense of a worse fit to the SEAMAP Trawl Late Survey (**Figure RW61**).

Trends in diagnostics were similar for RMSE (**Table 4**) and runs tests (**Table 5**). The retrospective analysis revealed similar trends in bias for *F* and SSB compared to the AP Model (**Table 6**), and while the bias in recruitment was much improved, it still remained in the unacceptable range at 0.55 (**Table 6**). Similar trajectories were observed for each retrospective peel (**Figure 43**). The hindcast analysis revealed worse prediction skill for the Trawl Late Survey length composition (**Table 7**). The jitter analysis results were similar to the AP Model, as no

lower NLL runs were identified although fewer (34%) runs exhibited the same NLL (**Figure RW92**). Overall, estimates of ln(R_0) and *H* remained similar (**Figure RW93**) and no large differences in derived quantities of SSB, recruitment, and *F* were observed (**Figure RW94**). Likelihood profiles for key recruitment and growth parameters revealed good correspondence between the RW Model estimates (**Figures RW84-91**), whereas lower *M* estimates resulted in lower NLLs (**Figure RW83**).

A further sensitivity run was conducted for the RW Model which did not constrain the sum of the recruitment deviations to be zero (they summed to -1). As discussed in the Assessment Process Report for the AP Model, this configuration led to very negatively biased recruitment deviations (summed to -14), highlighting a tension between the model estimated recruitment, particularly in the most recent years. Model fits and key parameter estimates were very similar (**Tables 1-2**), as were the derived quantities (**Figure 44**). The SSB ratio in 2024 was estimated at 19% (**Table 2**).

3.4.7 Alternate Start Years Estimating Steepness

To explore whether truncating the historical data impacted the model's estimate of *H*, a sensitivity run estimating *H* was conducted for the AP Model sensitivity runs starting in both 1963 and 1981.

Results: H was estimated in a similar range for these shortened historical time series models, with estimates (CV) of 0.42 (0.051) starting in 1963 and 0.509 (0.084) starting in 1981. When estimating *H*, time series of SSB, SSB ratio, recruitment, and *F* differed considerably for both a 1963 start (**Figure 45**) and a 1981 start (**Figure 46**).

4. Preliminary MSY projections for the AP Model

Given the RW Panel discussions regarding the estimation of *H* and the potential for estimating MSY-based reference points, MSY projections were presented for the AP Model (**Figure 47**). Additional details on projection assumptions and methods are provided in **Section 6 of the Assessment Process Report**.

The equivalent spawner-per-recruit (SPR) at MSY was 27.3% (**Table 9**). According to this projection, Gulf Gray Triggerfish has not been overfished nor undergoing overfishing at any point of the time series, including 2024 (**Table 10**; **Figure 48**). While these projections were provided for comparison to the RW Model, it is important to note that fixing *H* at 0.99 in the AP Model is not realistic, as we do not believe that recruitment and spawners are unrelated for this stock.

5. Preliminary MSY proxy and MSY projections for the RW Model

Unfortunately, achieving an SPR proxy of 30% was not possible in projections for the RW Model estimating *H*. In the projection, the population was unable to produce enough recruits to sustain the population, causing SPR to crash. As a result, projections were run that achieved an SSB ratio of 30% (**Figure RW103**), in additional to an MSY projection (**Figure RW105**) given that *H* appeared estimable.

According to the 30% SSB ratio projection, Gulf Gray Triggerfish is not currently overfished but is undergoing overfishing in 2024 (**Tables RW40 & RW42**; **Figure RW104**).

For the MSY projection, the equivalent SPR at MSY was 61.6% (**Table RW43**). According to this projection, Gulf Gray Triggerfish is overfished and undergoing overfishing in 2024 (**Tables RW43-44**; **Figure RW106**).

6. Other issues discussed but not pursued further during the RW

- Spatial and temporal distribution of length-at-age data to help determine how representative the data are of trends throughout the Gulf
- Lack of evidence for sexually dimorphic growth as estimated using the SEDAR 100 data
- Revisit the ageing error matrix to ensure bias is adjusting the mean age corresponding to the SD
- Alternative approaches to developing compositions such as bootstrapping to get better estimates of sample size inputs or spatiotemporal approaches to standardizing compositions
- Development of one-step-ahead residuals for conditional age-at-length
- Explore how *F* for bycatch fleets is treated in ss3diags to ensure calculations are accurate (e.g., how is forecast bias calculated?)
- Self-testing would be a useful diagnostic
- Setting of *SigmaR* and what value it should be fixed at
- Monitoring changes in distribution over space and time and with changing environmental conditions

7. References

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8. Tables

Table 1. Summary of sensitivity runs conducted for the AP Model and associated convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation). MLE = maximum likelihood estimates.

Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
AP Model	13,581.6	0.0054	268 (0)	20
Growth				
Fixed at Data Workshop recommendations	14,608.4	0.2079	265 (4)	-
Fixed parameters				
Fixed select selectivity & Dirichlet parameters	13,581.6	0.0550	261 (0)	17
Recreational length compositions				
Excluded recreational length compositions	10,678.9	0.1033	268 (3)	29
+ Estimate steepness (*H*)	10,673.8	0.0614	269 (2)	31
Estimate Natural Mortality (*M*)				
Estimate *M* without a prior (EstM_noP)	13,547.9	0.0443	269 (0)	19
Estimate both *M* and *H* without a prior (EstMH_noP)	13,576.1	0.0372	270 (0)	20
Estimate *M* with a prior (EstM_P)	13,560.0	0.0330	269 (0)	17
Estimate *M* with a prior & estimate *H* without a prior (EstMH_P)	13,553.7	0.0303	270 (0)	18
Fixed *M* and *H*				
M = 0.21 & *H* = 0.99	13,557.8	0.0139	268 (0)	19
M = 0.36 & *H* = 0.5	13,563.0	0.0255	268 (0)	19
M = 0.3 & *H* = 0.75	13,561.8	0.0244	268 (0)	17
Bivariate result investigation				
M = 0.06 & *H* = 0.34	14,508.1	3.8623	268 (0)	5
M = 0.06 & *H* = 0.34 (start MLE)	14,498.1	0.0229	268 (0)	5
M = 0.21 & *H* = 0.99	13,557.8	0.0139	268 (0)	19

Table 1 Continued. Summary of sensitivity runs conducted for the AP Model and associated convergence diagnostics (NLL = negative log-likelihood; CV = coefficient of variation). MLE = maximum likelihood estimates.

Description	NLL	Gradient	Estimated Parameters (Bounded)	Parameters with CV>1
M = 0.21 & *H* = 0.99 (start MLE)	13,560.3	0.0072	268 (0)	20
M = 0.36 & *H* = 0.49	13,562.3	0.0097	268 (0)	19
M = 0.36 & *H* = 0.49 (start MLE)	13,566.1	0.0263	268 (0)	22
M = 0.3 & *H* = 0.74	13,561.3	0.2937	268 (0)	17
M = 0.3 & *H* = 0.74 (start MLE)	13,561.3	0.1102	268 (0)	17
Estimate *H* without a prior				
Estimate *H* without a prior (RW Model)	13,559.0	0.0409	269 (0)	16
+ Unconstrained recruitment deviations	13,558.8	0.0287	269 (0)	21
Start 1963 & estimate *H*	13,588.6	0.0186	236 (1)	18
Start 1981 & estimate *H*	13,615.0	0.0021	201 (2)	19

Table 2. Summary of sensitivity runs conducted for the AP Model and associated key estimates and derived quantities. *M* = natural mortality, *H* = steepness, ln(R_0) = virgin recruitment (log-scale), SSB defined in metric tons (mt). SSB ratio was calculated as annual SSB divided by SSB_0. MLE = maximum likelihood estimates.

Description	*M*	*H*	*Sigma R*	ln(R_0)	Virgin SSB (metric tons)	Virgin Recruitment (1,000s of fish)	SSB ratio 2024
AP Model	0.360	0.990	0.6	11.469	8,817	95,744	0.55
Growth							
Fixed at Data Workshop recommendations	0.360	0.990	0.6	10.796	12,010	48,824	0.92
Fixed parameters							
Fixed select selectivity & Dirichlet parameters	0.360	0.990	0.6	11.469	8,817	95,742	0.55
Recreational length compositions							
Excluded recreational length compositions	0.360	0.990	0.6	11.595	10,109	108,576	0.43
+ Estimate steepness (*H*)	0.360	0.450	0.6	12.239	19,083	206,754	0.20
Estimate Natural Mortality (*M*)							
Estimate *M* without a prior (EstM_noP)	0.076	0.990	0.6	8.483	76,135	4,833	0.03
Estimate both *M* and *H* without a prior (EstMH_noP)	0.366	0.430	0.6	12.375	19,728	236,884	0.22
Estimate *M* with a prior (EstM_P)	0.128	0.990	0.6	8.954	35,528	7,735	0.08
Estimate *M* with a prior & estimate *H* without a prior (EstMH_P)	0.223	0.730	0.6	10.457	26,738	34,782	0.11
Fixed *M* and *H*							
M = 0.21 & *H* = 0.99	0.210	0.990	0.6	9.771	16,651	17,525	0.21
M = 0.36 & *H* = 0.5	0.360	0.500	0.6	12.041	15,485	169,621	0.29
M = 0.3 & *H* = 0.75	0.300	0.750	0.6	11.003	13,208	60,023	0.32

Table 2. Summary of sensitivity runs conducted for the AP Model and associated key estimates and derived quantities. *M* = natural mortality, *H* = steepness, ln(R_0) = virgin recruitment (log-scale), SSB defined in metric tons (mt). SSB ratio was calculated as annual SSB divided by SSB_0. MLE = maximum likelihood estimates.

Description	*M*	*H*	*Sigma R*	ln(R_0)	Virgin SSB (metric tons)	Virgin Recruitment (1,000s of fish)	SSB ratio 2024
Bivariate result investigation							
M = 0.06 & *H* = 0.34	0.060	0.340	0.6	8.390	93,723	4,405	0.01
M = 0.06 & *H* = 0.34 (start MLE)	0.060	0.340	0.6	8.401	94,050	4,450	0.01
M = 0.21 & *H* = 0.99	0.210	0.990	0.6	9.771	16,651	17,525	0.21
M = 0.21 & *H* = 0.99 (start MLE)	0.210	0.990	0.6	9.770	16,598	17,499	0.21
M = 0.36 & *H* = 0.49	0.360	0.490	0.6	12.070	15,929	174,533	0.28
M = 0.36 & *H* = 0.49 (start MLE)	0.360	0.490	0.6	12.067	15,882	174,058	0.27
M = 0.3 & *H* = 0.74	0.300	0.740	0.6	11.018	13,407	60,945	0.31
M = 0.3 & *H* = 0.74 (start MLE)	0.300	0.740	0.6	11.018	13,406	60,945	0.31
Estimate *H* without a prior							
Estimate *H* without a prior (RW Model)	0.360	0.422	0.6	12.290	19,799	217,028	0.18
+ Unconstrained recruitment deviations	0.360	0.440	0.6	12.270	19,450	213,187	0.19
Start 1963 & estimate *H*	0.360	0.420	0.6	12.296	19,962	218,710	0.18
Start 1981 & estimate *H*	0.360	0.510	0.6	11.859	12,896	141,331	0.29

Table 3. Summary of differences (Sensitivity - AP Model) in negative log-likelihoods (NLL) by data component (grey rows) and by fleet/surveys for sensitivity runs exploring the estimation of natural mortality and/or steepness (additional details on model settings are provided in **Table 1**).

NLL	EstM_noP	EstMH_noP	EstM_P	EstMH_P	RW Model
Total	-33.70	-5.50	-21.60	-27.90	-22.70
Catch	1.37	-3.92	2.50	-1.52	-4.21
Recreational	0.97	-3.92	2.21	-1.58	-4.21
Commercial Vertical Line	0.20	0.00	0.14	0.03	0.00
Commercial Longline	0.20	0.00	0.15	0.03	0.00
Indices	3.40	0.39	3.83	1.00	-0.12
Shrimp Effort	0.70	-0.67	0.89	-0.28	-0.66
Recreational (SRHS) CPUE	0.52	-0.18	0.66	0.42	-0.11
Trawl Early	1.85	0.65	1.64	1.21	0.27
Trawl Late	-0.05	0.17	-0.60	0.16	1.42
Video	0.39	0.41	1.23	-0.50	-1.04
Discard	-2.71	-1.38	-1.23	-1.54	-0.48
Recreational	-2.11	0.03	-1.73	-0.32	0.86
Commercial Vertical Line	0.48	-0.02	0.34	0.11	-0.02
Shrimp Bycatch	-1.09	-1.39	0.17	-1.34	-1.32
Mean weight of Recreational landings	-7.62	-4.78	-5.87	-6.20	-4.95
Length composition	-8.24	4.54	-9.49	-5.94	-11.50
Recreational	-12.91	-11.15	-12.76	-12.47	-11.95
Commercial Vertical Line	-7.37	1.80	-6.07	-4.47	2.01
Commercial Longline	0.36	0.04	0.11	-0.03	-0.28
Shrimp Bycatch	0.62	0.23	0.29	0.38	0.14
Trawl Early	6.92	2.17	5.53	3.96	-1.38
Trawl Late	7.68	10.74	7.59	8.38	1.87
Video	-2.91	0.94	-3.89	-1.29	-1.76
Conditional age-at-length	-21.66	-1.63	-17.47	-14.64	-3.81
Recreational	-15.70	-8.22	-12.05	-13.11	-0.01
Commercial Vertical Line	-8.74	8.21	-7.59	-2.22	-0.28
Commercial Longline	2.77	-1.63	2.17	0.68	-3.53

Table 3. Summary of differences (Sensitivity - AP Model) in negative log-likelihoods (NLL) by data component (grey rows) and by fleet/surveys for sensitivity runs exploring the estimation of natural mortality and/or steepness (additional details on model settings are provided in **Table 1**).

NLL	EstM_noP	EstMH_noP	EstM_P	EstMH_P	RW Model
Recruitment	1.37	1.09	0.29	-0.57	2.15
Parameter priors	0.29	0.08	5.82	1.42	0.14

Table 4. Joint residual summary statistics (RMSE = root mean squared error (as a percentage)) for the AP Model and sensitivity runs exploring the estimation of natural mortality and/or steepness (additional details on model settings are provided in **Table 1**). Values above 30% for individual or combined residuals (grey rows) highlighted in red if present and acceptable values below 30% highlighted in green. See Carvalho et al. (2021) for additional details.

Quantity	AP Model	EstM_noP	EstMH_noP	EstM_P	EstMH_P	RW Model
Index						
Shrimp Effort	2.7	3.8	0.8	4.0	2.1	0.9
Recreational SRHS CPUE	32.3	33.3	32.0	33.5	33.0	32.1
Trawl Early Survey	69.4	74.0	71.0	73.6	72.4	69.9
Trawl Late Survey	37.1	37.2	37.6	36.0	37.5	40.5
Combined Video Survey	29.4	28.6	29.6	29.2	28.4	28.4
Combined	32.3	33.8	32.8	33.6	33.2	32.7
Conditional age-at-length						
Recreational	8.9	8.8	8.9	8.8	8.8	8.9
Commercial Vertical Line	11.5	11.5	11.5	11.5	11.5	11.5
Commercial Longline	12.3	12.6	11.8	12.5	12.3	11.8
Combined	10.8	10.8	10.6	10.8	10.7	10.6
Length						
Recreational	1.6	2.1	1.5	1.7	1.7	1.5
Commercial Vertical Line	4.4	4.3	4.4	4.3	4.4	4.4
Commercial Longline	5.0	5.1	5.1	5.0	5.1	5.1
Shrimp Bycatch	17.1	20.3	18.3	18.9	19.4	17.9
Trawl Early Survey	10.8	11.6	11.6	11.1	11.6	11.1
Trawl Late Survey	17.1	20.2	21.4	20.0	19.5	17.4
Combined Video Survey	8.7	8.6	8.6	8.7	8.6	8.6
Combined	10.4	12.0	11.5	11.4	11.5	10.7

Table 5. Runs tests summary statistics for the AP Model and sensitivity runs exploring the estimation of natural mortality and/or steepness (additional details on model settings are provided in **Table 1**). P-values less than 0.05% (in red) indicate non-randomly distributed residuals whereas p-values greater than 0.05% (in green) provide support for randomly distributed residuals. See Carvalho et al. (2021) for additional details.

Quantity	AP Model	EstM_noP	EstMH_noP	EstM_P	EstMH_P	RW Model
Index						
Shrimp Effort	0.000	0.000	0.000	0.000	0.000	0.000
Recreational SRHS CPUE	0.042	0.005	0.040	0.005	0.005	0.005
Trawl Early Survey	0.042	0.042	0.042	0.042	0.042	0.042
Trawl Late Survey	0.203	0.203	0.203	0.203	0.203	0.065
Combined Video Survey	0.002	0.093	0.002	0.086	0.016	0.017
Conditional age-at-length						
Recreational	0.066	0.007	0.066	0.007	0.066	0.066
Commercial Vertical Line	0.047	0.047	0.047	0.047	0.047	0.047
Commercial Longline	0.658	0.658	0.658	0.658	0.658	0.658
Length						
Recreational	0.000	0.000	0.006	0.024	0.006	0.038
Commercial Vertical Line	0.002	0.002	0.002	0.002	0.002	0.002
Commercial Longline	0.890	0.890	0.890	0.890	0.890	0.890
Shrimp Bycatch	0.001	0.001	0.001	0.001	0.001	0.001
Trawl Early Survey	0.036	0.036	0.036	0.036	0.036	0.036
Trawl Late Survey	0.609	0.500	0.500	0.500	0.500	0.609
Combined Video Survey	0.619	0.334	0.264	0.619	0.619	0.158

Table 6. Retrospective analysis and retrospective forecast spawning stock biomass (SSB) and fishing mortality (F) for the last five terminal years and combined (grey rows) for the AP Model and sensitivity runs exploring the estimation of natural mortality and/or steepness (additional details on model settings are provided in **Table 1**). Retrospective bias in recruitment is also provided. Values outside the acceptable range of -0.15 to 0.2 for longer-lived species (Hurtado-Ferro et al. 2015) are highlighted in red and indicate an undesirable retrospective pattern. Values within -0.15 to 0.2 are highlighted in green and are considered acceptable levels of retrospective bias. See Carvalho et al. (2021) for additional details.

Quantity	Statistic	AP Model	EstM_ noP	EstMH_ noP	EstM_ P	EstMH _P	RW Model
Retro SSB (2024)	Mohn's Rho	0.043	0.274	-0.342	0.044	-0.025	0.078
Retro SSB (2023)	Mohn's Rho	-0.125	1.117	-0.413	-0.037	-0.123	-0.016
Retro SSB (2022)	Mohn's Rho	-0.064	-0.085	-0.503	-0.056	-0.202	-0.135
Retro SSB (2021)	Mohn's Rho	-0.210	-0.192	-0.602	-0.213	-0.253	-0.243
Retro SSB (2020)	Mohn's Rho	0.028	0.301	-0.365	0.381	0.117	0.000
Retro SSB (Combined)	Mohn's Rho	-0.065	0.283	-0.445	0.024	-0.097	-0.063
Retro Forecast SSB (2024)	Forecast bias	0.079	0.407	-0.304	0.096	0.040	0.125
Retro Forecast SSB (2023)	Forecast bias	0.015	1.574	-0.337	0.078	-0.012	0.154
Retro Forecast SSB (2022)	Forecast bias	0.018	-0.090	-0.461	-0.024	-0.183	-0.078
Retro Forecast SSB (2021)	Forecast bias	-0.219	-0.242	-0.612	-0.245	-0.297	-0.284
Retro Forecast SSB (2020)	Forecast bias	0.051	0.436	-0.337	0.528	0.165	0.012
Retro Forecast SSB (Combined)	Forecast bias	-0.011	0.417	-0.410	0.087	-0.057	-0.014
Retro F (2024)	Mohn's Rho	-0.059	-0.203	0.647	-0.051	0.018	-0.080
Retro F (2023)	Mohn's Rho	0.015	-0.545	0.861	0.061	0.185	0.019
Retro F (2022)	Mohn's Rho	0.117	0.233	1.333	0.179	0.398	0.252
Retro F (2021)	Mohn's Rho	0.142	0.281	1.788	0.296	0.414	0.397
Retro F (2020)	Mohn's Rho	-0.240	-0.330	0.703	-0.361	-0.182	-0.079
Retro F (Combined)	Mohn's Rho	-0.005	-0.113	1.066	0.025	0.166	0.102
Retro Forecast F (2024)	Forecast bias	-0.066	-0.229	0.649	-0.039	0.033	-0.067
Retro Forecast F (2023)	Forecast bias	4.437	0.690	1.485	0.746	0.672	1.429
Retro Forecast F (2022)	Forecast bias	1.274	0.278	1.326	0.177	0.460	0.264
Retro Forecast F (2021)	Forecast bias	5.787	0.171	1.370	0.177	0.265	0.248
Retro Forecast F (2020)	Forecast bias	4.518	0.042	1.414	-0.065	0.289	0.461
Retro Forecast F (Combined)	Forecast bias	3.190	0.191	1.249	0.199	0.344	0.467
Retro Recruitment (Combined)	Mohn's Rho	6.526	6.093	-0.890	0.502	0.051	0.554

Table 7. Hindcast cross-validation summary statistics (MASE = mean absolute scaled error) for the AP Model and sensitivity runs exploring the estimation of natural mortality and/or steepness (additional details on model settings are provided in **Table 1**). Values < 1 (in green) for individual or joint (grey rows) indicate superior prediction skill over a naïve baseline forecast (random walk) whereas values > 1 (in red) indicate poor prediction skill. See Carvalho et al. (2021) for additional details.

Quantity	AP Model	EstM_noP	EstMH_noP	EstM_P	EstMH_P	RW Model
Index						
Shrimp Effort	43.210	55.745	56.008	57.366	54.467	45.778
Trawl Late Survey	2.061	1.061	0.982	0.962	1.027	1.134
Combined Video Survey	2.796	2.078	1.959	2.215	1.964	2.036
Joint	9.332	10.736	10.703	11.003	10.465	9.054
Conditional age-at-length						
Recreational	0.842	0.922	0.925	0.899	0.904	0.885
Commercial Vertical Line	0.835	0.814	0.826	0.819	0.825	0.827
Commercial Longline	1.119	1.290	1.603	1.549	1.581	1.217
Joint	0.866	0.893	0.903	0.886	0.893	0.883
Length						
Recreational	1.148	1.488	1.479	1.582	1.503	1.544
Commercial Vertical Line	0.778	0.590	0.588	0.576	0.583	0.573
Commercial Longline	0.836	0.887	0.841	0.852	0.834	0.826
Shrimp Bycatch	5.711	13.759	14.436	13.600	13.981	13.212
Trawl Late Survey	0.920	1.094	1.106	1.100	1.139	1.145
Combined Video Survey	2.758	0.997	1.063	1.014	1.113	1.259
Joint	1.483	1.502	1.549	1.502	1.558	1.561

Table 8. Comparison of negative log-likelihood (NLL) estimates between AP Model sensitivity runs fixing natural mortality (*M*) and steepness (*H*) and the AP Model bivariate profile runs with the same specifications. Note that the bivariate profile runs started from the AP Model's Maximum Likelihood Estimates (MLE), as evident by identical results to the sensitivity runs starting from the same MLEs.

Source	*M*	*H*	NLL	DeltaNLL	Gradient
Sensitivity	0.06	0.34	14,508.1	-	3.8623
Sensitivity (start MLE)	0.06	0.34	14,498.1	10	0.0229
Bivariate	0.06	0.34	14,498.1	10	0.0229
Sensitivity	0.21	0.99	13,557.8	-	0.0139
Sensitivity (start MLE)	0.21	0.99	13,560.3	-2.5	0.0072
Bivariate	0.21	0.99	13,560.3	-2.5	0.0072
Sensitivity	0.36	0.49	13,562.3	-	0.0097
Sensitivity (start MLE)	0.36	0.49	13,566.1	-3.8	0.0263
Bivariate	0.36	0.49	13,566.1	-3.8	0.0263
Sensitivity	0.30	0.74	13,561.3	-	0.2937
Sensitivity (start MLE)	0.30	0.74	13,561.3	0	0.1102
Bivariate	0.30	0.74	13,561.3	0	0.1102

Table 9. Summary of Magnuson-Stevens Reauthorization Act benchmarks and reference points **assuming predicted recruitment from the stock-recruit curve (with steepness fixed at 0.99) throughout the projection period** for the AP Model. Spawning Stock Biomass (SSB) is in metric tons, whereas *F* is a harvest rate (total biomass killed / total biomass age 1+).

Criteria	Definition	Value
Base M	Target M for fully selected ages in the Lorenzen (2000) scaling	0.36
Steepness	Steepness of the Beverton-Holt stock-recruit relationship (fixed)	0.99
Unfished Recruitment (R_0)	Unfished recruitment (1,000s)	95,750
Generation Time	Fecundity-weighted mean age	7.12
Unfished SSB (SSB_0)	Unfished spawning stock biomass (metric tons)	8,816
	Mortality Rate Criteria	
F_{MSY}	Equilibrium F that achieves MSY	0.653
MFMT	F_{MSY}	0.653
$F_{current}$	Geometric mean of the last 3 years of the assessment ($F_{2022-2024}$)	0.214
$F_{current}$/MFMT	Current stock status based on MFMT	0.327
	Biomass Criteria	
SSB_{MSY}	Equilibrium SSB at F_{MSY}	2,395
MSST	0.5 * SSB_{MSY}	1,197
$SSB_{current}$	SSB in 2024	4,849
$SSB_{current}/SSB_{MSY}$	Current stock status based on SSB_{MSY} (Equilibrium)	2.02
$SSB_{current}$/MSST	Current stock status based on MSST	4.05
$SSB_{current}/SSB_0$	SSB ratio in 2024	0.55
SPR at MSY	Equivalent SPR (%) at MSY	27.3

Table 10. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve (with steepness fixed at 0.99) throughout the projection period** for the AP Model. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed / total biomass age 1+). Reference points include F_{MSY} = 0.653, SSB_{MSY} = 2,395 metric tons, and $MSST_{MSY}$ = 1,197 metric tons which was calculated as 0.5 * SSB_{MSY}. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 8,816 metric tons. Red indicates overfishing and/or overfished states if present.

Year	F	F/F_{MSY}	SSB	SSB/SSB_{MSY}	SSB/MSST	SSB ratio
1945	0.000	0.000	8,816	3.681	7.363	1.000
1946	0.006	0.009	8,815	3.681	7.362	1.000
1947	0.011	0.017	8,767	3.661	7.322	0.994
1948	0.017	0.025	8,678	3.624	7.247	0.984
1949	0.022	0.034	8,553	3.571	7.143	0.970
1950	0.028	0.043	8,398	3.507	7.014	0.953
1951	0.034	0.052	8,222	3.433	6.866	0.933
1952	0.042	0.065	8,025	3.351	6.702	0.910
1953	0.047	0.072	7,804	3.259	6.517	0.885
1954	0.053	0.081	7,587	3.168	6.336	0.861
1955	0.059	0.091	7,368	3.077	6.153	0.836
1956	0.065	0.099	7,146	2.984	5.968	0.811
1957	0.071	0.109	6,931	2.894	5.788	0.786
1958	0.078	0.120	6,718	2.805	5.610	0.762
1959	0.085	0.130	6,506	2.717	5.434	0.738
1960	0.093	0.142	6,299	2.630	5.260	0.714
1961	0.083	0.128	6,094	2.544	5.089	0.691
1962	0.092	0.140	6,003	2.507	5.013	0.681
1963	0.099	0.151	5,896	2.462	4.924	0.669
1964	0.105	0.161	5,773	2.411	4.821	0.655

Table 10 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve (with steepness fixed at 0.99) throughout the projection period** for the AP Model. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed/ total biomass age 1+). Reference points include F_{MSY} = 0.653, SSB_{MSY} = 2,395 metric tons, and $MSST_{MSY}$ = 1,197 metric tons which was calculated as 0.5 * SSB_{MSY}. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 8,816 metric tons. Red indicates overfishing and/or overfished states if present.

Year	F	F/F_{MSY}	SSB	SSB/SSB_{MSY}	SSB/MSST	SSB ratio
1965	0.103	0.158	5,640	2.355	4.710	0.640
1966	0.103	0.158	5,555	2.320	4.639	0.630
1967	0.112	0.171	5,500	2.296	4.593	0.624
1968	0.115	0.177	5,413	2.260	4.520	0.614
1969	0.126	0.193	5,327	2.224	4.448	0.604
1970	0.122	0.186	5,201	2.172	4.344	0.590
1971	0.131	0.201	5,135	2.144	4.288	0.582
1972	0.148	0.227	5,049	2.108	4.216	0.573
1973	0.151	0.232	4,905	2.048	4.096	0.556
1974	0.158	0.242	4,788	1.999	3.998	0.543
1975	0.160	0.245	4,678	1.954	3.907	0.531
1976	0.168	0.257	4,606	1.923	3.847	0.522
1977	0.168	0.257	4,523	1.889	3.778	0.513
1978	0.176	0.269	4,457	1.861	3.722	0.506
1979	0.180	0.276	4,362	1.821	3.643	0.495
1980	0.159	0.243	4,268	1.782	3.565	0.484
1981	0.138	0.211	4,301	1.796	3.592	0.488
1982	0.199	0.305	4,400	1.837	3.674	0.499
1983	0.160	0.244	4,983	2.081	4.162	0.565
1984	0.094	0.143	5,123	2.139	4.278	0.581

Table 10 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve (with steepness fixed at 0.99) throughout the projection period** for the AP Model. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed/ total biomass age 1+). Reference points include F_{MSY} = 0.653, SSB_{MSY} = 2,395 metric tons, and $MSST_{MSY}$ = 1,197 metric tons which was calculated as 0.5 * SSB_{MSY}. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 8,816 metric tons. Red indicates overfishing and/or overfished states if present.

Year	F	F/F_{MSY}	SSB	SSB/SSB_{MSY}	SSB/MSST	SSB ratio
1985	0.121	0.185	5,020	2.096	4.192	0.569
1986	0.180	0.275	4,537	1.894	3.789	0.515
1987	0.237	0.363	4,003	1.672	3.343	0.454
1988	0.231	0.354	3,533	1.475	2.950	0.401
1989	0.278	0.425	3,898	1.628	3.255	0.442
1990	0.356	0.545	4,217	1.761	3.521	0.478
1991	0.287	0.439	3,775	1.576	3.153	0.428
1992	0.331	0.507	3,617	1.510	3.021	0.410
1993	0.440	0.674	3,038	1.268	2.537	0.345
1994	0.282	0.432	2,633	1.100	2.199	0.299
1995	0.291	0.445	2,746	1.146	2.293	0.311
1996	0.215	0.329	2,672	1.116	2.231	0.303
1997	0.197	0.302	2,957	1.235	2.470	0.335
1998	0.308	0.471	3,096	1.293	2.586	0.351
1999	0.269	0.411	2,724	1.137	2.275	0.309
2000	0.204	0.312	2,707	1.130	2.260	0.307
2001	0.196	0.300	3,066	1.280	2.561	0.348
2002	0.311	0.476	3,277	1.368	2.737	0.372
2003	0.327	0.500	3,084	1.288	2.576	0.350
2004	0.367	0.561	2,821	1.178	2.356	0.320

Table 10 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve (with steepness fixed at 0.99) throughout the projection period** for the AP Model. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed/ total biomass age 1+). Reference points include F_{MSY} = 0.653, SSB_{MSY} = 2,395 metric tons, and $MSST_{MSY}$ = 1,197 metric tons which was calculated as 0.5 * SSB_{MSY}. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 8,816 metric tons. Red indicates overfishing and/or overfished states if present.

Year	F	F/F_{MSY}	SSB	SSB/SSB_{MSY}	SSB/MSST	SSB ratio
2005	0.296	0.453	2,427	1.013	2.027	0.275
2006	0.242	0.371	2,225	0.929	1.858	0.252
2007	0.291	0.445	2,149	0.897	1.795	0.244
2008	0.243	0.372	2,097	0.876	1.751	0.238
2009	0.160	0.244	2,370	0.989	1.979	0.269
2010	0.216	0.331	2,682	1.120	2.240	0.304
2011	0.249	0.380	2,884	1.204	2.408	0.327
2012	0.211	0.323	2,834	1.183	2.367	0.321
2013	0.423	0.648	3,006	1.255	2.511	0.341
2014	0.117	0.179	2,955	1.234	2.468	0.335
2015	0.132	0.201	4,100	1.712	3.424	0.465
2016	0.212	0.325	4,812	2.009	4.018	0.546
2017	0.224	0.343	4,809	2.008	4.016	0.546
2018	0.209	0.319	4,565	1.906	3.812	0.518
2019	0.185	0.284	4,853	2.026	4.053	0.550
2020	0.189	0.290	5,113	2.135	4.270	0.580
2021	0.169	0.259	5,155	2.153	4.305	0.585
2022	0.230	0.352	5,058	2.112	4.224	0.574
2023	0.202	0.309	4,693	1.960	3.919	0.532
2024	0.210	0.322	4,849	2.025	4.049	0.550

9. Figures

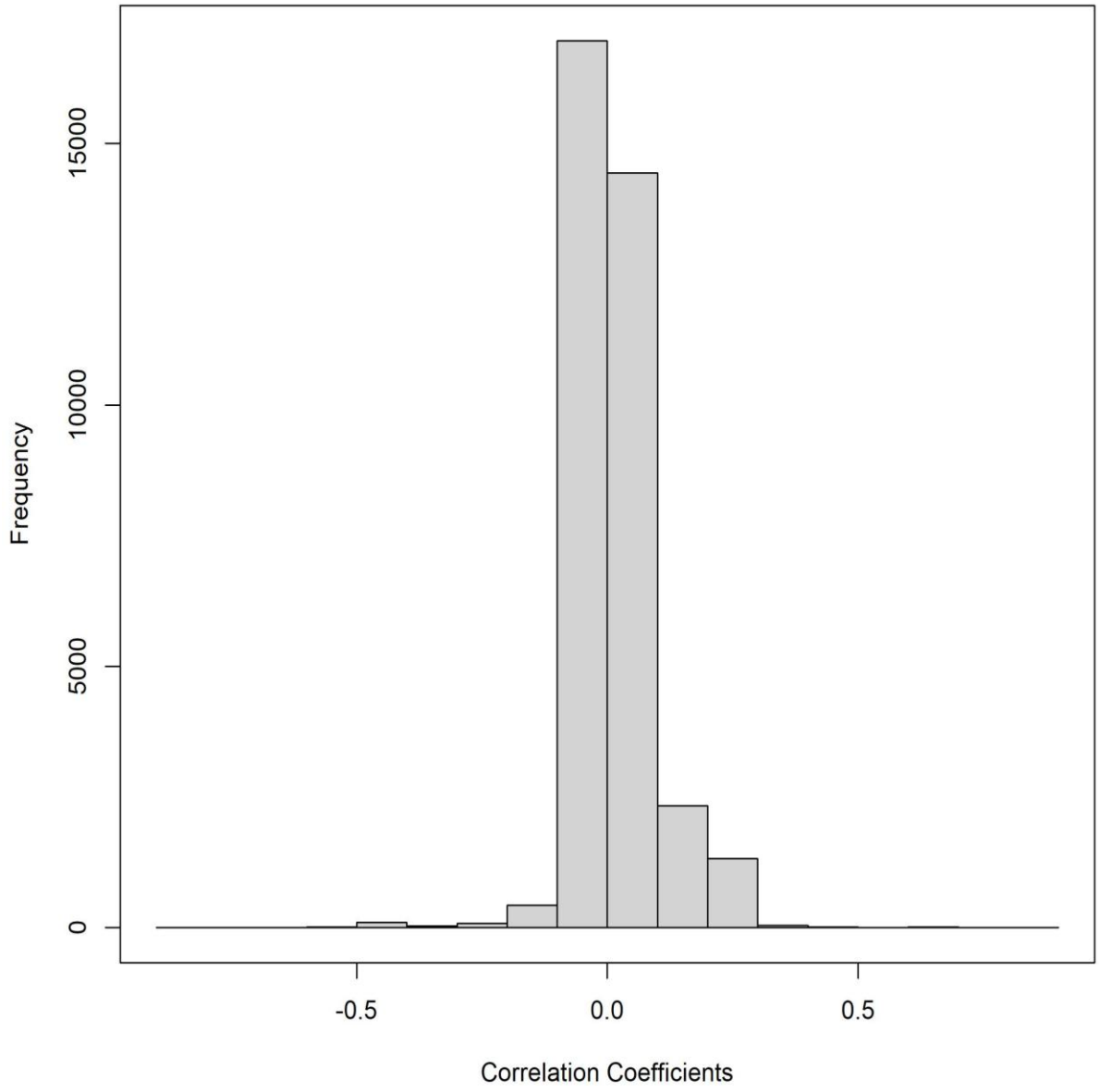


Figure 1. Distribution of correlation coefficients for all parameter combinations (including annual Fs for the Recreational and Shrimp Bycatch fleets) from the AP Model.

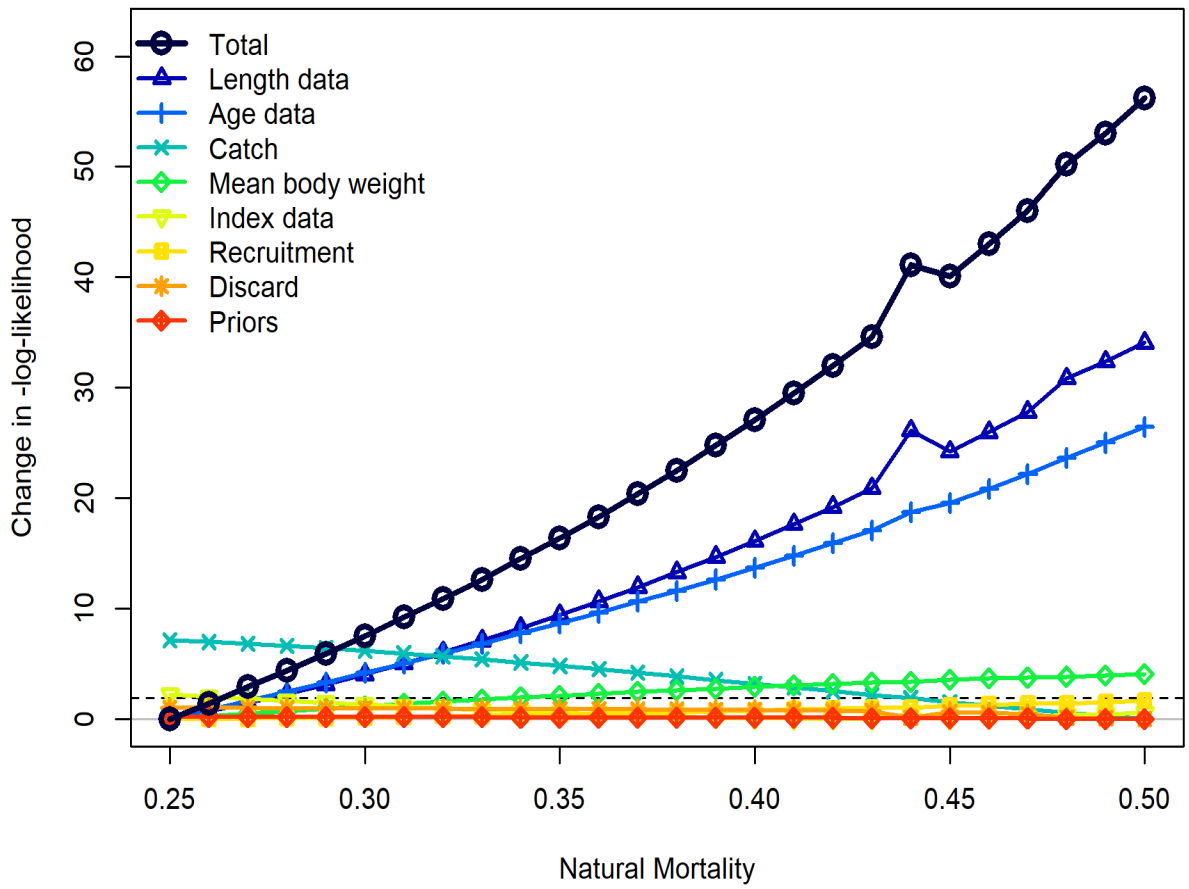


Figure 2. The likelihood profile for the natural mortality parameter across a range of 0.25 to 0.5. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. Natural mortality was fixed at 0.36 in the AP Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

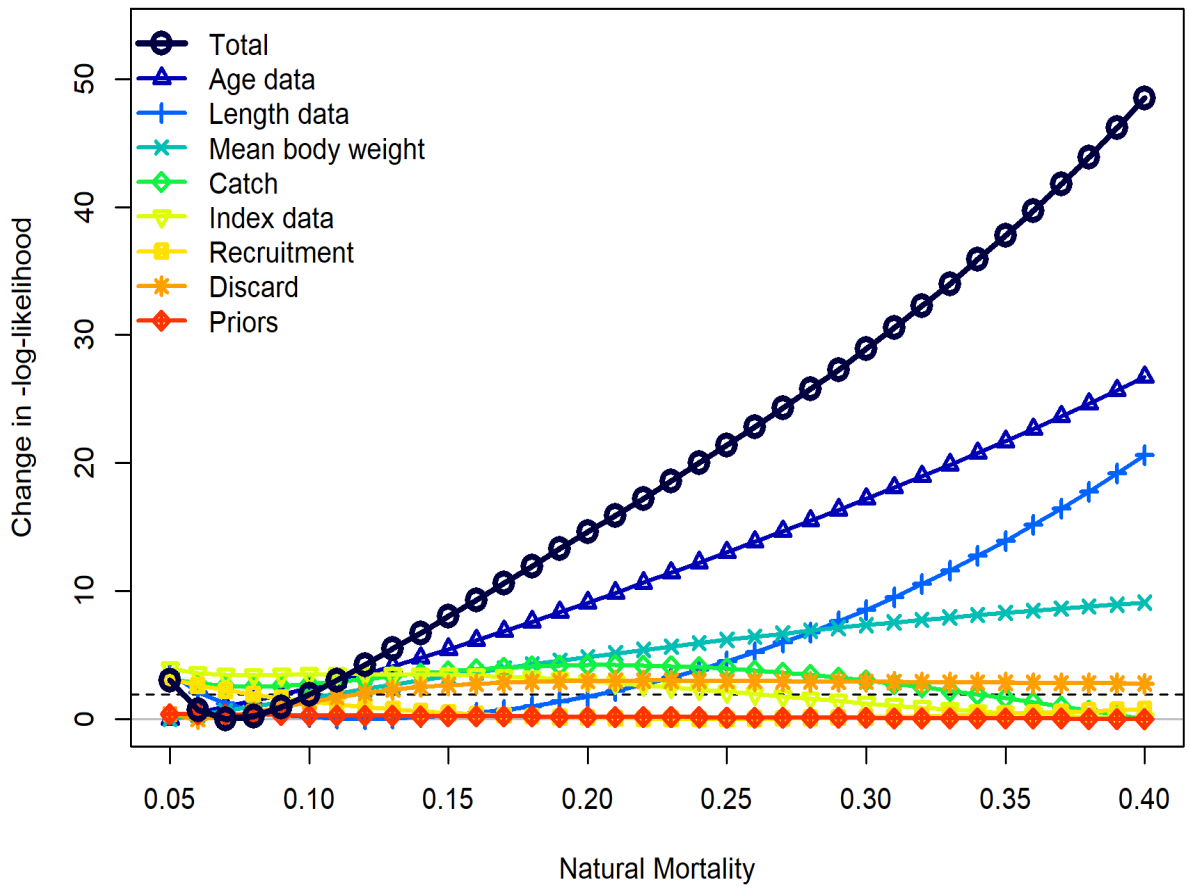


Figure 3. The likelihood profile for the natural mortality parameter across a range of 0.05 to 0.4, which was updated after reviewing the AP Model sensitivity runs estimating natural mortality. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. Natural mortality was fixed at 0.36 in the AP Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

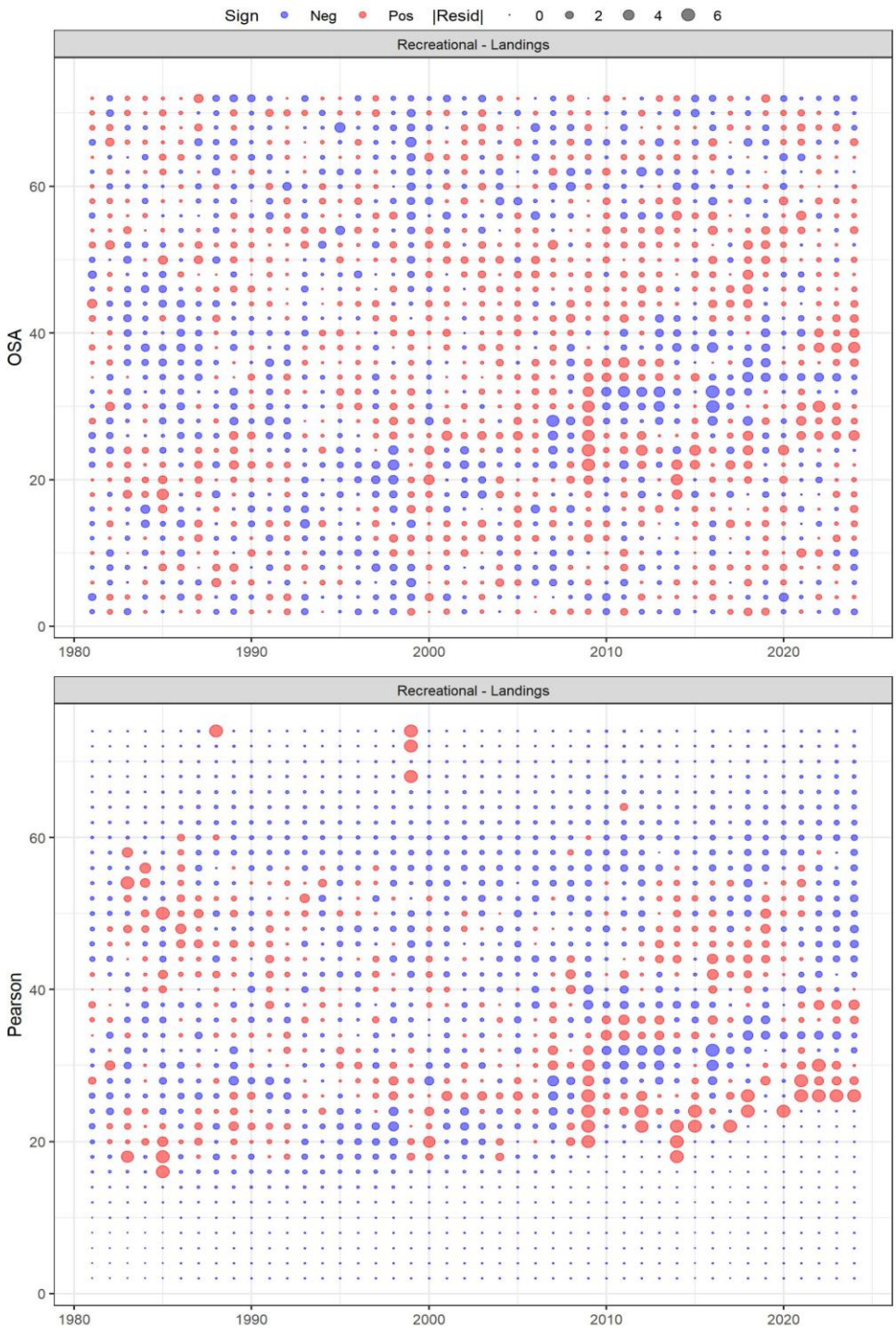


Figure 4. One-step ahead residuals (OSA; top panel) and pearson residuals (bottom panel) for the retained length compositions for the Recreational fishery. Note that extreme OSA residuals (-8.21) and Pearson residuals (>6; see Figure 64 in Assessment Process Report) were capped at 6 for visualization.

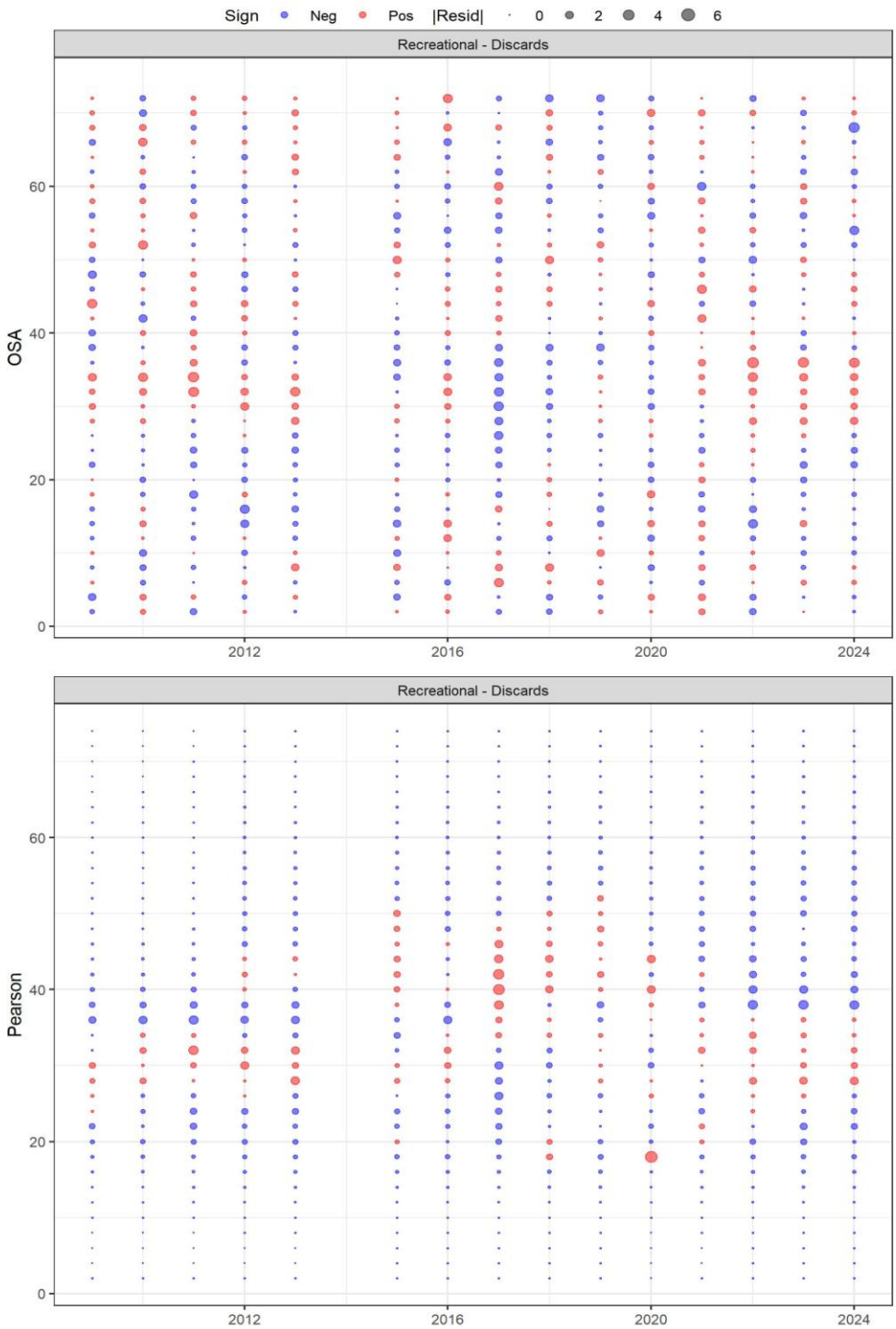


Figure 5. One-step ahead residuals (OSA; top panel) and pearson residuals (bottom panel) for the discard length compositions for the Recreational fishery.

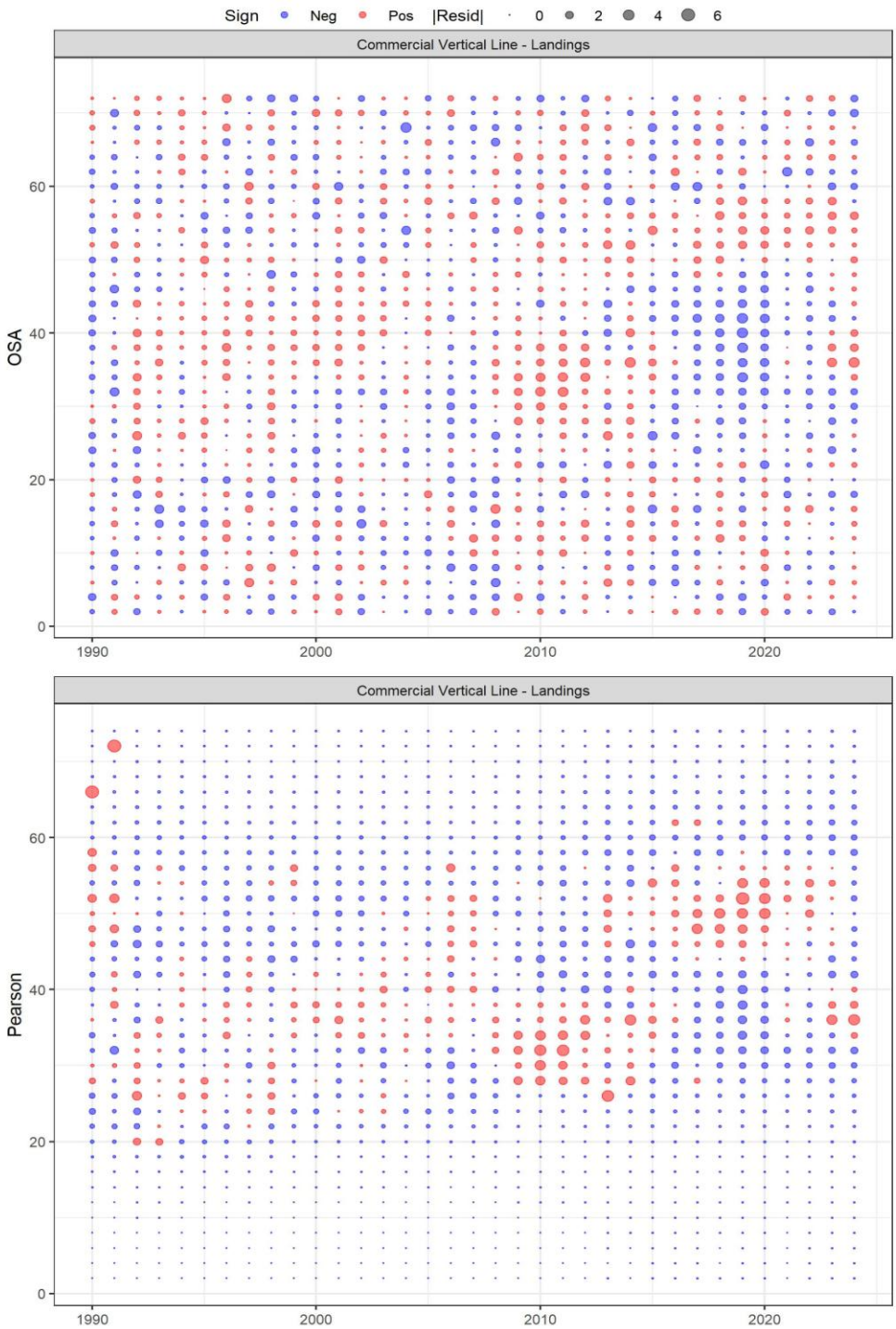


Figure 6. One-step ahead residuals (OSA; top panel) and pearson residuals (bottom panel) for the retained length compositions for the Commercial Vertical Line fishery. Note that extreme Pearson residuals (>6; see Figure 66 in Assessment Process Report) were capped at 6 for visualization.

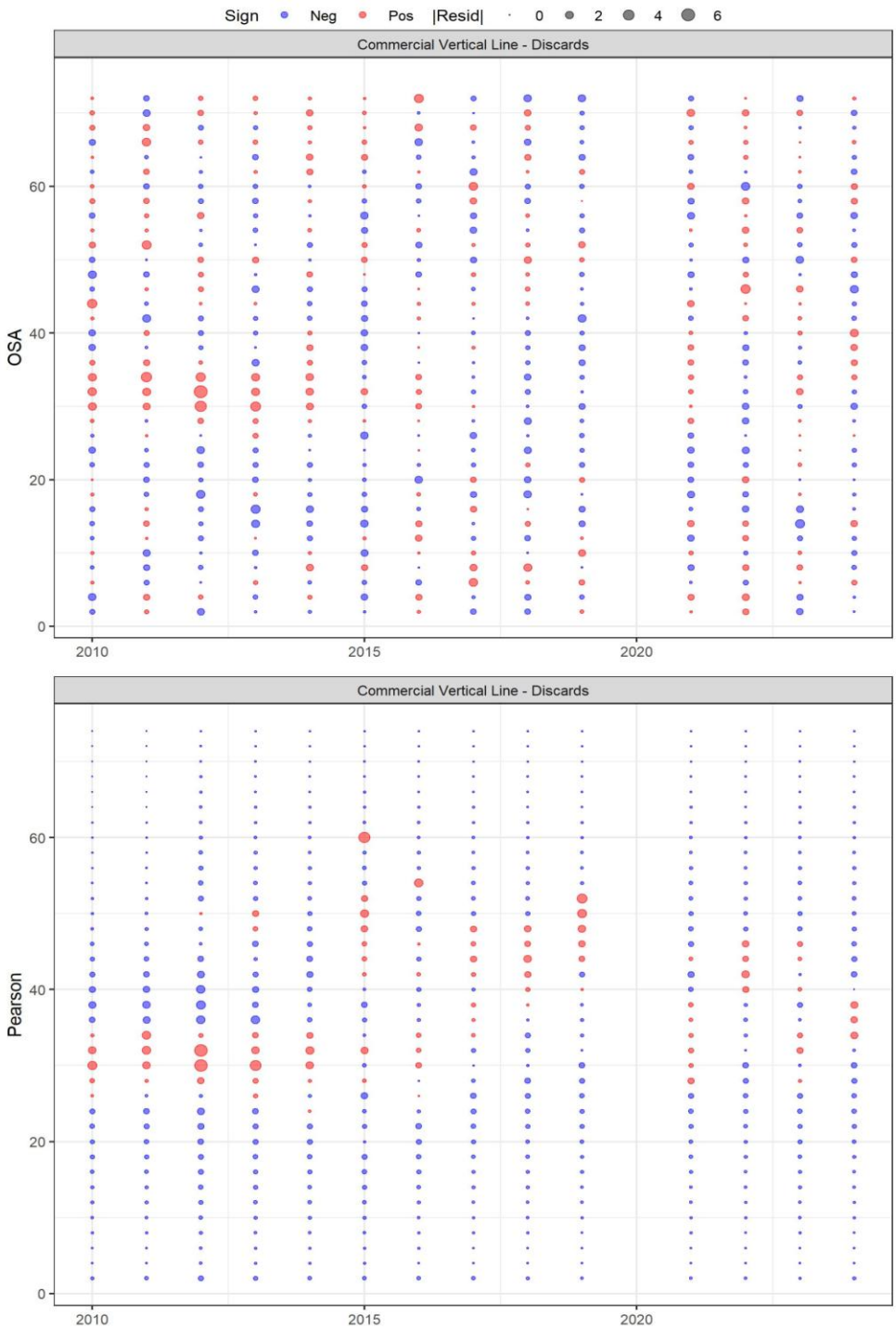


Figure 7. One-step ahead residuals (OSA; top panel) and pearson residuals (bottom panel) for the discard length compositions for the Commercial Vertical Line fishery. Note that extreme Pearson residuals (>6; see Figure 67 in Assessment Process Report) were capped at 6 for visualization.

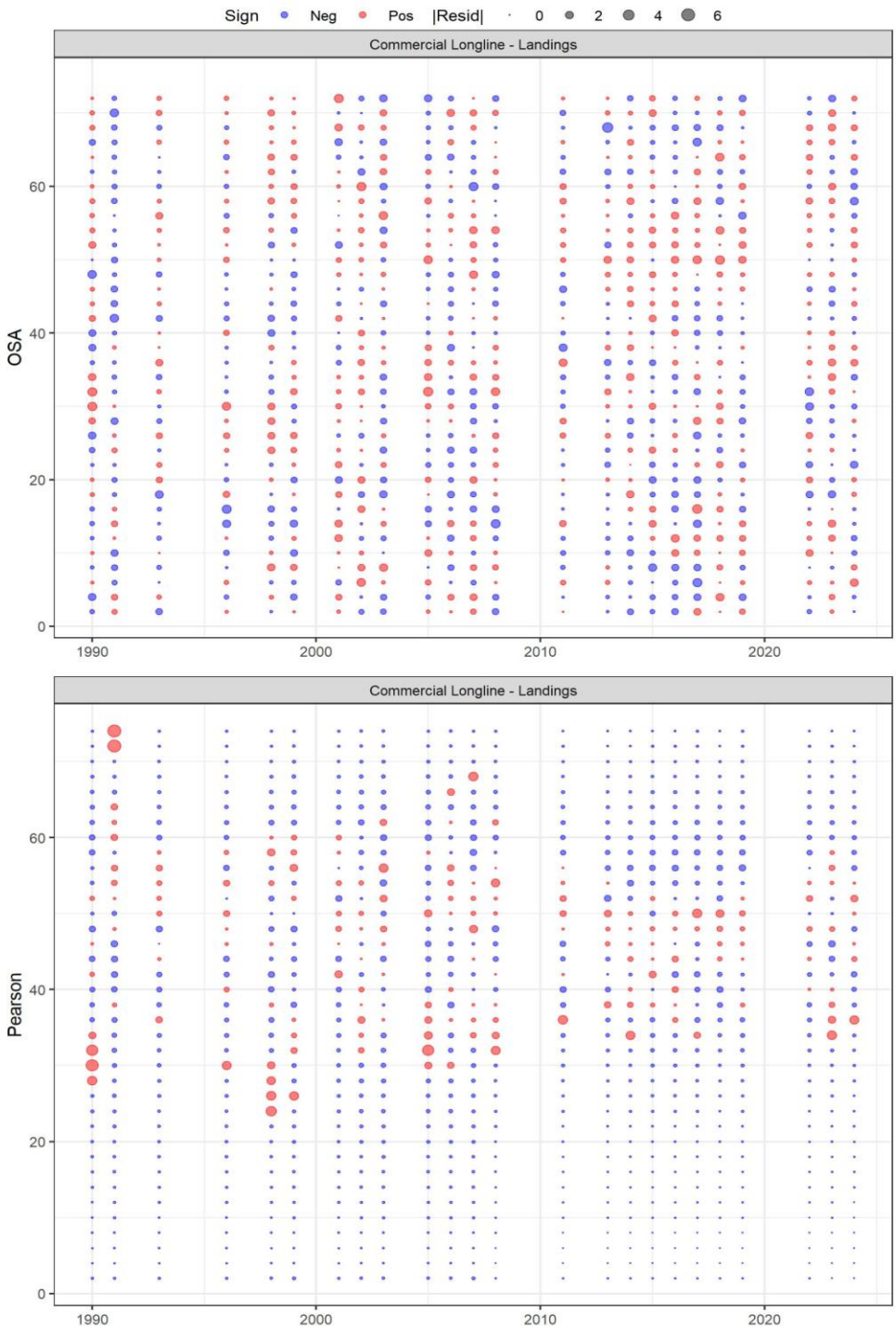


Figure 8. One-step ahead residuals (OSA; top panel) and pearson residuals (bottom panel) for the retained length compositions for the Commercial Longline fishery. Note that extreme Pearson residuals (>6; see Figure 68 in Assessment Process Report) were capped at 6 for visualization.

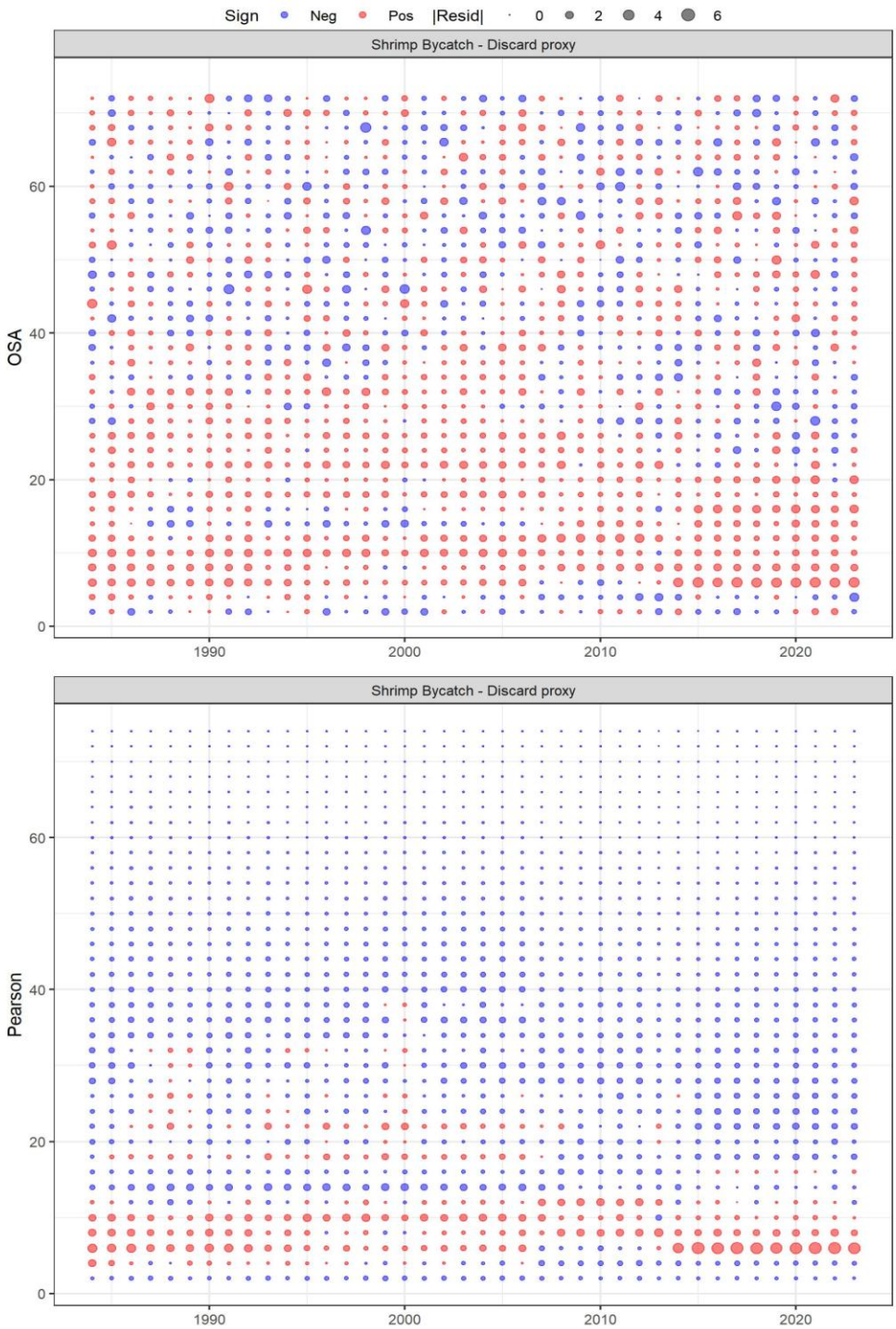


Figure 9. One-step ahead residuals (OSA; top panel) and pearson residuals (bottom panel) for the discarded length compositions for the Shrimp Bycatch fishery.

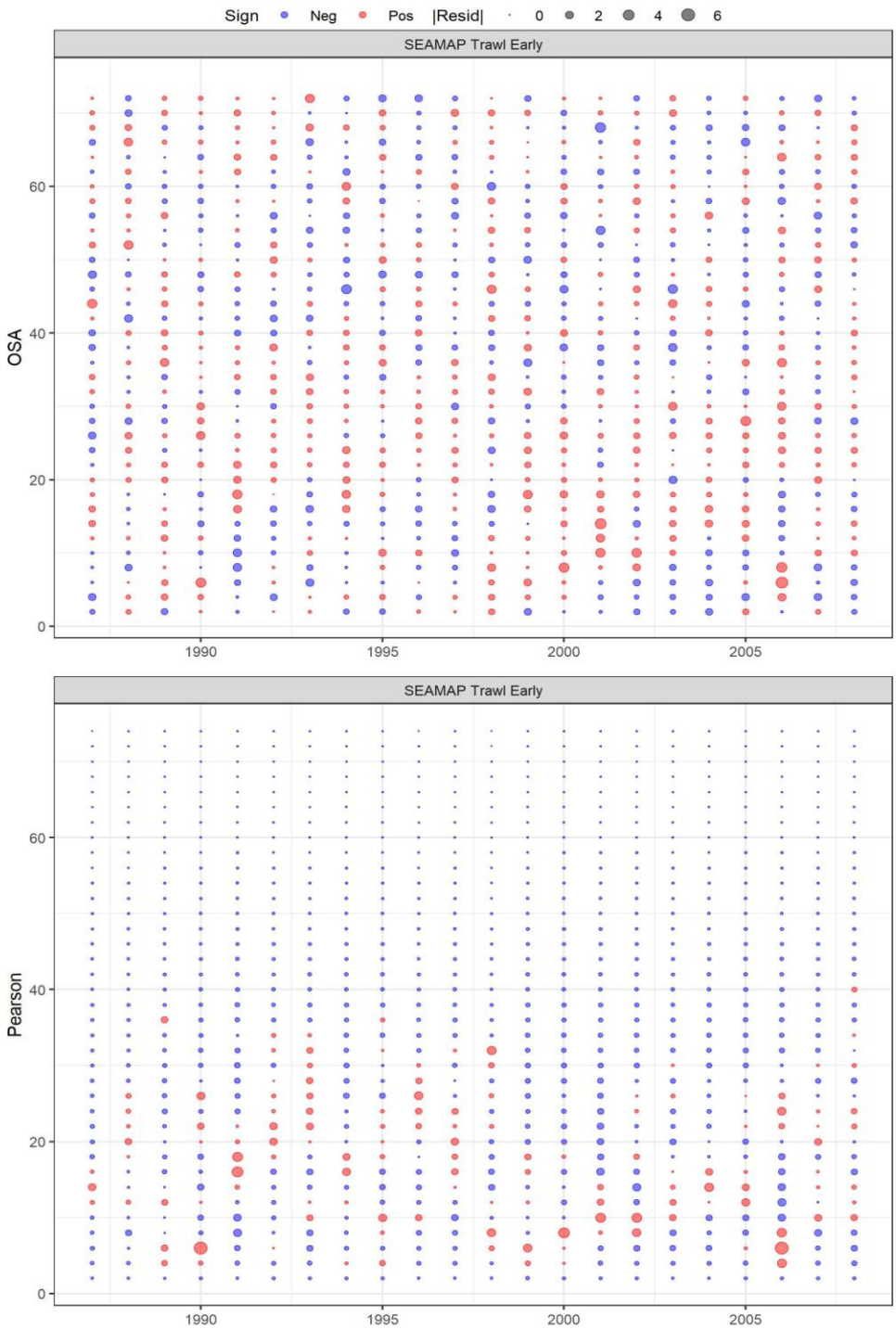


Figure 10. One-step ahead residuals (OSA; top panel) and pearson residuals (bottom panel) for the length compositions for the SEAMAP Trawl Early Survey. Note that extreme Pearson residuals (>6; see Figure 71 in Assessment Process Report) were capped at 6 for visualization.

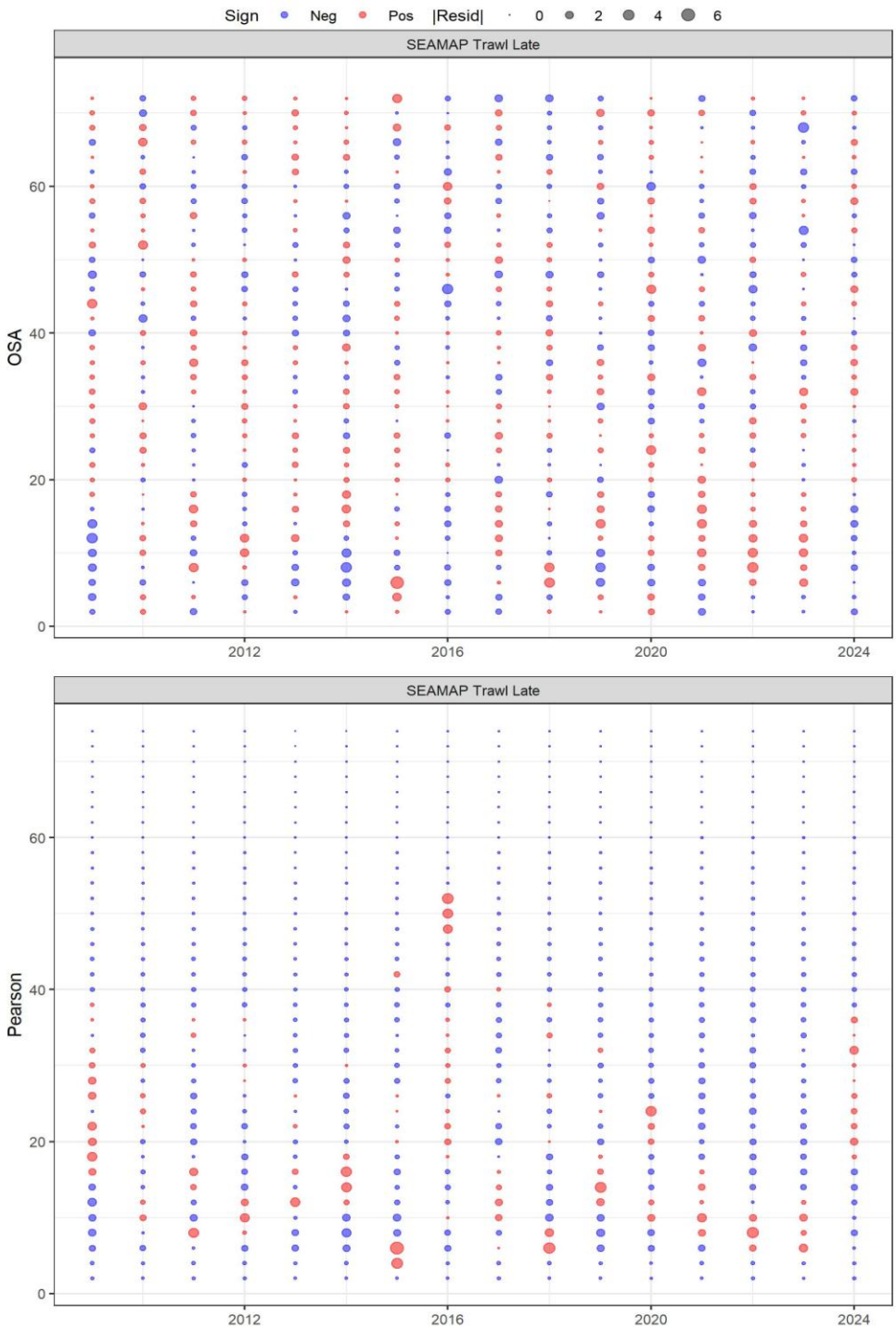


Figure 11. One-step ahead residuals (OSA; top panel) and pearson residuals (bottom panel) for the length compositions for the SEAMAP Trawl Late Survey. Note that extreme Pearson residuals (>6; see Figure 72 in Assessment Process Report) were capped at 6 for visualization.

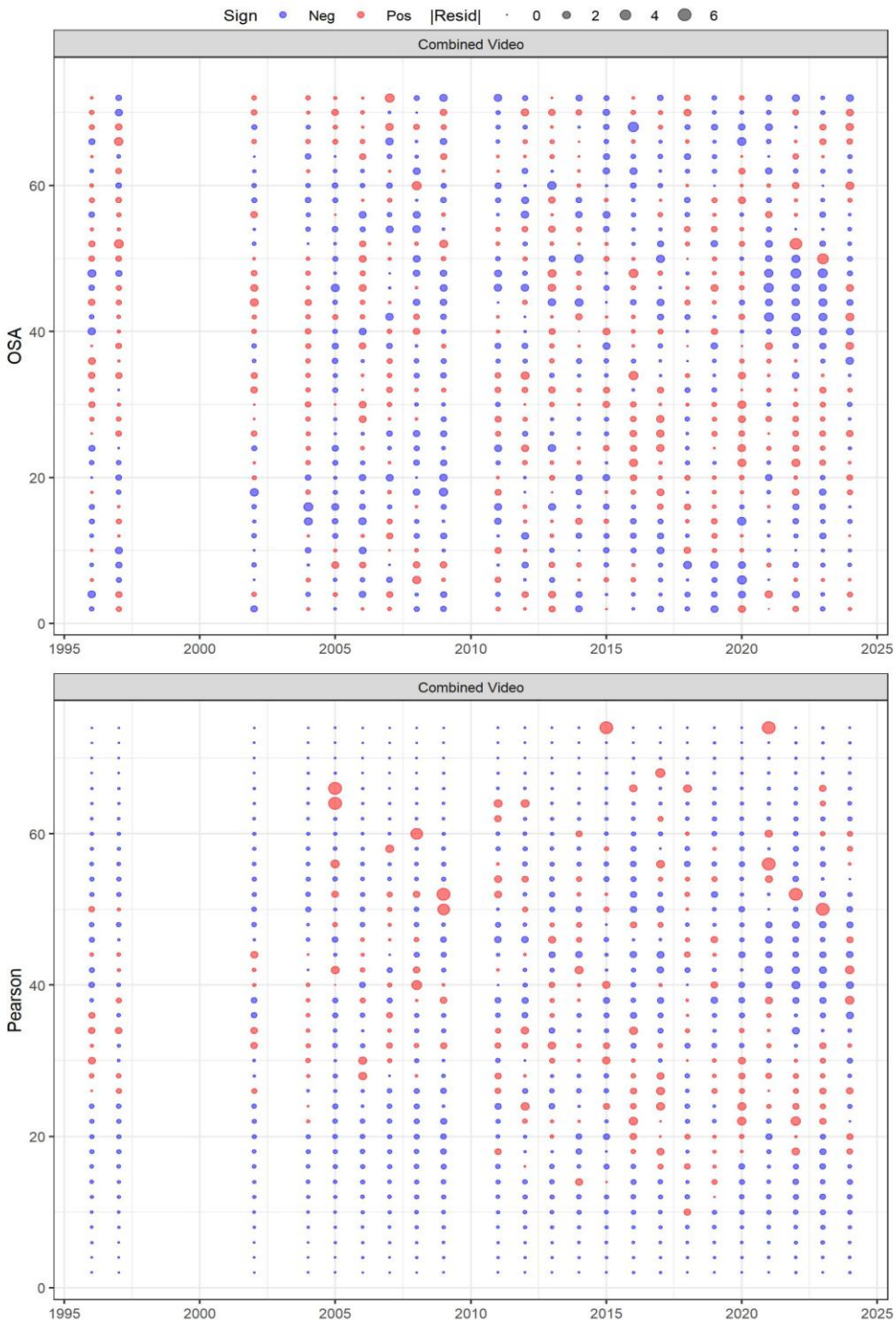


Figure 12. One-step ahead residuals (OSA; top panel) and pearson residuals (bottom panel) for the length compositions for the Combined Video Survey. Note that extreme Pearson residuals (>6; see Figure 73 in Assessment Process Report) were capped at 6 for visualization.

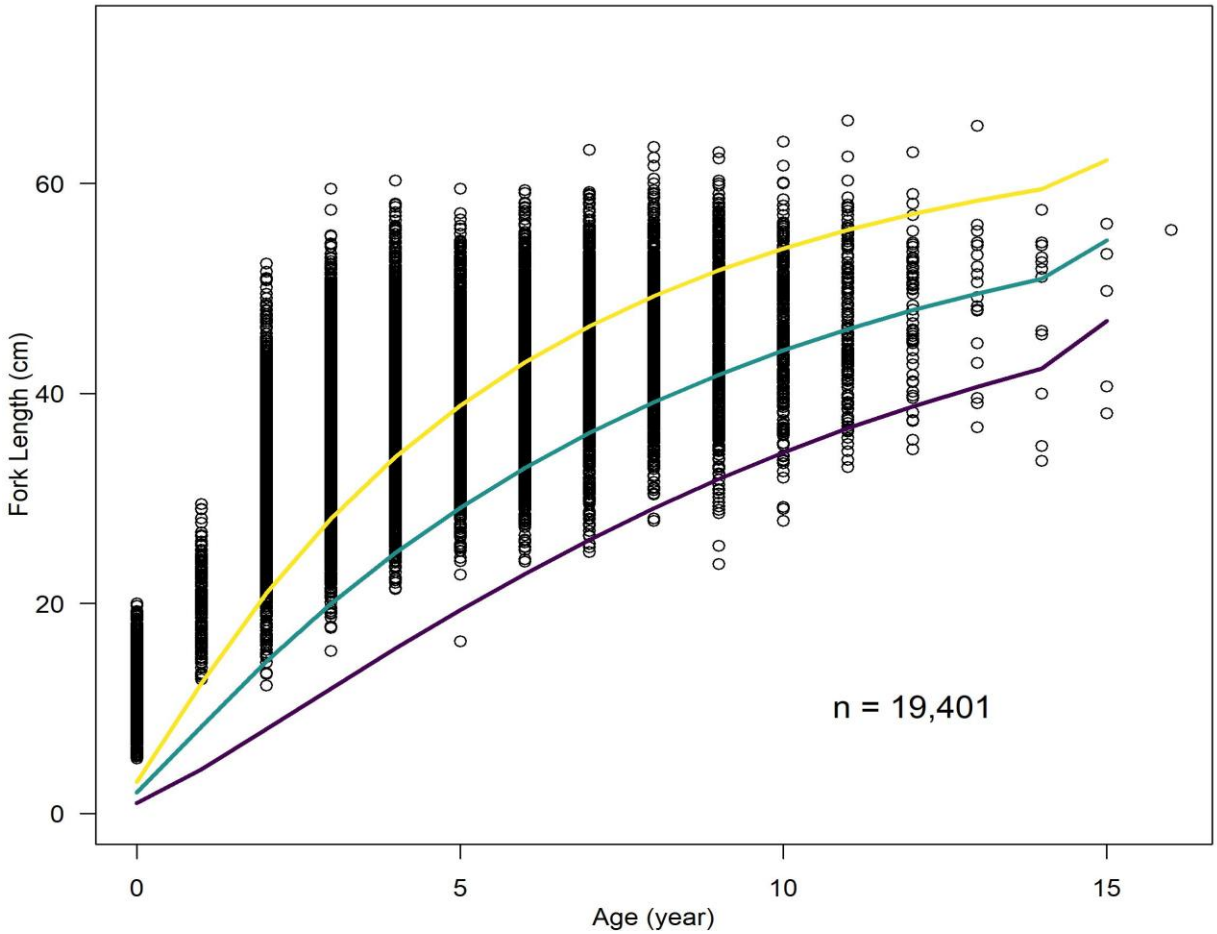


Figure 13. Comparison of length-at-age data with expected growth curves for each of the three platoons.

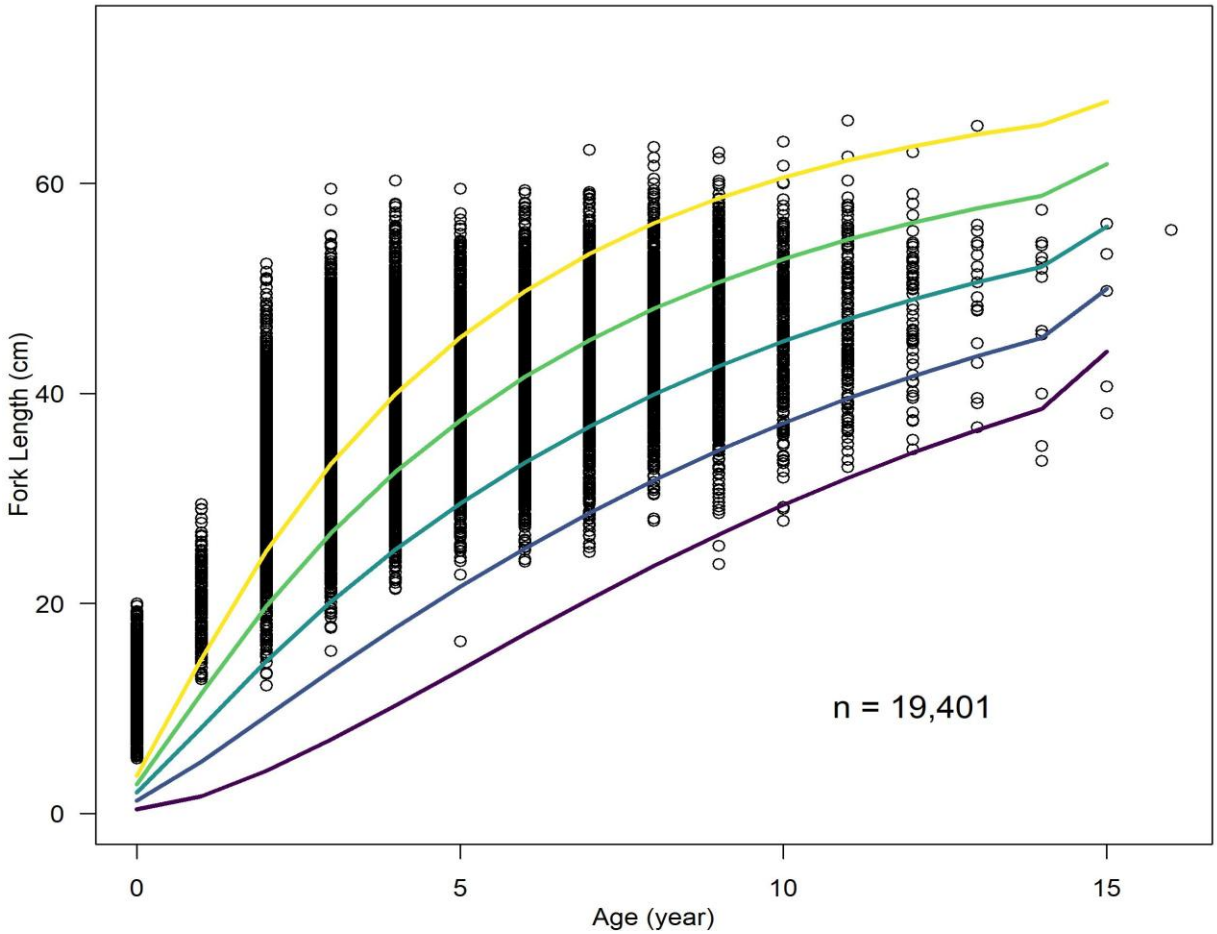


Figure 14. Comparison of length-at-age data with expected growth curves for each of the five platoons.

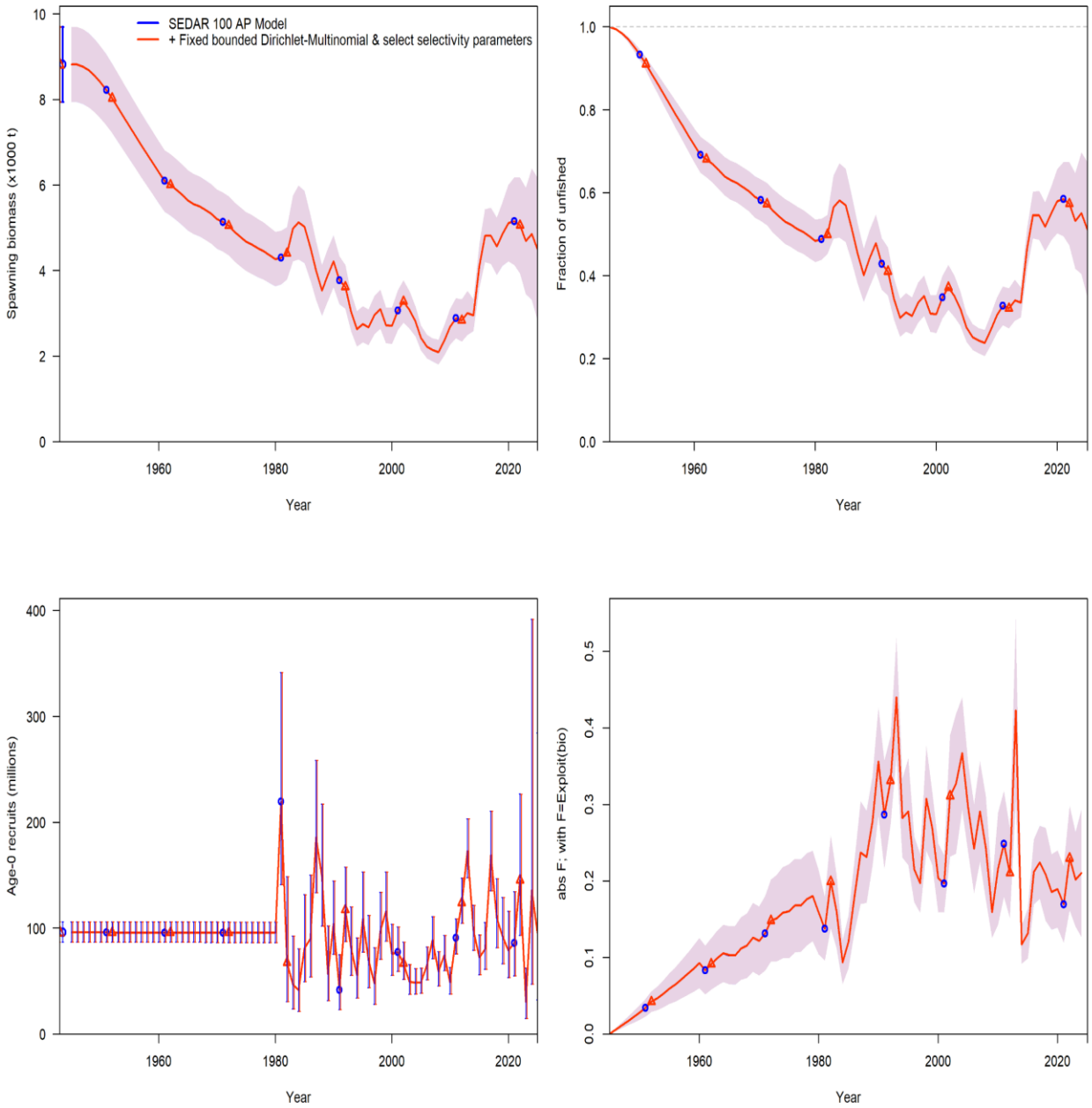


Figure 15. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the sensitivity run fixing bounded Dirichlet Multinomial parameters for the recreational and commercial length compositions and select selectivity parameters for the AP Model.

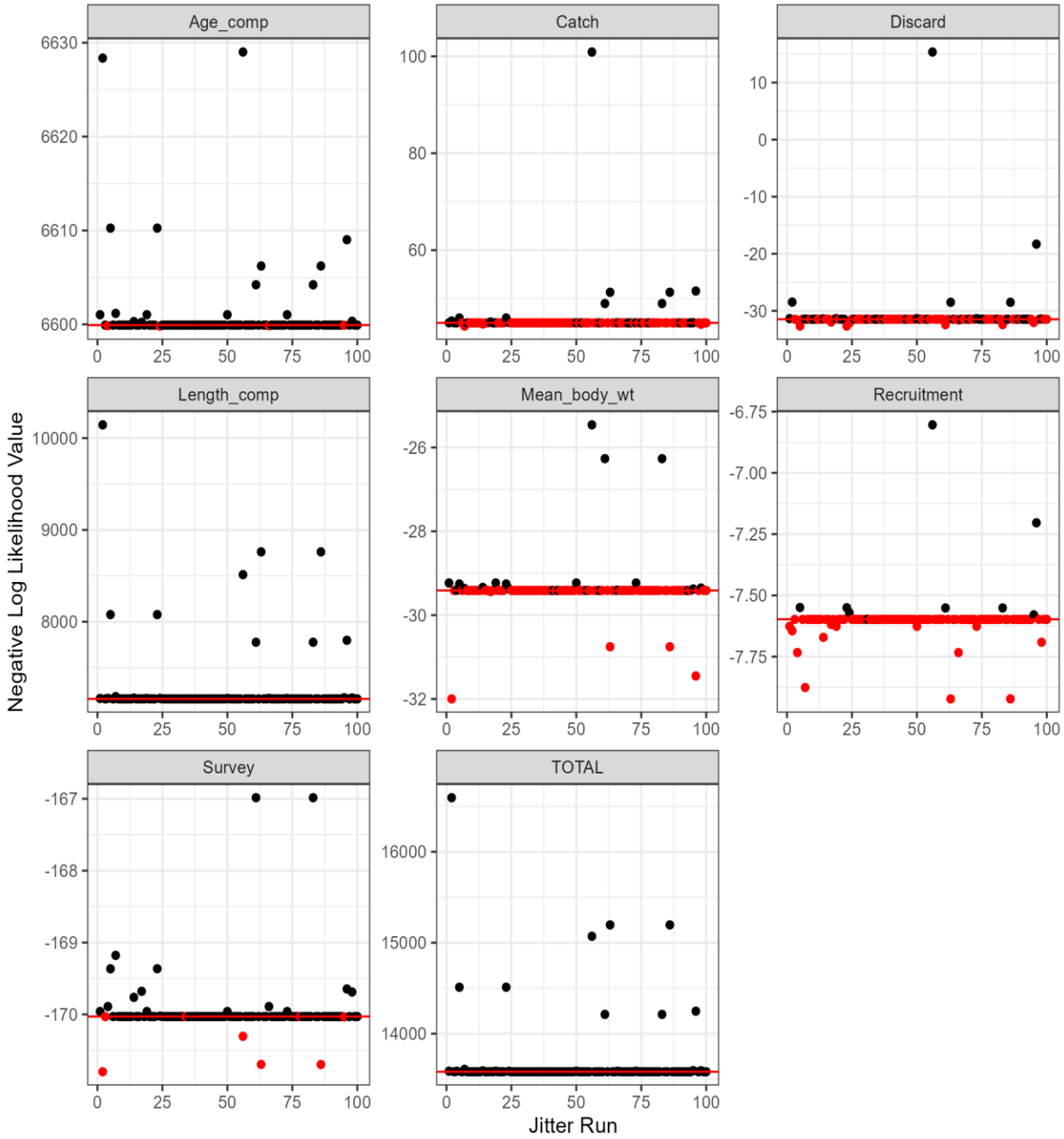


Figure 16. Results of the jitter analysis for various likelihood components for the AP Model sensitivity run fixing bounded Dirichlet Multinomial parameters for the recreational and commercial length compositions and select selectivity parameters. Each panel gives the results of 100 model runs where the starting parameter values for each run were randomly changed ('jittered') by 10% from the best fit values. Note that the y-axes differ between panels. Negative log-likelihood components shown from top left through bottom right include: conditional age-at-length (Age_comp), catch, discards, length composition (length_comp), mean weight of landings (Mean_body_wt), recruitment, survey, and total.

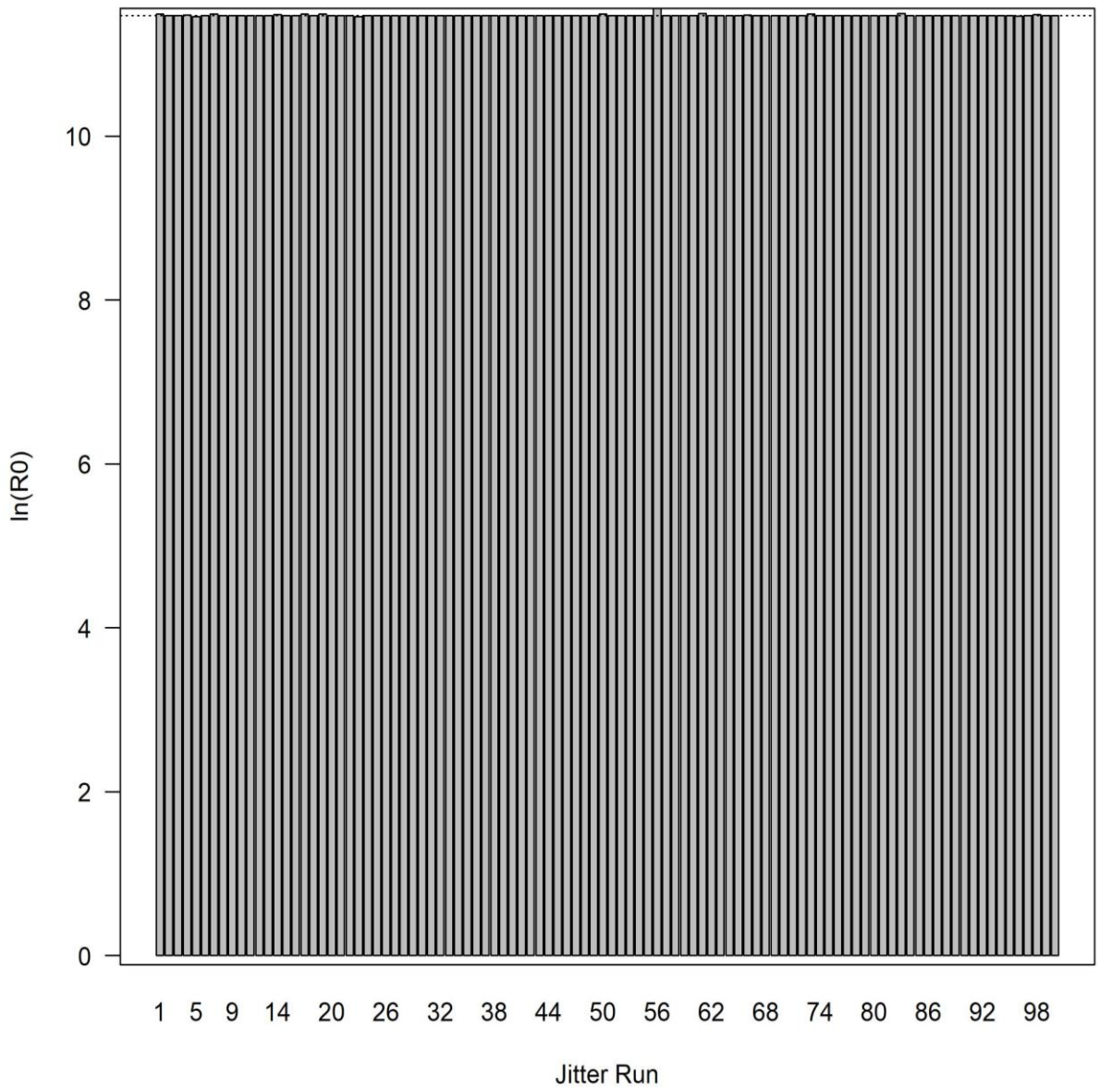


Figure 17. Results of the jitter analysis for the natural log of the virgin recruitment parameter ($ln(R_0)$) for the AP Model sensitivity run fixing bounded Dirichlet Multinomial parameters for the recreational and commercial length compositions and select selectivity parameters from 100 model runs where the starting parameter values for each run were randomly changed ('jittered') by 10% from the best fit value (dashed horizontal line).

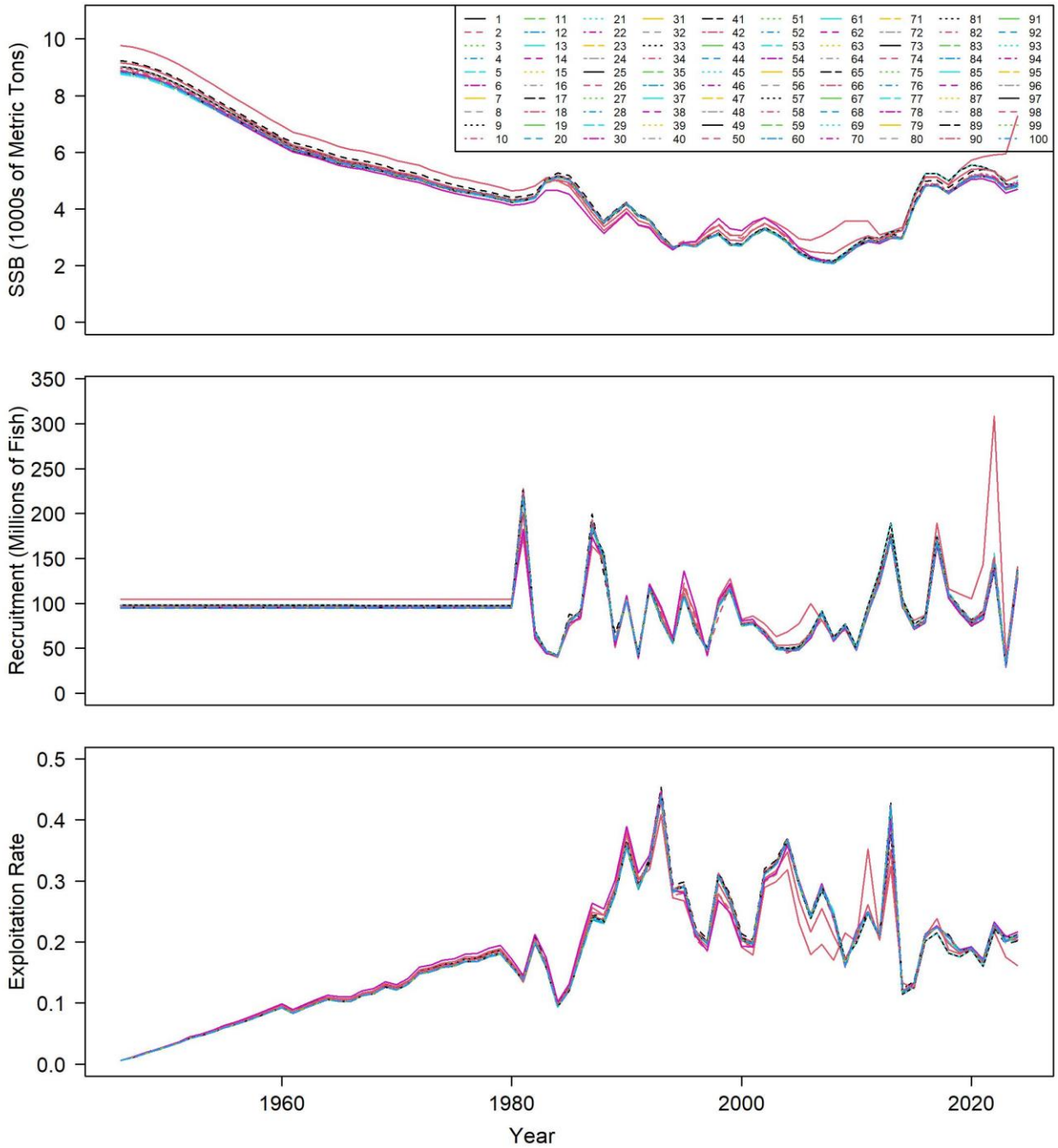


Figure 18. Estimated trajectories in spawning stock biomass (SSB in 1,000s of metric tons; top panel), recruitment (millions of age-0; middle panel), and fishing mortality (as an exploitation rate of total biomass killed /total biomass age 1+; bottom panel) for the AP Model sensitivity run fixing bounded Dirichlet Multinomial parameters for the recreational and commercial length compositions and select selectivity parameters.

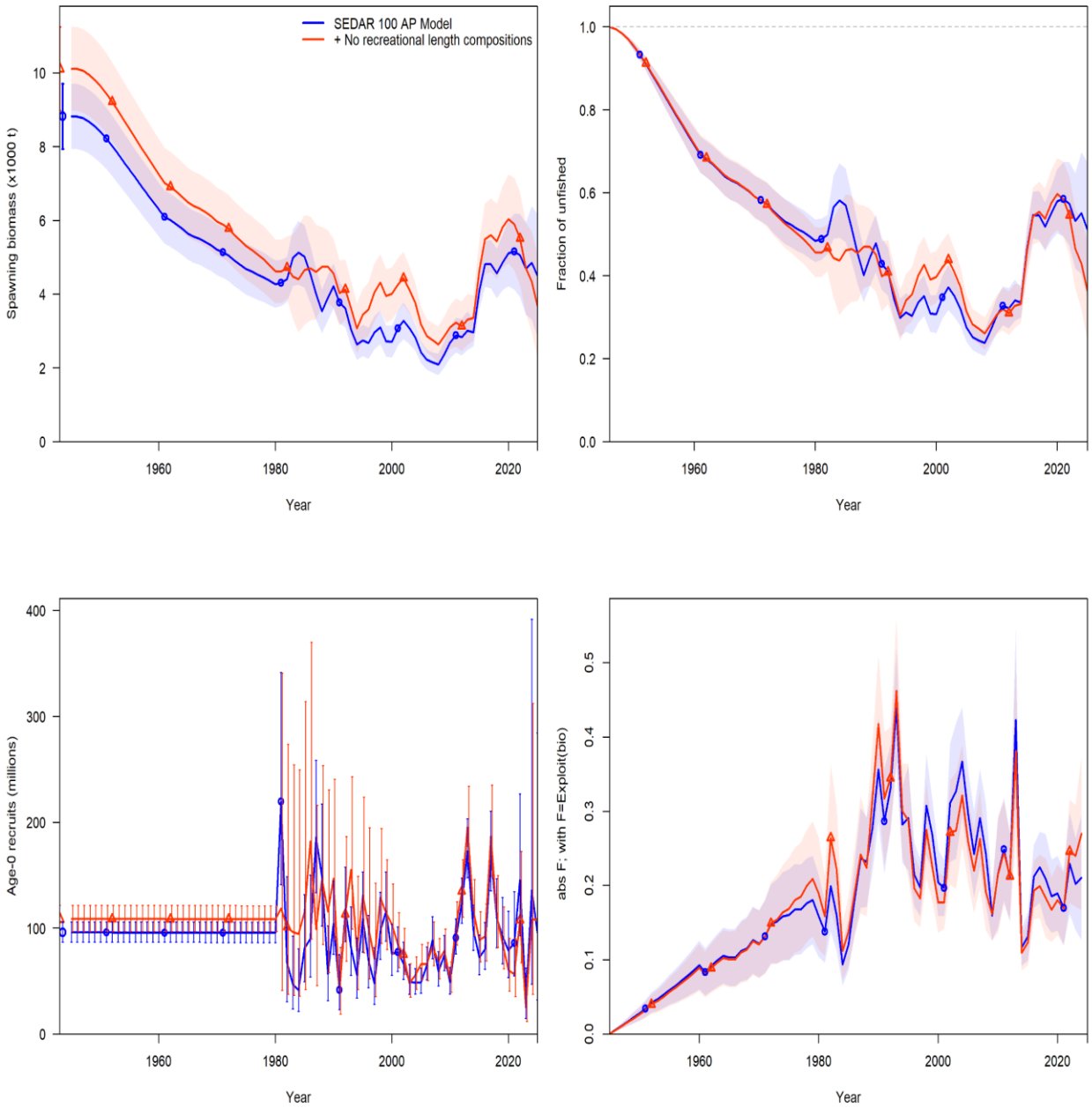


Figure 19. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the AP Model sensitivity run excluding fitting to the recreational length compositions.

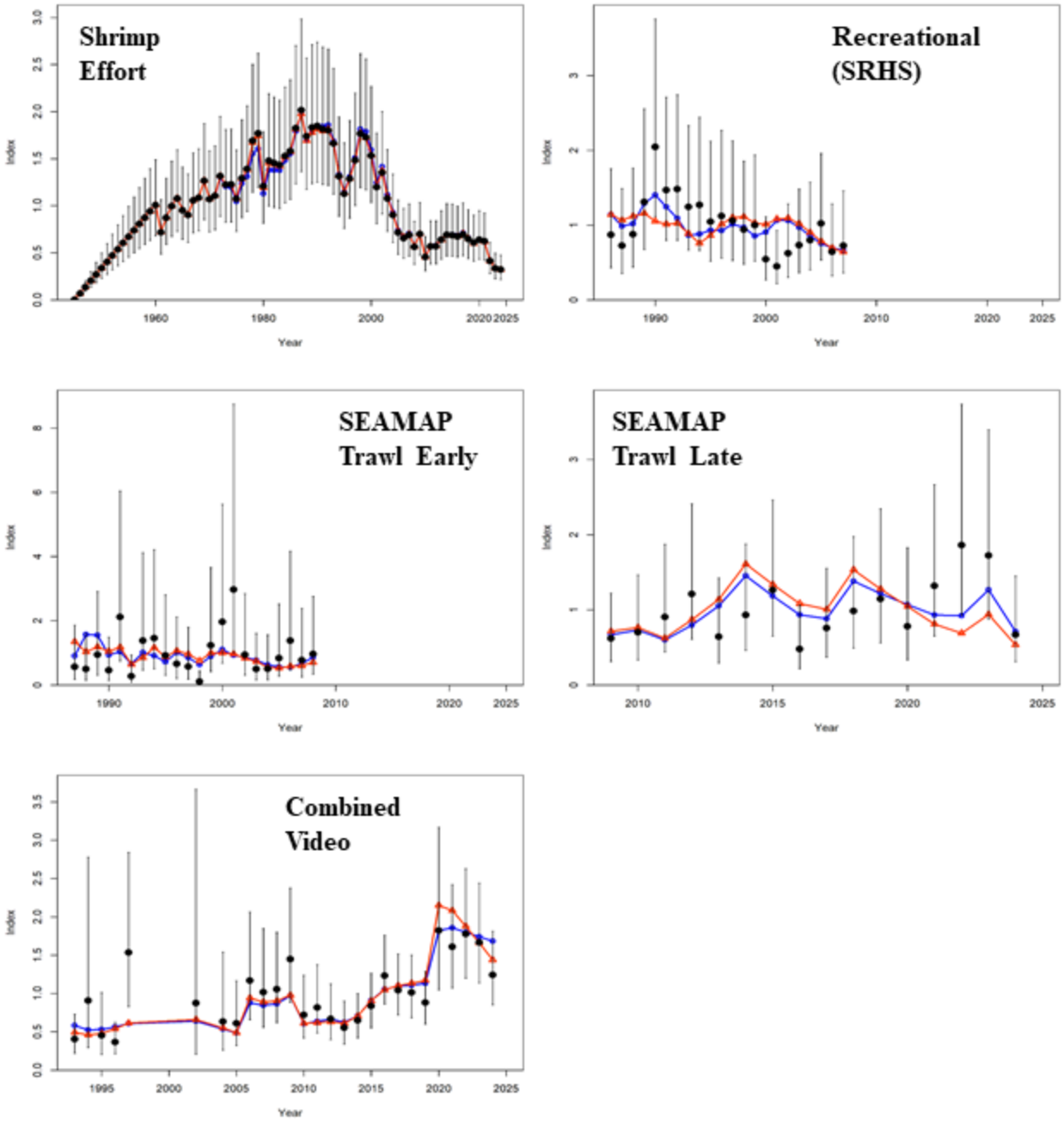


Figure 20. Comparison of fits to indices for the AP Model sensitivity run excluding fitting to the recreational length compositions.

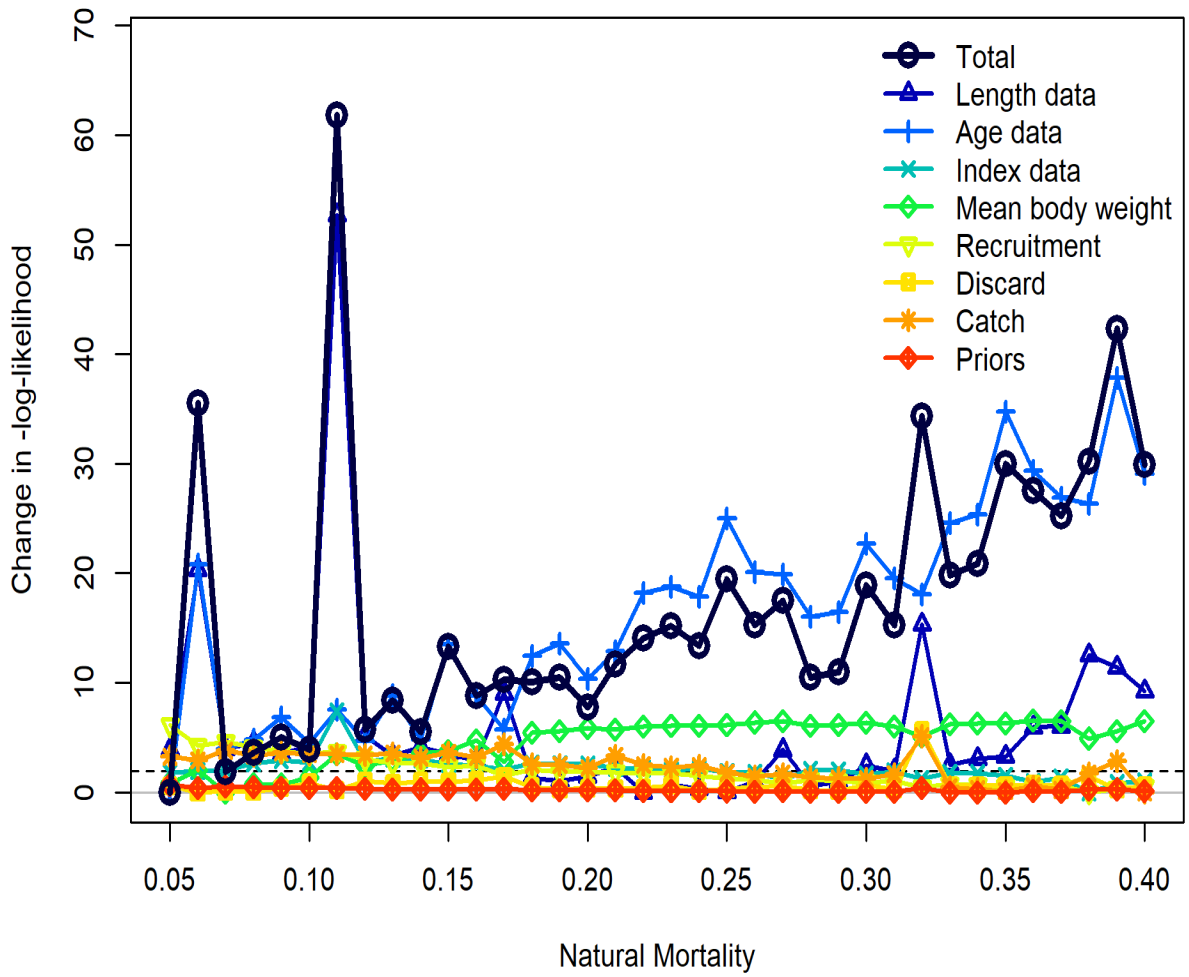


Figure 21. The likelihood profile for the natural mortality parameter for the AP Model sensitivity run excluding fitting to the recreational length compositions. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. Natural mortality was fixed at 0.36 in the AP Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

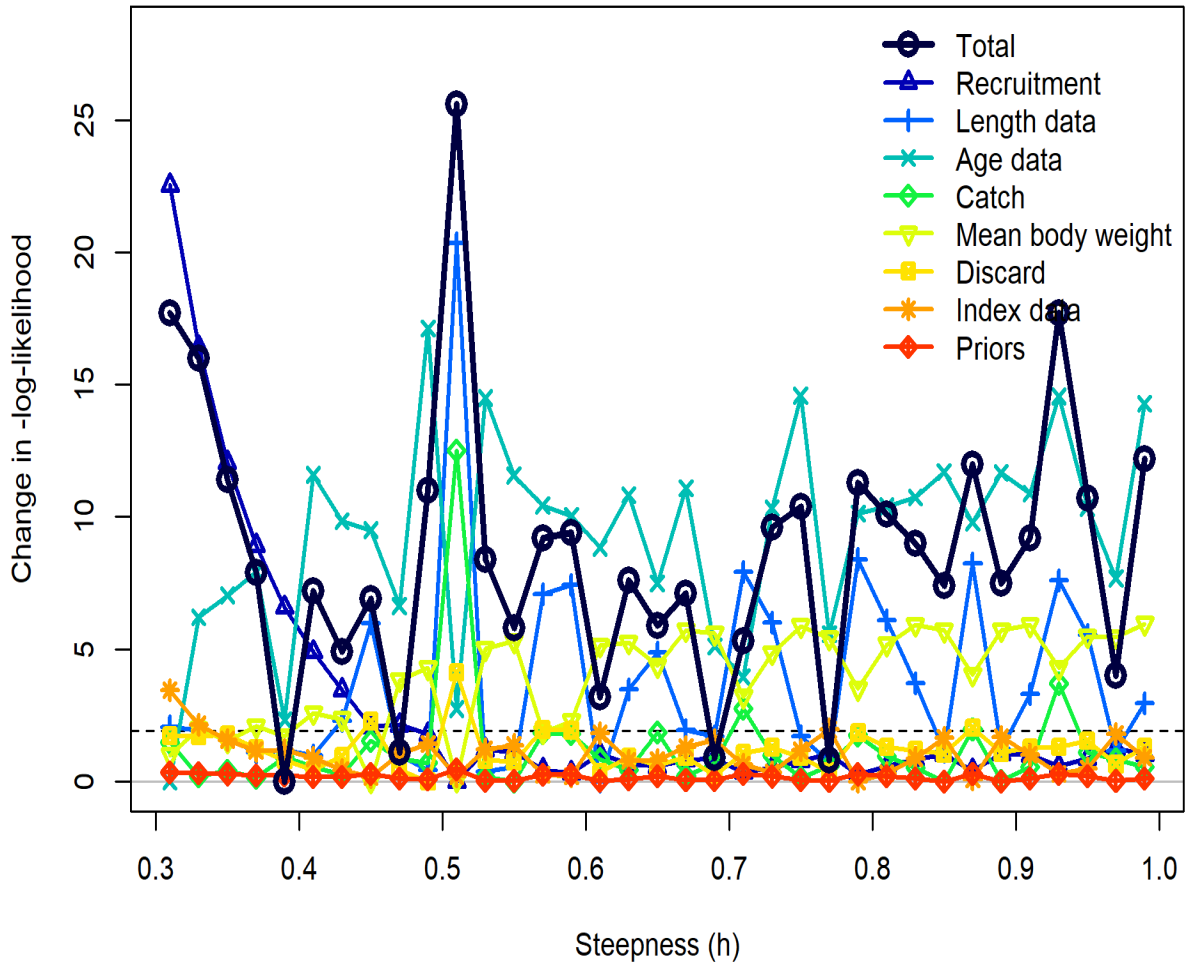


Figure 22. The likelihood profile for the steepness parameter for the AP Model sensitivity run excluding fitting to the recreational length compositions. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. Steepness was fixed at 0.99 in the AP Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

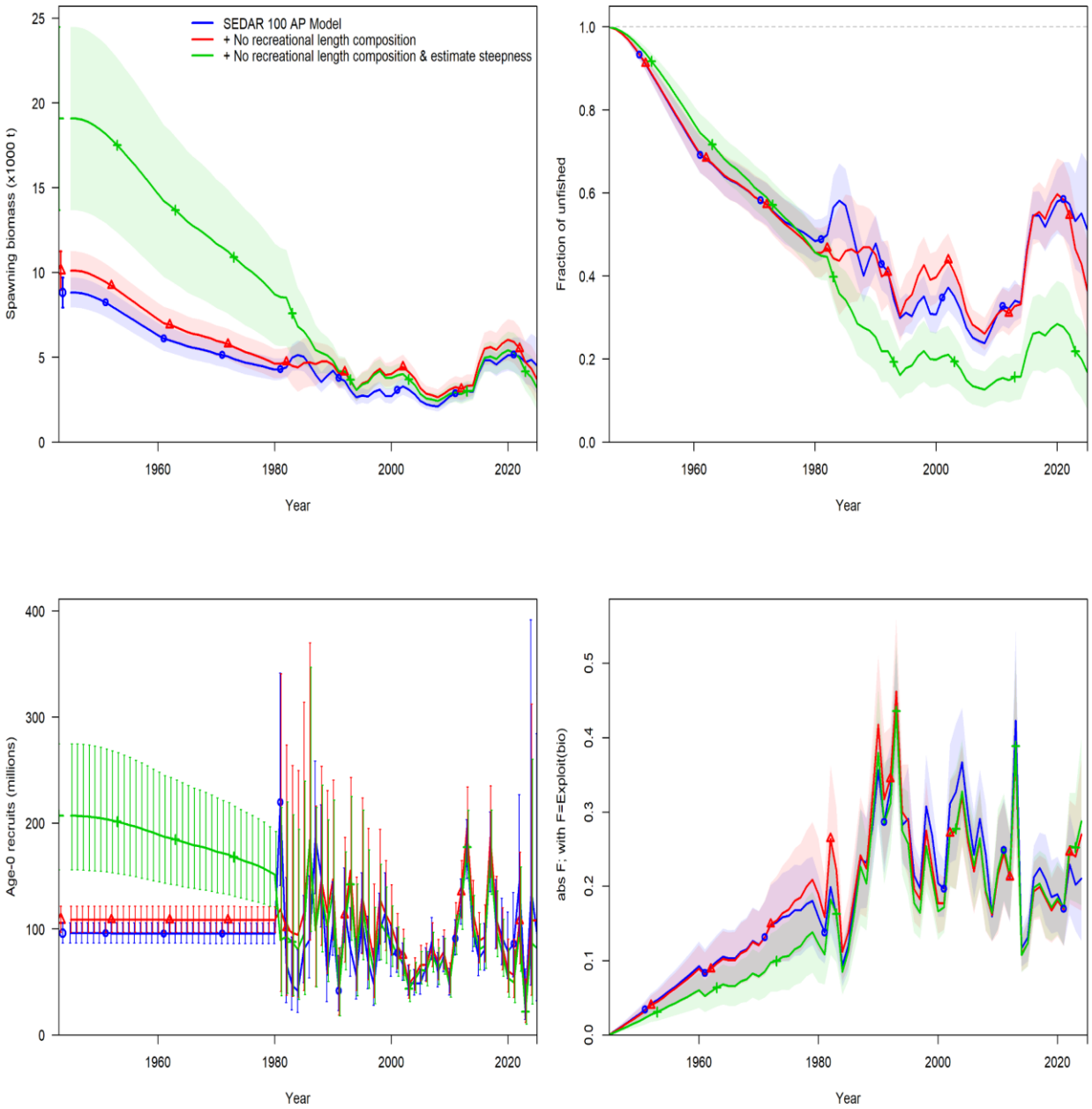


Figure 23. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the AP Model sensitivity run estimating steepness while also excluding fitting to the recreational length compositions.

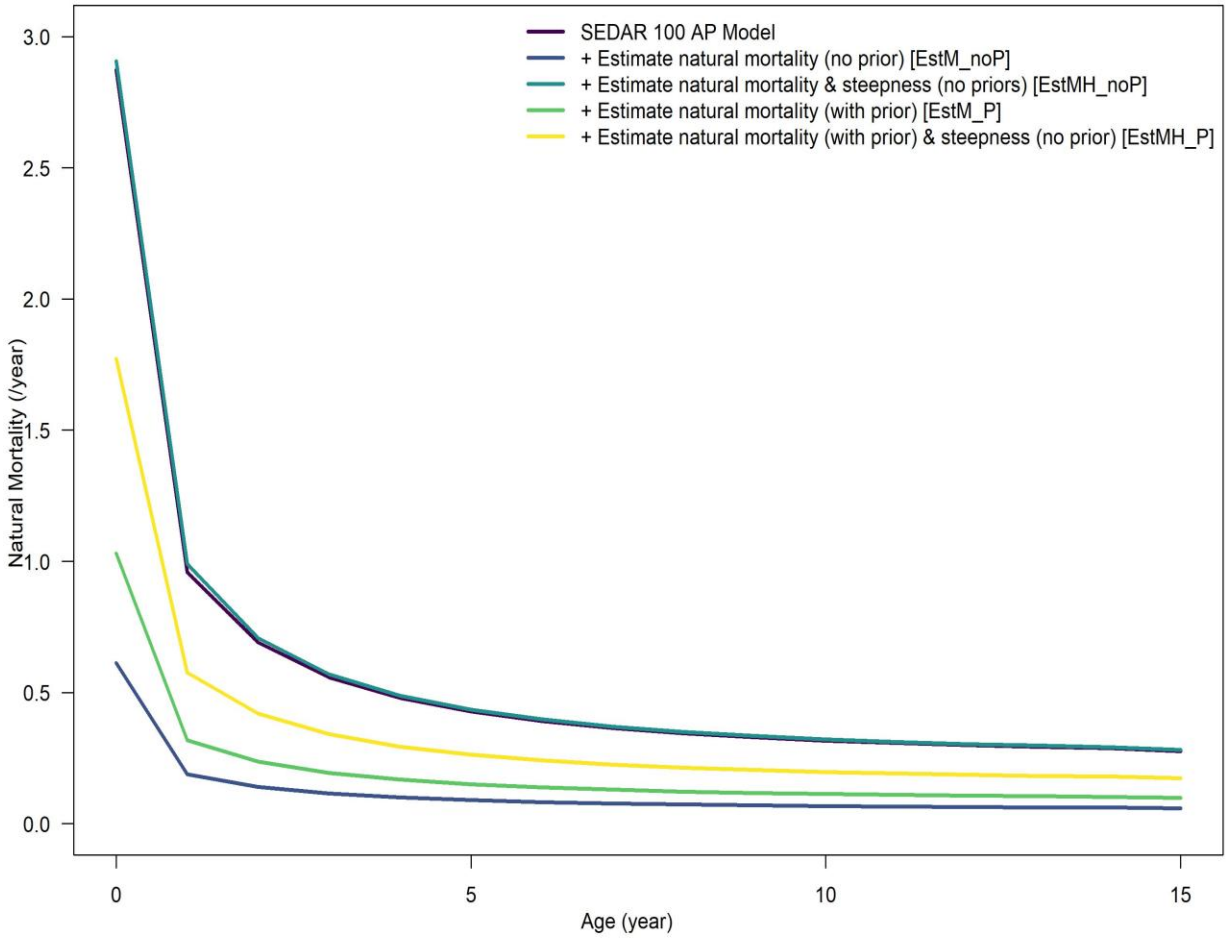


Figure 24. Age-specific natural mortality scaled within the AP Model and each sensitivity run estimating natural mortality.

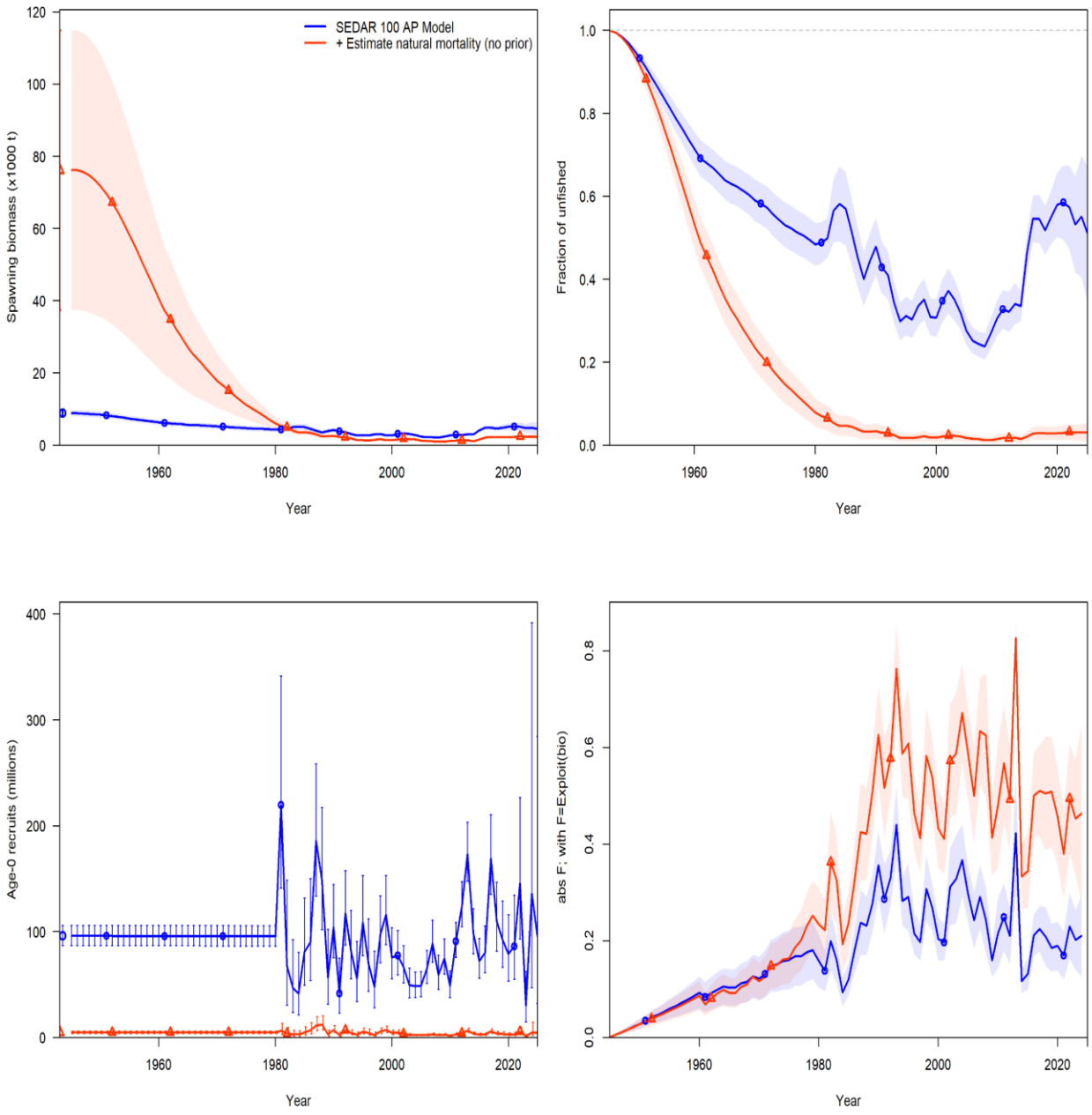


Figure 25. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the AP Model sensitivity run estimating natural mortality without a prior.

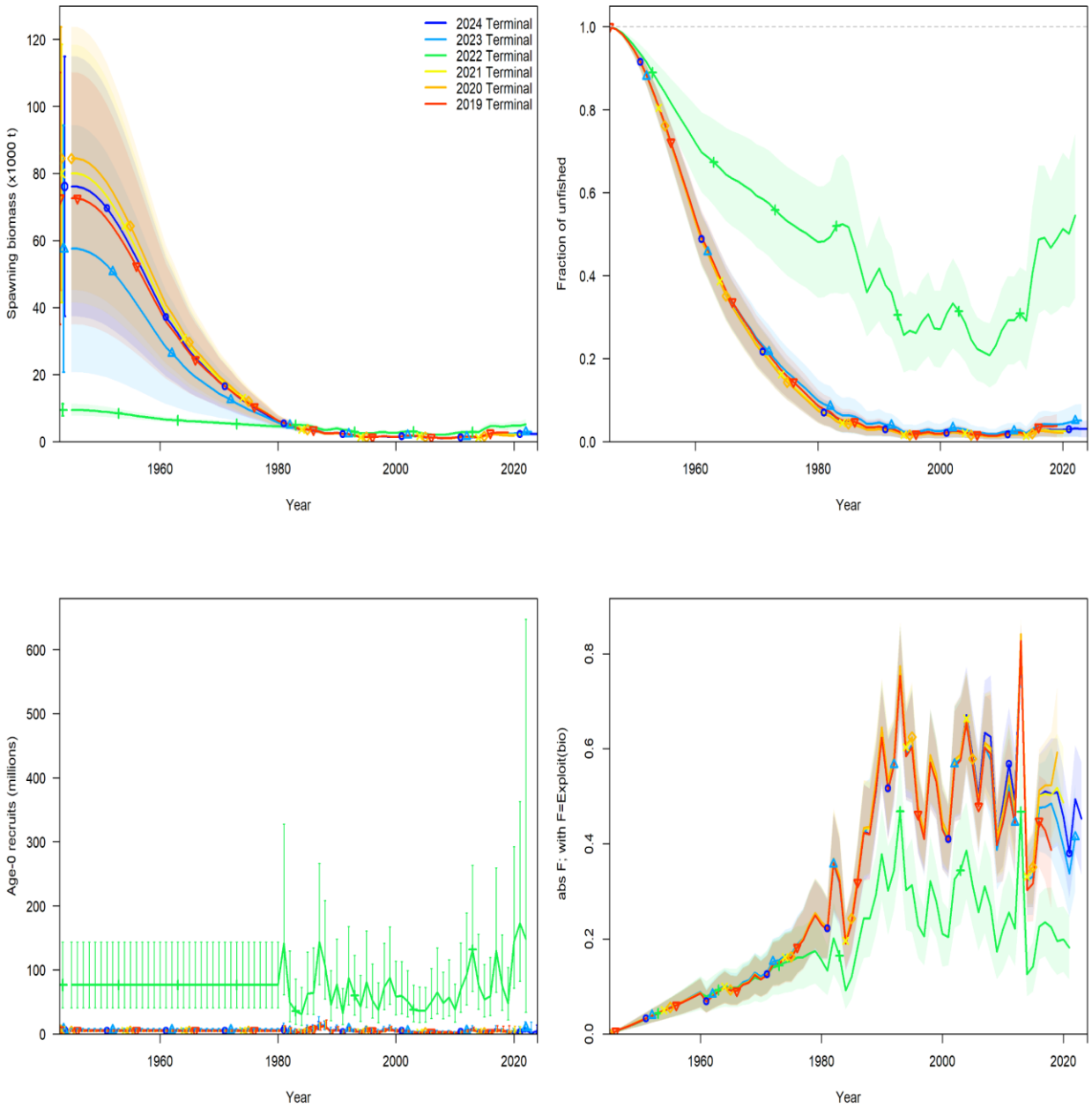


Figure 26. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the retrospective analysis for the AP Model sensitivity run estimating natural mortality without a prior.

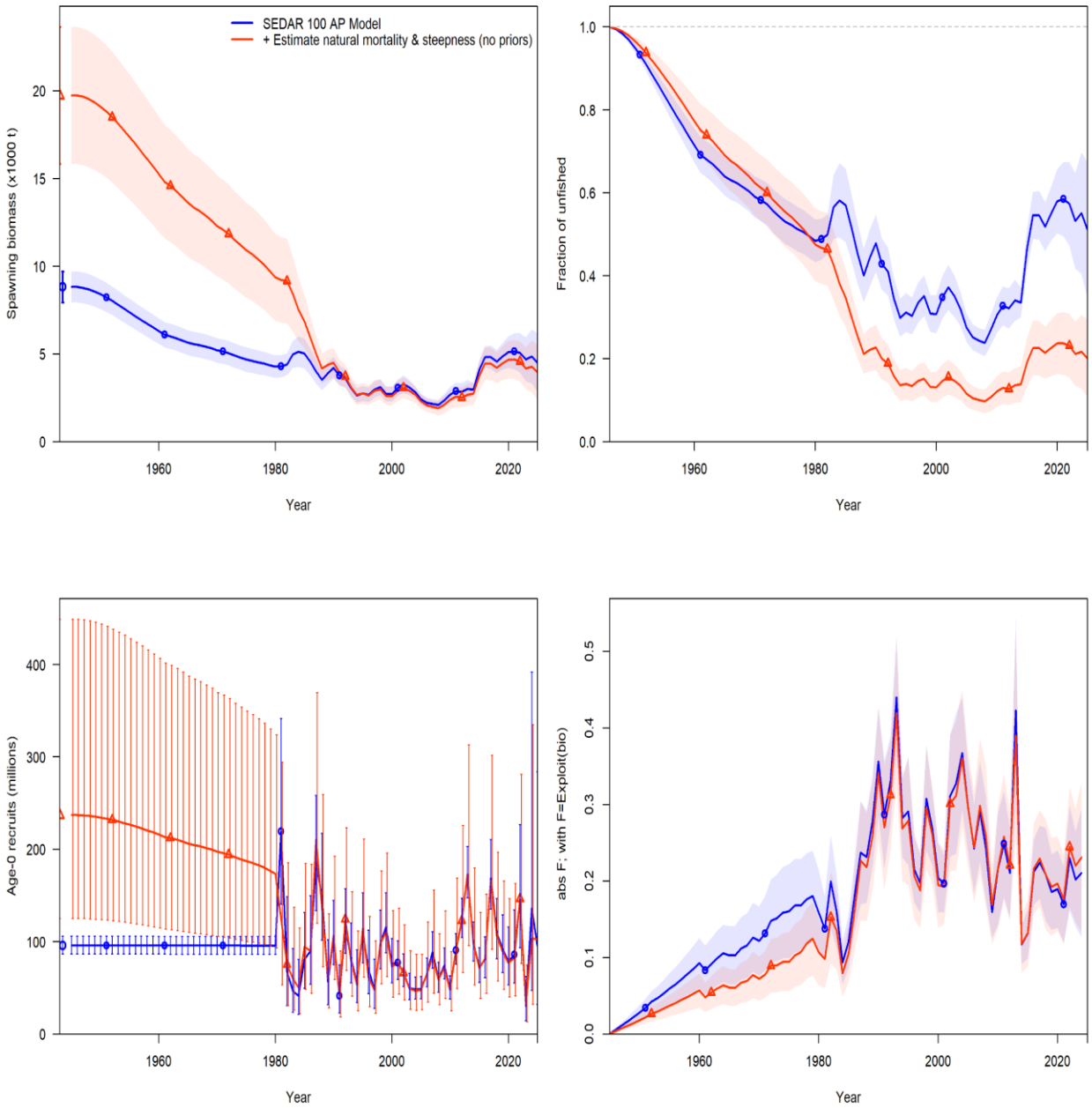


Figure 27. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the AP Model sensitivity run estimating both natural mortality and steepness without a prior.

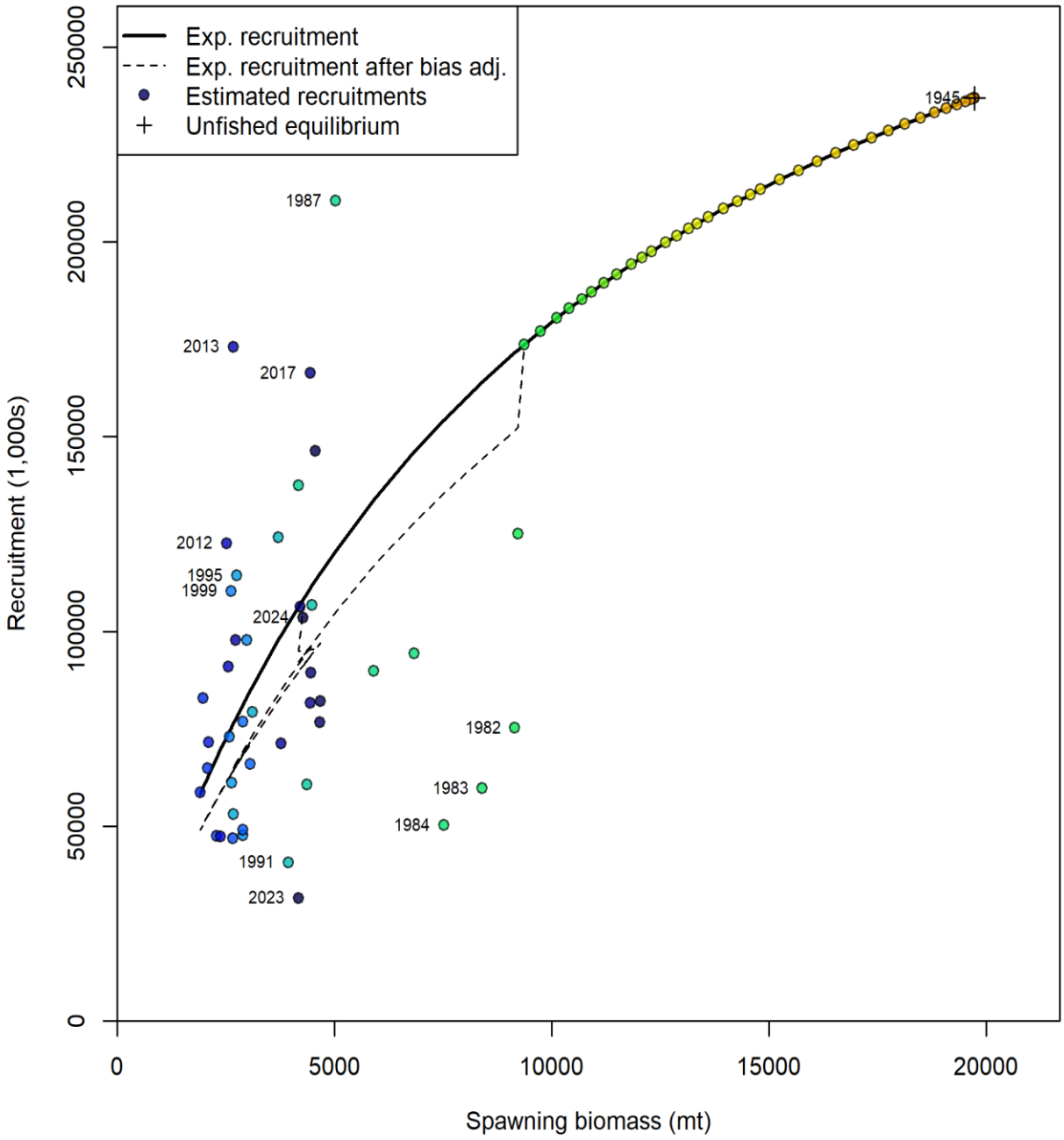


Figure 28. Predicted stock-recruit relationship for the sensitivity run estimating both natural mortality and steepness without a prior. Plotted are predicted annual recruitments from Stock Synthesis (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line).

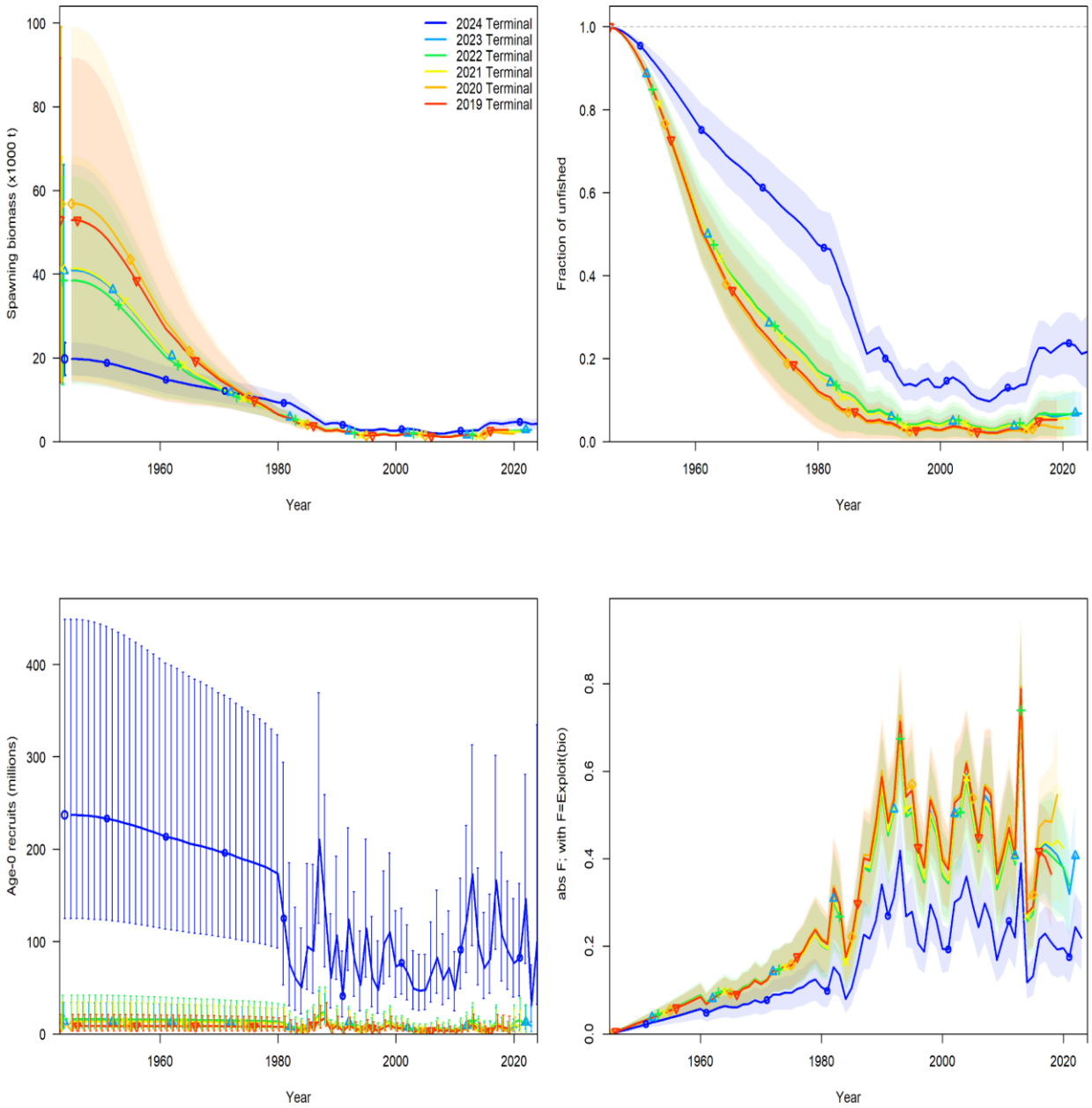


Figure 29. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the retrospective analysis for the AP Model sensitivity run estimating both natural mortality and steepness without a prior.

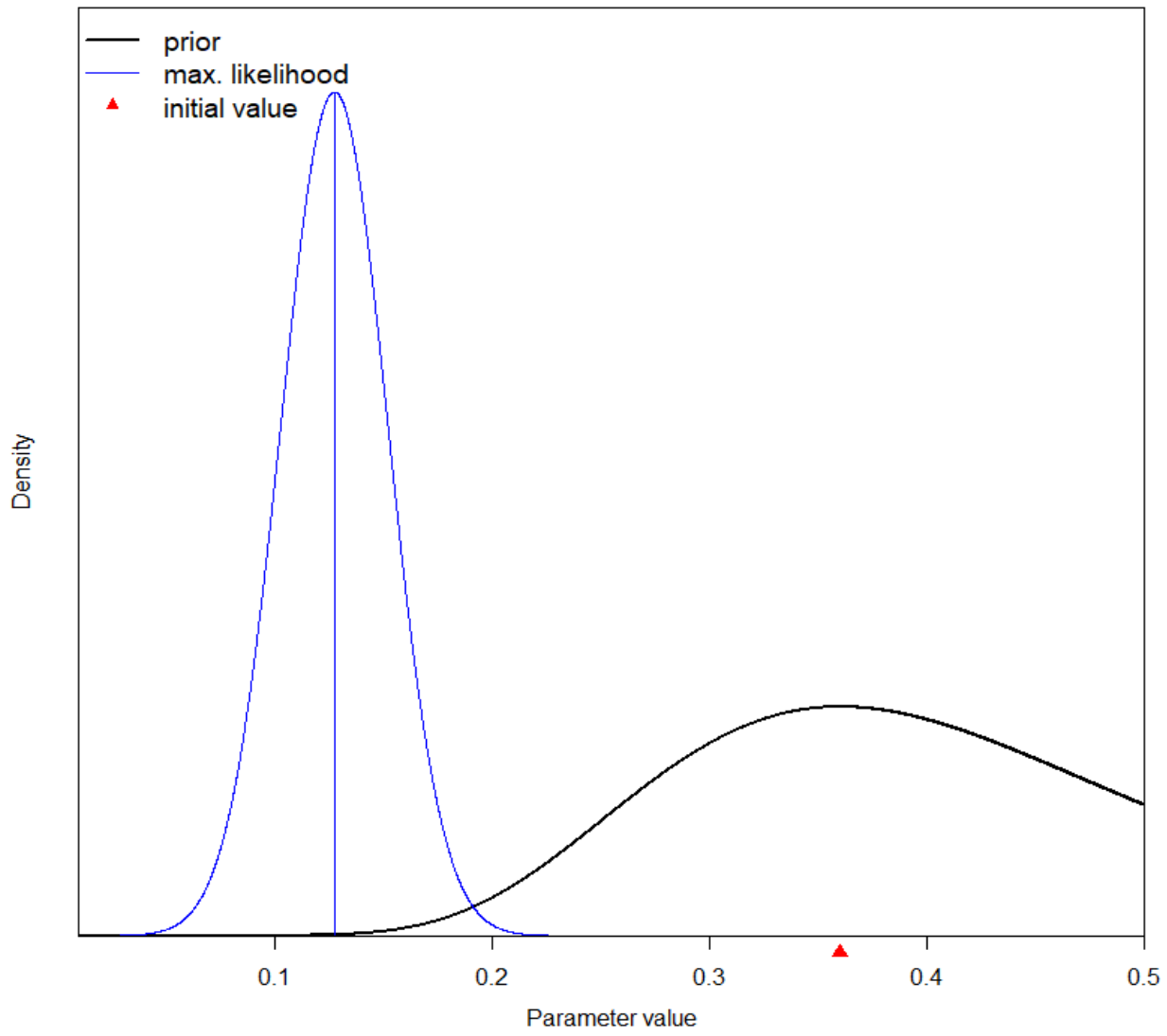


Figure 30. Comparison of the prior log-normal distribution assumed for natural mortality and the estimated value and distribution.

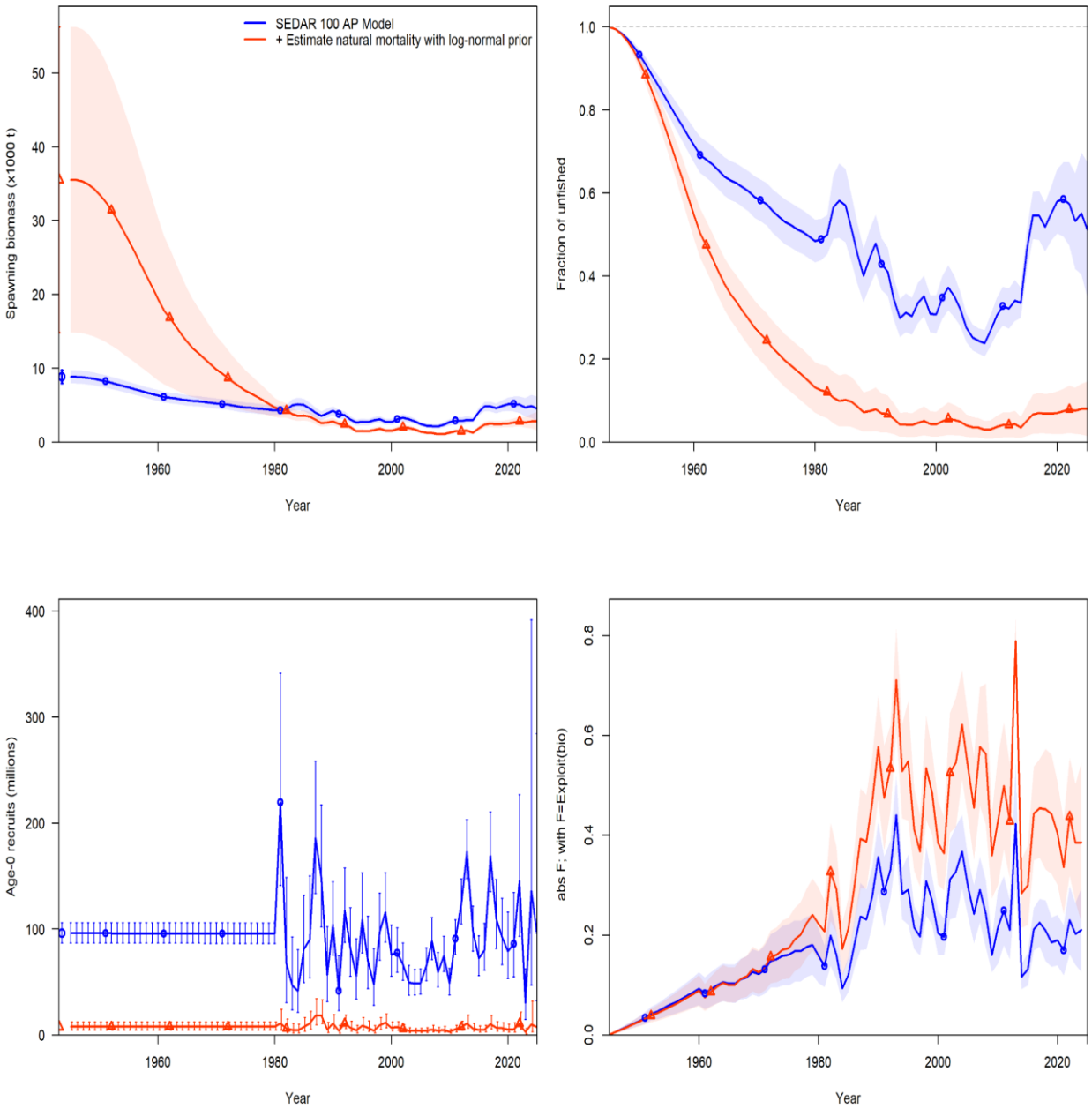


Figure 31. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the AP Model sensitivity run estimating natural mortality with a log-normal prior.

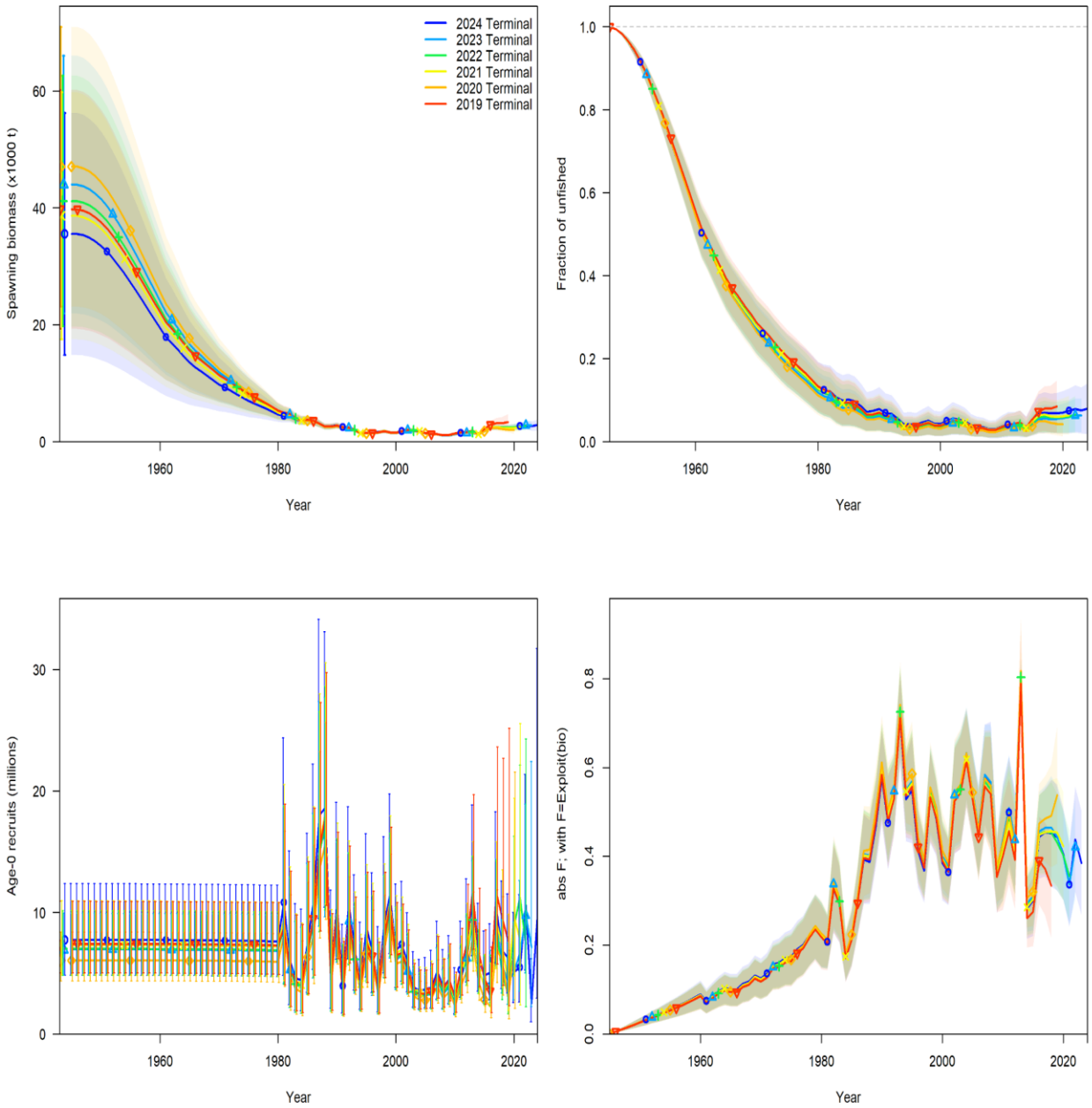


Figure 32. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the retrospective analysis for the AP Model sensitivity run estimating natural mortality with a log-normal prior.

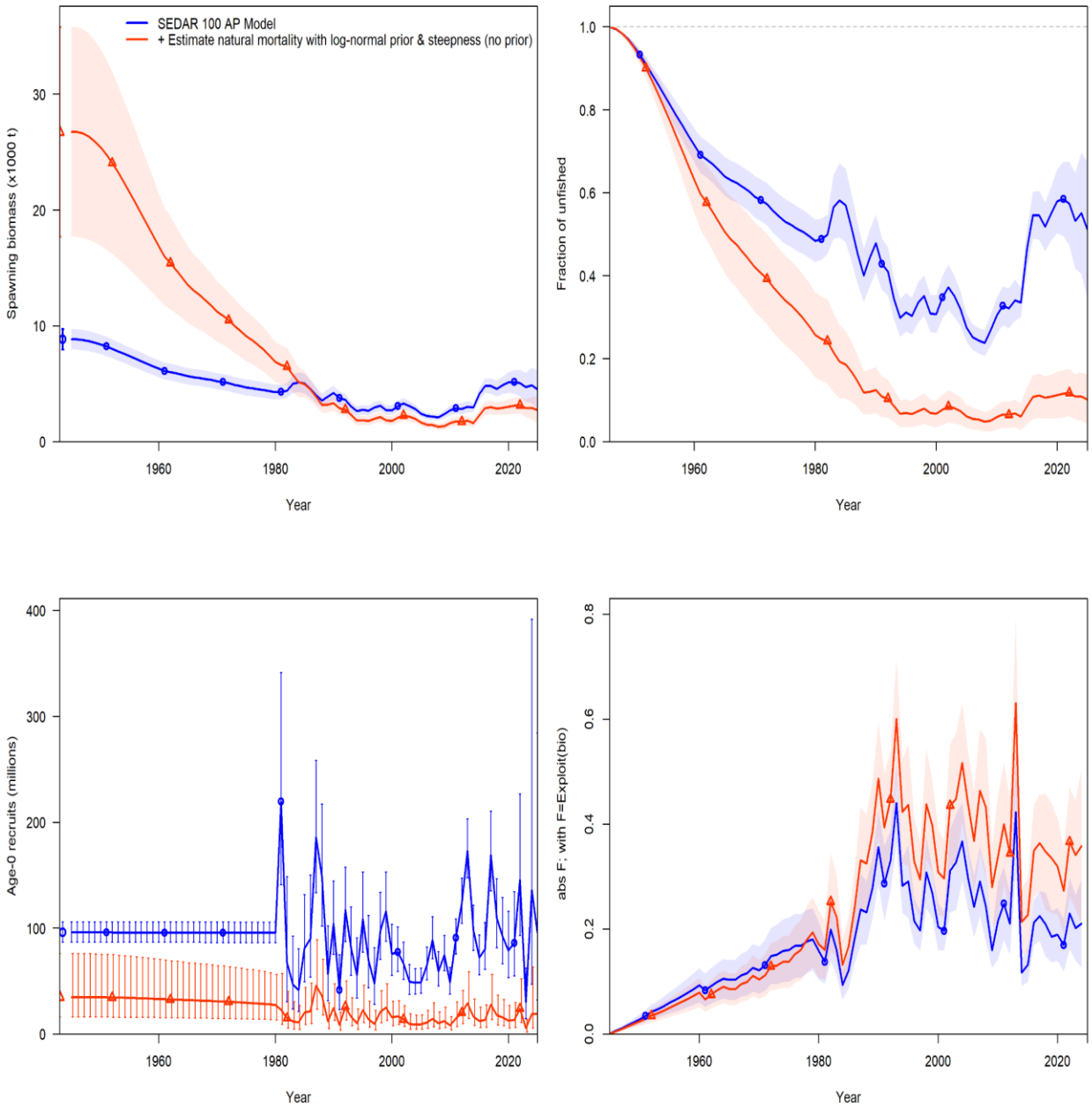


Figure 33. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the AP Model sensitivity run estimating natural mortality with a log-normal prior and steepness without a prior.

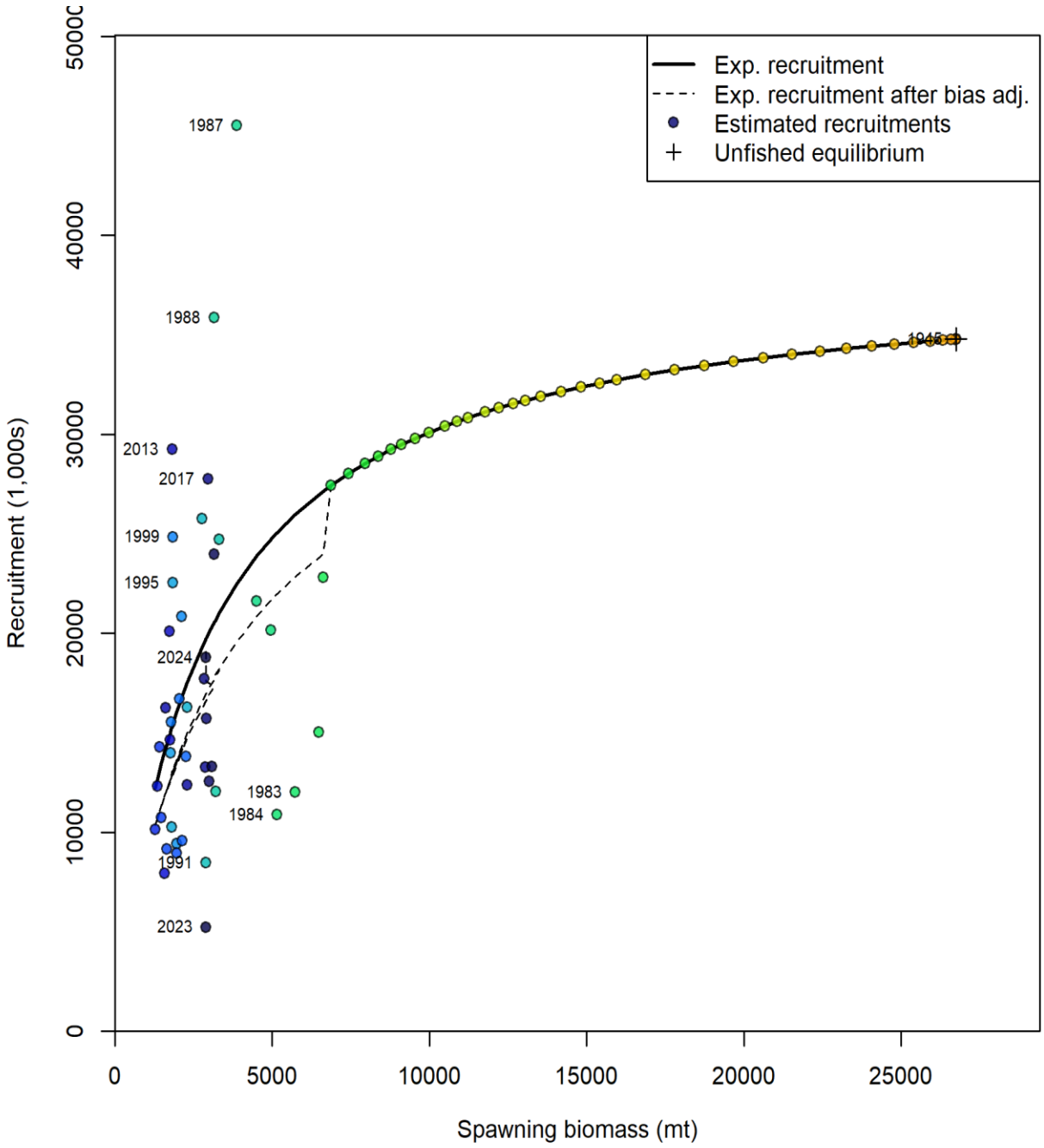


Figure 34. Predicted stock-recruit relationship for the AP Model sensitivity run estimating natural mortality with a log-normal prior and steepness without a prior. Plotted are predicted annual recruitments from Stock Synthesis (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line).

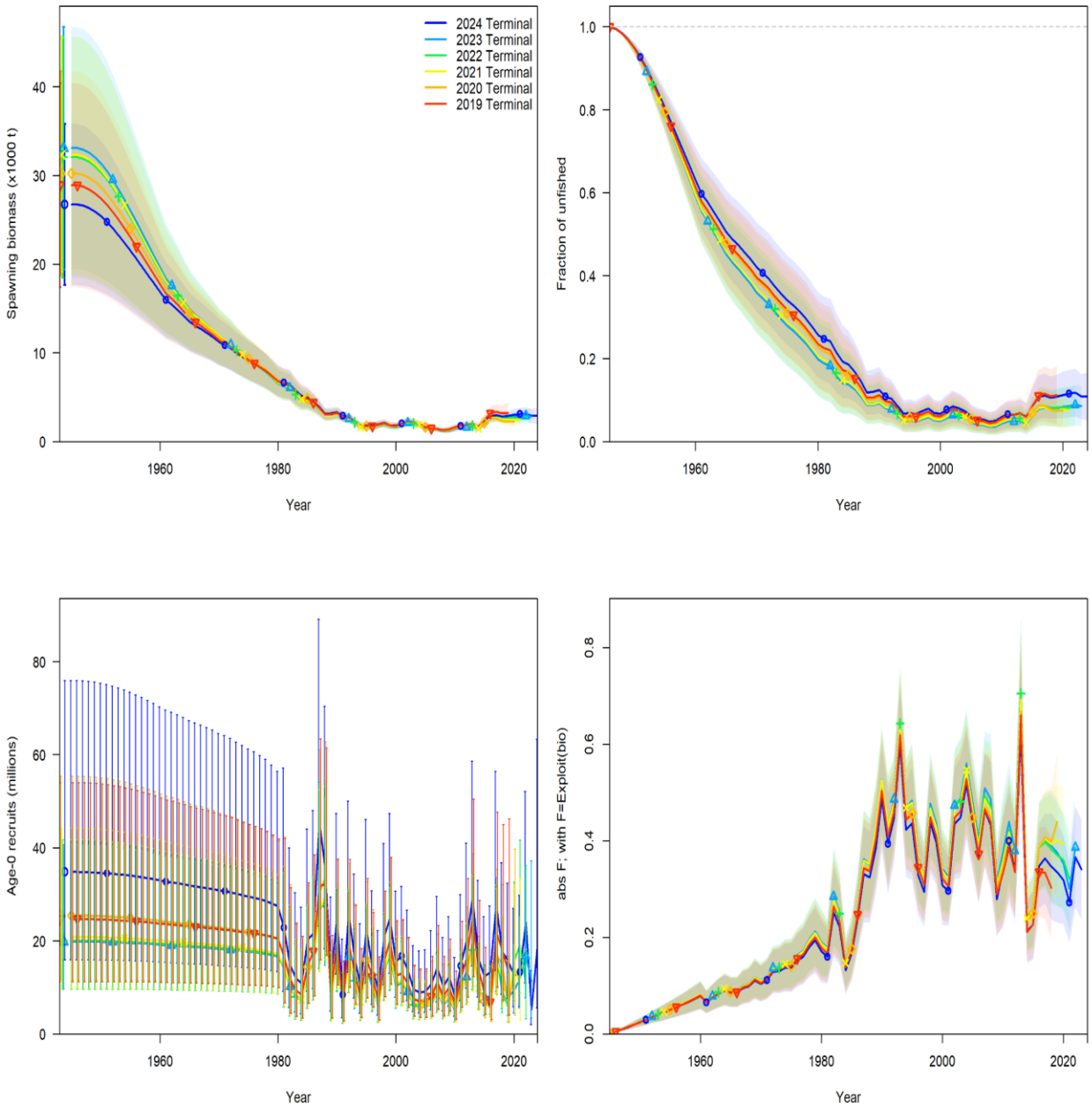


Figure 35. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the retrospective analysis for the AP Model sensitivity run estimating natural mortality with a log-normal prior and steepness without a prior.

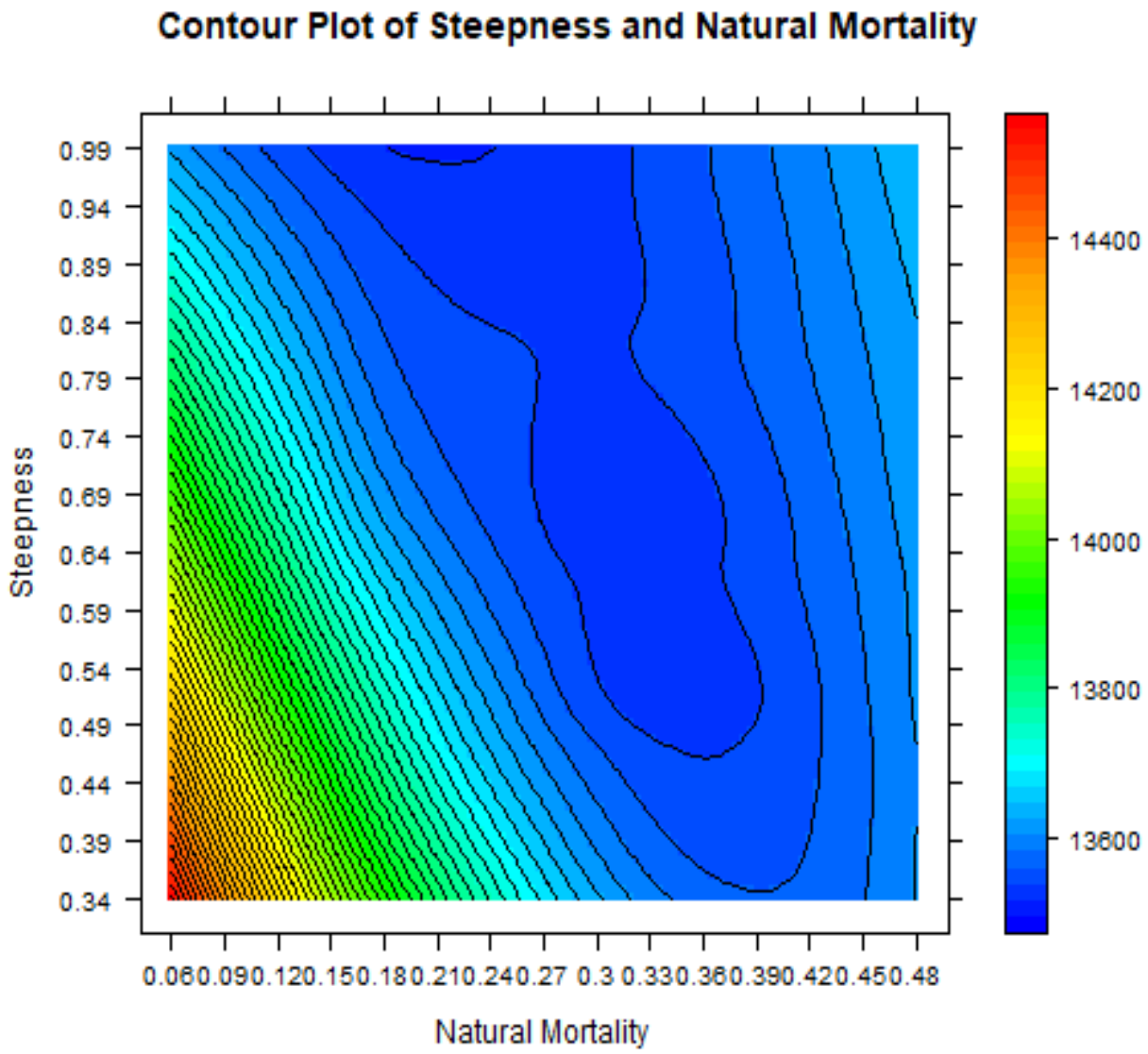


Figure 36. Bivariate likelihood profile (smoothed) of natural mortality (0.06-0.48 in 0.03 intervals) and steepness (0.34-0.99 in 0.05 intervals) for the AP Model (M fixed at 0.36 and H fixed at 0.99).

		Natural Mortality														
		0.06	**0.09**	**0.12**	**0.15**	**0.18**	**0.21**	**0.24**	**0.27**	**0.3**	**0.33**	**0.36**	**0.39**	**0.42**	**0.45**	**0.48**
	0.34	14498.1	14415	14218.1	14029.7	13919.2	13810.3	13720.3	13671.3	13623.8	13589.2	13573.2	13567.8	13571.6	13581.7	13594.9
	0.39	14439.7	14228.3	14085.5	13936.3	13836.6	13769.2	13675.7	13622.4	13584.8	13565.6	13560.4	13565	13574.9	13587.3	13601.2
	0.44	14382	14231	14015.1	13879.9	13787.7	13684.7	13626	13586.2	13564.8	13558.7	13559.8	13568.7	13579.9	13591.8	13604.8
	0.49	14448.3	14125.3	13972.4	13813.3	13730.3	13647.2	13595.2	13563.6	13555.3	13558.5	13566.1	13573	13583.9	13595	13606.4
	0.54	14260.8	14090.6	13870.8	13751.5	13677.8	13606.3	13568.3	13553.4	13553.7	13556.6	13566.6	13576.4	13586.7	13597.2	13608
	0.59	14144	14005.1	13823.6	13701.7	13660.3	13591.5	13563	13548.8	13551.6	13560.2	13569.7	13579.3	13588.9	13598.7	13609.1
Steepness	**0.64**	14129.1	13915.9	13817.7	13668.7	13595.5	13557.6	13545.6	13547.5	13554.8	13567.3	13572.5	13581.4	13590.5	13599.9	13609.9
	0.69	14028	13829	13708	13616.5	13572.2	13557.9	13544.3	13551.7	13561.4	13566.5	13574.8	13583.1	13591.8	13600.7	13612.9
	0.74	14007.2	13763.4	13657.1	13582.3	13591.3	13542.5	13554.5	13553.5	13561.3	13569.7	13576.6	13584.6	13592.7	13601.4	13611.9
	0.79	13914.7	13723.5	13605.9	13556.5	13544.3	13547.4	13549.5	13559.6	13565.4	13571	13578.1	13585.7	13593.4	13602	13611.4
	0.84	13778.2	13641.1	13607	13543.1	13541.4	13546.4	13553	13561.1	13566.1	13572.6	13579.2	13590.4	13594.1	13602.4	13611.8
	0.89	13695.6	13594.3	13544.7	13588.9	13544.5	13552.8	13556.3	13575.9	13579.6	13573.9	13580.2	13587.2	13594.5	13602.8	13612.1
	0.94	13587	13546.5	13615.5	13550.3	13570.2	13572.3	13559.3	13564.3	13572.7	13575	13581	13587.6	13595.9	13606	13613.3
	0.99	13612.2	13570.5	13546.1	13552.1	13553.8	13560.3	13565.8	13566.2	13570.8	13576.7	13581.6	13588.3	13595.4	13603.4	13612.8

Figure 37. Bivariate likelihood profile (raw NLL values for tested combinations) of natural mortality (0.06-0.48 in 0.03 intervals) and steepness (0.34-0.99 in 0.05 intervals) for the AP Model (M fixed at 0.36 and H fixed at 0.99).

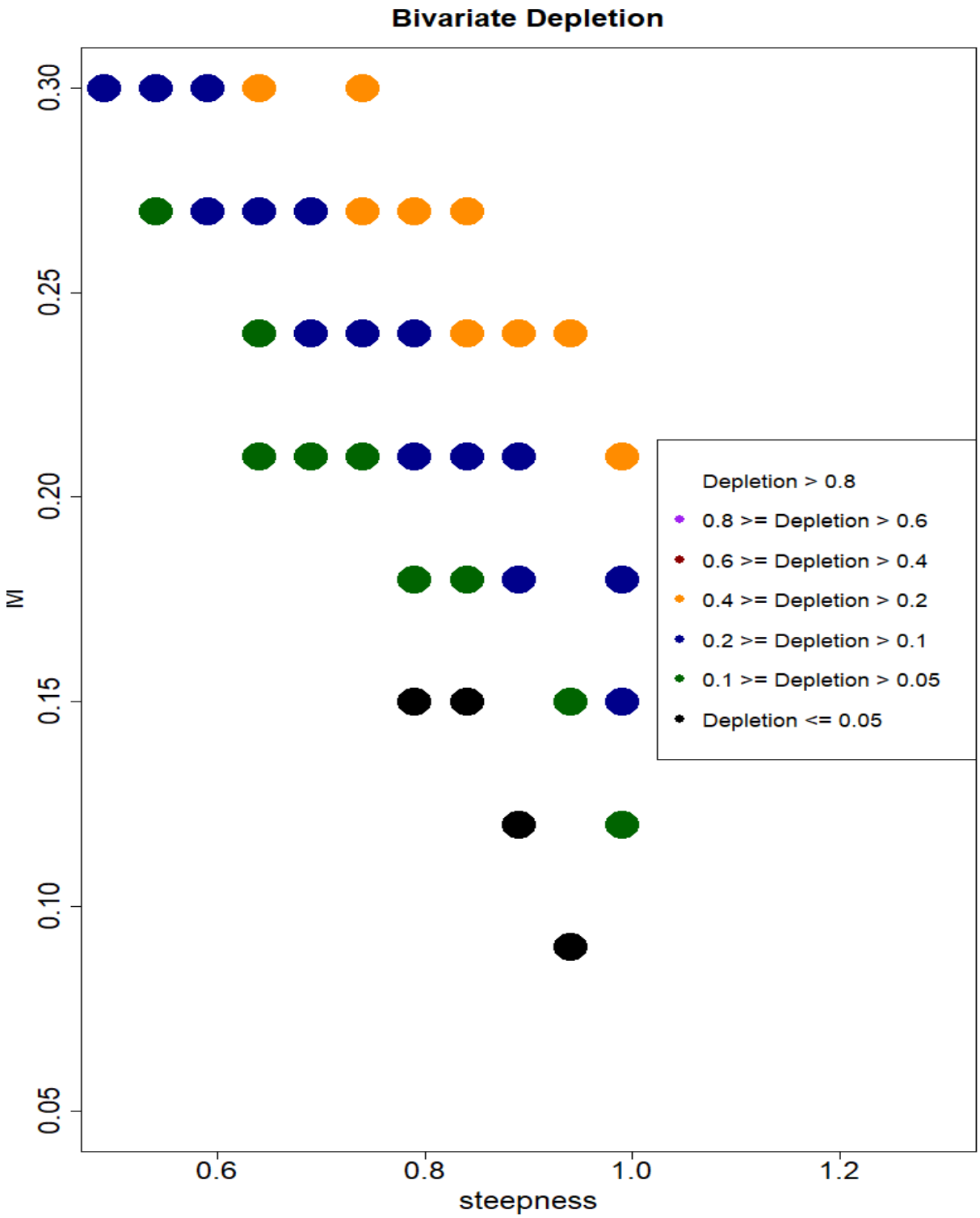


Figure 38. Depletion in 2024 (i.e., SSB ratio) across bivariate likelihood profile combinations of M and H. White areas indicate combinations where the NLL was more than 20 units from the minimum.

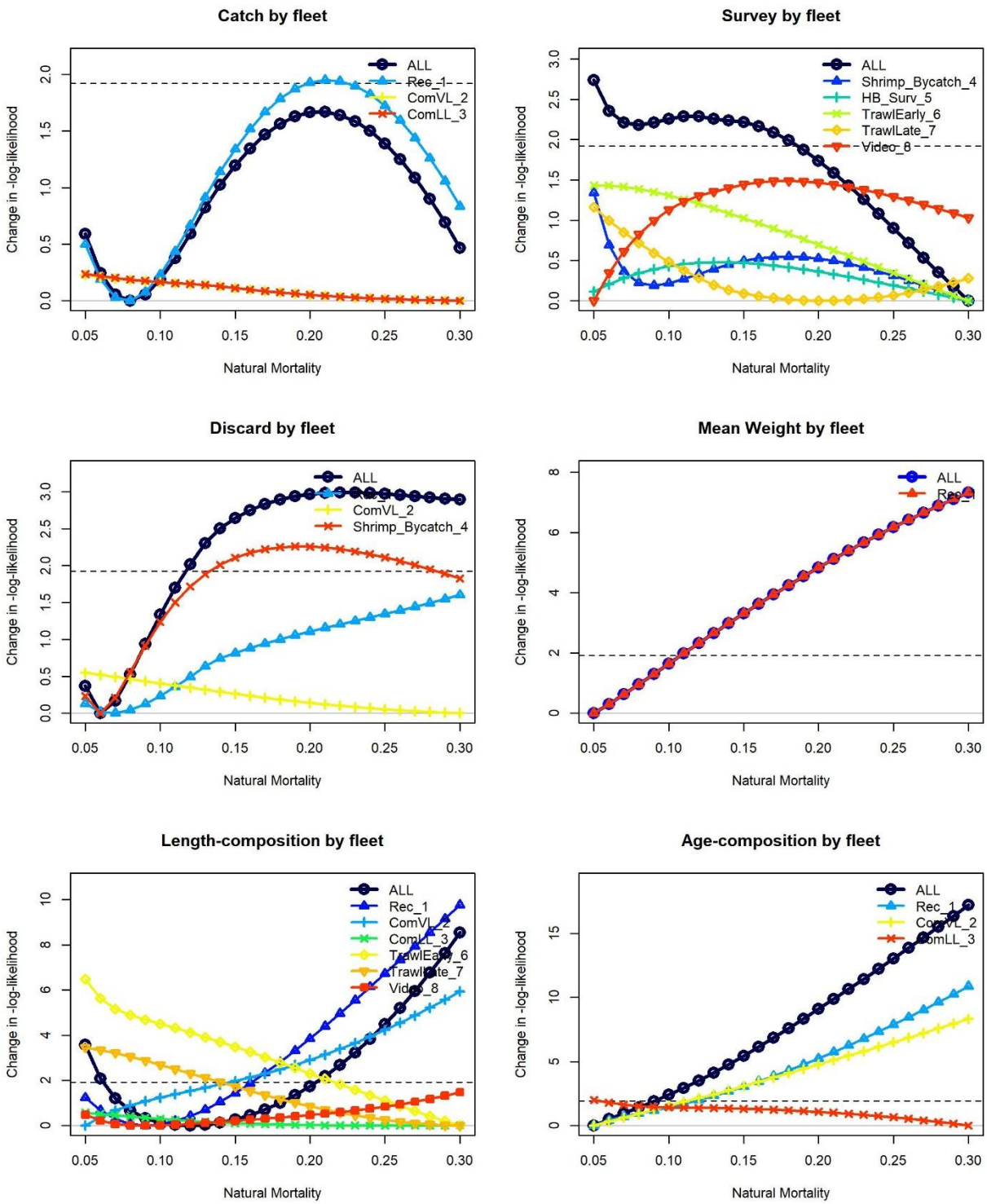


Figure 39. Piner plot of natural mortality showing the change in negative log-likelihood values across data types and fleets/surveys. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

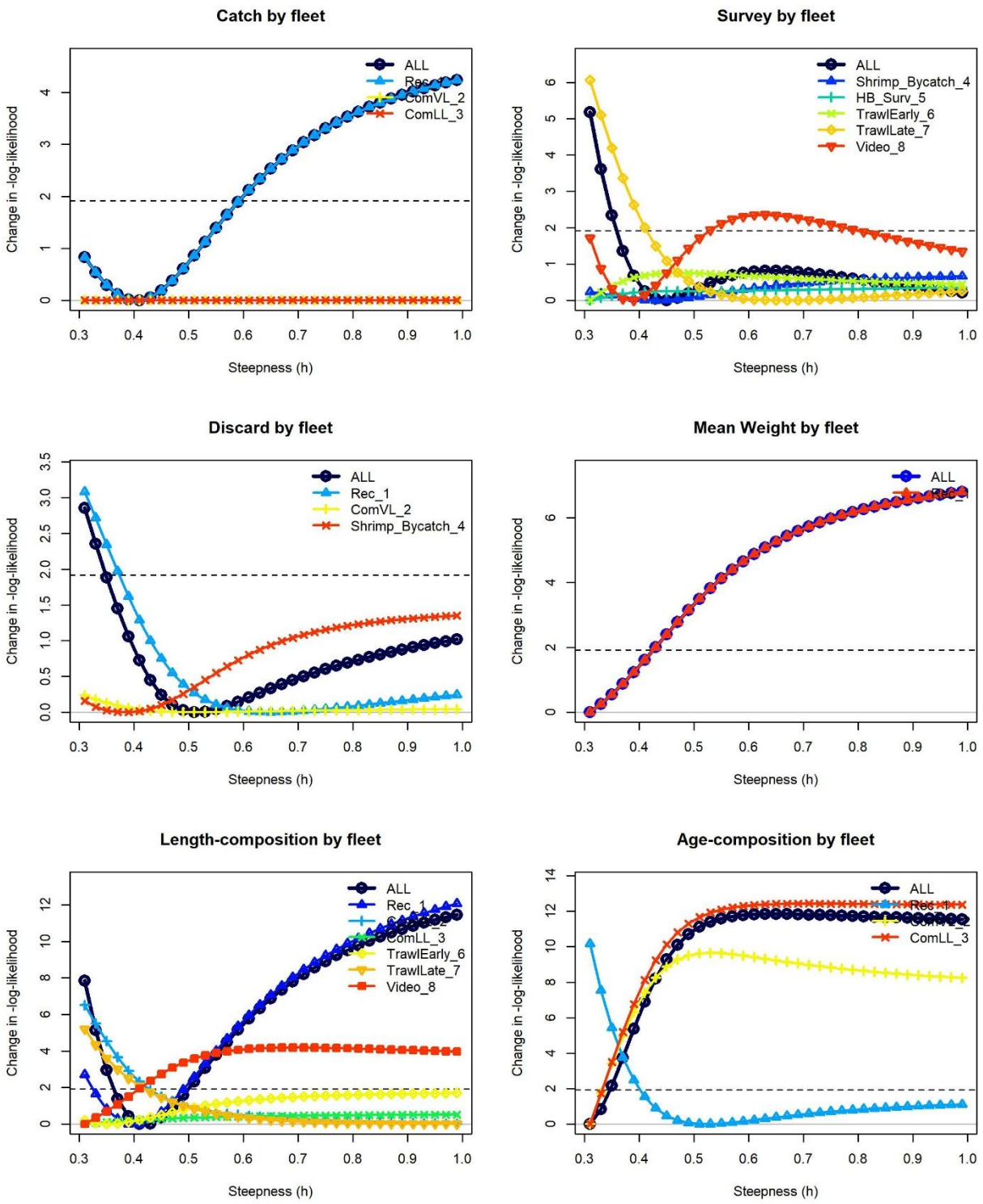


Figure 40. Piner plot of steepness showing the change in negative log-likelihood values across data types and fleets/surveys. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

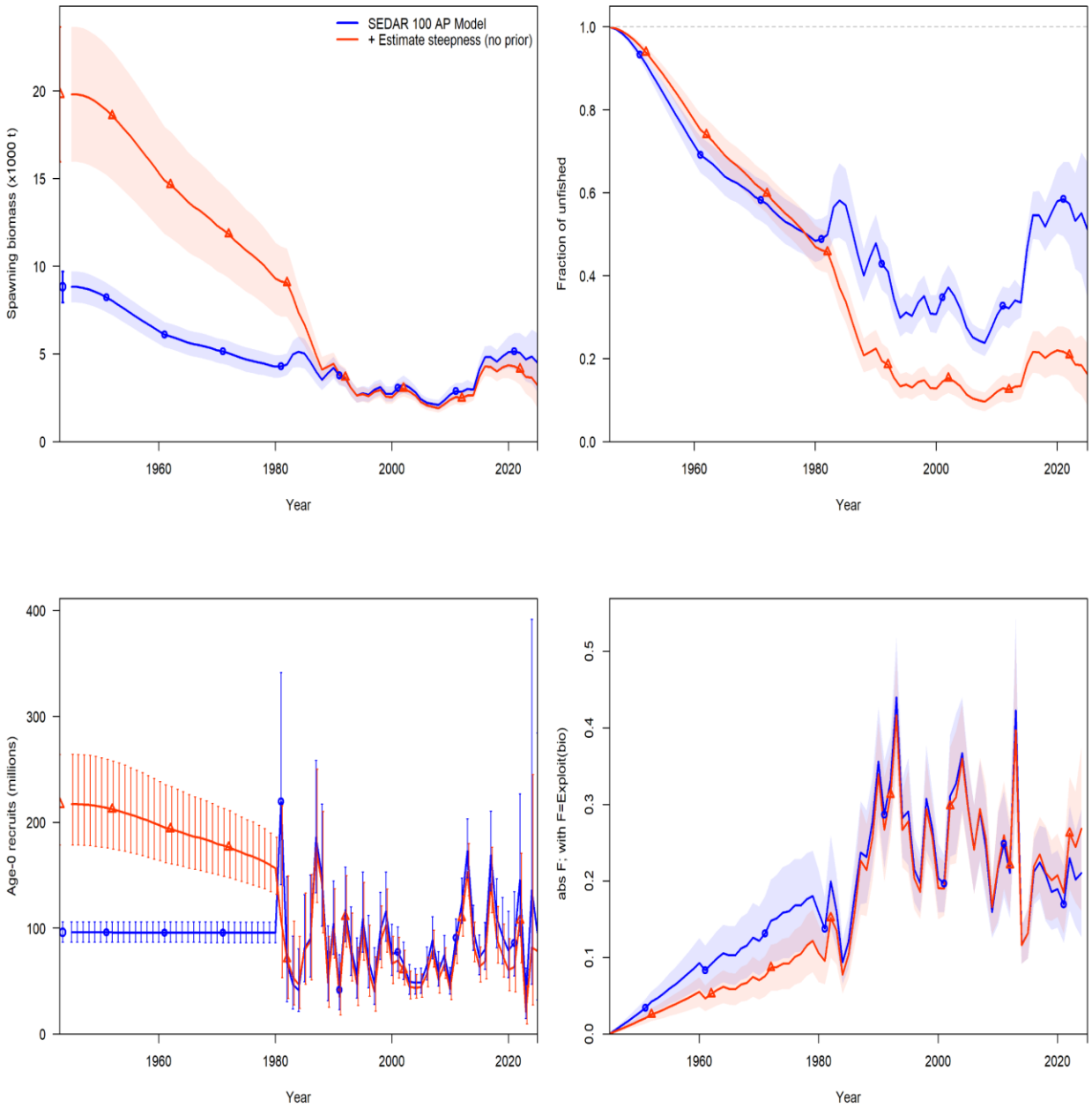


Figure 41. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the AP Model sensitivity run estimating steepness without a prior (RW Model).

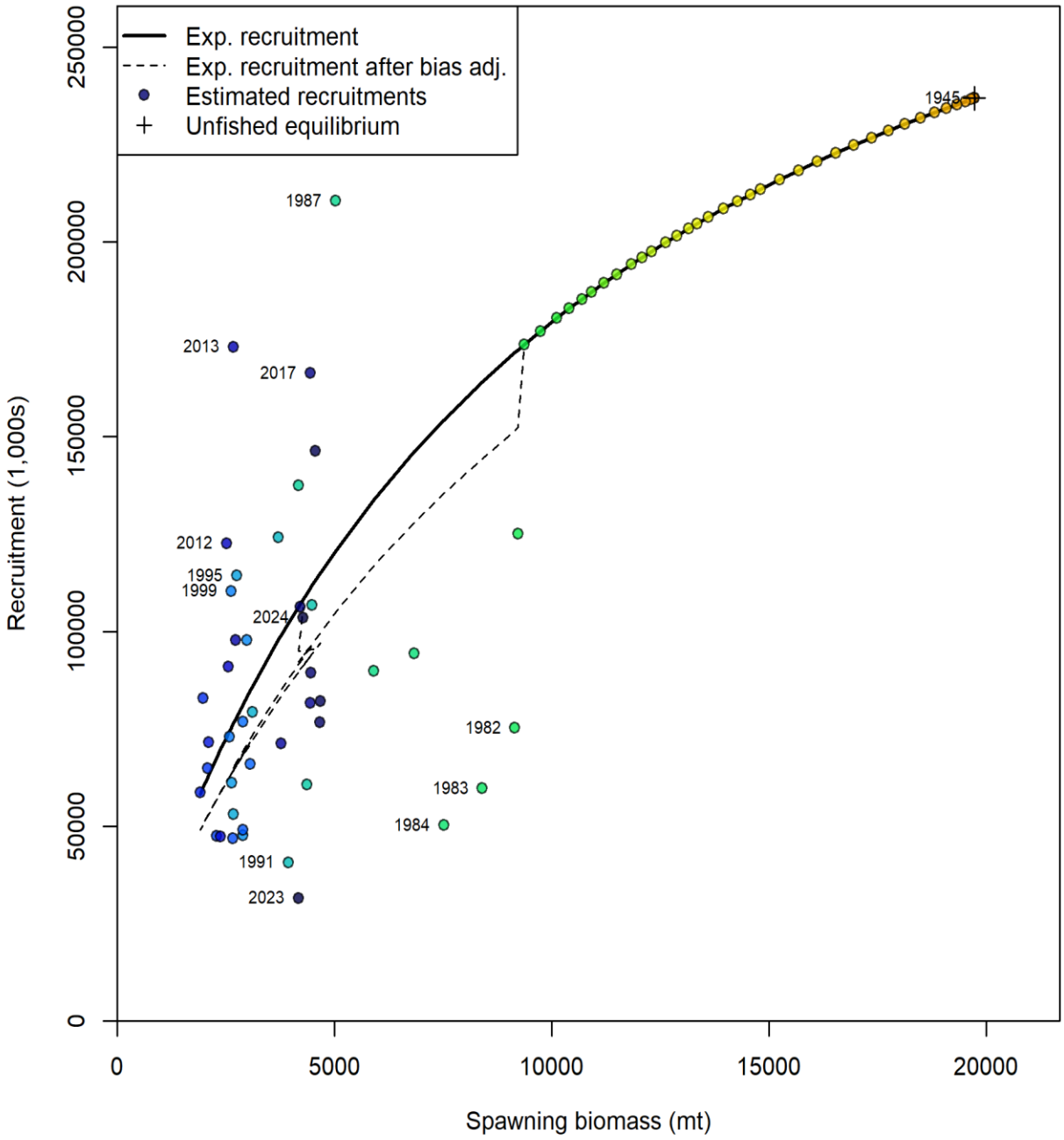


Figure 42. Predicted stock-recruit relationship for the AP Model sensitivity run estimating steepness without a prior (RW Model). Plotted are predicted annual recruitments from Stock Synthesis (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line).

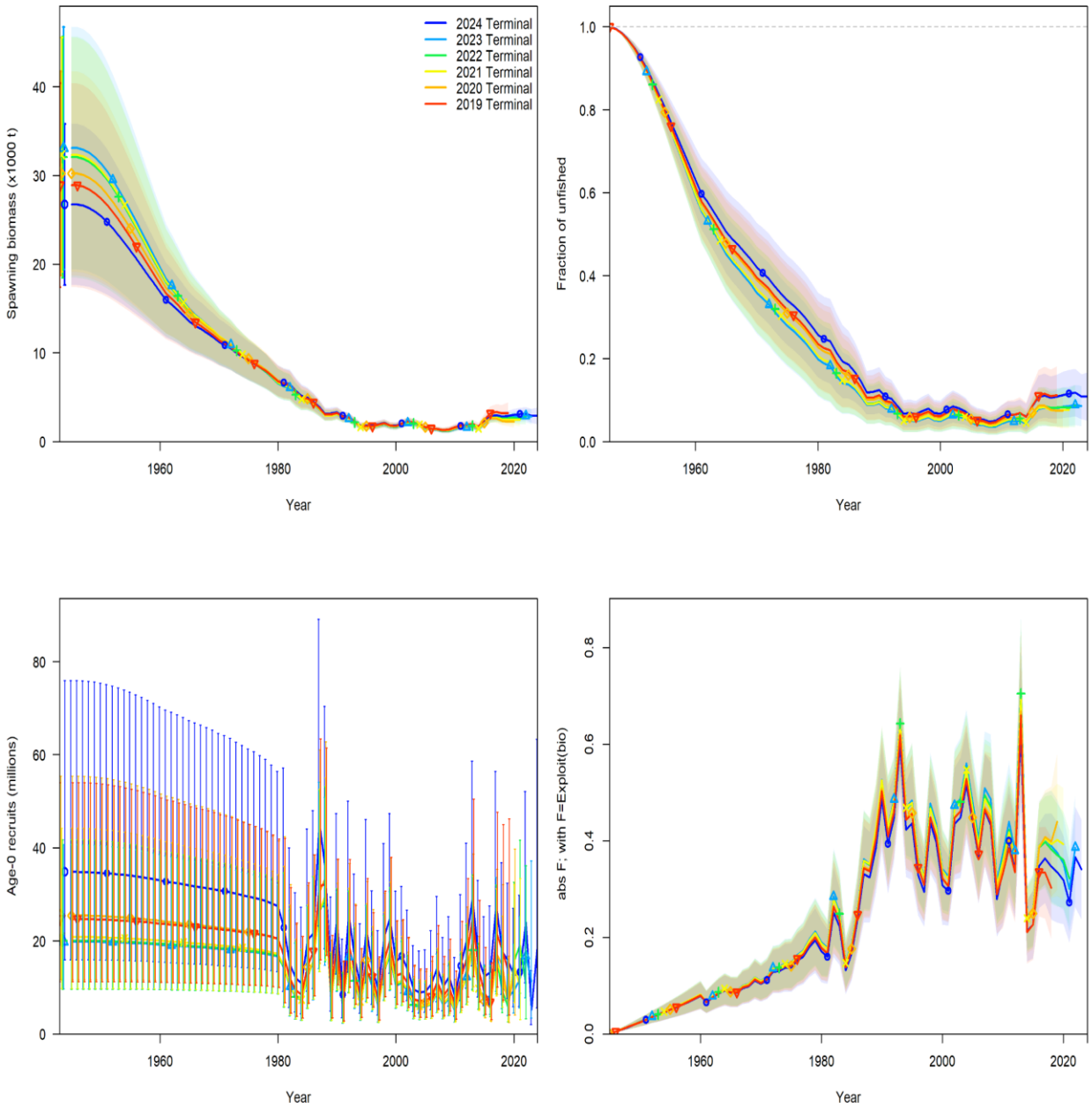


Figure 43. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the retrospective analysis for the AP Model sensitivity run estimating steepness without a prior (RW Model).

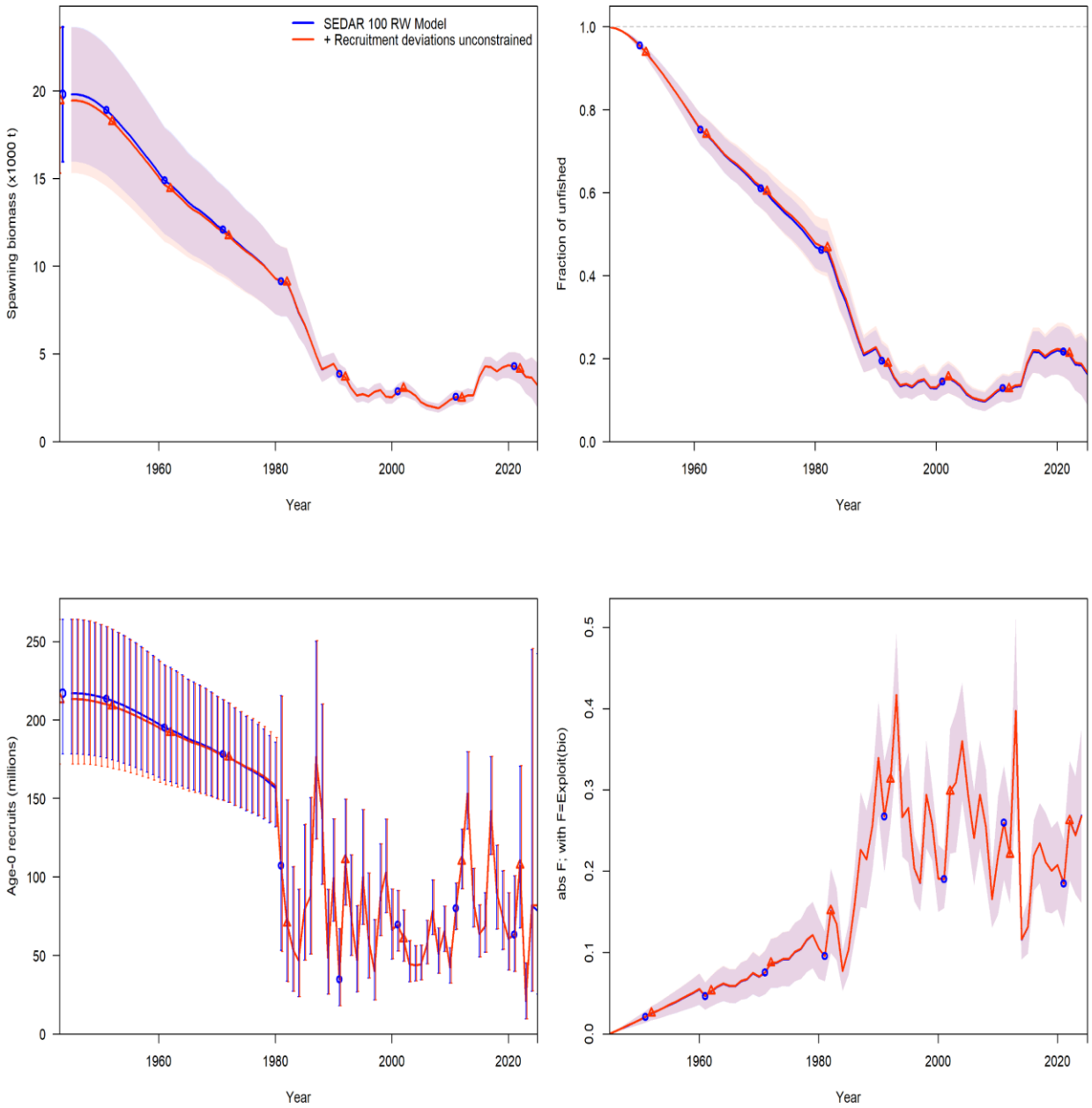


Figure 44. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the RW Model sensitivity run estimating unconstrained recruitment deviations.

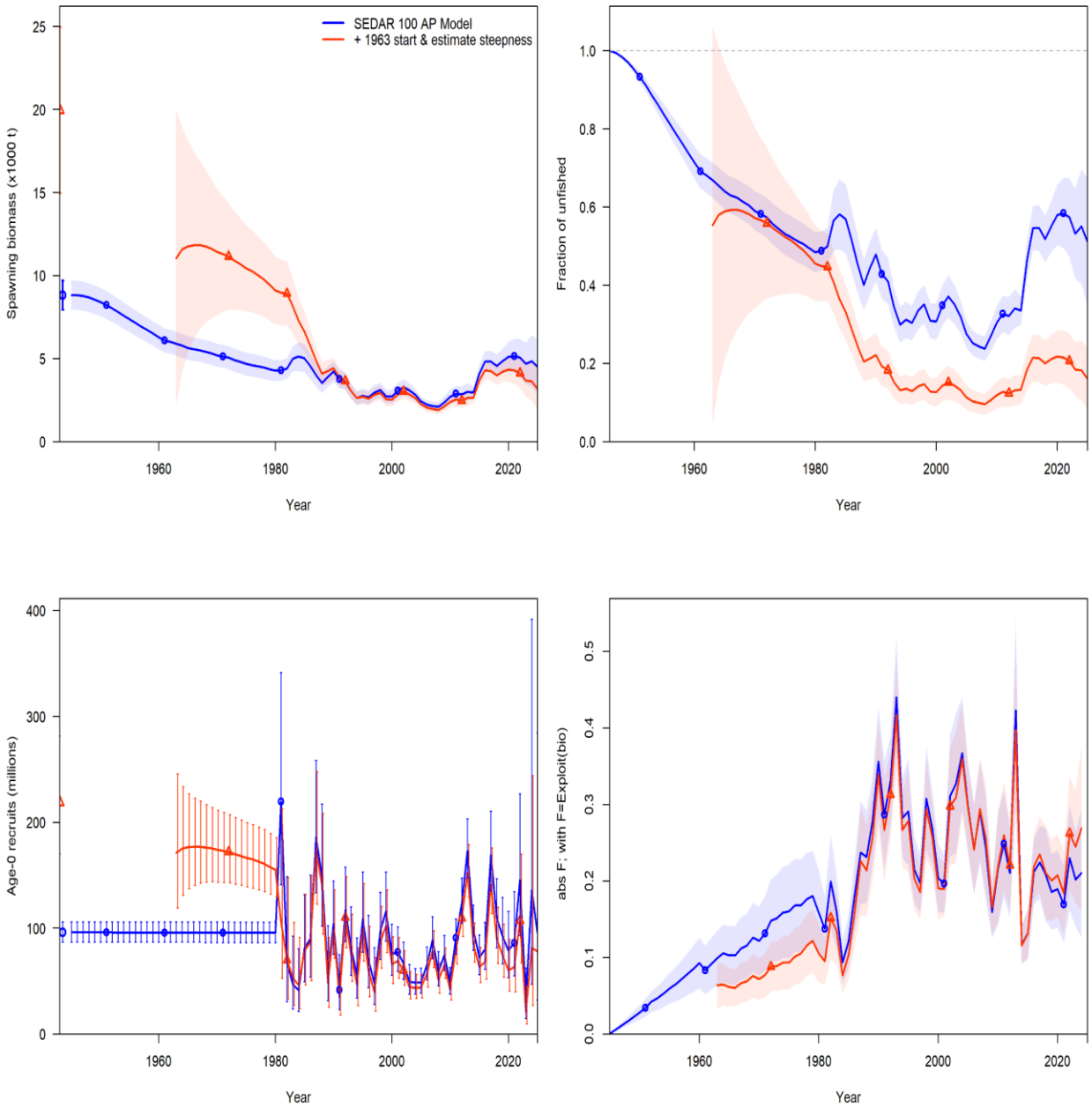


Figure 45. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the AP Model sensitivity run starting in 1963 and estimating steepness without a prior.

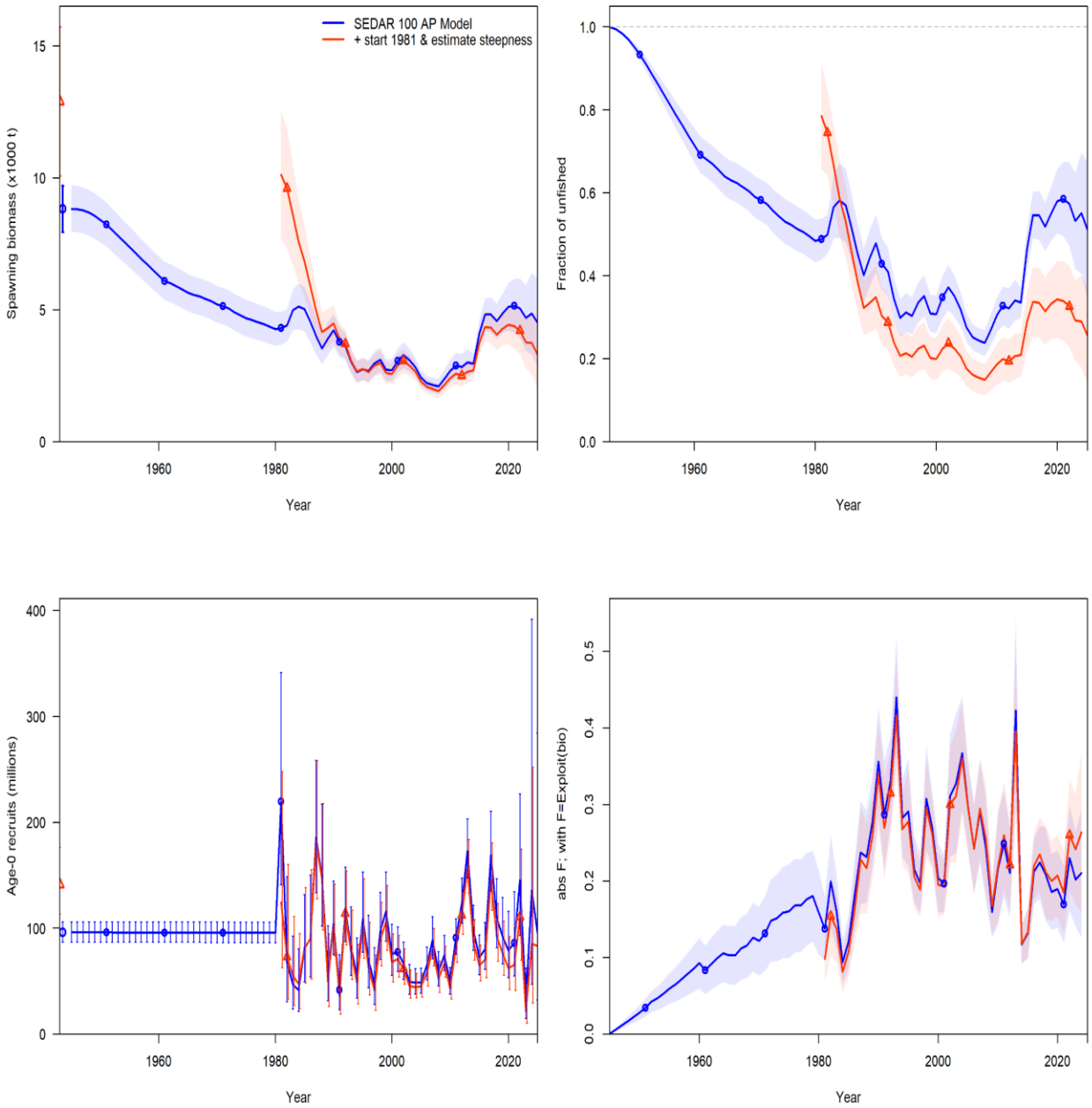


Figure 46. Estimates of spawning stock biomass (SSB in 1,000s of metric tons; top left panel), the ratio of SSB to virgin SSB (top right panel), recruitment (millions of fish; bottom left panel), and fishing mortality (total biomass killed / total biomass age 1+; bottom right panel) for the AP Model sensitivity run starting in 1981 and estimating steepness without a prior.

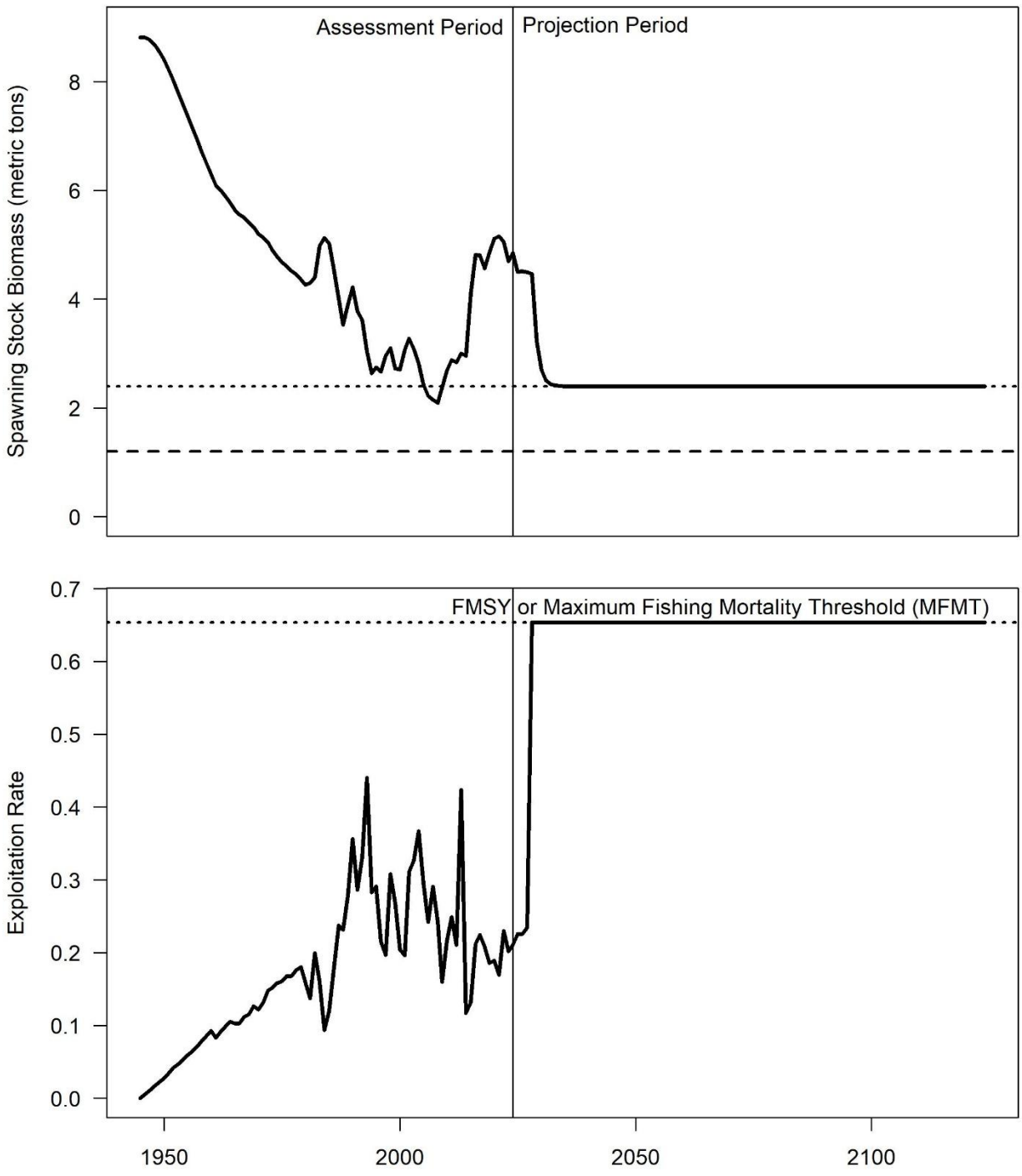


Figure 47. Time series of SSB (1,000s of metric tons) and fishing mortality (as an exploitation rate in total biomass killed / total biomass age 1+) with respect to status determination criteria for the MSY projection for the AP Model where steepness is fixed at 0.99.

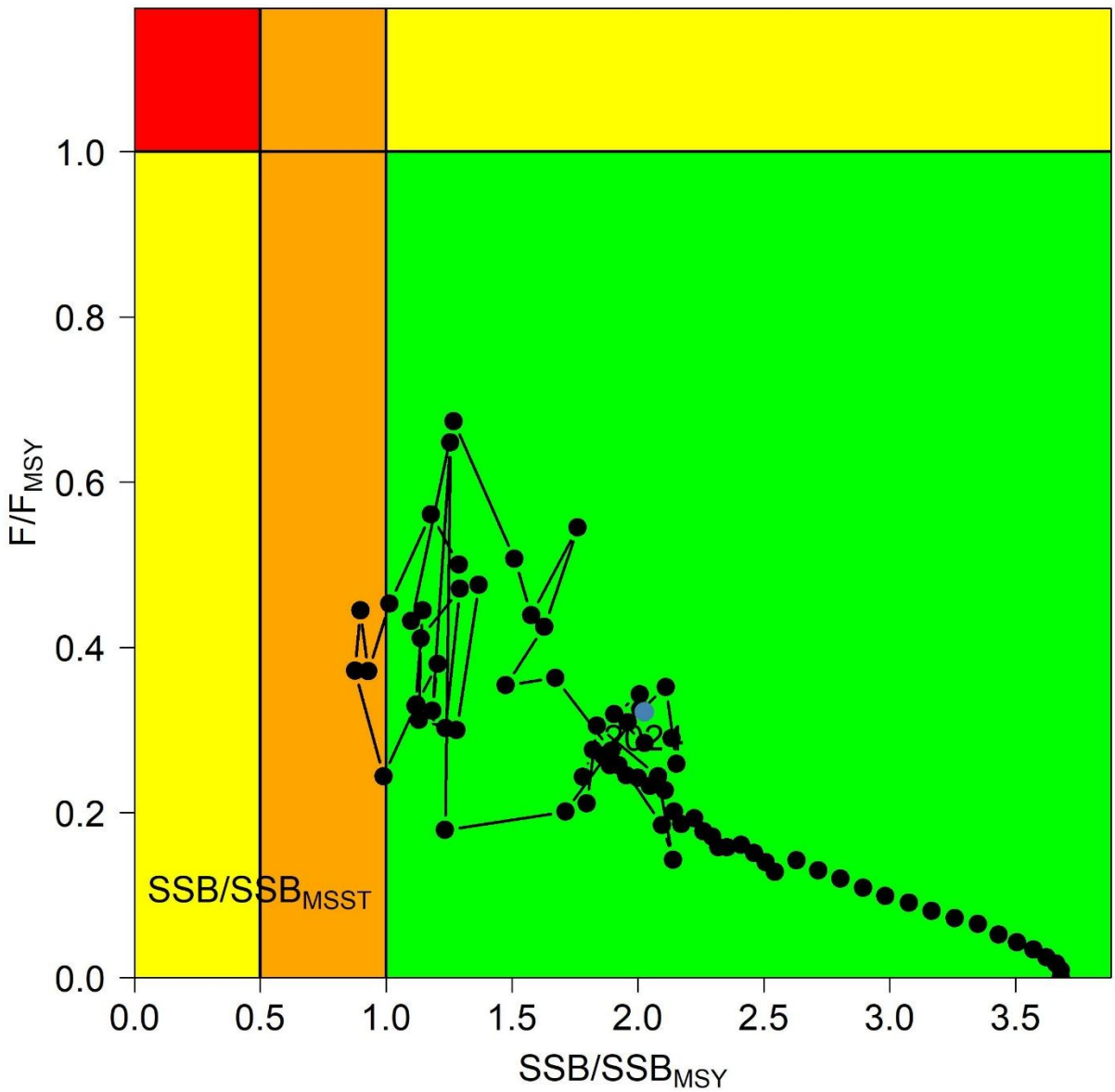


Figure 48. Kobe plot illustrating the trajectory of stock status for the MSY projection for the AP Model where steepness is fixed at 0.99. The orange coloring indicates regions where the stock is below the biomass target but above the biomass threshold (MSST = 0.5 x SSB_{MSY}). The 2024 terminal year stock status is indicated by the gray dot. See ***Table 10*** *for values. SSB is in metric tons.*

10. Appendix

SEDAR 100 Gulf of America Gray Triggerfish Stock Assessment - RW Model Outputs

Gulf Fisheries Branch
Sustainable Fisheries Division
NOAA Fisheries - Southeast Fisheries Science Center

August 2026

RW Tables

Table RW17. List of Stock Synthesis parameters. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), the prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
NatM_Lorenzen_averageFem_GP_1	0.36	(0,1)				Fixed
L_at_Amin_Fem_GP_1	8.628	(5,25)	0.323	0.037		3
L_at_Amax_Fem_GP_1	53.846	(30,60)	0.632	0.012		5
VonBert_K_Fem_GP_1	0.149	(0.05,0.3)	0.007	0.049		5
CV_young_Fem_GP_1	0.437	(0.01,0.5)				Fixed
CV_old_Fem_GP_1	0.124	(0.01,0.5)				Fixed
Wtlen_1_Fem_GP_1	1.70e-05	(0,1)				Fixed
Wtlen_2_Fem_GP_1	3.07	(0,4)				Fixed
Mat50%_Fem_GP_1	15.259	(10,30)				Fixed
Mat_slope_Fem_GP_1	-0.232	(-1,0)				Fixed
Eggs_scalar_Fem_GP_1	1	(-1,1)				Fixed
Eggs_exp_wt_Fem_GP_1	1	(0,4)				Fixed
CohortGrowDev	1	(0.1,10)			Normal(1,1)	Fixed
FracFemale_GP_1	0.5	(1e-06,0.99)				Fixed
SR_LN(R0)	12.288	(3,20)	0.100	0.008		1
SR_BH_steep	0.422	(0.2,1)	0.021	0.049		2
SR_sigmaR	0.6	(0.2,2)				Fixed
SR_regime	0	(-5,5)				Fixed
SR_autocorr	0	(0,0)				Fixed
Main_RecrDev_1981	-0.248	(-5,5)	0.393	1.586		3
Main_RecrDev_1982	-0.656	(-5,5)	0.400	0.610		3
Main_RecrDev_1983	-0.873	(-5,5)	0.357	0.409		3
Main_RecrDev_1984	-0.946	(-5,5)	0.351	0.371		3
Main_RecrDev_1985	-0.363	(-5,5)	0.270	0.742		3
Main_RecrDev_1986	-0.169	(-5,5)	0.278	1.650		3
Main_RecrDev_1987	0.639	(-5,5)	0.177	0.277		3
Main_RecrDev_1988	0.549	(-5,5)	0.207	0.378		3
Main_RecrDev_1989	-0.548	(-5,5)	0.325	0.593		3

Table RW17 Continued. List of Stock Synthesis parameters. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), the prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Main_RecrDev_1990	0.146	(-5,5)	0.169	1.155		3
Main_RecrDev_1991	-0.800	(-5,5)	0.335	0.419		3
Main_RecrDev_1992	0.398	(-5,5)	0.154	0.385		3
Main_RecrDev_1993	0.157	(-5,5)	0.213	1.353		3
Main_RecrDev_1994	-0.201	(-5,5)	0.283	1.405		3
Main_RecrDev_1995	0.532	(-5,5)	0.184	0.346		3
Main_RecrDev_1996	0.069	(-5,5)	0.272	3.942		3
Main_RecrDev_1997	-0.419	(-5,5)	0.307	0.731		3
Main_RecrDev_1998	0.341	(-5,5)	0.164	0.479		3
Main_RecrDev_1999	0.618	(-5,5)	0.143	0.232		3
Main_RecrDev_2000	0.189	(-5,5)	0.165	0.872		3
Main_RecrDev_2001	0.138	(-5,5)	0.141	1.021		3
Main_RecrDev_2002	-0.044	(-5,5)	0.142	3.214		3
Main_RecrDev_2003	-0.308	(-5,5)	0.152	0.494		3
Main_RecrDev_2004	-0.261	(-5,5)	0.134	0.512		3
Main_RecrDev_2005	-0.127	(-5,5)	0.128	1.010		3
Main_RecrDev_2006	0.202	(-5,5)	0.124	0.612		3
Main_RecrDev_2007	0.562	(-5,5)	0.115	0.205		3
Main_RecrDev_2008	0.162	(-5,5)	0.136	0.844		3
Main_RecrDev_2009	0.320	(-5,5)	0.106	0.332		3
Main_RecrDev_2010	-0.213	(-5,5)	0.129	0.607		3
Main_RecrDev_2011	0.371	(-5,5)	0.096	0.257		3
Main_RecrDev_2012	0.710	(-5,5)	0.097	0.137		3
Main_RecrDev_2013	0.998	(-5,5)	0.085	0.085		3
Main_RecrDev_2014	0.396	(-5,5)	0.100	0.253		3
Main_RecrDev_2015	-0.144	(-5,5)	0.119	0.830		3
Main_RecrDev_2016	-0.179	(-5,5)	0.125	0.697		3
Main_RecrDev_2017	0.557	(-5,5)	0.090	0.161		3
Main_RecrDev_2018	0.141	(-5,5)	0.128	0.904		3

Table RW17 Continued. List of Stock Synthesis parameters. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), the prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Main_RecrDev_2019	-0.079	(-5,5)	0.141	1.794		3
Main_RecrDev_2020	-0.312	(-5,5)	0.169	0.541		3
Main_RecrDev_2021	-0.258	(-5,5)	0.198	0.767		3
Main_RecrDev_2022	0.297	(-5,5)	0.190	0.639		3
Main_RecrDev_2023	-1.314	(-5,5)	0.376	0.286		3
Main_RecrDev_2024	-0.034	(-5,5)	0.574	16.86		3
LnQ_base_Shrimp_Bycatch_4(4)	2.537	(-10,40)	0.107	0.042		1
LnQ_base_HB_Surv_5(5)	-7.955	(-25,25)				Fixed
Q_extraSD_HB_Surv_5(5)	0.073	(0,0.5)	0.049	0.671	Sym_Beta(0,1)	4
LnQ_base_TrawlEarly_6(6)	-9.447	(-25,25)				Fixed
Q_extraSD_TrawlEarly_6(6)	0.417	(0,0.5)	0.056	0.135	Sym_Beta(0,1)	4
LnQ_base_TrawlLate_7(7)	-9.634	(-25,25)				Fixed
Q_extraSD_TrawlLate_7(7)	0.261	(0,0.5)	0.072	0.275	Sym_Beta(0,1)	4
LnQ_base_Video_8(8)	-6.142	(-25,25)				Fixed
Q_extraSD_Video_8(8)	0.105	(0,0.5)	0.043	0.410	Sym_Beta(0,1)	4
Size_DblN_peak_Rec_1(1)	30.224	(10,60)	0.186	0.006		2
Size_DblN_top_logit_Rec_1(1)	-13.179	(-15,15)	34.90	2.648		3
Size_DblN_ascend_se_Rec_1(1)	3.638	(-15,15)	0.038	0.010		3
Size_DblN_descend_se_Rec_1(1)	4.352	(-15,15)	0.145	0.033		3
Size_DblN_start_logit_Rec_1(1)	-999	(-999,15)				Fixed
Size_DblN_end_logit_Rec_1(1)	-0.538	(-15,15)	0.151	0.280		4
Retain_L_infl_Rec_1(1)	25.722	(0,60)				Fixed
Retain_L_width_Rec_1(1)	2.598	(0,20)				Fixed
Retain_L_asymptote_logit_Rec_1(1)	5.056	(-10,10)	1.748	0.346		2
Retain_L_maleoffset_Rec_1(1)	0	(-1,2)				Fixed
DiscMort_L_infl_Rec_1(1)	-5	(-10,10)				Fixed
DiscMort_L_width_Rec_1(1)	1	(-1,2)				Fixed
DiscMort_L_level_old_Rec_1(1)	0.4	(0,2)				Fixed
DiscMort_L_male_offset_Rec_1(1)	0	(-1,2)				Fixed

Table RW17 Continued. List of Stock Synthesis parameters. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), the prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Size_inflection_ComVL_2(2)	31.042	(10,60)	0.275	0.009		2
Size_95%width_ComVL_2(2)	5.315	(0.01,20)	0.272	0.051		3
Retain_L_infl_ComVL_2(2)	20.667	(0,60)				Fixed
Retain_L_width_ComVL_2(2)	1.073	(0,20)				Fixed
Retain_L_asymptote_logit_ComVL_2(2)	9.749	(-10,10)	6.898	0.708		2
Retain_L_maleoffset_ComVL_2(2)	0	(-1,2)				Fixed
DiscMort_L_infl_ComVL_2(2)	-5	(-10,10)				Fixed
DiscMort_L_width_ComVL_2(2)	1	(-1,2)				Fixed
DiscMort_L_level_old_ComVL_2(2)	0.4	(0,2)				Fixed
DiscMort_L_male_offset_ComVL_2(2)	0	(-1,2)				Fixed
Size_inflection_ComLL_3(3)	56.168	(10,60)	1.115	0.020		2
Size_95%width_ComLL_3(3)	10.513	(0.01,20)	0.444	0.042		3
Size_DblN_peak_Shrimp_Bycatch_4(4)	11.589	(5,20)	0.453	0.039		2
Size_DblN_top_logit_Shrimp_Bycatch_4(4)	-11.886	(-15,15)	50.93	4.285		3
Size_DblN_ascend_se_Shrimp_Bycatch_4(4)	2.734	(-15,15)	0.214	0.078		3
Size_DblN_descend_se_Shrimp_Bycatch_4(4)	2.575	(-15,15)	0.449	0.174		3
Size_DblN_start_logit_Shrimp_Bycatch_4(4)	-8.517	(-15,15)	0.755	0.089		2
Size_DblN_end_logit_Shrimp_Bycatch_4(4)	-0.456	(-15,15)	0.157	0.344		4
Size_DblN_peak_TrawlLate_7(7)	7.977	(5,20)	0.323	0.040		2
Size_DblN_top_logit_TrawlLate_7(7)	-2.947	(-15,15)	0.543	0.184		3
Size_DblN_ascend_se_TrawlLate_7(7)	0.781	(-15,15)	0.331	0.423		3
Size_DblN_descend_se_TrawlLate_7(7)	2.22	(-15,15)	1.127	0.508		3
Size_DblN_start_logit_TrawlLate_7(7)	-8.731	(-15,15)	1.012	0.116		2
Size_DblN_end_logit_TrawlLate_7(7)	0.216	(-15,15)	0.231	1.069		4
Size_DblN_peak_Video_8(8)	62.7	(10,72)				Fixed
Size_DblN_top_logit_Video_8(8)	-1.35e-07	(-15,15)	335.4	>>>1		3
Size_DblN_ascend_se_Video_8(8)	5.815	(-15,15)	0.04	0.007		3
Size_DblN_descend_se_Video_8(8)	1.51e-08	(-15,15)	335.4	>>>1		3
Size_DblN_start_logit_Video_8(8)	-14.9	(-15,15)				Fixed

Table RW17 Continued. List of Stock Synthesis parameters. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), the prior type and densities (value, SD) if applicable, and phases. Parameters designated as fixed were held at their initial values and have no associated range or SD.

Label	Value	Range	SD	CV	Prior	Phase
Size_DblN_end_logit_Video_8(8)	999	(-15,999)				Fixed
ln(DM_theta)_Len_P1	7.895	(-5,10)	0.872	0.110	Normal(0,1.81)	6
ln(DM_theta)_Len_P2	5.468	(-5,10)	0.759	0.139	Normal(0,1.81)	6
ln(DM_theta)_Len_P3	-0.194	(-5,10)	0.107	0.550	Normal(0,1.81)	6
ln(DM_theta)_Len_P4	-0.378	(-5,10)	0.104	0.275	Normal(0,1.81)	6
ln(DM_theta)_Age_P5	0.457	(-5,10)	0.104	0.227	Normal(0,1.81)	6
ln(DM_theta)_Age_P6	0.497	(-5,10)	0.091	0.182	Normal(0,1.81)	6
Size_DblN_peak_Rec_1(1)_BLK4repl_2008	34.691	(10,60)	0.2	0.006		3
Size_DblN_descend_se_Rec_1(1)_BLK4repl_2008	2.684	(-15,15)	0.15	0.056		3
Size_DblN_end_logit_Rec_1(1)_BLK4repl_2008	-0.8	(-15,15)	0.097	0.121		4
Retain_L_infl_Rec_1(1)_BLK1repl_1999	26.506	(1,60)	0.137	0.005		3
Retain_L_infl_Rec_1(1)_BLK1repl_2009	37.155	(1,60)	0.254	0.007		3
Retain_L_infl_Rec_1(1)_BLK1repl_2018	38.468	(1,60)	0.129	0.003		3
Retain_L_width_Rec_1(1)_BLK1repl_1999	1.605	(0,20)	0.081	0.051		3
Retain_L_width_Rec_1(1)_BLK1repl_2009	2.183	(0,20)	0.077	0.035		3
Retain_L_width_Rec_1(1)_BLK1repl_2018	1.211	(0,20)	0.041	0.034		3
Retain_L_asymptote_logit_Rec_1(1)_BLK3repl_2012	-0.105	(-10,10)	0.132	1.257		3
Size_inflection_ComVL_2(2)_BLK4repl_2008	39.093	(10,60)	0.622	0.016		3
Size_95%width_ComVL_2(2)_BLK4repl_2008	9.226	(0.01,20)	0.389	0.042		3
Retain_L_infl_ComVL_2(2)_BLK2repl_1999	24.521	(1,60)	0.829	0.034		3
Retain_L_infl_ComVL_2(2)_BLK2repl_2009	38.05	(1,60)	0.505	0.013		3
Retain_L_width_ComVL_2(2)_BLK2repl_1999	1.46	(0,20)	0.496	0.340		3
Retain_L_width_ComVL_2(2)_BLK2repl_2009	3.002	(0,20)	0.254	0.085		3
Retain_L_asymptote_logit_ComVL_2(2)_BLK3repl_2012	1.546	(-10,10)	0.239	0.155		3
Size_inflection_ComLL_3(3)_BLK4repl_2008	47.78	(10,60)	0.5	0.010		3
Size_95%width_ComLL_3(3)_BLK4repl_2008	6.336	(0.01,20)	0.369	0.058		3
Size_DblN_peak_Video_8(8)_BLK5repl_2006	57.711	(10,72)	1.237	0.021		3
Size_DblN_peak_Video_8(8)_BLK5repl_2010	61.767	(10,72)	0.9	0.015		3
Size_DblN_peak_Video_8(8)_BLK5repl_2020	58.082	(10,72)	1.103	0.019		3

Table RW18. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) combined across all fleets, which was used as the proxy for annual fishing mortality rate.

Year	RW Model	Year	RW Model
1945	0.0001	1985	0.1038
1946	0.0035	1986	0.1575
1947	0.0069	1987	0.2265
1948	0.0103	1988	0.2143
1949	0.0138	1989	0.2570
1950	0.0172	1990	0.3395
1951	0.0209	1991	0.2671
1952	0.0254	1992	0.3130
1953	0.0283	1993	0.4168
1954	0.0319	1994	0.2665
1955	0.0357	1995	0.2781
1956	0.0390	1996	0.2036
1957	0.0428	1997	0.1855
1958	0.0467	1998	0.2942
1959	0.0507	1999	0.2576
1960	0.0549	2000	0.1911
1961	0.0464	2001	0.1902
1962	0.0524	2002	0.2982
1963	0.0575	2003	0.3095
1964	0.0617	2004	0.3599
1965	0.0589	2005	0.2939
1966	0.0583	2006	0.2411
1967	0.0648	2007	0.2944
1968	0.0670	2008	0.2552
1969	0.0748	2009	0.1657
1970	0.0701	2010	0.2191
1971	0.0753	2011	0.2599
1972	0.0867	2012	0.2209
1973	0.0876	2013	0.3973

Table RW18 Continued. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) combined across all fleets, which was used as the proxy for annual fishing mortality rate.

Year	RW Model	Year	RW Model
1974	0.0919	2014	0.1161
1975	0.0921	2015	0.1316
1976	0.1006	2016	0.2193
1977	0.1044	2017	0.2347
1978	0.1156	2018	0.2112
1979	0.1218	2019	0.2008
1980	0.1054	2020	0.2078
1981	0.0956	2021	0.1847
1982	0.1518	2022	0.2623
1983	0.1351	2023	0.2443
1984	0.0773	2024	0.2685

Table RW19. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet and combined across all fleets (Total), which was used as the proxy for annual fishing mortality rate.

Year	Recreational	Commercial Vertical Line	Commercial Longline	Shrimp Bycatch	Total
1945	0.0001	0.0000		0.0000	0.0001
1946	0.0012	0.0001		0.0023	0.0035
1947	0.0023	0.0001		0.0045	0.0069
1948	0.0034	0.0002		0.0067	0.0103
1949	0.0045	0.0003		0.0090	0.0138
1950	0.0057	0.0003		0.0112	0.0172
1951	0.0069	0.0006		0.0134	0.0209
1952	0.0082	0.0016		0.0157	0.0254
1953	0.0095	0.0010		0.0179	0.0283
1954	0.0108	0.0009		0.0201	0.0319
1955	0.0122	0.0011		0.0224	0.0357
1956	0.0138	0.0005		0.0246	0.0390
1957	0.0155	0.0004		0.0269	0.0428
1958	0.0172	0.0004		0.0291	0.0467
1959	0.0190	0.0003		0.0314	0.0507
1960	0.0209	0.0003		0.0336	0.0549
1961	0.0220	0.0002		0.0242	0.0464
1962	0.0229	0.0002		0.0293	0.0524
1963	0.0239	0.0002		0.0334	0.0575
1964	0.0250	0.0006		0.0361	0.0617
1965	0.0262	0.0006		0.0321	0.0589
1966	0.0275	0.0004		0.0305	0.0583
1967	0.0287	0.0005		0.0356	0.0648
1968	0.0301	0.0004		0.0365	0.0670
1969	0.0315	0.0007		0.0425	0.0748
1970	0.0332	0.0008		0.0361	0.0701
1971	0.0367	0.0013		0.0373	0.0753

Table RW19 Continued. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet and combined across all fleets (Total), which was used as the proxy for annual fishing mortality rate.

Year	Recreational	Commercial Vertical Line	Commercial Longline	Shrimp Bycatch	Total
1972	0.0404	0.0021		0.0442	0.0867
1973	0.0445	0.0018		0.0412	0.0876
1974	0.0487	0.0019		0.0413	0.0919
1975	0.0529	0.0028		0.0364	0.0921
1976	0.0539	0.0031		0.0436	0.1006
1977	0.0552	0.0022		0.0470	0.1044
1978	0.0565	0.0023		0.0568	0.1156
1979	0.0580	0.0039	0.0002	0.0597	0.1218
1980	0.0598	0.0039	0.0002	0.0416	0.1054
1981	0.0400	0.0035	0.0003	0.0518	0.0956
1982	0.0995	0.0036	0.0007	0.0480	0.1518
1983	0.0854	0.0030	0.0007	0.0461	0.1351
1984	0.0241	0.0033	0.0007	0.0492	0.0773
1985	0.0482	0.0047	0.0011	0.0498	0.1038
1986	0.0923	0.0062	0.0006	0.0584	0.1575
1987	0.1510	0.0099	0.0001	0.0655	0.2265
1988	0.1321	0.0165	0.0002	0.0654	0.2143
1989	0.1634	0.0254	0.0009	0.0673	0.2570
1990	0.2389	0.0347	0.0057	0.0602	0.3395
1991	0.1612	0.0408	0.0020	0.0631	0.2671
1992	0.2053	0.0480	0.0025	0.0572	0.3130
1993	0.2931	0.0647	0.0018	0.0572	0.4168
1994	0.1634	0.0521	0.0026	0.0483	0.2665
1995	0.1930	0.0453	0.0010	0.0388	0.2781
1996	0.1194	0.0345	0.0009	0.0487	0.2036
1997	0.1094	0.0220	0.0014	0.0527	0.1855
1998	0.2142	0.0225	0.0007	0.0568	0.2942

Table RW19 Continued. Estimates of annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet and combined across all fleets (Total), which was used as the proxy for annual fishing mortality rate.

Year	Recreational	Commercial Vertical Line	Commercial Longline	Shrimp Bycatch	Total
1999	0.1630	0.0307	0.0014	0.0625	0.2577
2000	0.1092	0.0208	0.0008	0.0604	0.1911
2001	0.1233	0.0216	0.0008	0.0445	0.1902
2002	0.2219	0.0284	0.0004	0.0475	0.2982
2003	0.2393	0.0321	0.0009	0.0372	0.3095
2004	0.2987	0.0292	0.0022	0.0298	0.3599
2005	0.2447	0.0236	0.0011	0.0245	0.2939
2006	0.2011	0.0155	0.0014	0.0231	0.2411
2007	0.2521	0.0161	0.0015	0.0247	0.2944
2008	0.2194	0.0110	0.0028	0.0219	0.2552
2009	0.1244	0.0135	0.0015	0.0263	0.1657
2010	0.1926	0.0092	0.0004	0.0169	0.2191
2011	0.2225	0.0177	0.0001	0.0196	0.2599
2012	0.1865	0.0131	0.0001	0.0212	0.2209
2013	0.3629	0.0102	0.0002	0.0240	0.3973
2014	0.0800	0.0055	0.0005	0.0301	0.1161
2015	0.0996	0.0051	0.0007	0.0263	0.1316
2016	0.1895	0.0055	0.0010	0.0233	0.2193
2017	0.2040	0.0064	0.0006	0.0236	0.2347
2018	0.1797	0.0063	0.0008	0.0244	0.2112
2019	0.1724	0.0058	0.0008	0.0217	0.2008
2020	0.1802	0.0053	0.0003	0.0219	0.2078
2021	0.1588	0.0042	0.0007	0.0209	0.1847
2022	0.2437	0.0044	0.0008	0.0135	0.2623
2023	0.2258	0.0058	0.0008	0.0120	0.2443
2024	0.2515	0.0058	0.0009	0.0103	0.2685

Table RW20. Expected biomass (metric tons) for all and exploited Gray Triggerfish (1+ years), spawning stock biomass (SSB, metric tons), exploited numbers (1+ years), age-0 recruits, and SSB ratio (SSB/SSB_0) where SSB_0 = 19,799 metric tons.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
1945	22,514	22,038	19,799.1	98,186,700	217,029,00	1.00
1946	22,512	22,036	19,797.3	98,183,400	217,022,00	1.00
1947	22,438	21,962	19,727.9	98,018,300	216,762,00	1.00
1948	22,298	21,824	19,596.6	97,701,800	216,265,00	0.99
1949	22,100	21,626	19,409.7	97,250,100	215,551,00	0.98
1950	21,849	21,378	19,173.9	96,678,100	214,637,00	0.97
1951	21,554	21,086	18,896.8	96,000,300	213,544,00	0.95
1952	21,218	20,752	18,580.2	95,225,900	212,270,00	0.94
1953	20,836	20,374	18,221.0	94,355,100	210,789,00	0.92
1954	20,440	19,981	17,848.9	93,407,600	209,216,00	0.90
1955	20,024	19,568	17,458.2	92,401,100	207,519,00	0.88
1956	19,588	19,136	17,049.3	91,337,100	205,691,00	0.86
1957	19,143	18,696	16,633.8	90,223,500	203,776,00	0.84
1958	18,688	18,245	16,208.0	89,067,100	201,751,00	0.82
1959	18,222	17,784	15,773.6	87,867,300	199,618,00	0.80
1960	17,750	17,317	15,333.9	86,627,000	197,385,00	0.77
1961	17,272	16,844	14,889.2	85,347,900	195,046,00	0.75
1962	17,012	16,587	14,644.8	84,660,700	193,726,00	0.74
1963	16,691	16,269	14,347.3	83,765,600	192,083,00	0.72
1964	16,327	15,910	14,011.9	82,723,300	190,183,00	0.71
1965	15,945	15,532	13,659.1	81,615,600	188,126,00	0.69
1966	15,662	15,253	13,397.3	80,786,200	186,561,00	0.68
1967	15,431	15,025	13,183.6	80,101,000	185,257,00	0.67
1968	15,135	14,732	12,911.2	79,214,100	183,561,00	0.65
1969	14,844	14,445	12,644.5	78,324,700	181,860,00	0.64
1970	14,479	14,084	12,309.6	77,201,000	179,668,00	0.62
1971	14,235	13,844	12,085.3	76,426,400	178,163,00	0.61

Table RW20 Continued. Expected biomass (metric tons) for all and exploited Gray Triggerfish (1+ years), spawning stock biomass (SSB, metric tons), exploited numbers (1+ years), age-0 recruits, and SSB ratio (SSB/SSB_0) where SSB_0 = 19,799 metric tons.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
1972	13,965	13,577	11,836.30	75,624,000	176,457,00	0.60
1973	13,586	13,204	11,489.20	74,483,700	174,013,00	0.58
1974	13,260	12,883	11,190.50	73,455,700	171,847,00	0.56
1975	12,938	12,566	10,895.30	72,427,000	169,646,00	0.55
1976	12,679	12,311	10,657.60	71,599,900	167,829,00	0.54
1977	12,353	11,990	10,362.30	70,487,100	165,513,00	0.52
1978	12,022	11,664	10,063.90	69,283,900	163,105,00	0.51
1979	11,597	11,246	9,682.18	67,757,100	159,919,00	0.49
1980	11,166	10,822	9,294.94	66,173,200	156,560,00	0.47
1981	10,886	10,651	9,138.43	65,370,700	107,155,00	0.46
1982	10,470	10,315	9,056.53	53,224,100	70,679,700	0.46
1983	9,314	9,196	8,251.88	39,682,100	53,976,400	0.42
1984	8,169	8,066	7,353.80	30,478,200	46,847,600	0.37
1985	7,438	7,265	6,691.70	25,193,800	79,110,700	0.34
1986	6,654	6,462	5,801.58	30,173,600	87,693,100	0.29
1987	6,052	5,665	4,926.32	33,134,800	176,173,00	0.25
1988	5,627	5,316	4,115.14	54,567,200	141,574,00	0.21
1989	5,638	5,532	4,268.66	54,223,400	48,369,800	0.22
1990	5,486	5,268	4,439.91	32,568,500	99,326,900	0.22
1991	4,788	4,712	3,862.21	36,694,200	34,811,900	0.20
1992	4,470	4,227	3,666.93	22,674,400	110,807,00	0.18
1993	4,004	3,838	3,047.55	35,484,700	75,522,100	0.15
1994	3,464	3,361	2,633.31	30,935,000	46,925,100	0.13
1995	3,511	3,291	2,715.37	23,523,900	99,839,300	0.14
1996	3,482	3,349	2,592.93	33,355,400	60,389,500	0.13
1997	3,587	3,500	2,840.77	27,565,200	39,717,700	0.14
1998	3,639	3,448	2,938.96	20,862,000	87,039,500	0.15

Table RW20 Continued. Expected biomass (metric tons) for all and exploited Gray Triggerfish (1+ years), spawning stock biomass (SSB, metric tons), exploited numbers (1+ years), age-0 recruits, and SSB ratio (SSB/SSB_0) where SSB_0 = 19,799 metric tons.

Year	Biomass (all)	Biomass (exploited)	SSB	Abundance (exploited)	Recruits	SSB ratio
1999	3,442	3,217	2,563.18	29,044,200	102,860,00	0.13
2000	3,486	3,340	2,533.12	35,514,700	66,409,300	0.13
2001	3,724	3,572	2,859.16	29,703,500	69,447,000	0.14
2002	3,845	3,712	3,029.27	28,813,900	60,523,000	0.15
2003	3,569	3,472	2,860.06	25,841,300	44,449,900	0.14
2004	3,236	3,140	2,637.37	20,959,900	43,711,800	0.13
2005	2,803	2,706	2,261.61	18,806,200	44,139,600	0.11
2006	2,611	2,486	2,060.32	18,187,600	56,819,000	0.10
2007	2,634	2,462	1,978.28	21,011,800	78,681,800	0.10
2008	2,634	2,522	1,905.07	27,049,600	51,074,900	0.10
2009	2,823	2,679	2,122.26	23,103,600	65,472,000	0.11
2010	3,068	2,975	2,377.26	25,468,300	42,200,800	0.12
2011	3,226	3,050	2,546.51	20,821,200	80,007,200	0.13
2012	3,355	3,114	2,476.84	27,935,400	109,805,00	0.12
2013	3,811	3,475	2,622.36	37,525,200	153,244,00	0.13
2014	4,007	3,821	2,657.28	51,029,600	84,794,800	0.13
2015	4,825	4,686	3,681.10	41,042,000	63,461,300	0.19
2016	5,254	5,103	4,289.75	33,021,700	68,437,800	0.22
2017	5,294	4,982	4,254.20	30,740,400	142,050,00	0.22
2018	5,241	5,044	3,998.62	46,807,100	89,635,200	0.20
2019	5,346	5,181	4,221.88	40,349,300	74,799,000	0.21
2020	5,328	5,195	4,351.33	35,041,000	60,502,800	0.22
2021	5,144	5,005	4,295.17	29,573,300	63,311,300	0.22
2022	5,025	4,789	4,131.69	28,079,500	107,267,00	0.21
2023	4,580	4,534	3,689.13	37,437,600	20,887,400	0.19
2024	4,350	4,171	3,644.39	20,552,700	81,839,600	0.18

Table RW21. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish.

Year	Input N SE	Input N	Exp N	Exp B	Exp Mean Weight
1945	0.25	1,250	1,250	2,696	2.2
1946	0.25	24,709	24,708	53,296	2.2
1947	0.25	48,168	48,165	103,888	2.2
1948	0.25	71,627	71,619	154,436	2.2
1949	0.25	95,086	95,070	204,879	2.2
1950	0.25	118,545	118,518	255,147	2.2
1951	0.25	142,003	141,962	305,172	2.1
1952	0.25	165,462	165,400	354,864	2.1
1953	0.25	188,921	188,831	404,186	2.1
1954	0.25	212,380	212,255	453,157	2.1
1955	0.25	235,839	235,669	501,725	2.1
1956	0.25	261,207	260,978	553,924	2.1
1957	0.25	286,575	286,271	605,666	2.1
1958	0.25	311,943	311,547	656,906	2.1
1959	0.25	337,310	336,803	707,610	2.1
1960	0.25	362,678	362,033	757,743	2.1
1961	0.25	373,036	372,288	775,995	2.1
1962	0.25	383,394	382,532	793,703	2.1
1963	0.25	393,752	392,757	812,120	2.1
1964	0.25	404,110	402,961	830,906	2.1
1965	0.25	414,468	413,147	849,400	2.1
1966	0.25	428,263	426,731	874,282	2.0
1967	0.25	442,058	440,294	899,154	2.0
1968	0.25	455,853	453,831	924,454	2.0
1969	0.25	469,648	467,293	949,523	2.0
1970	0.25	483,443	480,671	974,153	2.0
1971	0.25	528,016	524,343	1,058,877	2.0

Table RW21 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish.

Year	Input N SE	Input N	Exp N	Exp B	Exp Mean Weight
1972	0.250	572,590	567,718	1,142,330	2.0
1973	0.250	617,163	610,717	1,224,543	2.0
1974	0.250	661,736	653,496	1,304,668	2.0
1975	0.250	706,310	695,983	1,382,899	2.0
1976	0.250	708,678	697,114	1,378,544	2.0
1977	0.250	711,046	697,665	1,374,856	2.0
1978	0.250	713,414	696,266	1,368,218	2.0
1979	0.250	715,782	691,551	1,355,169	2.0
1980	0.250	718,150	688,040	1,342,797	2.0
1981	0.250	594,521	454,335	883,050	1.9
1982	0.250	1,310,960	1,096,430	2,131,151	1.9
1983	0.250	643,902	828,107	1,636,597	2.0
1984	0.250	154,184	198,984	408,331	2.1
1985	0.250	264,952	343,464	737,324	2.1
1986	0.185	578,985	568,317	1,257,758	2.2
1987	0.250	881,861	833,305	1,791,329	2.1
1988	0.239	823,971	735,416	1,446,625	2.0
1989	0.181	1,381,620	1,058,600	1,826,270	1.7
1990	0.156	1,794,840	1,537,160	2,549,070	1.7
1991	0.230	1,279,590	898,452	1,556,920	1.7
1992	0.154	1,371,630	1,009,170	1,782,541	1.8
1993	0.188	1,011,460	1,289,330	2,311,875	1.8
1994	0.135	902,830	661,535	1,111,625	1.7
1995	0.197	1,098,140	777,373	1,289,312	1.7
1996	0.137	457,025	477,572	816,194	1.7
1997	0.115	459,115	459,044	778,965	1.7
1998	0.176	662,554	874,385	1,512,863	1.7

Table RW21 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish.

Year	Input N SE	Input N	Exp N	Exp B	Exp Mean Weight
1999	0.117	540,938	587,946	1,079,788	1.8
2000	0.158	465,405	413,331	741,405	1.8
2001	0.132	472,211	514,839	891,535	1.7
2002	0.233	993,396	960,465	1,679,857	1.7
2003	0.250	1,201,970	959,395	1,699,068	1.8
2004	0.162	1,066,900	1,079,440	1,921,104	1.8
2005	0.152	769,463	756,401	1,359,792	1.8
2006	0.169	530,644	565,596	1,026,925	1.8
2007	0.147	458,399	702,021	1,270,298	1.8
2008	0.154	355,584	585,839	1,186,083	2.0
2009	0.178	170,511	146,919	428,472	2.9
2010	0.220	299,264	257,238	742,016	2.9
2011	0.186	454,382	308,273	895,210	2.9
2012	0.192	231,054	157,311	462,584	2.9
2013	0.250	332,655	334,380	986,058	2.9
2014	0.250	144,002	77,423	221,813	2.9
2015	0.250	76,782	117,496	330,907	2.8
2016	0.187	311,420	253,746	718,245	2.8
2017	0.250	84,842	278,536	811,909	2.9
2018	0.250	207,655	169,756	606,259	3.6
2019	0.250	101,808	160,611	583,550	3.6
2020	0.250	212,253	162,809	586,885	3.6
2021	0.246	112,976	142,870	513,540	3.6
2022	0.207	211,212	218,429	793,090	3.6
2023	0.212	193,029	193,741	711,828	3.7
2024	0.199	200,695	189,116	696,325	3.7

Table RW22. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Vertical Line fleet in biomass (B, pounds whole weight) and number (N). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. "*" indicates confidential data.

Year	Input B SE	Input B	Exp B	Exp N	Exp Mean Weight
1945	0.2	22	22	7	3.3
1946	0.2	3,592	3,592	1,088	3.3
1947	0.2	7,161	7,161	2,169	3.3
1948	0.2	10,731	10,731	3,250	3.3
1949	0.2	14,300	14,300	4,332	3.3
1950	0.2	14,700	14,700	4,457	3.3
1951	0.2	28,000	28,000	8,499	3.3
1952	0.2	72,400	72,400	22,011	3.3
1953	0.2	43,600	43,600	13,282	3.3
1954	0.2	39,600	39,600	12,092	3.3
1955	0.2	46,600	46,600	14,268	3.3
1956	0.2	22,800	22,800	7,001	3.3
1957	0.2	17,400	17,400	5,360	3.2
1958	0.2	15,200	15,200	4,698	3.2
1959	0.2	10,300	10,300	3,195	3.2
1960	0.2	11,900	11,900	3,705	3.2
1961	0.2	6,500	6,500	2,032	3.2
1962	0.2	5,600	5,600	1,759	3.2
1963	0.2	7,300	7,300	2,303	3.2
1964	0.2	20,000	20,000	6,332	3.2
1965	0.2	21,650	21,650	6,877	3.1
1966	0.2	13,800	13,800	4,399	3.1
1967	0.2	17,400	17,400	5,567	3.1
1968	0.2	12,500	12,500	4,012	3.1
1969	0.2	22,300	22,300	7,178	3.1
1970	0.2	24,051	24,051	7,763	3.1
1971	0.2	40,400	40,400	13,087	3.1

Table RW22 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Vertical Line fleet in biomass (B, pounds whole weight) and number (N). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. "*" indicates confidential data.

Year	Input B SE	Input B	Exp B	Exp N	Exp Mean Weight
1972	0.200	62,600	62,600	20,358	3.1
1973	0.200	53,200	53,200	17,368	3.1
1974	0.200	53,552	53,552	17,561	3.0
1975	0.200	78,000	78,000	25,709	3.0
1976	0.200	84,500	84,500	28,003	3.0
1977	0.100	59,386	59,386	19,770	3.0
1978	0.100	58,823	58,823	19,654	3.0
1979	0.100	97,484	97,485	32,679	3.0
1980	0.100	92,776	92,776	31,228	3.0
1981	0.100	82,101	82,101	27,763	3.0
1982	0.100	81,633	81,635	27,690	2.9
1983	0.100	59,836	59,837	20,174	3.0
1984	0.100	*	*	*	3.0
1985	0.100	75,563	75,563	23,879	3.2
1986	0.060	88,853	88,856	27,074	3.3
1987	0.062	124,185	124,206	37,649	3.3
1988	0.063	193,744	193,764	61,710	3.1
1989	0.061	309,533	309,577	111,120	2.8
1990	0.061	402,652	402,758	159,636	2.5
1991	0.062	423,455	423,485	168,006	2.5
1992	0.063	447,128	447,205	173,281	2.6
1993	0.067	*	*	*	2.6
1994	0.071	385,853	385,881	152,453	2.5
1995	0.070	328,557	328,581	134,484	2.4
1996	0.072	254,607	254,612	102,617	2.5
1997	0.073	169,593	169,597	67,808	2.5
1998	0.071	170,648	170,683	67,662	2.5

Table RW22 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Vertical Line fleet in biomass (B, pounds whole weight) and number (N). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. "*" indicates confidential data.

Year	Input B SE	Input B	Exp B	Exp N	Exp Mean Weight
1999	0.074	216,844	216,867	82,466	2.6
2000	0.055	152,492	152,497	57,920	2.6
2001	0.056	169,373	169,378	66,541	2.5
2002	0.053	231,893	231,937	92,031	2.5
2003	0.055	244,486	244,541	96,231	2.5
2004	0.057	201,293	201,394	78,796	2.6
2005	0.056	140,258	140,288	54,432	2.6
2006	0.059	84,688	84,697	32,401	2.6
2007	0.065	*	*	*	2.6
2008	0.064	61,209	61,229	17,271	3.5
2009	0.056	69,251	69,253	15,963	4.3
2010	0.054	52,364	52,370	12,317	4.3
2011	0.052	103,093	103,110	24,312	4.2
2012	0.052	71,281	71,288	16,654	4.3
2013	0.052	62,005	62,185	14,412	4.3
2014	0.050	36,239	36,239	8,545	4.2
2015	0.050	40,745	40,746	9,778	4.2
2016	0.050	47,667	47,671	11,531	4.1
2017	0.050	55,654	55,660	13,214	4.2
2018	0.050	56,281	56,288	12,939	4.4
2019	0.050	53,248	53,255	11,977	4.4
2020	0.050	48,923	48,929	11,053	4.4
2021	0.050	37,384	37,387	8,474	4.4
2022	0.050	37,163	37,175	8,340	4.5
2023	0.050	47,316	47,330	10,481	4.5
2024	0.050	43,340	43,359	9,566	4.5

Table RW23. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Longline fleet in biomass (B, pounds whole weight) and number (N). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. "*" indicates confidential data.

Year	Input B SE	Input B	Exp B	Exp N	Exp Mean Weight
1979	0.100	3,919	3,919	514	7.6
1980	0.100	3,700	3,700	486	7.6
1981	0.100	7,759	7,759	1,022	7.6
1982	0.100	15,040	15,040	1,984	7.6
1983	0.100	13,583	13,583	1,794	7.6
1984	0.100	11,683	11,683	1,539	7.6
1985	0.100	17,063	17,063	2,229	7.7
1986	0.098	8,149	8,149	1,051	7.8
1987	0.100	642	642	82	7.8
1988	0.098	2,589	2,589	329	7.9
1989	0.097	10,543	10,545	1,361	7.7
1990	0.060	*	*	*	7.4
1991	0.081	20,887	20,888	2,979	7.0
1992	0.077	23,028	23,032	3,381	6.8
1993	0.052	15,293	15,305	2,263	6.8
1994	0.051	19,424	19,426	2,894	6.7
1995	0.052	6,965	6,966	1,053	6.6
1996	0.052	6,822	6,822	1,045	6.5
1997	0.055	11,021	11,021	1,684	6.5
1998	0.051	*	*	*	6.6
1999	0.050	10,277	10,278	1,544	6.7
2000	0.051	5,770	5,770	858	6.7
2001	0.050	6,043	6,044	896	6.7
2002	0.050	*	*	*	6.7
2003	0.050	7,269	7,271	1,101	6.6
2004	0.050	*	*	*	6.6
2005	0.050	*	*	*	6.6

Table RW23 Continued. Input (with log-scale standard errors, SE) and expected (Exp) landings for the Commercial Longline fleet in biomass (B, pounds whole weight) and number (N). The expected mean weight (pounds whole weight per fish) was determined by dividing the expected landings in weights by expected landings in numbers of fish. "*" indicates confidential data.

Year	Input B SE	Input B	Exp B	Exp N	Exp Mean Weight
2006	0.050	*	*	*	6.7
2007	0.050	*	*	*	6.7
2008	0.050	*	*	*	6.2
2009	0.050	*	*	*	6.1
2010	0.071	*	*	*	6.0
2011	0.051	*	*	*	6.0
2012	0.050	*	*	*	6.0
2013	0.056	*	*	*	6.0
2014	0.050	4,446	4,446	743	6.0
2015	0.050	6,751	6,751	1,138	5.9
2016	0.050	*	*	*	5.9
2017	0.050	*	*	*	5.9
2018	0.050	8,417	8,418	1,403	6.0
2019	0.050	9,243	9,244	1,510	6.1
2020	0.050	3,857	3,858	626	6.2
2021	0.050	*	*	*	6.1
2022	0.050	8,117	8,120	1,317	6.2
2023	0.050	7,543	7,545	1,215	6.2
2024	0.050	8,264	8,268	1,323	6.3

Table RW24. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1945			398	159	338	135	0.8
1946			7,865	3,146	6,677	2,671	0.8
1947			15,338	6,135	13,018	5,207	0.8
1948			22,835	9,134	19,373	7,749	0.8
1949			30,374	12,150	25,753	10,301	0.8
1950			37,968	15,187	32,168	12,866	0.8
1951			45,629	18,252	38,625	15,450	0.8
1952			53,374	21,350	45,135	18,054	0.8
1953			61,205	24,482	51,701	20,682	0.8
1954			69,107	27,643	58,312	23,325	0.8
1955			77,096	30,838	64,981	25,992	0.8
1956			85,803	34,321	72,232	28,892	0.8
1957			94,604	37,842	79,547	31,819	0.8
1958			103,513	41,405	86,928	34,771	0.8
1959			112,536	45,014	94,380	37,752	0.8
1960			121,673	48,669	101,904	40,761	0.8
1961			125,934	50,374	105,310	42,124	0.8
1962			130,144	52,058	108,734	43,495	0.8
1963			133,969	53,588	111,893	44,756	0.8
1964			137,873	55,149	115,064	46,026	0.8
1965			142,006	56,802	118,370	47,349	0.8
1966			147,426	58,970	122,758	49,104	0.8
1967			152,630	61,052	127,028	50,812	0.8
1968			157,738	63,095	131,199	52,481	0.8
1969			162,986	65,195	135,450	54,181	0.8
1970			168,403	67,361	139,780	55,911	0.8
1971			184,769	73,908	153,177	61,271	0.8

Table RW24 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1972			200,956	80,382	166,460	66,584	0.8
1973			217,315	86,926	179,774	71,910	0.8
1974			234,153	93,661	193,407	77,362	0.8
1975			251,027	100,411	207,071	82,828	0.8
1976			252,796	101,118	208,359	83,343	0.8
1977			253,772	101,509	209,044	83,619	0.8
1978			254,158	101,663	209,172	83,670	0.8
1979			253,677	101,471	208,471	83,388	0.8
1980			254,474	101,790	208,667	83,467	0.8
1981	0.542	67,195	168,639	67,456	138,294	55,318	0.8
1982	0.545	223,188	395,120	158,050	328,830	131,539	0.8
1983	0.540	815,540	275,883	110,353	235,680	94,272	0.9
1984	0.604	221,934	59,929	23,971	52,536	21,014	0.9
1985	0.516	256,072	95,543	38,217	84,993	33,997	0.9
1986	0.745	119,173	164,272	65,708	141,373	56,549	0.9
1987	0.607	209,715	292,215	116,885	236,959	94,783	0.8
1988	0.416	251,017	337,654	135,063	253,231	101,291	0.7
1989	0.246	389,037	553,630	221,450	416,093	166,436	0.8
1990	0.332	533,592	704,290	281,720	563,876	225,555	0.8
1991	0.407	162,744	360,358	144,148	294,147	117,658	0.8
1992	0.174	281,864	395,160	158,060	325,931	130,372	0.8
1993	0.178	593,145	531,390	212,560	419,958	167,992	0.8
1994	0.202	175,527	323,165	129,266	247,943	99,177	0.8
1995	0.282	174,520	348,387	139,353	278,541	111,417	0.8
1996	0.363	252,162	207,959	83,183	163,918	65,568	0.8
1997	0.269	193,024	205,485	82,194	162,439	64,975	0.8
1998	0.294	592,497	352,005	140,805	289,037	115,615	0.8

Table RW24 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Recreational fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1999	0.193	320,289	260,477	104,191	191,035	76,414	0.7
2000	0.308	167,603	221,176	88,470	156,731	62,693	0.7
2001	0.190	341,247	272,909	109,164	198,469	79,388	0.7
2002	0.387	732,106	458,275	183,305	339,273	135,710	0.7
2003	0.434	433,876	446,225	178,485	330,797	132,319	0.7
2004	0.293	651,386	491,340	196,540	366,851	146,744	0.7
2005	0.211	331,300	334,969	133,987	250,489	100,196	0.7
2006	0.295	256,773	252,579	101,031	187,708	75,083	0.7
2007	0.275	622,104	335,469	134,186	244,459	97,784	0.7
2008	0.408	217,540	89,415	35,766	84,761	33,905	0.9
2009	0.153	416,421	507,997	203,199	766,363	306,546	1.5
2010	0.353	501,986	845,742	338,297	1,303,744	521,498	1.5
2011	0.238	507,923	966,247	386,500	1,503,042	601,218	1.6
2012	0.236	687,101	1,149,469	459,786	2,043,782	817,508	1.8
2013	0.453	832,930	2,592,590	1,037,040	4,485,235	1,794,100	1.7
2014	0.141	590,101	682,840	273,136	1,129,943	451,978	1.7
2015	0.234	1,834,190	1,055,634	422,254	1,745,481	698,192	1.7
2016	0.159	2,257,350	2,051,414	820,564	3,534,136	1,413,657	1.7
2017	0.157	3,517,870	1,986,004	794,404	3,572,662	1,429,066	1.8
2018	0.309	2,085,990	1,890,114	756,046	3,481,150	1,392,460	1.8
2019	0.179	1,997,510	1,942,579	777,033	3,465,455	1,386,183	1.8
2020	0.174	1,793,090	2,075,291	830,115	3,693,406	1,477,360	1.8
2021	0.241	2,491,380	1,703,030	681,210	3,097,738	1,239,096	1.8
2022	0.214	3,002,520	2,395,021	958,011	4,448,923	1,779,569	1.9
2023	0.131	2,168,010	2,079,599	831,839	3,861,370	1,544,557	1.9
2024	0.215	2,167,260	2,242,894	897,154	4,040,015	1,616,013	1.8

Table RW25. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Commercial Vertical Line fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1945			0	0	0	0	0.5
1946			2	1	1	1	0.5
1947			5	2	2	1	0.5
1948			7	3	4	1	0.5
1949			10	4	5	2	0.5
1950			10	4	5	2	0.5
1951			19	8	10	4	0.5
1952			50	20	25	10	0.5
1953			31	12	15	6	0.5
1954			28	11	14	6	0.5
1955			34	13	17	7	0.5
1956			17	7	8	3	0.5
1957			13	5	6	3	0.5
1958			11	5	6	2	0.5
1959			8	3	4	2	0.5
1960			9	4	5	2	0.5
1961			5	2	3	1	0.5
1962			5	2	2	1	0.5
1963			6	2	3	1	0.5
1964			16	7	8	3	0.5
1965			18	7	9	4	0.5
1966			12	5	6	2	0.5
1967			15	6	7	3	0.5
1968			11	4	5	2	0.5
1969			19	8	9	4	0.5
1970			21	8	10	4	0.5
1971			36	14	17	7	0.5

Table RW25 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Commercial Vertical Line fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1972			57	23	28	11	0.5
1973			49	20	24	9	0.5
1974			50	20	24	10	0.5
1975			75	30	36	14	0.5
1976			82	33	39	16	0.5
1977			58	23	28	11	0.5
1978			59	23	28	11	0.5
1979			99	39	47	19	0.5
1980			96	38	45	18	0.5
1981			86	34	41	16	0.5
1982			78	31	38	15	0.5
1983			47	19	24	10	0.5
1984			37	15	20	8	0.5
1985			40	16	22	9	0.5
1986			55	22	28	11	0.5
1987			109	44	51	20	0.5
1988			314	126	132	53	0.4
1989			678	271	293	117	0.4
1990			701	280	331	132	0.5
1991			637	255	291	117	0.5
1992			571	229	276	110	0.5
1993			908	363	388	154	0.4
1994			834	333	364	146	0.4
1995			595	238	273	110	0.5
1996			484	194	209	84	0.4
1997			306	123	138	55	0.5
1998			239	96	113	45	0.5

Table RW25 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Commercial Vertical Line fleet in numbers (N) and biomass (B, pounds whole weight). Dead discards in numbers (discard mortality rate = 40%), dead discards in biomass, and mean weight (MW, pounds whole weight per fish) are included. Mean weight was determined by dividing the expected discards in weights by the expected discards in numbers.

Year	Input N SE	Input N	Exp N	Exp Dead N	Exp B	Exp Dead B	Exp MW
1999			2,135	854	1,698	679	0.8
2000	0.368	1,502	1,844	738	1,410	564	0.8
2001	0.368	1,632	2,225	890	1,745	698	0.8
2002	0.368	2,076	2,750	1,100	2,202	880	0.8
2003	0.368	2,264	2,751	1,100	2,207	882	0.8
2004	0.368	2,039	2,195	878	1,773	709	0.8
2005	0.368	1,565	1,457	583	1,180	472	0.8
2006	0.368	1,149	861	344	693	277	0.8
2007	0.368	1,078	941	376	741	297	0.8
2008	0.368	977	821	328	406	162	0.5
2009	0.289	15,977	13,103	5,241	26,000	10,400	2.0
2010	0.289	11,642	10,088	4,035	20,496	8,199	2.0
2011	0.289	14,944	19,009	7,604	39,374	15,750	2.1
2012	0.180	24,285	18,564	7,426	46,584	18,633	2.5
2013	0.121	13,827	16,670	6,668	40,522	16,209	2.4
2014	0.121	12,367	11,220	4,488	25,599	10,240	2.3
2015	0.121	12,920	13,168	5,267	30,138	12,055	2.3
2016	0.121	15,412	14,429	5,772	34,636	13,854	2.4
2017	0.121	13,869	14,662	5,865	37,220	14,888	2.5
2018	0.170	10,380	13,196	5,279	34,561	13,824	2.6
2019	0.170	11,735	12,397	4,959	32,030	12,812	2.6
2020	0.170	9,866	11,857	4,743	30,362	12,145	2.6
2021	0.170	9,729	8,794	3,518	23,014	9,206	2.6
2022	0.170	10,060	8,180	3,272	21,985	8,794	2.7
2023	0.170	11,630	10,056	4,022	27,179	10,871	2.7
2024	0.170	10,412	9,560	3,824	25,292	10,117	2.6

Table RW26. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Shrimp Bycatch fleet in numbers (N) and biomass (B, pounds whole weight). All discards are assumed dead. Mean weight (MW, pounds whole weight per fish) was determined by dividing the expected discards in weights by the expected discards in numbers. Input and expected super-period median values are 1,612,310 and 1,528,110, respectively.

Year	Input N SE	Input N	Exp N	Exp B	Exp MW
1945			3,499	1,805	0.5
1946			214,974	110,864	0.5
1947	0.121	26,000	424,529	218,593	0.5
1948	0.121	152,257	632,240	324,628	0.5
1949	0.121	278,515	836,978	428,049	0.5
1950	0.121	404,772	1,038,060	528,247	0.5
1951	0.121	531,029	1,234,900	624,688	0.5
1952	0.121	657,287	1,426,860	716,718	0.5
1953	0.121	783,544	1,613,600	804,232	0.5
1954	0.121	909,802	1,794,620	887,296	0.5
1955	0.121	1,036,060	1,969,930	965,577	0.5
1956	0.121	1,162,320	2,139,200	1,039,064	0.5
1957	0.121	1,288,570	2,302,150	1,107,775	0.5
1958	0.121	1,414,830	2,458,710	1,171,522	0.5
1959	0.121	1,541,090	2,608,650	1,230,326	0.5
1960	0.121	1,667,350	2,751,660	1,284,151	0.5
1961	0.121	1,190,580	1,947,130	898,134	0.5
1962	0.121	1,446,180	2,338,470	1,072,847	0.5
1963	0.121	1,648,900	2,630,980	1,198,736	0.5
1964	0.121	1,783,630	2,805,550	1,267,815	0.5
1965	0.121	1,577,330	2,454,050	1,098,628	0.4
1966	0.121	1,494,620	2,303,760	1,024,445	0.4
1967	0.121	1,747,940	2,661,610	1,177,640	0.4
1968	0.121	1,795,860	2,701,680	1,186,804	0.4
1969	0.121	2,096,460	3,104,460	1,354,609	0.4
1970	0.121	1,772,490	2,597,830	1,122,365	0.4
1971	0.121	1,831,360	2,653,250	1,138,907	0.4

Table RW26 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Shrimp Bycatch fleet in numbers (N) and biomass (B, pounds whole weight). All discards are assumed dead. Mean weight (MW, pounds whole weight per fish) was determined by dividing the expected discards in weights by the expected discards in numbers. Input and expected super-period median values are 1,612,310 and 1,528,110 respectively.

Year	Input N SE	Input N	Exp N	Exp B	Exp MW
1972	0.121	2,179,220	3,106,090	1,323,264	0.4
1973	0.121	2,025,270	2,848,210	1,199,503	0.4
1974	0.121	2,029,790	2,814,370	1,174,086	0.4
1975	0.121	1,781,700	2,443,380	1,008,997	0.4
1976	0.121	2,141,520	2,887,450	1,184,569	0.4
1977	0.121	2,305,560	3,053,910	1,242,425	0.4
1978	0.121	2,800,400	3,620,720	1,461,544	0.4
1979	0.121	2,932,030	3,710,020	1,479,556	0.4
1980	0.121	1,999,860	2,522,850	992,516	0.4
1981	0.121	2,450,010	3,074,860	1,215,892	0.4
1982	0.121	2,410,730	2,414,450	1,092,627	0.5
1983	0.121	2,374,920	1,758,140	934,452	0.5
1984	0.121	2,530,670	1,445,720	874,906	0.6
1985	0.113	2,788,040	1,240,230	798,147	0.6
1986	0.112	3,105,700	1,727,580	831,882	0.5
1987	0.117	3,637,800	2,107,150	818,392	0.4
1988	0.134	3,182,320	2,984,210	767,104	0.3
1989	0.129	3,049,860	3,039,660	821,199	0.3
1990	0.107	2,955,210	1,813,430	699,191	0.4
1991	0.117	2,982,040	2,037,540	656,009	0.3
1992	0.191	3,037,810	1,244,310	533,364	0.4
1993	0.113	2,969,450	1,807,530	484,201	0.3
1994	0.124	2,210,770	1,267,100	357,902	0.3
1995	0.143	2,045,920	822,973	281,883	0.3
1996	0.152	2,300,480	1,338,240	359,939	0.3
1997	0.171	2,664,580	1,254,690	406,724	0.3
1998	0.135	2,191,770	1,104,500	431,512	0.4

Table RW26 Continued. Input (with log-scale standard errors, SE) and expected (Exp) discards for the Shrimp Bycatch fleet in numbers (N) and biomass (B, pounds whole weight). All discards are assumed dead. Mean weight (MW, pounds whole weight per fish) was determined by dividing the expected discards in weights by the expected discards in numbers. Input and expected super-period median values are 1,612,310 and 1,528,110, respectively.

Year	Input N SE	Input N	Exp N	Exp B	Exp MW
1999	0.114	2,140,670	1,562,860	443,051	0.3
2000	0.102	1,988,940	1,728,360	444,652	0.3
2001	0.11	1,612,310	1,131,460	350,484	0.3
2002	0.113	1,789,790	1,215,000	388,725	0.3
2003	0.141	1,376,500	866,506	284,577	0.3
2004	0.125	1,203,720	583,285	206,296	0.4
2005	0.127	938,446	423,311	146,138	0.3
2006	0.121	841,732	380,185	126,665	0.3
2007	0.246	602,379	460,739	134,135	0.3
2008	0.266	670,997	485,466	121,704	0.3
2009	0.123	966,090	513,621	155,203	0.3
2010	0.094	540,201	367,955	110,533	0.3
2011	0.102	758,124	371,689	131,715	0.4
2012	0.134	704,027	509,584	145,631	0.3
2013	0.141	484,904	763,742	184,180	0.2
2014	0.085	660,309	1,129,570	253,209	0.2
2015	0.114	463,600	894,571	271,382	0.3
2016	0.119	437,446	692,315	261,860	0.4
2017	0.111	477,767	674,450	259,279	0.4
2018	0.096	424,302	974,296	271,404	0.3
2019	0.084	387,097	772,337	248,185	0.3
2020	0.085	368,221	693,895	250,936	0.4
2021	0.094	392,766	571,760	230,782	0.4
2022	0.076	257,934	363,397	143,052	0.4
2023	0.107	250,215	399,017	120,011	0.3
2024			205,414	94,581	0.5

Table RW27. Observed (Obs) versus expected (Exp) standardized index of fishing effort for the Shrimp Bycatch fleet.

Year	Shrimp Effort (Obs)	Shrimp Effort (Exp)	Shrimp Effort (SE)
1945	0.001	0.001	0.2
1946	0.068	0.068	0.2
1947	0.135	0.135	0.2
1948	0.202	0.202	0.2
1949	0.269	0.269	0.2
1950	0.336	0.336	0.2
1951	0.403	0.404	0.2
1952	0.470	0.471	0.2
1953	0.537	0.538	0.2
1954	0.604	0.605	0.2
1955	0.671	0.672	0.2
1956	0.738	0.739	0.2
1957	0.805	0.806	0.2
1958	0.872	0.873	0.2
1959	0.939	0.940	0.2
1960	1.006	1.007	0.2
1961	0.719	0.719	0.2
1962	0.873	0.873	0.2
1963	0.995	0.995	0.2
1964	1.077	1.076	0.2
1965	0.952	0.951	0.2
1966	0.902	0.901	0.2
1967	1.055	1.053	0.2
1968	1.084	1.082	0.2
1969	1.266	1.261	0.2
1970	1.070	1.066	0.2
1971	1.105	1.101	0.2

Table RW27 Continued. Observed (Obs) versus expected (Exp) standardized index of fishing effort for the Shrimp Bycatch fleet.

Year	Shrimp Effort (Obs)	Shrimp Effort (Exp)	Shrimp Effort (SE)
1972	1.315	1.309	0.2
1973	1.223	1.216	0.2
1974	1.225	1.219	0.2
1975	1.075	1.070	0.2
1976	1.293	1.285	0.2
1977	1.392	1.383	0.2
1978	1.690	1.677	0.2
1979	1.770	1.760	0.2
1980	1.207	1.211	0.2
1981	1.479	1.503	0.2
1982	1.455	1.474	0.2
1983	1.434	1.455	0.2
1984	1.528	1.558	0.2
1985	1.580	1.623	0.2
1986	1.825	1.864	0.2
1987	2.017	2.050	0.2
1988	1.737	1.728	0.2
1989	1.832	1.793	0.2
1990	1.849	1.848	0.2
1991	1.813	1.813	0.2
1992	1.800	1.819	0.2
1993	1.662	1.653	0.2
1994	1.312	1.303	0.2
1995	1.126	1.124	0.2
1996	1.286	1.270	0.2
1997	1.485	1.455	0.2
1998	1.766	1.744	0.2

Table RW27 Continued. Observed (Obs) versus expected (Exp) standardized index of fishing effort for the Shrimp Bycatch fleet.

Year	Shrimp Effort (Obs)	Shrimp Effort (Exp)	Shrimp Effort (SE)
1999	1.728	1.722	0.2
2000	1.532	1.537	0.2
2001	1.198	1.207	0.2
2002	1.352	1.365	0.2
2003	1.078	1.084	0.2
2004	0.901	0.908	0.2
2005	0.716	0.724	0.2
2006	0.654	0.664	0.2
2007	0.688	0.692	0.2
2008	0.563	0.558	0.2
2009	0.699	0.693	0.2
2010	0.455	0.453	0.2
2011	0.567	0.565	0.2
2012	0.567	0.568	0.2
2013	0.639	0.635	0.2
2014	0.690	0.681	0.2
2015	0.686	0.681	0.2
2016	0.672	0.673	0.2
2017	0.695	0.701	0.2
2018	0.647	0.650	0.2
2019	0.607	0.600	0.2
2020	0.639	0.630	0.2
2021	0.623	0.618	0.2
2022	0.413	0.413	0.2
2023	0.334	0.334	0.2
2024	0.321	0.321	0.2

Table RW28. Observed (Obs) versus expected (Exp) standardized fishery-dependent catch-per-unit-effort (CPUE) indices for the Recreational fleet (SRHS). SEs shown below include extra SD estimated (**Table RW17**) and added to the input SE values for each year (**Table 16 in Assessment Process Report**).

Year	Recreational SRHS (Obs)	Recreational SRHS (Exp)	Recreational SRHS (SE)
1986	0.871	1.282	0.355
1987	0.725	1.098	0.366
1988	0.877	1.108	0.355
1989	1.309	1.360	0.340
1990	2.048	1.449	0.309
1991	1.470	1.273	0.311
1992	1.481	1.113	0.313
1993	1.245	0.880	0.318
1994	1.271	0.894	0.332
1995	1.047	0.936	0.359
1996	1.122	0.916	0.358
1997	1.060	0.988	0.354
1998	0.942	0.937	0.345
1999	1.000	0.817	0.336
2000	0.542	0.871	0.364
2001	0.448	1.013	0.372
2002	0.624	1.012	0.366
2003	0.732	0.931	0.359
2004	0.797	0.824	0.346
2005	1.022	0.721	0.331
2006	0.642	0.663	0.353
2007	0.726	0.628	0.355

Table RW29. Observed (Obs) versus expected (Exp) standardized survey indices. SEs shown below include extra SD estimated (**Table RW17**) and added to the input SE values for each year (**Table 16 in Assessment Process Report**).

Year	Trawl Early (Obs)	Trawl Early (Exp)	Trawl Early (SE)	Trawl Late (Obs)	Trawl Late (Exp)	Trawl Late (SE)	Video (Obs)	Video (Exp)	Video (SE)
1987	0.568	0.983	0.610						
1988	0.495	1.651	0.605						
1989	0.945	1.626	0.577						
1990	0.455	0.943	0.606						
1991	2.121	1.078	0.537						
1992	0.274	0.657	0.623						
1993	1.380	1.044	0.561				0.403	0.650	0.292
1994	1.454	0.935	0.546				0.907	0.578	0.559
1995	0.920	0.704	0.572				0.454	0.575	0.395
1996	0.655	1.011	0.601				0.365	0.600	0.260
1997	0.570	0.830	0.589				1.534	0.641	0.302
1998	0.105	0.608	0.730						
1999	1.237	0.868	0.556						
2000	1.961	1.079	0.541						
2001	2.971	0.902	0.554						
2002	0.942	0.855	0.567				0.876	0.650	0.719
2003	0.498	0.768	0.600						
2004	0.502	0.617	0.581				0.634	0.550	0.440
2005	0.835	0.562	0.567				0.611	0.495	0.317
2006	1.380	0.551	0.567				1.167	0.925	0.279
2007	0.770	0.639	0.581				1.016	0.878	0.294
2008	0.961	0.837	0.540				1.056	0.884	0.259
2009				0.619	0.696	0.377	1.448	0.977	0.241
2010				0.700	0.764	0.406	0.721	0.607	0.262
2011				0.906	0.621	0.400	0.818	0.634	0.253
2012				1.212	0.837	0.381	0.670	0.655	0.253
2013				0.643	1.112	0.436	0.553	0.626	0.237

Table RW29 Continued. Observed (Obs) versus expected (Exp) standardized survey indices. SEs shown below include extra SD estimated (**Table RW17**) and added to the input SE values for each year (**Table 16 in Assessment Process Report**).

Year	Trawl Early (Obs)	Trawl Early (Exp)	Trawl Early (SE)	Trawl Late (Obs)	Trawl Late (Exp)	Trawl Late (SE)	Video (Obs)	Video (Exp)	Video (SE)
2014				0.930	1.541	0.388	0.648	0.716	0.209
2015				1.265	1.239	0.371	0.835	0.919	0.200
2016				0.479	0.982	0.437	1.231	1.061	0.170
2017				0.757	0.912	0.397	1.043	1.096	0.178
2018				0.985	1.399	0.384	1.013	1.098	0.188
2019				1.146	1.212	0.396	0.880	1.107	0.183
2020				0.781	1.046	0.463	1.820	1.867	0.271
2021				1.319	0.883	0.389	1.610	1.865	0.196
2022				1.863	0.834	0.386	1.776	1.753	0.188
2023				1.724	1.122	0.377	1.668	1.625	0.182
2024				0.670	0.613	0.423	1.242	1.487	0.181

Table RW30. Summary of correlated parameters with correlation coefficients exceeding 0.7 for the SEDAR 100 RW Model.

Parameter 1	Parameter 2	Correlation
Size_DblN_ascend_se_Shrimp_Bycatch_4(4)	Size_DblN_peak_Shrimp_Bycatch_4(4)	0.866
Size_DblN_ascend_se_TrawlLate_7(7)	Size_DblN_peak_TrawlLate_7(7)	0.864
Retain_L_asymptote_logit_ComVL_2(2)_BLK3repl_2012	Retain_L_infl_ComVL_2(2)_BLK2repl_2009	0.861
Size_95%width_ComVL_2(2)_BLK4repl_2008	Size_inflection_ComVL_2(2)_BLK4repl_2008	0.830
Size_DblN_peak_Rec_1(1)_BLK4repl_2008	Size_DblN_ascend_se_Rec_1(1)	0.771
Retain_L_width_ComVL_2(2)_BLK2repl_2009	Retain_L_infl_ComVL_2(2)_BLK2repl_2009	0.757
Retain_L_width_Rec_1(1)_BLK1repl_2009	Retain_L_infl_Rec_1(1)_BLK1repl_2009	0.751
Size_95%width_ComVL_2(2)	Size_inflection_ComVL_2(2)	0.729
Size_DblN_peak_Video_8(8)_BLK5repl_2010	Size_DblN_ascend_se_Video_8(8)	0.710
SR_BH_steep	SR_LN(R0)	-0.707
Size_DblN_descend_se_Rec_1(1)_BLK4repl_2008	Size_DblN_peak_Rec_1(1)_BLK4repl_2008	-0.765
VonBert_K_Fem_GP_1	L_at_Amax_Fem_GP_1	-0.850
VonBert_K_Fem_GP_1	L_at_Amin_Fem_GP_1	-0.852
Size_DblN_descend_se_TrawlLate_7(7)	Size_DblN_top_logit_TrawlLate_7(7)	-0.869
Retain_L_width_ComVL_2(2)_BLK2repl_1999	Retain_L_infl_ComVL_2(2)_BLK2repl_1999	-0.881

Table RW31. Retrospective analysis and retrospective forecast spawning stock biomass (SSB, metric tons) and fishing mortality (F, total biomass killed all ages / total biomass age 1+) for the last five terminal years and combined (grey rows). N = number of observations to compute each statistic. Values within -0.15 to 0.2 are highlighted in green and are considered acceptable levels of retrospective bias. Values outside the acceptable range of -0.15 to 0.2 for longer-lived species (Hurtado-Ferro et al. 2015) are highlighted in red and indicate an undesirable retrospective pattern. See Carvalho et al. (2021) for additional details.

Quantity	Statistic	Value	N
SSB (-2023)	Mohn's Rho	0.078	1
SSB (-2022)	Mohn's Rho	-0.016	1
SSB (-2021)	Mohn's Rho	-0.135	1
SSB (-2020)	Mohn's Rho	-0.243	1
SSB (-2019)	Mohn's Rho	0.000	1
SSB (-Combined)	Mohn's Rho	-0.063	5
SSB (-2023)	Forecast bias	0.125	1
SSB (-2022)	Forecast bias	0.154	1
SSB (-2021)	Forecast bias	-0.078	1
SSB (-2020)	Forecast bias	-0.284	1
SSB (-2019)	Forecast bias	0.012	1
SSB (-Combined)	Forecast bias	-0.014	5
F (-2023)	Mohn's Rho	-0.080	1
F (-2022)	Mohn's Rho	0.019	1
F (-2021)	Mohn's Rho	0.252	1
F (-2020)	Mohn's Rho	0.397	1
F (-2019)	Mohn's Rho	-0.079	1
F (-Combined)	Mohn's Rho	0.102	5
F (-2023)	Forecast bias	-0.067	1
F (-2022)	Forecast bias	1.429	1
F (-2021)	Forecast bias	0.264	1
F (-2020)	Forecast bias	0.248	1
F (-2019)	Forecast bias	0.461	1
F (-Combined)	Forecast bias	0.467	5

Table RW32. Joint residual summary statistics. N = number of observations to compute each statistic. RMSE = root mean squared error (as a percentage), with values above 30% for individual or joint residuals (grey rows) highlighted in red if present and acceptable values below 30% highlighted in green. See Carvalho et al. (2021) for additional details.

Quantity	Statistic	Value	N
Index			
Shrimp Effort	RMSE(%)	0.9	80
Recreational SRHS CPUE	RMSE(%)	32.1	22
Trawl Early Survey	RMSE(%)	69.9	22
Trawl Late Survey	RMSE(%)	40.5	16
Combined Video Survey	RMSE(%)	28.4	27
Combined	RMSE(%)	32.7	167
Conditional Age-at-Length			
Recreational	RMSE(%)	8.9	21
Commercial Vertical Line	RMSE(%)	11.5	17
Commercial Longline	RMSE(%)	11.8	14
Combined	RMSE(%)	10.6	52
Length			
Recreational	RMSE(%)	1.5	44
Commercial Vertical Line	RMSE(%)	4.4	35
Commercial Longline	RMSE(%)	5.1	24
Shrimp Bycatch	RMSE(%)	17.9	40
Trawl Early Survey	RMSE(%)	11.1	22
Trawl Late Survey	RMSE(%)	17.4	16
Combined Video Survey	RMSE(%)	8.6	23
Combined	RMSE(%)	10.7	204

Table RW33. Runs tests summary statistics. N = number of observations to compute each statistic. P-values greater than 0.05% (in green) provide support for randomly distributed residuals whereas p-values less than 0.05% (in red) indicate non-randomly distributed residuals. See Carvalho et al. (2021) for additional details.

Quantity	Statistic	Value	N
Index			
Shrimp Effort	p-value	0	80
Recreational SRHS CPUE	p-value	0.005	22
Trawl Early Survey	p-value	0.042	22
Trawl Late Survey	p-value	0.065	16
Combined Video Survey	p-value	0.017	27
Conditional Age-at-Length			
Recreational	p-value	0.066	21
Commercial Vertical Line	p-value	0.047	17
Commercial Longline	p-value	0.658	14
Length			
Recreational	p-value	0.038	44
Commercial Vertical Line	p-value	0.002	35
Commercial Longline	p-value	0.89	24
Shrimp Bycatch	p-value	0.001	40
Trawl Early Survey	p-value	0.036	22
Trawl Late Survey	p-value	0.609	16
Combined Video Survey	p-value	0.158	23

Table RW34. Hindcast cross-validation summary statistics. N = number of observations to compute each statistic. MASE = mean absolute scaled error, with individual or joint values (grey rows) < 1 (in green) indicative of superior prediction skill over a naïve baseline forecast (random walk) and values > 1 (in red) indicative of poor prediction skill. See Carvalho et al. (2021) for additional details.

Quantity	Statistic	Value	N
Index			
Shrimp Effort	MASE	45.778	5
Recreational SRHS CPUE	MASE		0
Trawl Early Survey	MASE		0
Trawl Late Survey	MASE	1.134	5
Combined Video Survey	MASE	2.036	5
Joint	MASE	9.054	15
Conditional age-at-length			
Recreational	MASE	0.885	5
Commercial Vertical Line	MASE	0.827	5
Commercial Longline	MASE	1.217	1
Joint	MASE	0.883	11
Length			
Recreational	MASE	1.544	5
Commercial Vertical Line	MASE	0.573	5
Commercial Longline	MASE	0.826	3
Shrimp Bycatch	MASE	13.212	4
Trawl Late Survey	MASE	1.145	5
Combined Video Survey	MASE	1.259	5
Joint	MASE	1.561	27

Table RW39. Settings used for projections.

Parameter	Value	Comment
Relative F		Not used due to allocations below
Selectivity	Average from 2022-2024	Fleet specific selectivity estimated over terminal three years of model
Retention	Average from 2022-2024	Fleet specific retention estimated over terminal three years of model
Recruitment		Derived from the Beverton-Holt stock-recruit relationship with steepness estimated at 0.42
Interim Landings (2025-2027)	201.64 numbers (Recreational); 19.33 metric tons (Commercial Vertical Line); 3.62 metric tons (Commercial Longline)	For 2025 through 2027, used 3-year average of landings (2022-2024)
Shrimp bycatch F	0.034	Average F over 2022-2024
Allocation Ratio	21:79	Commercial:Recreational

Table RW40. Summary of Magnuson-Stevens Reauthorization Act benchmarks and reference points **assuming predicted recruitment from the stock-recruit curve throughout the projection period**. Spawning Stock Biomass (SSB) is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2 in the Assessment Process Report**), and was approximated for this model using an SSB ratio of 30%.

Criteria	Definition	Value
Base M	Target M for fully selected ages in the Lorenzen (2000) scaling	0.36
Steepness	Steepness of the Beverton-Holt stock-recruit relationship (estimated)	0.422
Unfished Recruitment (R_0)	Unfished recruitment (1,000s)	217,054
Generation Time	Fecundity-weighted mean age	7.11
Unfished SSB (SSB_0)	Unfished spawning stock biomass (metric tons)	19,799
	Mortality Rate Criteria	
$F_{MSYproxy}$	Equilibrium F that achieves MSYproxy	0.198
MFMT	$F_{MSYproxy}$	0.198
$F_{current}$	Geometric mean of the last 3 years of the assessment ($F_{2022-2024}$), including shrimp bycatch fleet	0.258
$F_{current}$/MFMT	Current stock status based on MFMT	1.307
	Biomass Criteria	
$SSB_{MSYproxy}$	Equilibrium SSB at MSYproxy	5,944
MSST	0.5 * $SSB_{MSYproxy}$	2,972
$SSB_{current}$	SSB in 2024	3,642
$SSB_{current}/SSB_{MSYproxy}$	Current stock status based on $SSB_{MSYproxy}$ (Equilibrium)	0.61
$SSB_{current}$/MSST	Current stock status based on MSST	1.23
$SSB_{current}/SSB_0$	SSB ratio in 2024	0.18

Table RW41. Comparison of equilibrium yield (million pounds whole weight) estimated from previous Gray Triggerfish assessments, the SEDAR 100 AP Model and the two sensitivity runs which reduced recreational removals by 40% (to mimic the MRIP-FES pilot study results; Andrews 2022) and excluded shrimp bycatch, and the SEDAR 100 RW Model. The type of assessment model used is also provided for context.

Assessment (Reference)	Model	Yield
SEDAR 9 (SEDAR 2006)	State Space Age-Structured Production Model (SS-ASPM)	1.638
SEDAR 9 Update (SEDAR 2011)	State Space Age-Structured Production Model (SS-ASPM)	0.984
SEDAR 43 (SEDAR 2015)	Stock Synthesis	2.230
SEDAR 100 AP Model	Stock Synthesis	1.014
SEDAR 100 AP Model Sensitivity Runs		
Reduced Recreational Removals by 40%	Stock Synthesis	0.718
No Shrimp Bycatch	Stock Synthesis	0.785
SEDAR 100 RW Model	Stock Synthesis	1.026

Table RW42. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include $F_{MSYproxy}$ = 0.198, $SSB_{MSYproxy}$ = 5,944 metric tons, and $MSST_{MSYproxy}$ = 2,972 metric tons which was calculated as (0.5) * $SSB_{MSYproxy}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 19,799 metric tons. Red indicates overfishing and/or overfished states if present. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2 in the Assessment Process Report**), and was approximated for this model using an SSB ratio of 30%.

Year	F	$F/F_{MSYproxy}$	SSB	$SSB/SSB_{MSYproxy}$	SSB/MSST	SSB ratio
1945	0.000	0.000	19,799	3.331	6.662	1.000
1946	0.004	0.018	19,797	3.331	6.661	1.000
1947	0.007	0.035	19,728	3.319	6.638	0.996
1948	0.010	0.052	19,596	3.297	6.594	0.990
1949	0.014	0.070	19,410	3.265	6.531	0.980
1950	0.017	0.087	19,174	3.226	6.451	0.968
1951	0.021	0.106	18,897	3.179	6.358	0.954
1952	0.025	0.129	18,580	3.126	6.252	0.938
1953	0.028	0.143	18,221	3.065	6.131	0.920
1954	0.032	0.161	17,849	3.003	6.006	0.902
1955	0.036	0.181	17,458	2.937	5.874	0.882
1956	0.039	0.197	17,049	2.868	5.736	0.861
1957	0.043	0.216	16,634	2.798	5.597	0.840
1958	0.047	0.236	16,208	2.727	5.453	0.819
1959	0.051	0.256	15,773	2.654	5.307	0.797
1960	0.055	0.278	15,334	2.580	5.159	0.774
1961	0.046	0.235	14,889	2.505	5.010	0.752
1962	0.052	0.265	14,645	2.464	4.927	0.740
1963	0.058	0.291	14,347	2.414	4.827	0.725
1964	0.062	0.312	14,012	2.357	4.714	0.708

Table RW42 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include $F_{MSYproxy}$ = 0.198, $SSB_{MSYproxy}$ = 5,944 metric tons, and $MSST_{MSYproxy}$ = 2,972 metric tons which was calculated as (0.5) * $SSB_{MSYproxy}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 19,799 metric tons. Red indicates overfishing and/or overfished states if present. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2 in the Assessment Process Report**), and was approximated for this model using an SSB ratio of 30%.

Year	F	$F/F_{MSYproxy}$	SSB	$SSB/SSB_{MSYproxy}$	SSB/MSST	SSB ratio
1965	0.059	0.298	13,659	2.298	4.596	0.690
1966	0.058	0.295	13,397	2.254	4.508	0.677
1967	0.065	0.328	13,183	2.218	4.436	0.666
1968	0.067	0.339	12,911	2.172	4.344	0.652
1969	0.075	0.378	12,644	2.127	4.254	0.639
1970	0.070	0.355	12,309	2.071	4.142	0.622
1971	0.075	0.381	12,085	2.033	4.066	0.610
1972	0.087	0.439	11,836	1.991	3.982	0.598
1973	0.088	0.443	11,489	1.933	3.866	0.580
1974	0.092	0.465	11,190	1.883	3.765	0.565
1975	0.092	0.466	10,895	1.833	3.666	0.550
1976	0.101	0.509	10,657	1.793	3.586	0.538
1977	0.104	0.528	10,362	1.743	3.486	0.523
1978	0.116	0.585	10,063	1.693	3.386	0.508
1979	0.122	0.616	9,682	1.629	3.258	0.489
1980	0.105	0.534	9,294	1.564	3.127	0.469
1981	0.096	0.484	9,138	1.537	3.075	0.462
1982	0.152	0.768	9,056	1.524	3.047	0.457
1983	0.135	0.684	8,251	1.388	2.776	0.417
1984	0.077	0.391	7,353	1.237	2.474	0.371

Table RW42 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include $F_{MSYproxy}$ = 0.198, $SSB_{MSYproxy}$ = 5,944 metric tons, and $MSST_{MSYproxy}$ = 2,972 metric tons which was calculated as (0.5) * $SSB_{MSYproxy}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 19,799 metric tons. Red indicates overfishing and/or overfished states if present. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2 in the Assessment Process Report**), and was approximated for this model using an SSB ratio of 30%.

Year	F	$F/F_{MSYproxy}$	SSB	$SSB/SSB_{MSYproxy}$	SSB/MSST	SSB ratio
1985	0.104	0.525	6,691	1.126	2.251	0.338
1986	0.157	0.797	5,801	0.976	1.952	0.293
1987	0.227	1.146	4,926	0.829	1.657	0.249
1988	0.214	1.084	4,115	0.692	1.385	0.208
1989	0.257	1.300	4,269	0.718	1.436	0.216
1990	0.339	1.717	4,440	0.747	1.494	0.224
1991	0.267	1.351	3,863	0.650	1.300	0.195
1992	0.313	1.584	3,668	0.617	1.234	0.185
1993	0.417	2.110	3,048	0.513	1.026	0.154
1994	0.267	1.349	2,633	0.443	0.886	0.133
1995	0.278	1.409	2,715	0.457	0.913	0.137
1996	0.204	1.031	2,592	0.436	0.872	0.131
1997	0.186	0.939	2,839	0.478	0.955	0.143
1998	0.294	1.490	2,937	0.494	0.988	0.148
1999	0.258	1.305	2,561	0.431	0.862	0.129
2000	0.191	0.967	2,531	0.426	0.852	0.128
2001	0.190	0.962	2,857	0.481	0.961	0.144
2002	0.298	1.508	3,028	0.509	1.019	0.153
2003	0.309	1.565	2,860	0.481	0.962	0.144
2004	0.360	1.820	2,638	0.444	0.888	0.133

Table RW42 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include $F_{MSYproxy}$ = 0.198, $SSB_{MSYproxy}$ = 5,944 metric tons, and $MSST_{MSYproxy}$ = 2,972 metric tons which was calculated as (0.5) * $SSB_{MSYproxy}$. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 19,799 metric tons. Red indicates overfishing and/or overfished states if present. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2 in the Assessment Process Report**), and was approximated for this model using an SSB ratio of 30%.

Year	F	$F/F_{MSYproxy}$	SSB	$SSB/SSB_{MSYproxy}$	SSB/MSST	SSB ratio
2005	0.294	1.487	2,263	0.381	0.761	0.114
2006	0.241	1.220	2,061	0.347	0.694	0.104
2007	0.294	1.490	1,979	0.333	0.666	0.100
2008	0.255	1.292	1,905	0.321	0.641	0.096
2009	0.166	0.839	2,122	0.357	0.714	0.107
2010	0.219	1.110	2,377	0.400	0.800	0.120
2011	0.260	1.315	2,546	0.428	0.857	0.129
2012	0.221	1.120	2,476	0.417	0.833	0.125
2013	0.397	2.010	2,622	0.441	0.882	0.132
2014	0.116	0.588	2,657	0.447	0.894	0.134
2015	0.132	0.666	3,680	0.619	1.238	0.186
2016	0.219	1.110	4,289	0.721	1.443	0.217
2017	0.235	1.188	4,253	0.716	1.431	0.215
2018	0.211	1.068	3,998	0.673	1.345	0.202
2019	0.201	1.015	4,223	0.710	1.421	0.213
2020	0.208	1.050	4,353	0.732	1.465	0.220
2021	0.185	0.934	4,297	0.723	1.446	0.217
2022	0.262	1.328	4,133	0.695	1.391	0.209
2023	0.244	1.237	3,689	0.621	1.241	0.186
2024	0.269	1.360	3,642	0.613	1.226	0.184

Table RW43. Summary of Magnuson-Stevens Reauthorization Act benchmarks and reference points **assuming predicted recruitment from the stock-recruit curve throughout the projection period**. Spawning Stock Biomass (SSB) is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+).

Criteria	Definition	Value
Base M	Target M for fully selected ages in the Lorenzen (2000) scaling	0.36
Steepness	Steepness of the Beverton-Holt stock-recruit relationship (estimated)	0.422
Unfished Recruitment (R_0)	Unfished recruitment (1,000s)	217,054
Generation Time	Fecundity-weighted mean age	7.11
Unfished SSB (SSB_0)	Unfished spawning stock biomass (metric tons)	19,799
	Mortality Rate Criteria	
F_{MSY}	Equilibrium F that achieves MSY	0.144
MFMT	F_{MSY}	0.144
$F_{current}$	Geometric mean of the last 3 years of the assessment ($F_{2022-2024}$)	0.258
$F_{current}$/MFMT	Current stock status based on MFMT	1.791
	Biomass Criteria	
SSB_{MSY}	Equilibrium SSB at F_{MSY}	8,252
MSST	0.5 * SSB_{MSY}	4,126
$SSB_{current}$	SSB in 2024	3,642
$SSB_{current}/SSB_{MSY}$	Current stock status based on SSB_{MSY} (Equilibrium)	0.44
$SSB_{current}$/MSST	Current stock status based on MSST	0.88
$SSB_{current}/SSB_0$	SSB ratio in 2024	0.18
SPR at MSY	Equivalent SPR (%) at MSY	61.6

Table RW44. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include F_{MSY} = 0.144, SSB_{MSY} = 8,252 metric tons, and $MSST_{MSY}$ = 2,972 metric tons which was calculated as (0.5) * SSB_{MSY}. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 19,799 metric tons. Red indicates overfishing and/or overfished states if present.

Year	F	F/F_{MSY}	SSB	SSB/SSB_{MSY}	SSB/MSST	SSB ratio
1945	0.000	0.001	19,799	2.399	4.799	1.000
1946	0.004	0.024	19,797	2.399	4.798	1.000
1947	0.007	0.048	19,728	2.391	4.781	0.996
1948	0.010	0.072	19,596	2.375	4.749	0.990
1949	0.014	0.096	19,410	2.352	4.704	0.980
1950	0.017	0.119	19,174	2.323	4.647	0.968
1951	0.021	0.145	18,897	2.290	4.580	0.954
1952	0.025	0.176	18,580	2.252	4.503	0.938
1953	0.028	0.196	18,221	2.208	4.416	0.920
1954	0.032	0.221	17,849	2.163	4.326	0.902
1955	0.036	0.247	17,458	2.116	4.231	0.882
1956	0.039	0.270	17,049	2.066	4.132	0.861
1957	0.043	0.296	16,634	2.016	4.031	0.840
1958	0.047	0.324	16,208	1.964	3.928	0.819
1959	0.051	0.351	15,773	1.911	3.823	0.797
1960	0.055	0.380	15,334	1.858	3.716	0.774
1961	0.046	0.322	14,889	1.804	3.609	0.752
1962	0.052	0.363	14,645	1.775	3.549	0.740
1963	0.058	0.399	14,347	1.739	3.477	0.725
1964	0.062	0.428	14,012	1.698	3.396	0.708

Table RW44 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include F_{MSY} = 0.144, SSB_{MSY} = 8,252 metric tons, and $MSST_{MSY}$ = 2,972 metric tons which was calculated as (0.5) * SSB_{MSY}. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 19,799 metric tons. Red indicates overfishing and/or overfished states if present.

Year	F	F/F_{MSY}	SSB	SSB/SSB_{MSY}	SSB/MSST	SSB ratio
1965	0.059	0.408	13,659	1.655	3.310	0.690
1966	0.058	0.404	13,397	1.623	3.247	0.677
1967	0.065	0.449	13,183	1.598	3.195	0.666
1968	0.067	0.464	12,911	1.565	3.129	0.652
1969	0.075	0.518	12,644	1.532	3.064	0.639
1970	0.070	0.486	12,309	1.492	2.983	0.622
1971	0.075	0.522	12,085	1.464	2.929	0.610
1972	0.087	0.601	11,836	1.434	2.869	0.598
1973	0.088	0.607	11,489	1.392	2.784	0.580
1974	0.092	0.637	11,190	1.356	2.712	0.565
1975	0.092	0.639	10,895	1.320	2.640	0.550
1976	0.101	0.698	10,657	1.291	2.583	0.538
1977	0.104	0.724	10,362	1.256	2.511	0.523
1978	0.116	0.801	10,063	1.219	2.439	0.508
1979	0.122	0.844	9,682	1.173	2.346	0.489
1980	0.105	0.731	9,294	1.126	2.253	0.469
1981	0.096	0.663	9,138	1.107	2.215	0.462
1982	0.152	1.052	9,056	1.097	2.195	0.457
1983	0.135	0.936	8,251	1.000	2.000	0.417
1984	0.077	0.536	7,353	0.891	1.782	0.371

Table RW44 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include F_{MSY} = 0.144, SSB_{MSY} = 8,252 metric tons, and $MSST_{MSY}$ = 2,972 metric tons which was calculated as (0.5) * SSB_{MSY}. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 19,799 metric tons. Red indicates overfishing and/or overfished states if present.

Year	F	F/F_{MSY}	SSB	SSB/SSB_{MSY}	SSB/MSST	SSB ratio
1985	0.104	0.719	6,691	0.811	1.622	0.338
1986	0.157	1.092	5,801	0.703	1.406	0.293
1987	0.227	1.570	4,926	0.597	1.194	0.249
1988	0.214	1.485	4,115	0.499	0.997	0.208
1989	0.257	1.781	4,269	0.517	1.035	0.216
1990	0.339	2.352	4,440	0.538	1.076	0.224
1991	0.267	1.851	3,863	0.468	0.936	0.195
1992	0.313	2.170	3,668	0.444	0.889	0.185
1993	0.417	2.890	3,048	0.369	0.739	0.154
1994	0.267	1.848	2,633	0.319	0.638	0.133
1995	0.278	1.930	2,715	0.329	0.658	0.137
1996	0.204	1.412	2,592	0.314	0.628	0.131
1997	0.186	1.287	2,839	0.344	0.688	0.143
1998	0.294	2.041	2,937	0.356	0.712	0.148
1999	0.258	1.787	2,561	0.310	0.621	0.129
2000	0.191	1.325	2,531	0.307	0.613	0.128
2001	0.190	1.317	2,857	0.346	0.693	0.144
2002	0.298	2.066	3,028	0.367	0.734	0.153
2003	0.309	2.144	2,860	0.347	0.693	0.144
2004	0.360	2.493	2,638	0.320	0.639	0.133

Table RW44 Continued. Time series of fishing mortality (*F*) and SSB relative to associated biological reference points **assuming predicted recruitment from the stock-recruit curve throughout the projection period**. SSB is in metric tons, whereas *F* is a harvest rate (total biomass killed all ages / total biomass age 1+). Reference points include F_{MSY} = 0.144, SSB_{MSY} = 8,252 metric tons, and $MSST_{MSY}$ = 2,972 metric tons which was calculated as (0.5) * SSB_{MSY}. SSB ratio was calculated as annual SSB divided by SSB_0 where SSB_0 = 19,799 metric tons. Red indicates overfishing and/or overfished states if present.

Year	F	F/F_{MSY}	SSB	SSB/SSB_{MSY}	SSB/MSST	SSB ratio
2005	0.294	2.036	2,263	0.274	0.548	0.114
2006	0.241	1.671	2,061	0.250	0.500	0.104
2007	0.294	2.041	1,979	0.240	0.480	0.100
2008	0.255	1.769	1,905	0.231	0.462	0.096
2009	0.166	1.150	2,122	0.257	0.514	0.107
2010	0.219	1.520	2,377	0.288	0.576	0.120
2011	0.260	1.801	2,546	0.308	0.617	0.129
2012	0.221	1.534	2,476	0.300	0.600	0.125
2013	0.397	2.754	2,622	0.318	0.635	0.132
2014	0.116	0.805	2,657	0.322	0.644	0.134
2015	0.132	0.913	3,680	0.446	0.892	0.186
2016	0.219	1.521	4,289	0.520	1.039	0.217
2017	0.235	1.627	4,253	0.515	1.031	0.215
2018	0.211	1.463	3,998	0.485	0.969	0.202
2019	0.201	1.391	4,223	0.512	1.023	0.213
2020	0.208	1.439	4,353	0.528	1.055	0.220
2021	0.185	1.280	4,297	0.521	1.041	0.217
2022	0.262	1.819	4,133	0.501	1.002	0.209
2023	0.244	1.695	3,689	0.447	0.894	0.186
2024	0.269	1.862	3,642	0.441	0.883	0.184

RW Figures

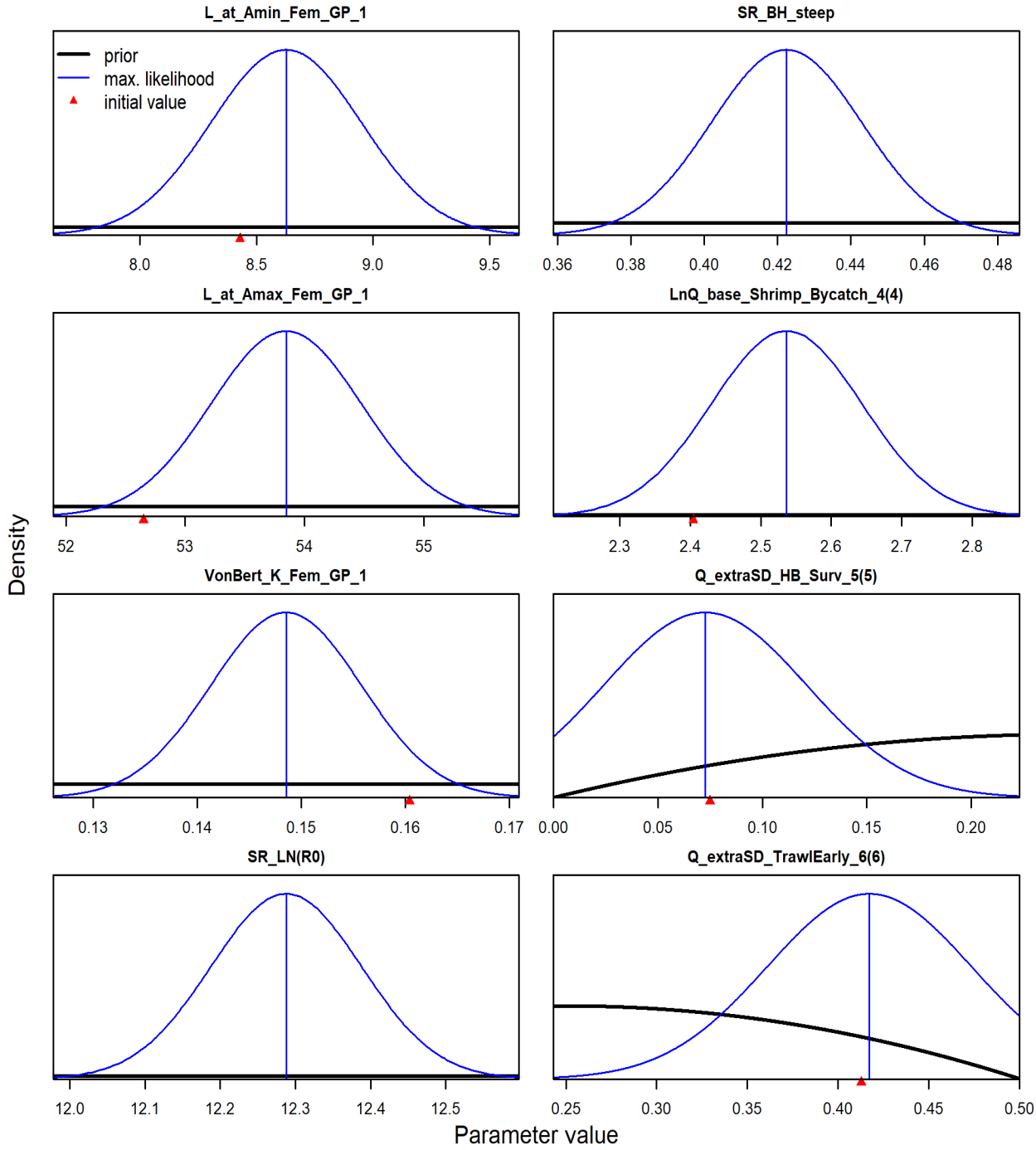


Figure RW27. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

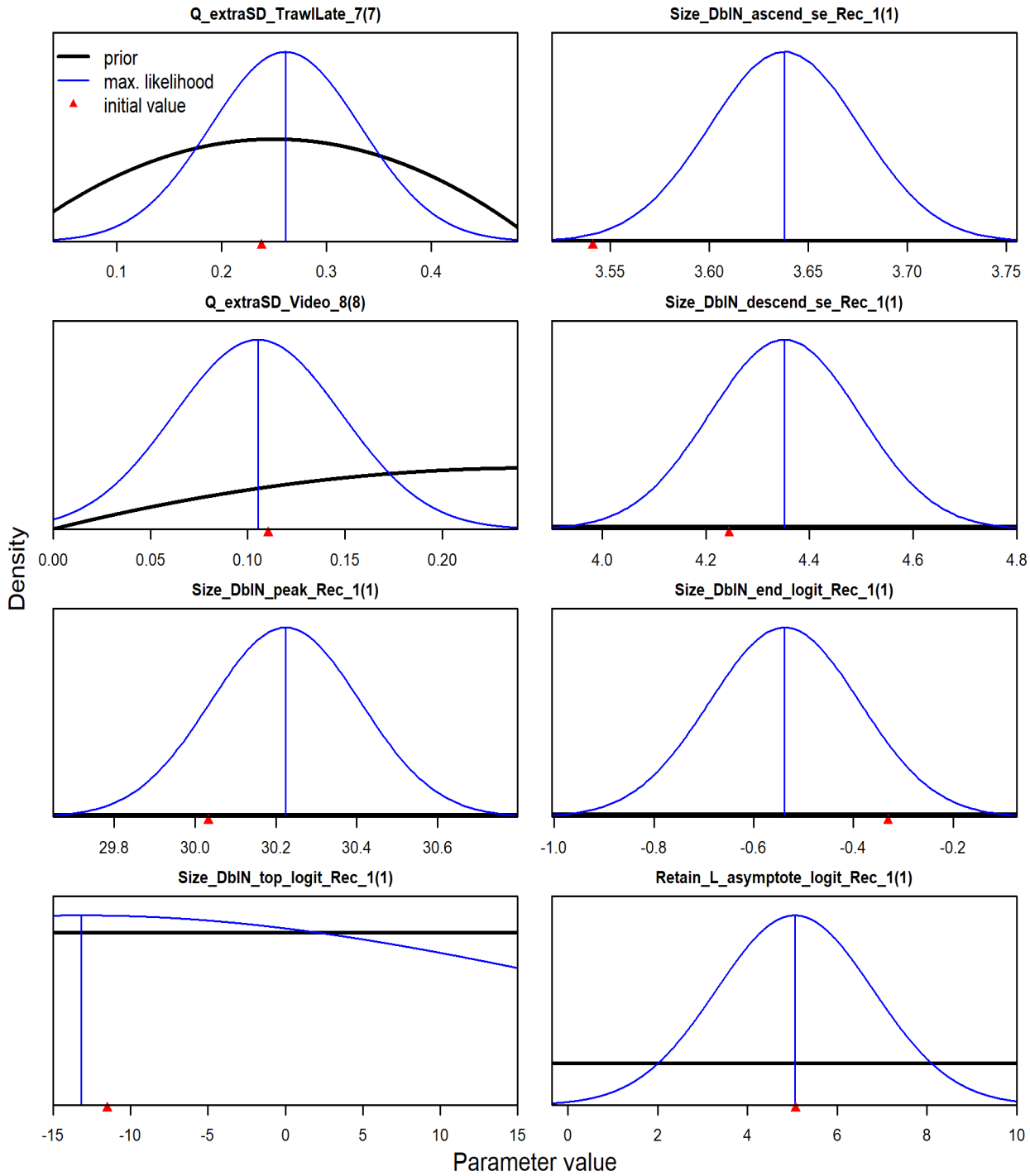


Figure RW27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

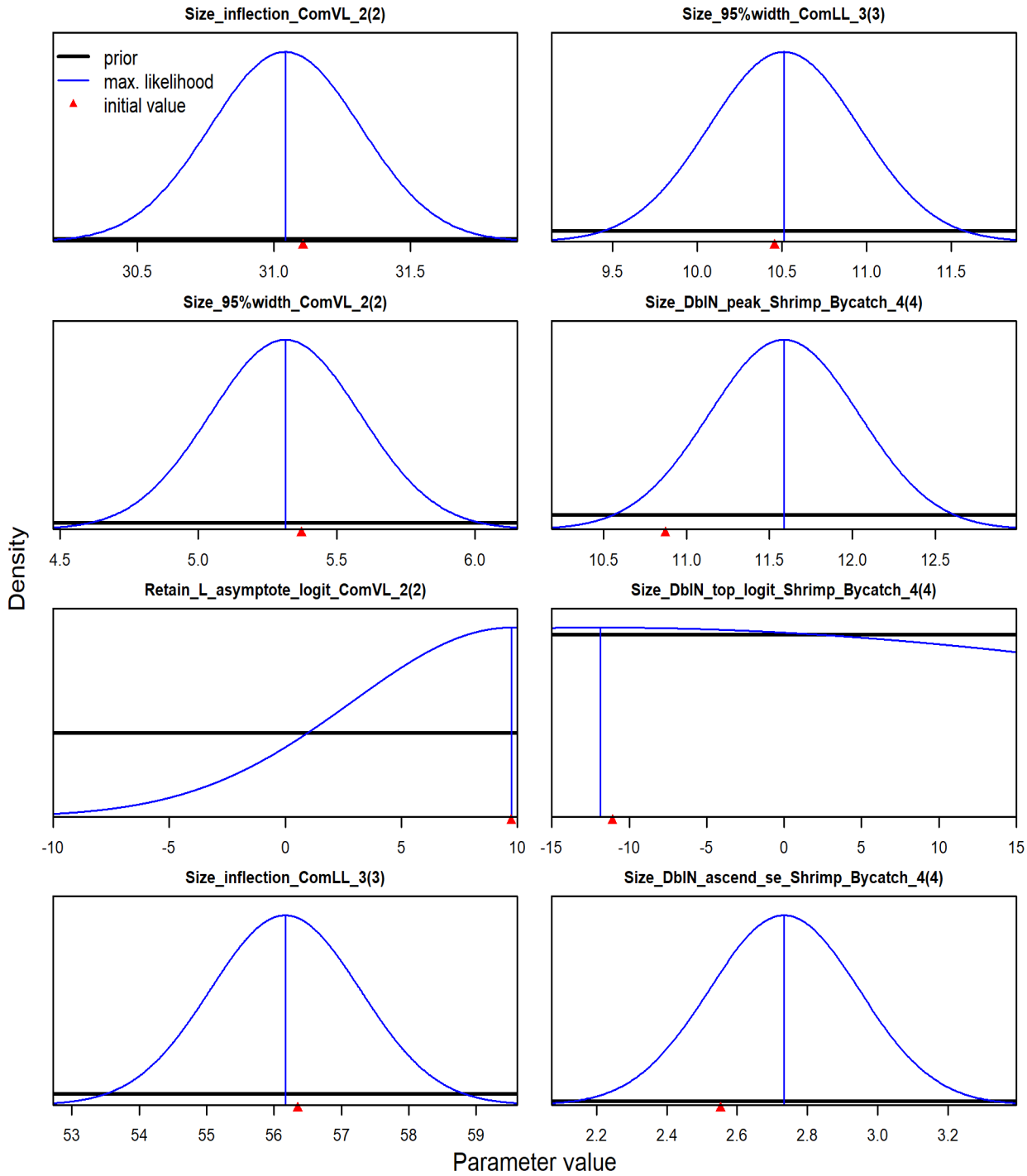


Figure RW27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

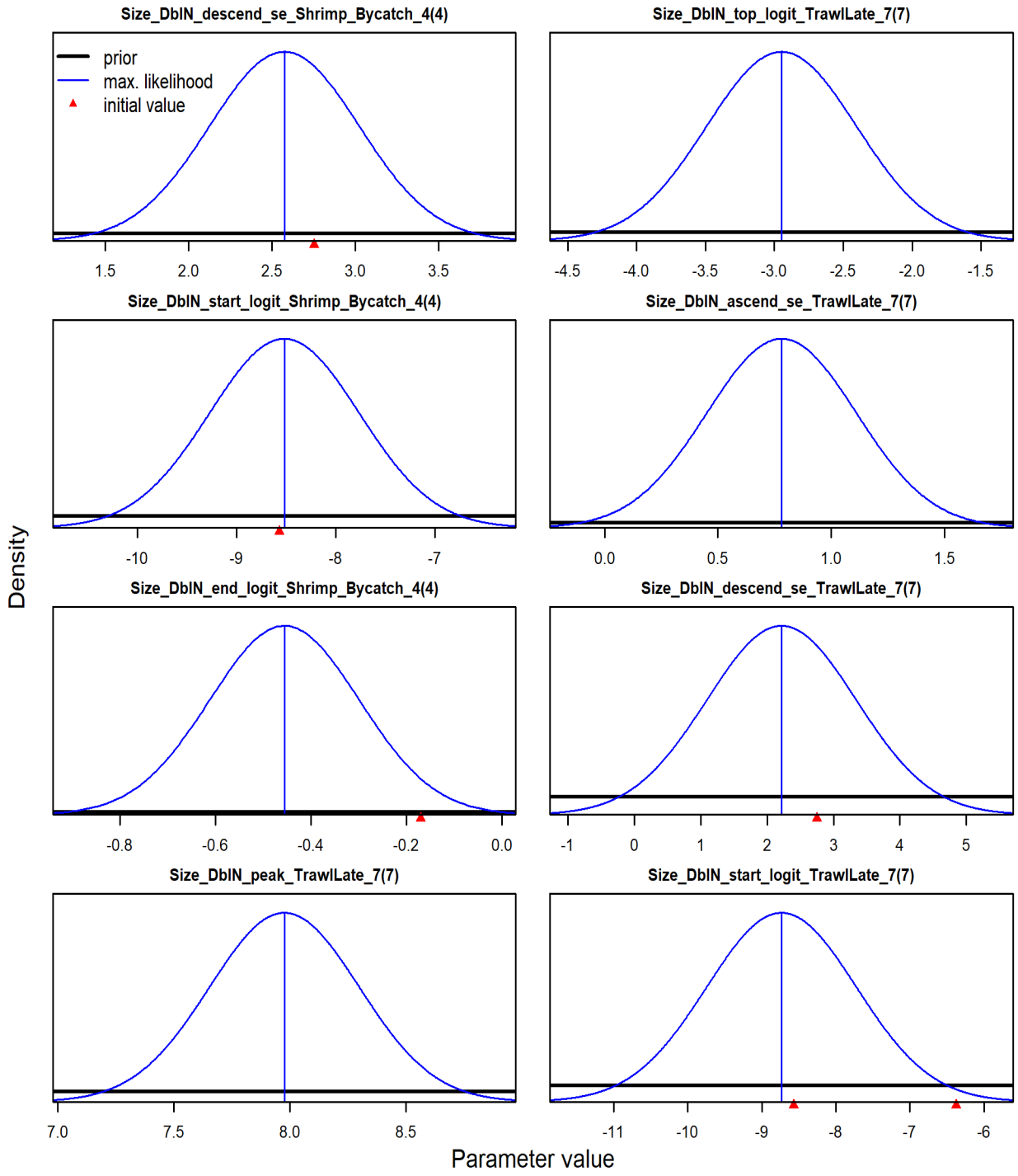


Figure RW27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

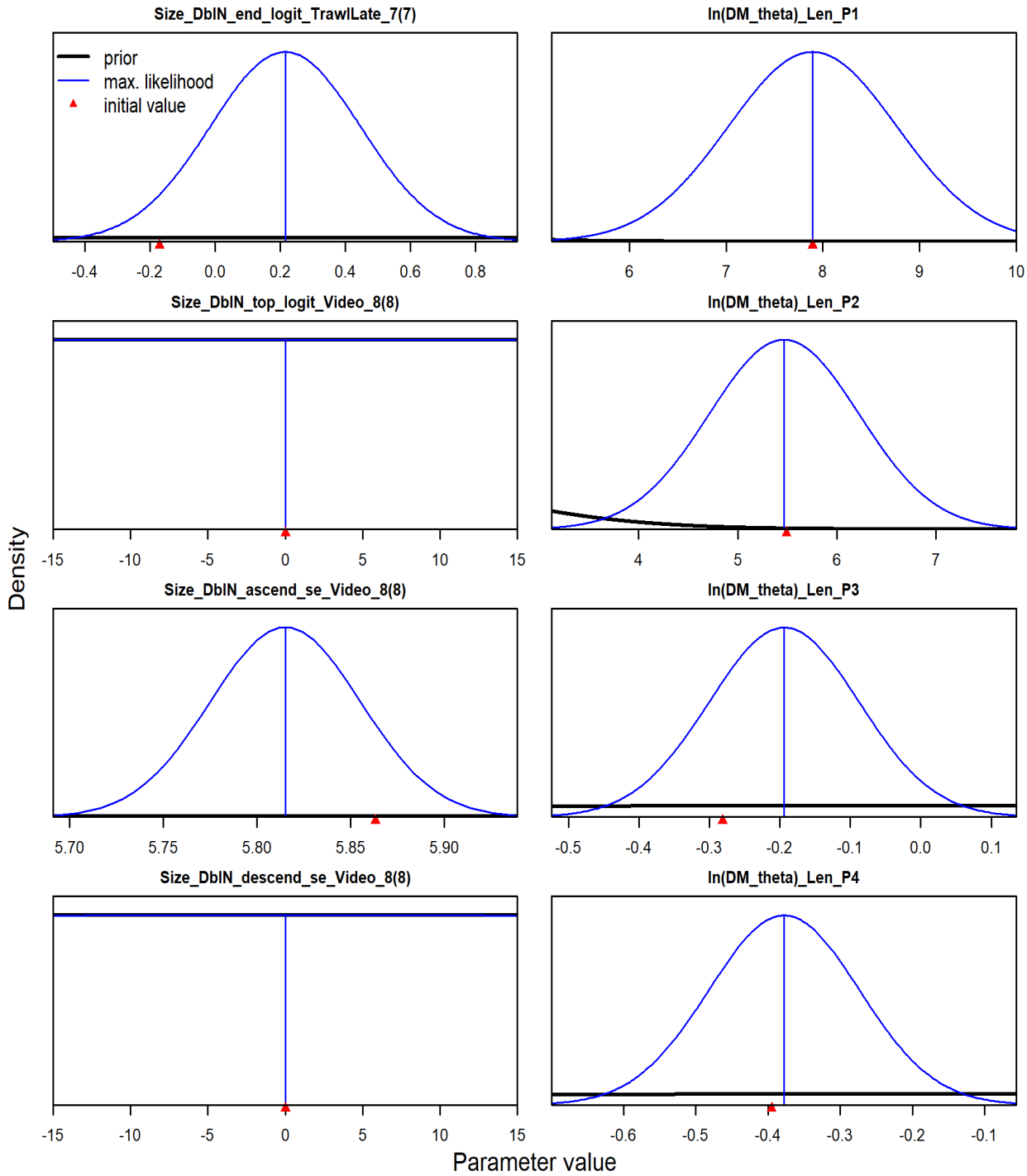


Figure RW27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

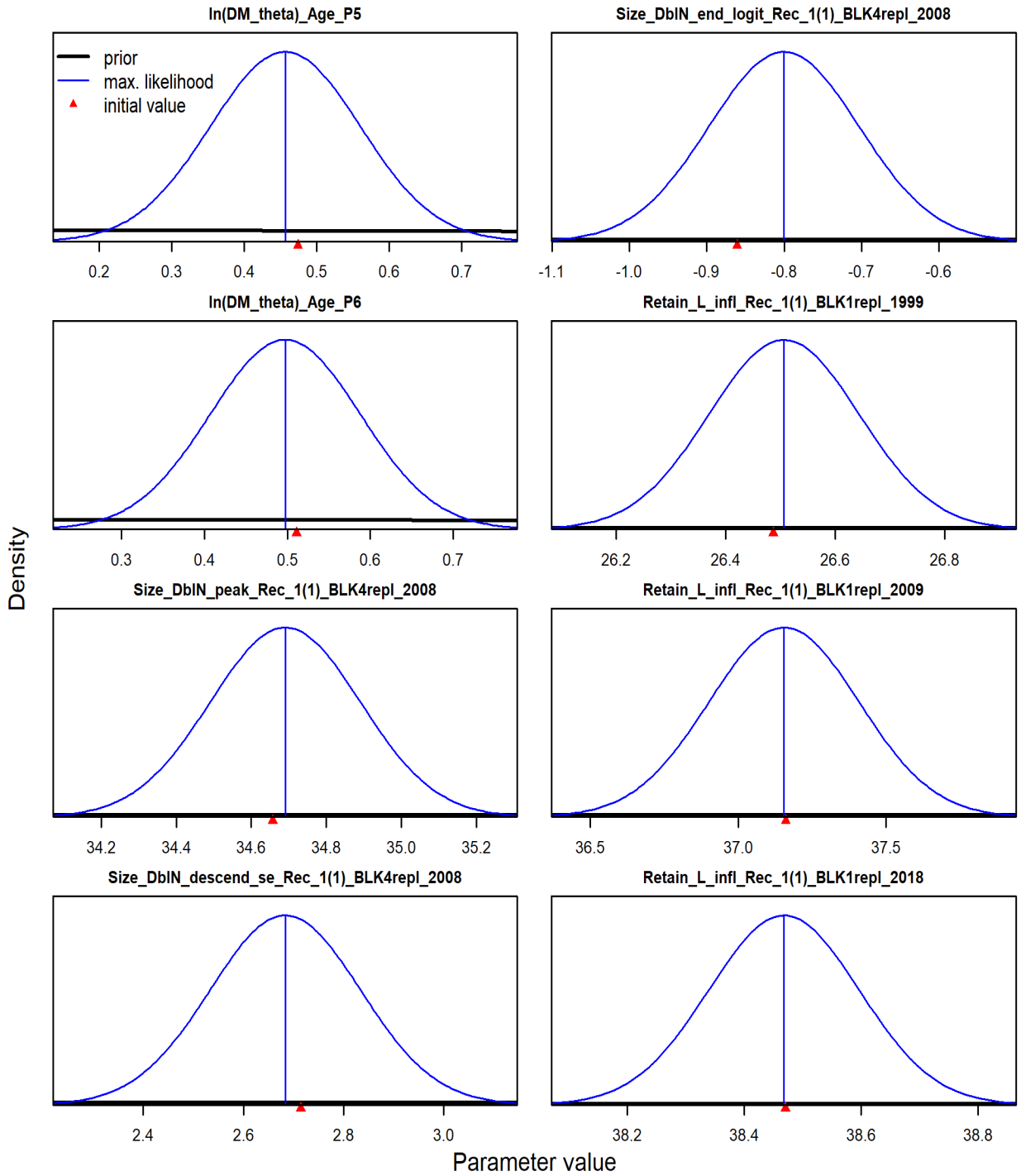


Figure RW27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

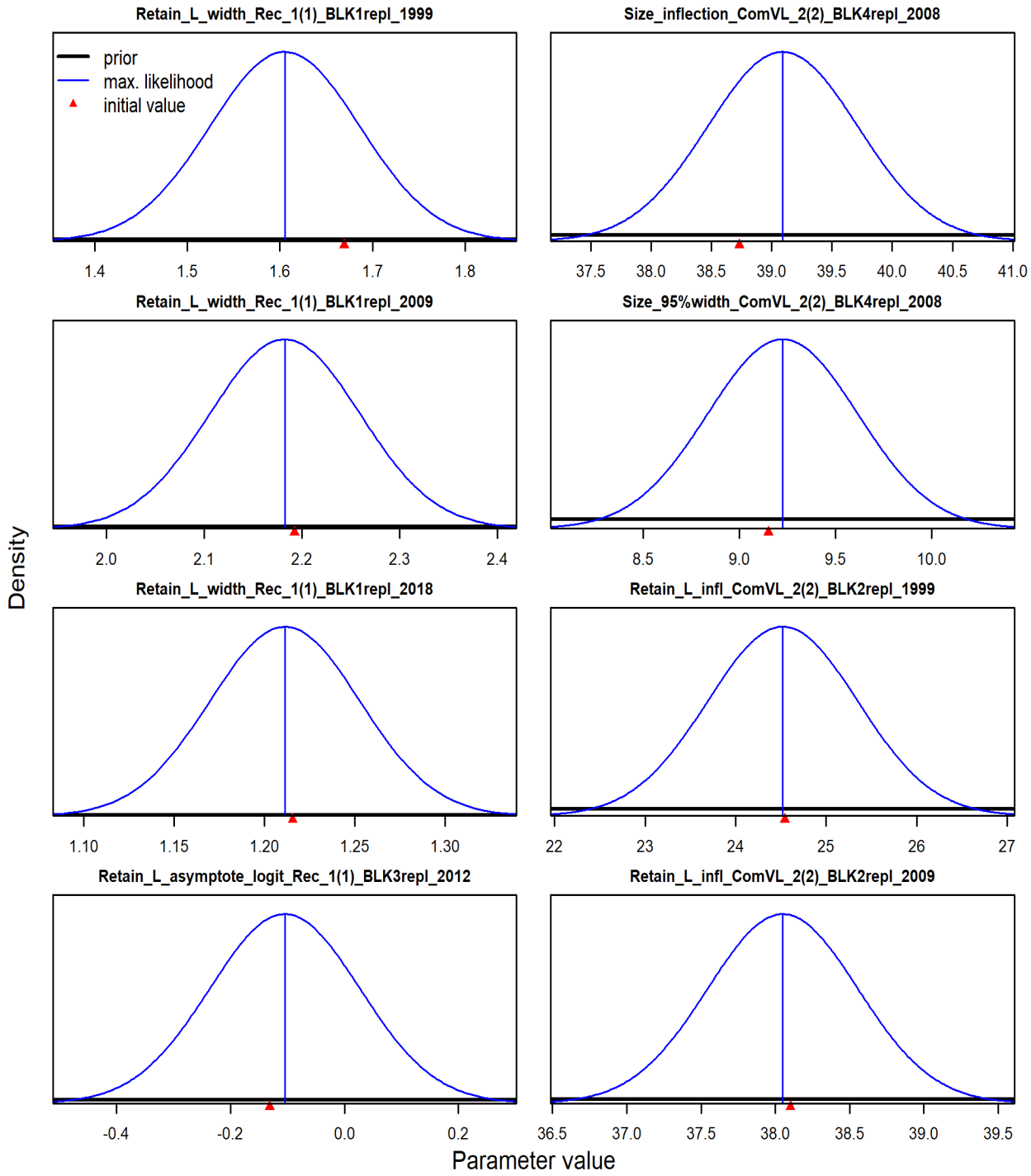


Figure RW27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

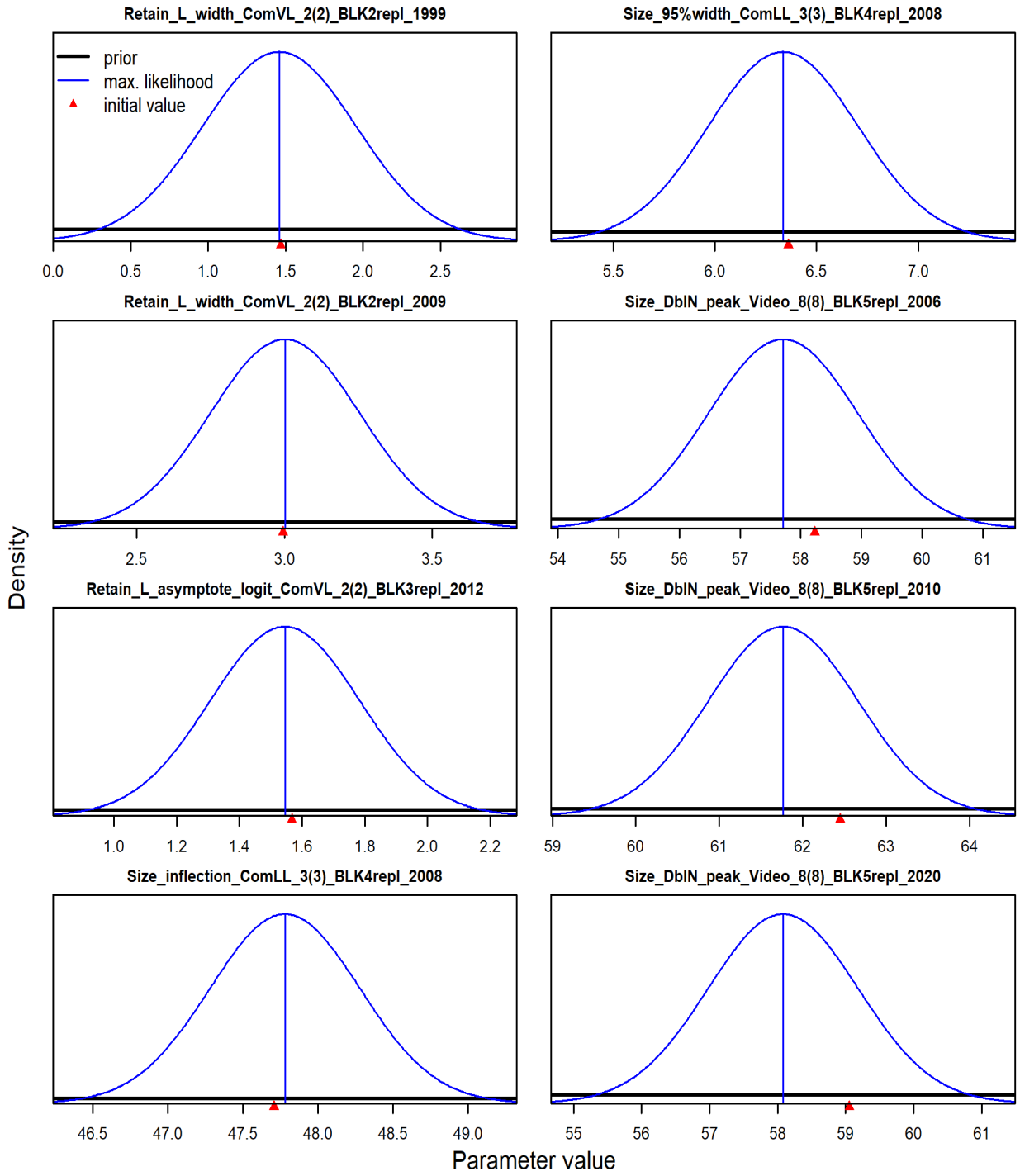


Figure RW27 Continued. Parameter distribution (blue line) plots along with starting values (red arrow) and priors (black lines). X-axis may not reflect bounds as it is zoomed in on the distribution. Deviation parameters and F parameters are not included. Note: parameter point estimates from a previous model fit were used as the starting values for this final model run.

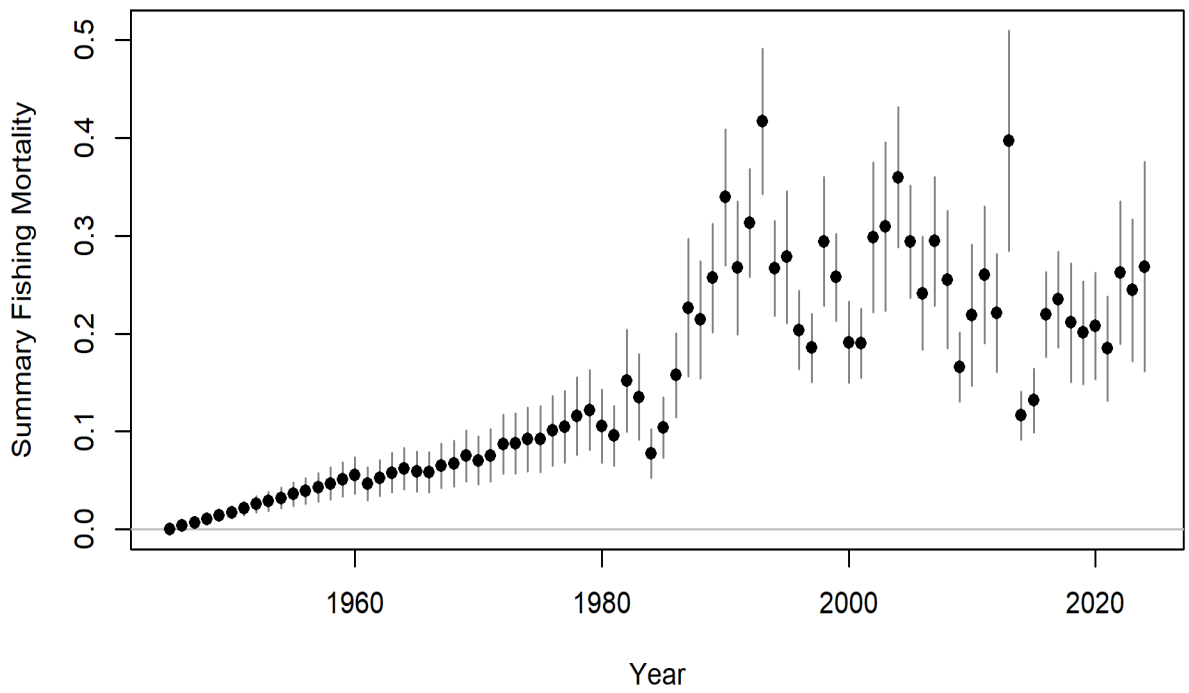


Figure RW28. Annual exploitation rate estimates (total biomass killed all ages / total biomass age 1+) for the SEDAR 100 RW Model.

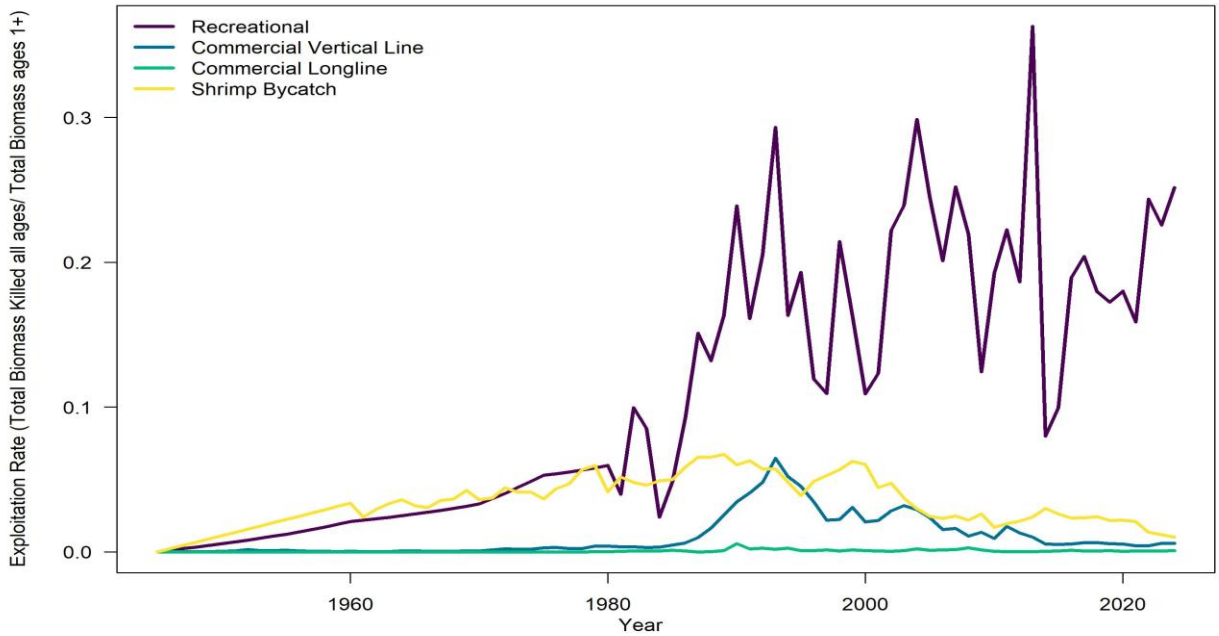


Figure RW29. Annual exploitation rate (total biomass killed all ages / total biomass age 1+) by fleet for the SEDAR 100 RW Model.

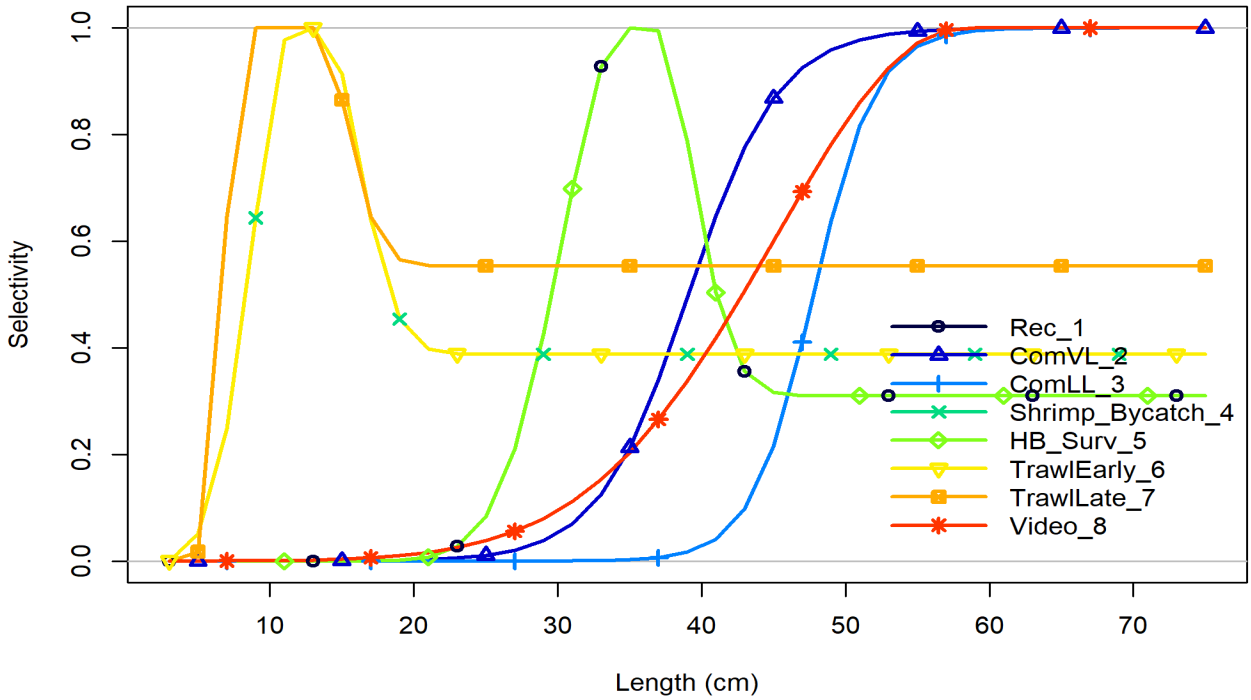


Figure RW30. Length-based selectivity for each fleet and survey in the terminal year of the assessment, 2024.

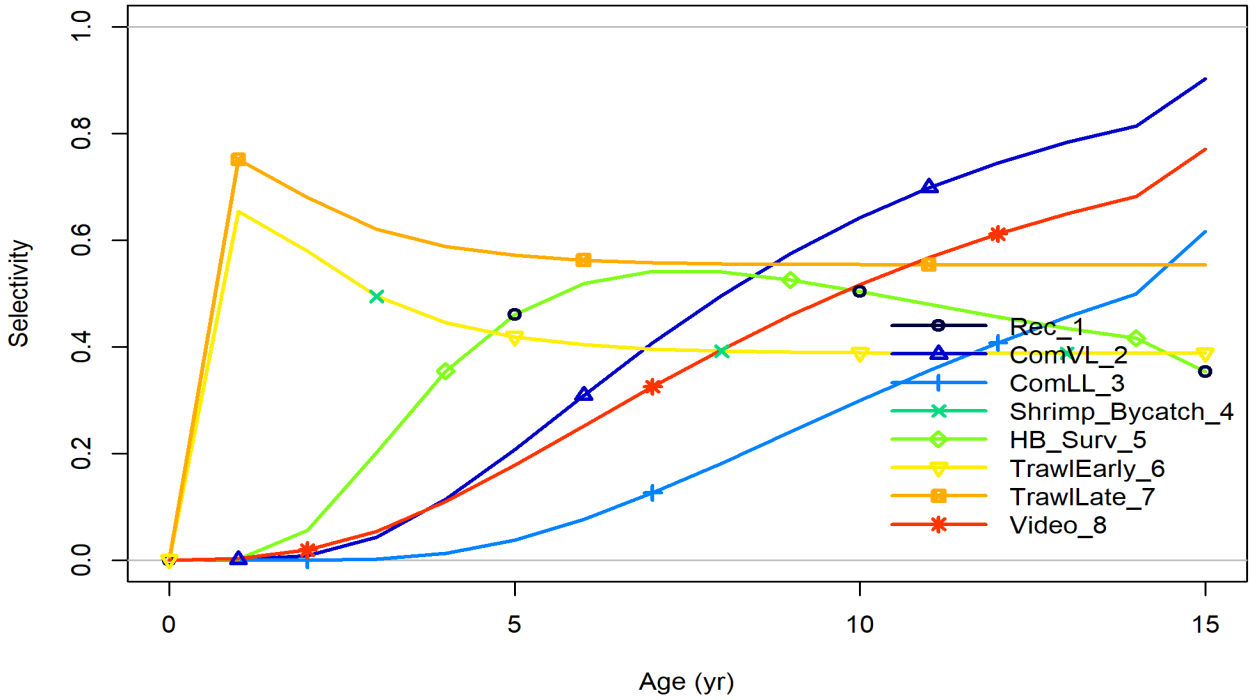


Figure RW31. Derived age-based selectivity for each fleet and survey in the terminal year of the assessment, 2024.

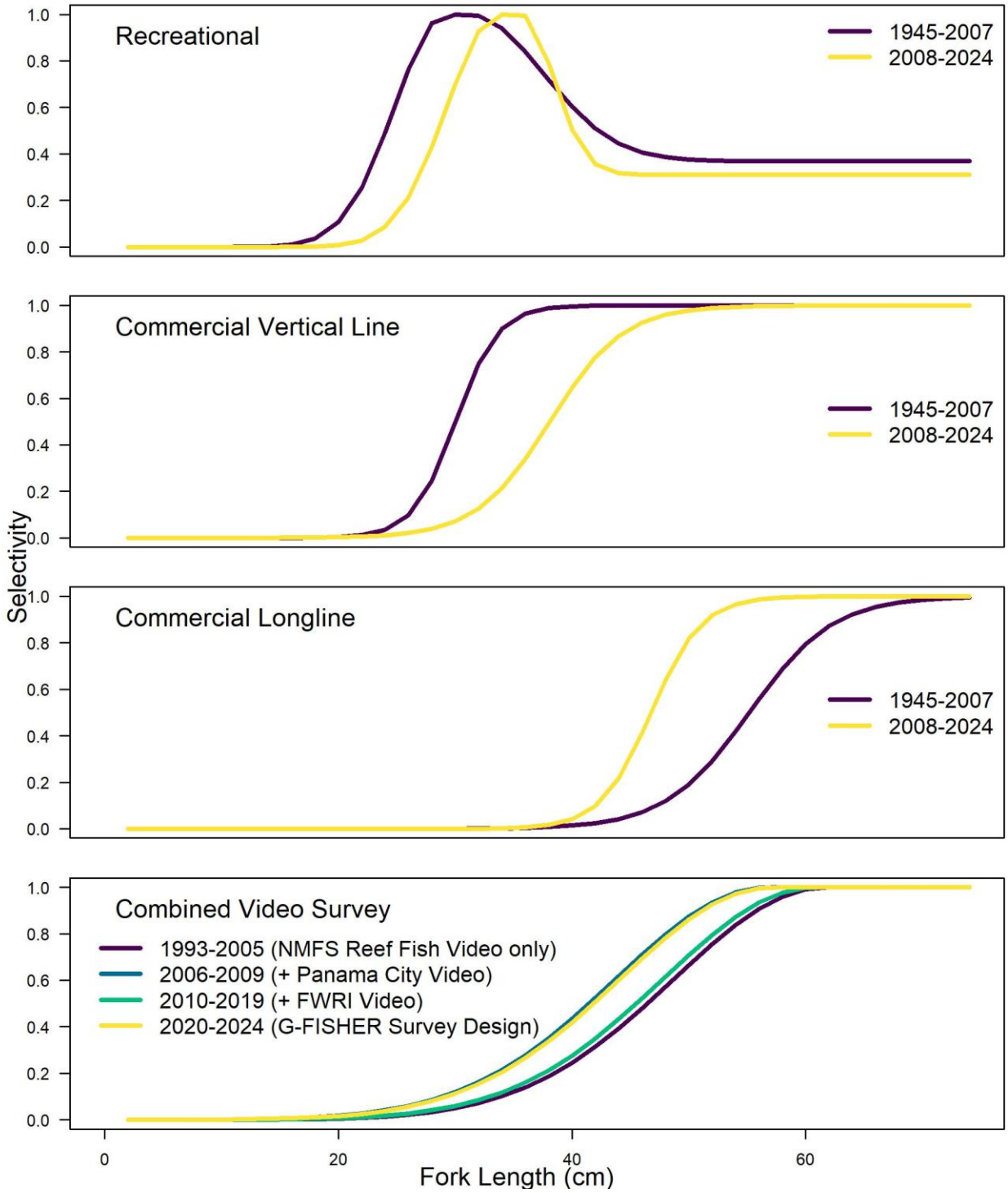


Figure RW32. Time-varying selectivity at length for the fishing fleets and the Combined Video Survey.

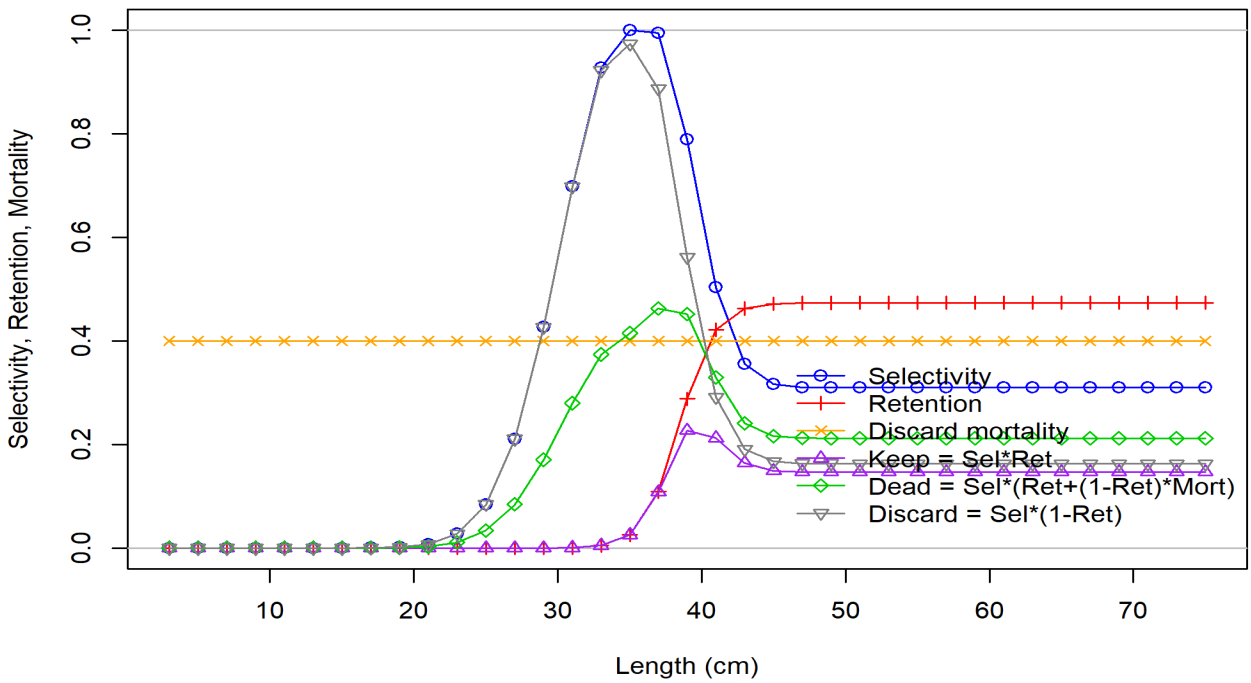


Figure RW33. Length-based selectivity, retention, and discard mortality for the Recreational fleet in the terminal year of the assessment, 2024.

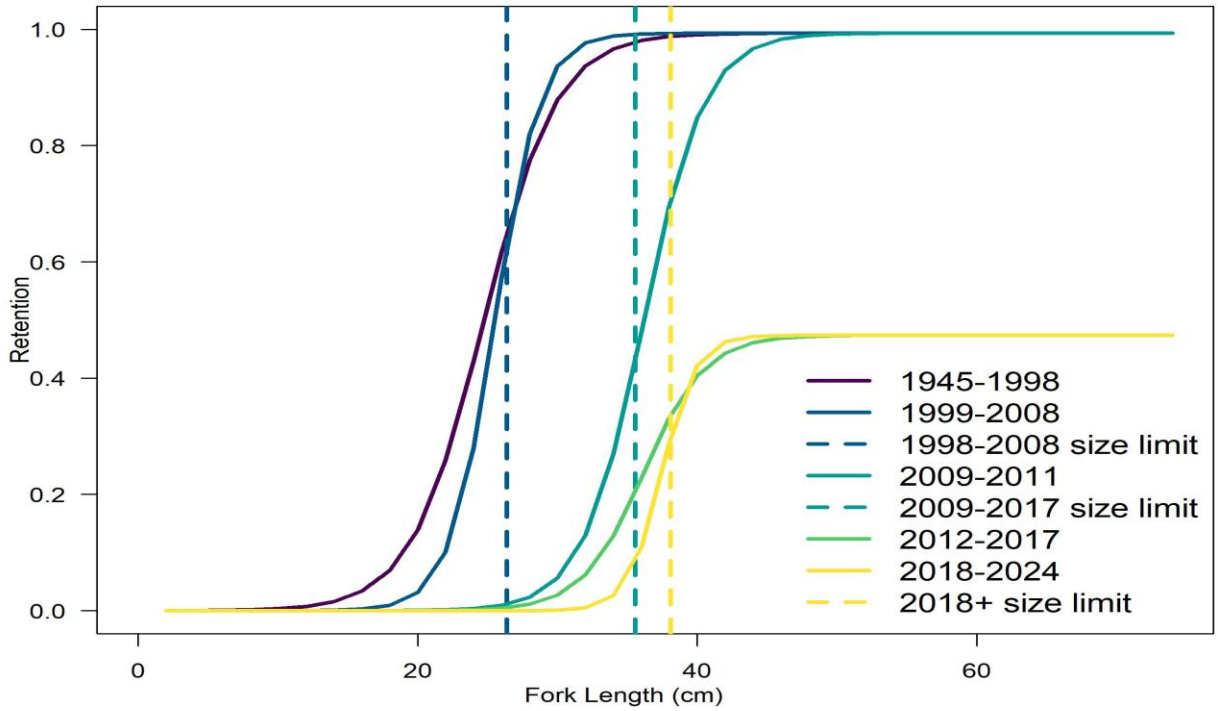


Figure RW34. Time-varying retention at length for the Recreational fleet.

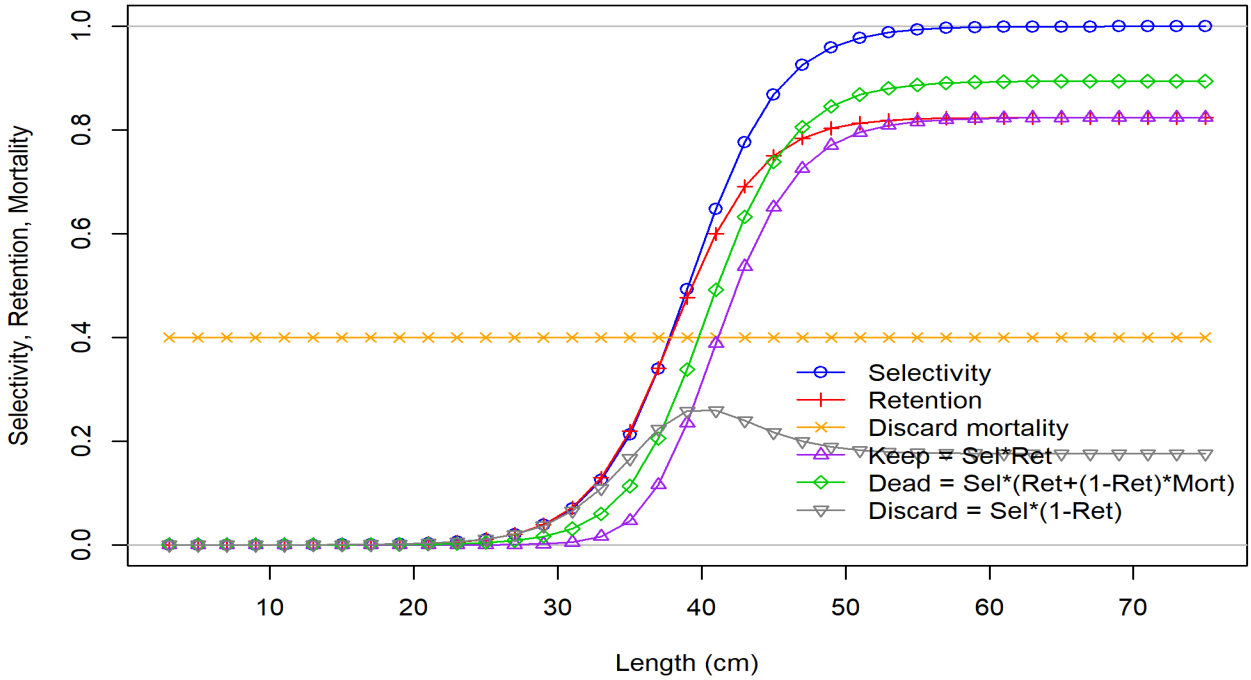


Figure RW35. Length-based selectivity, retention, and discard mortality for the Commercial Vertical Line fleet in the terminal year of the assessment, 2024.

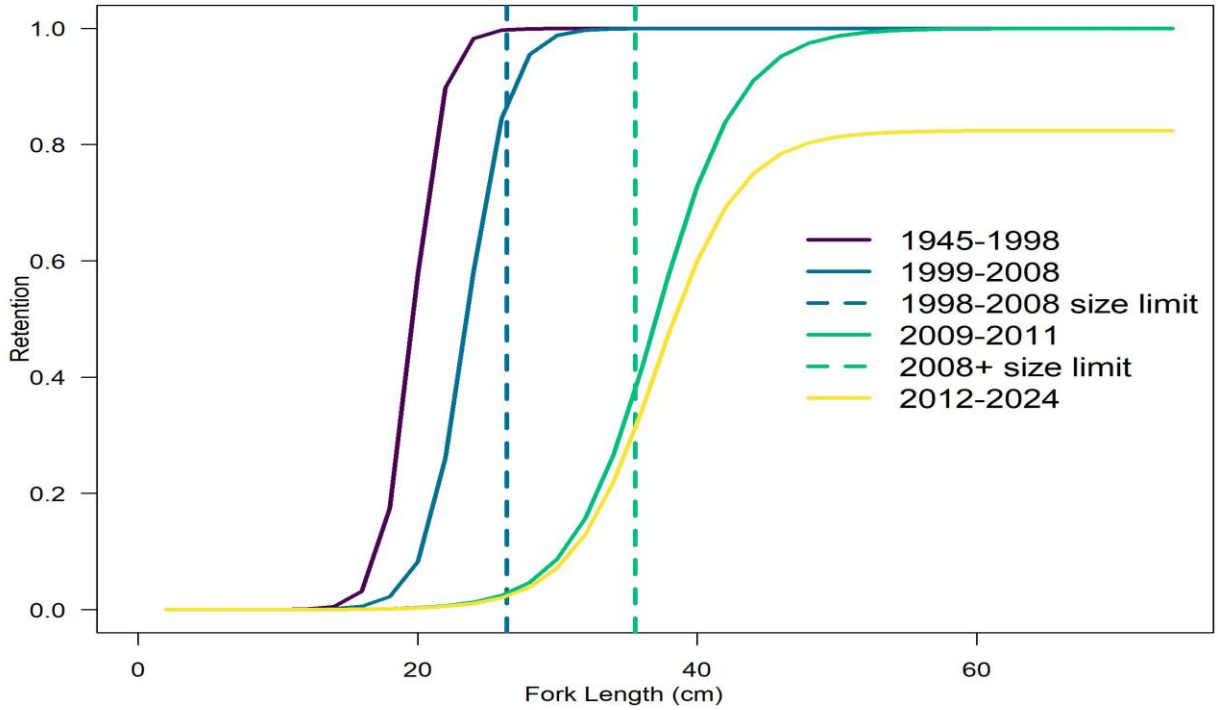


Figure RW36. Time-varying retention at length for the Commercial Vertical Line fleet.

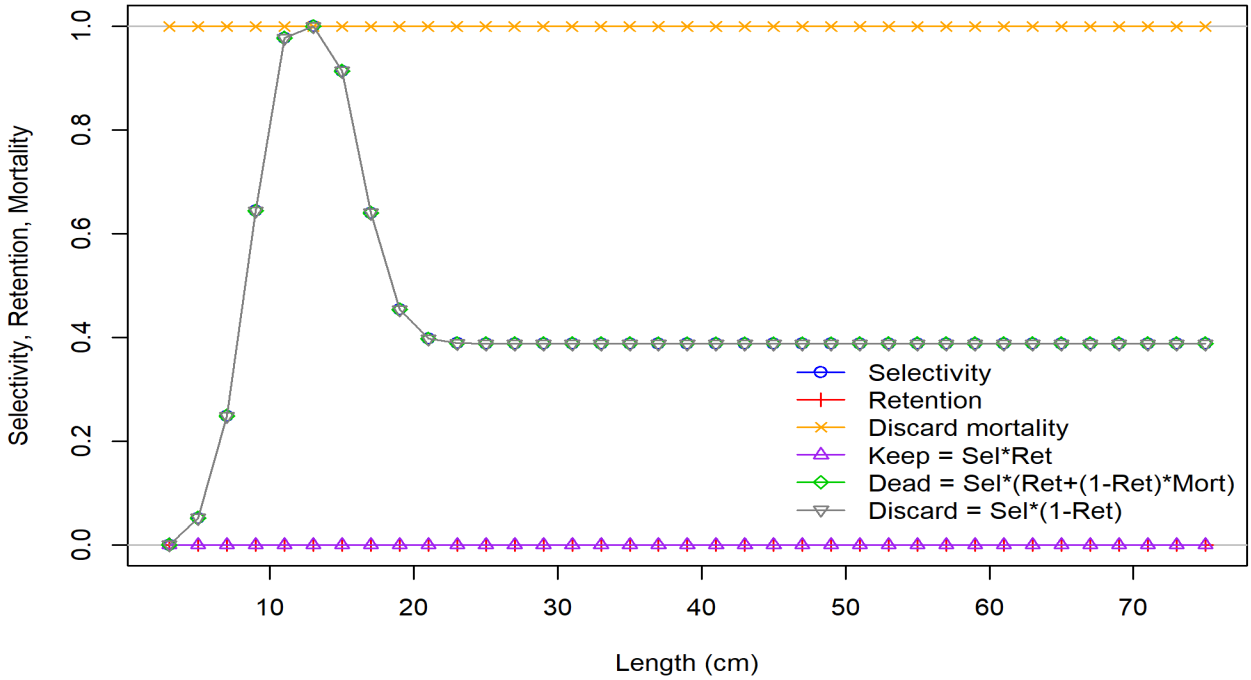


Figure RW37. Length-based selectivity, retention, and discard mortality (100%) for the Shrimp Bycatch fleet in the terminal year of the assessment, 2024. Selectivity (blue line) is constant over the entire assessment time period (1945-2024).

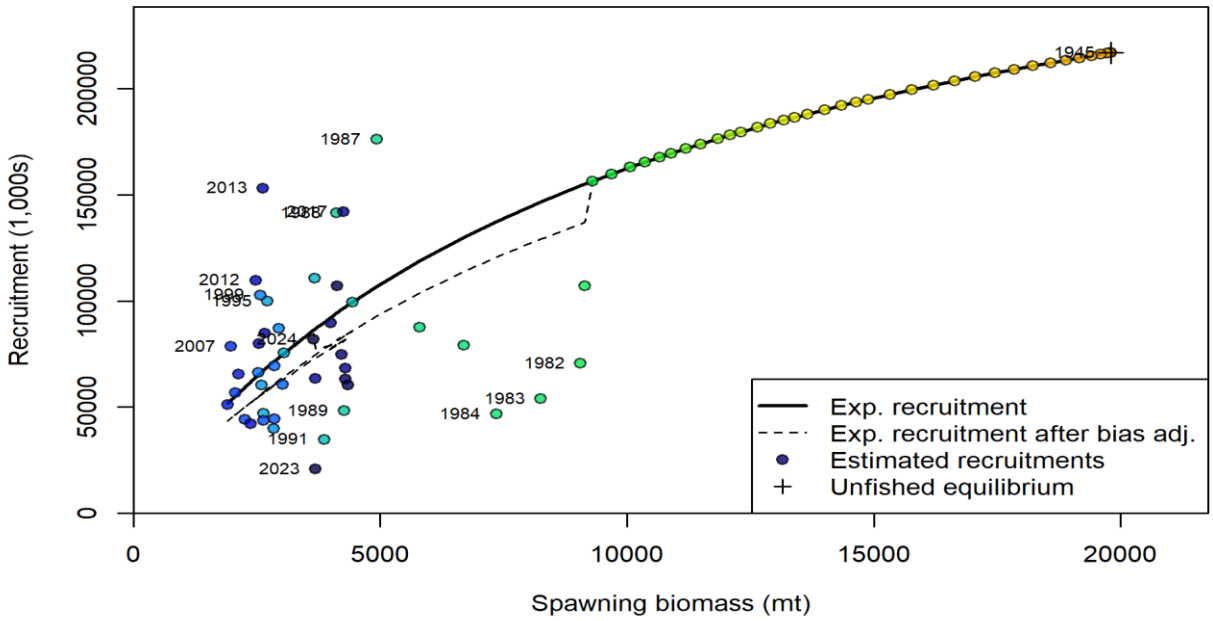


Figure RW38. Predicted stock-recruit relationship for the SEDAR 100 RW Model where steepness is estimated at 0.422 and SigmaR is fixed at 0.6. Plotted are predicted annual recruitments from Stock Synthesis (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line).

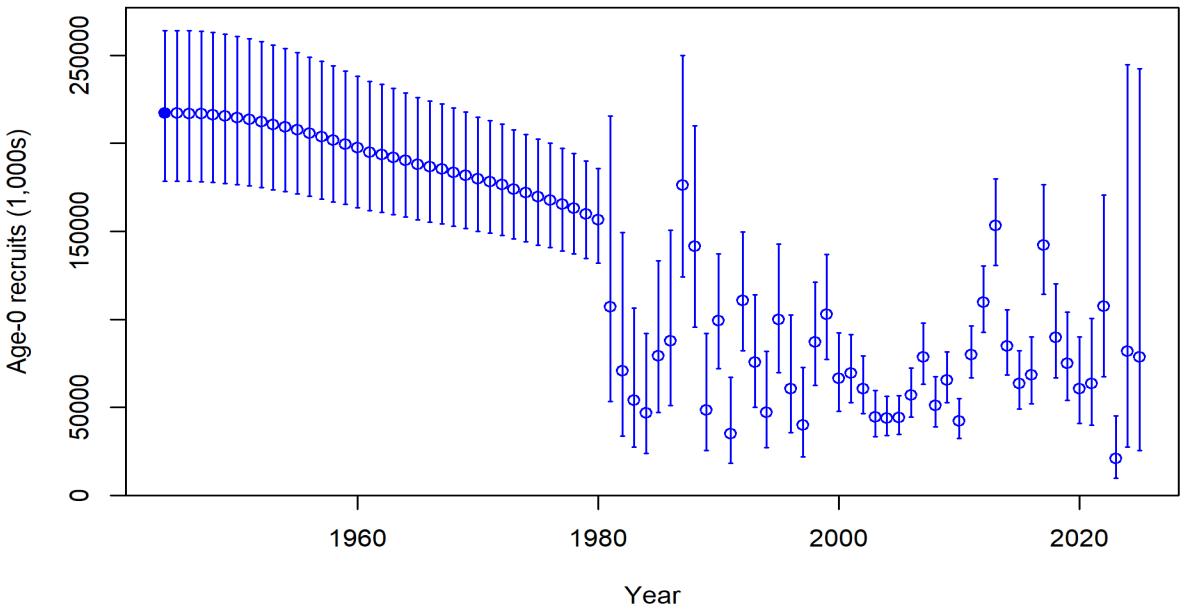


Figure RW39. Estimated Age-0 recruitment with 95% confidence intervals for the SEDAR 100 RW Model where steepness is estimated at 0.422 and SigmaR is fixed at 0.6.

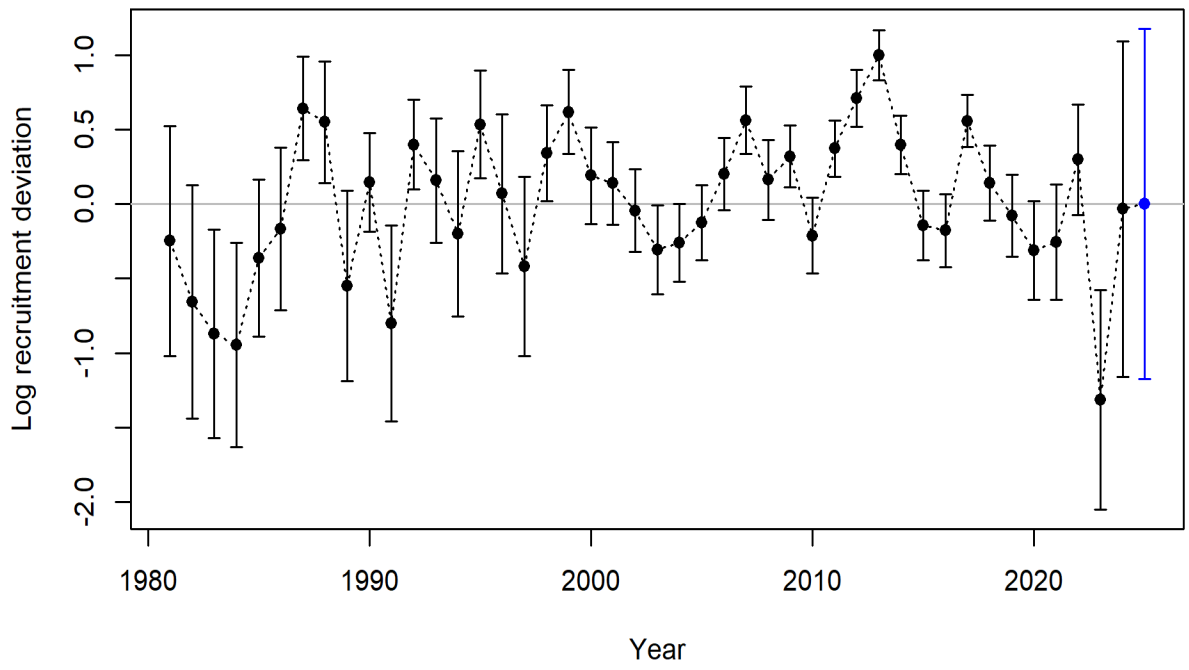


Figure RW40. Estimated log recruitment deviations for the SEDAR 100 RW Model where steepness is estimated at 0.422 and SigmaR is fixed at 0.6. Blue dots identify years where recruitment deviations were not estimated.

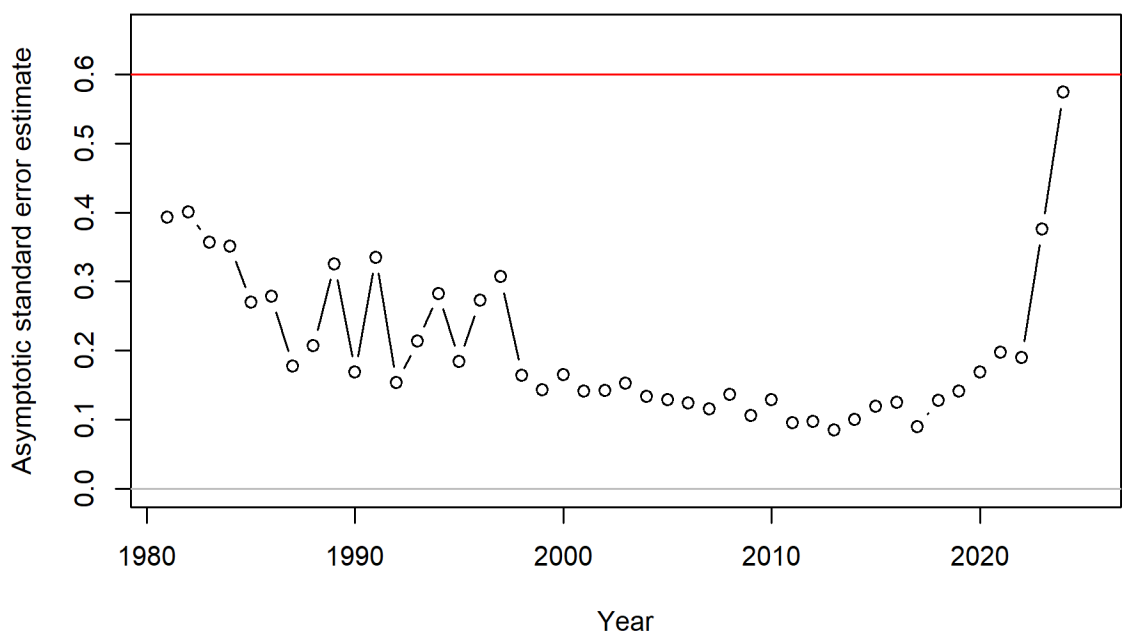


Figure RW41. Asymptotic standard errors for recruitment deviations for the SEDAR 100 RW Model. The red line represents the fixed value of 0.6.

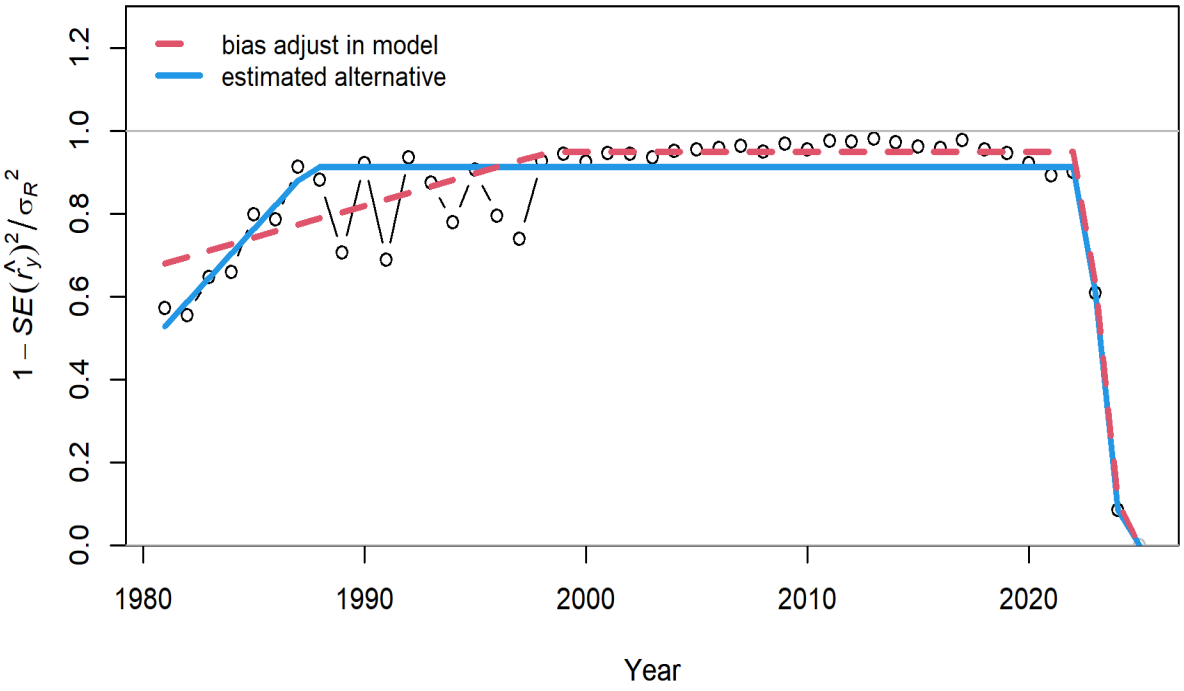


Figure RW42. Points are transformed variances. Red line shows current settings for bias adjustment specified for the SEDAR 100 RW Model. The least squares estimate of alternative bias adjustment relationship for recruitment deviations (solid blue line) is also shown and will be tuned during future model development. For more information, see Methot and Taylor (2011).

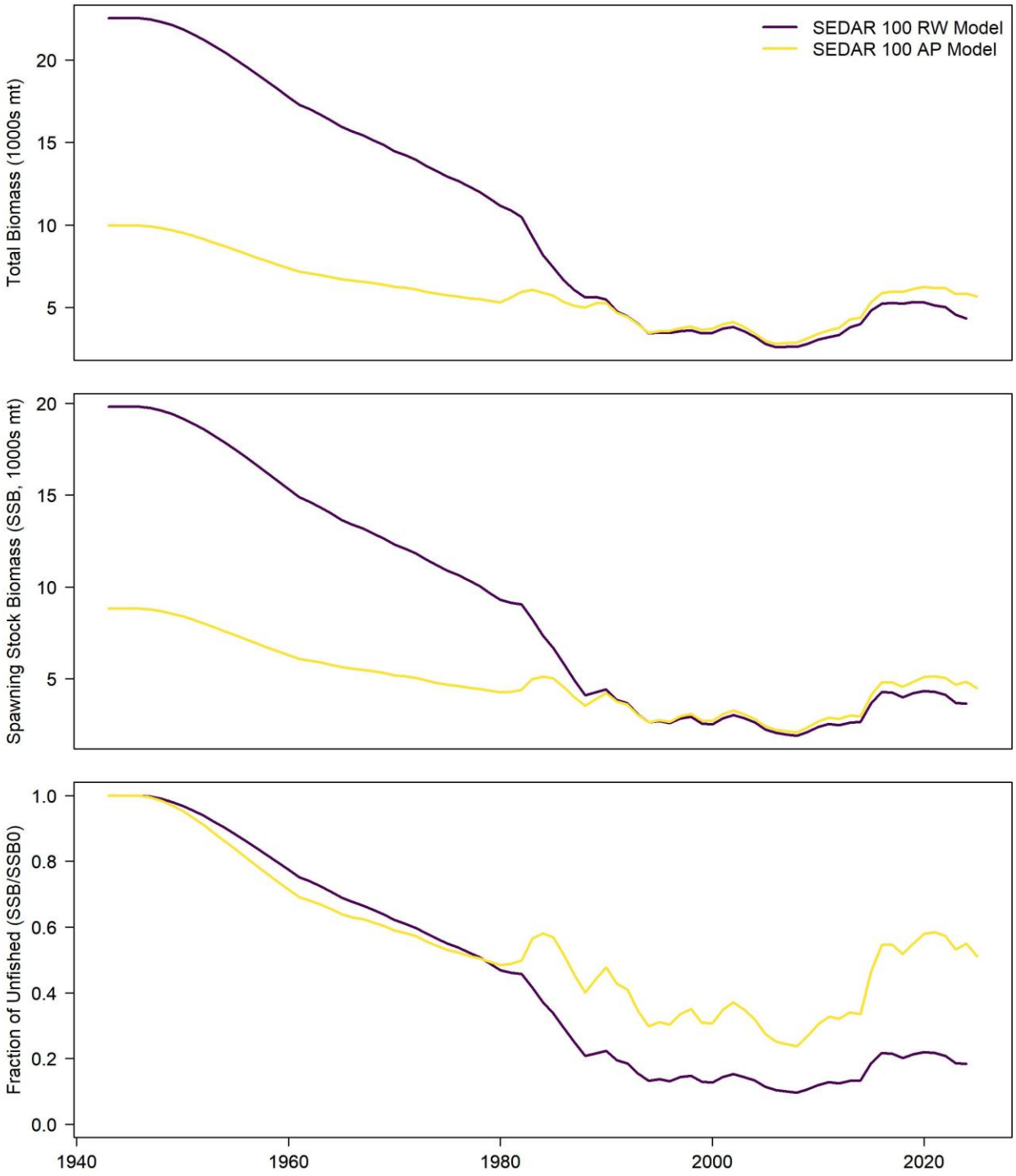


Figure RW43. Estimates of annual total biomass (in 1000s of metric tons; top panel), spawning stock biomass (in 1000s of metric tons; middle panel), and the fraction of virgin or unfished SSB (SSB/SSB_0; bottom panel) for the SEDAR 100 RW Model.

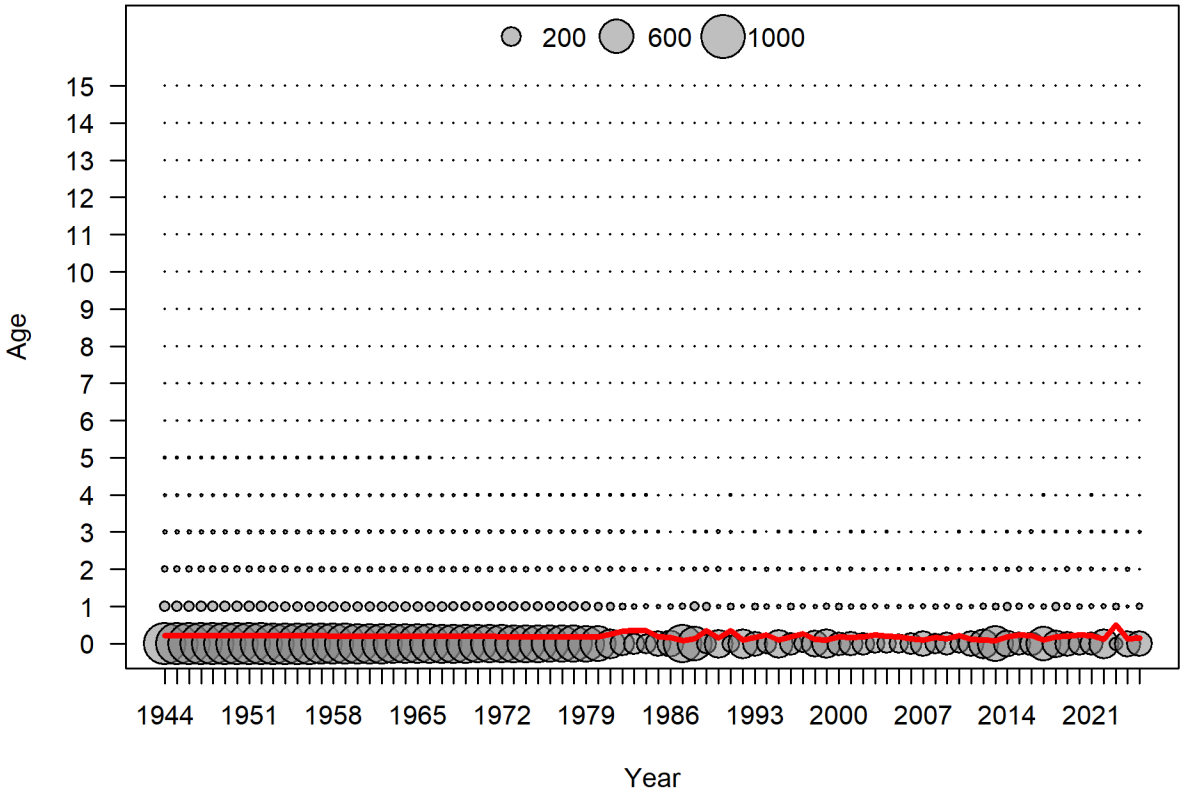


Figure RW44. Expected beginning of year numbers-at-age (bubbles) and mean age (red line) for the SEDAR 100 RW Model.

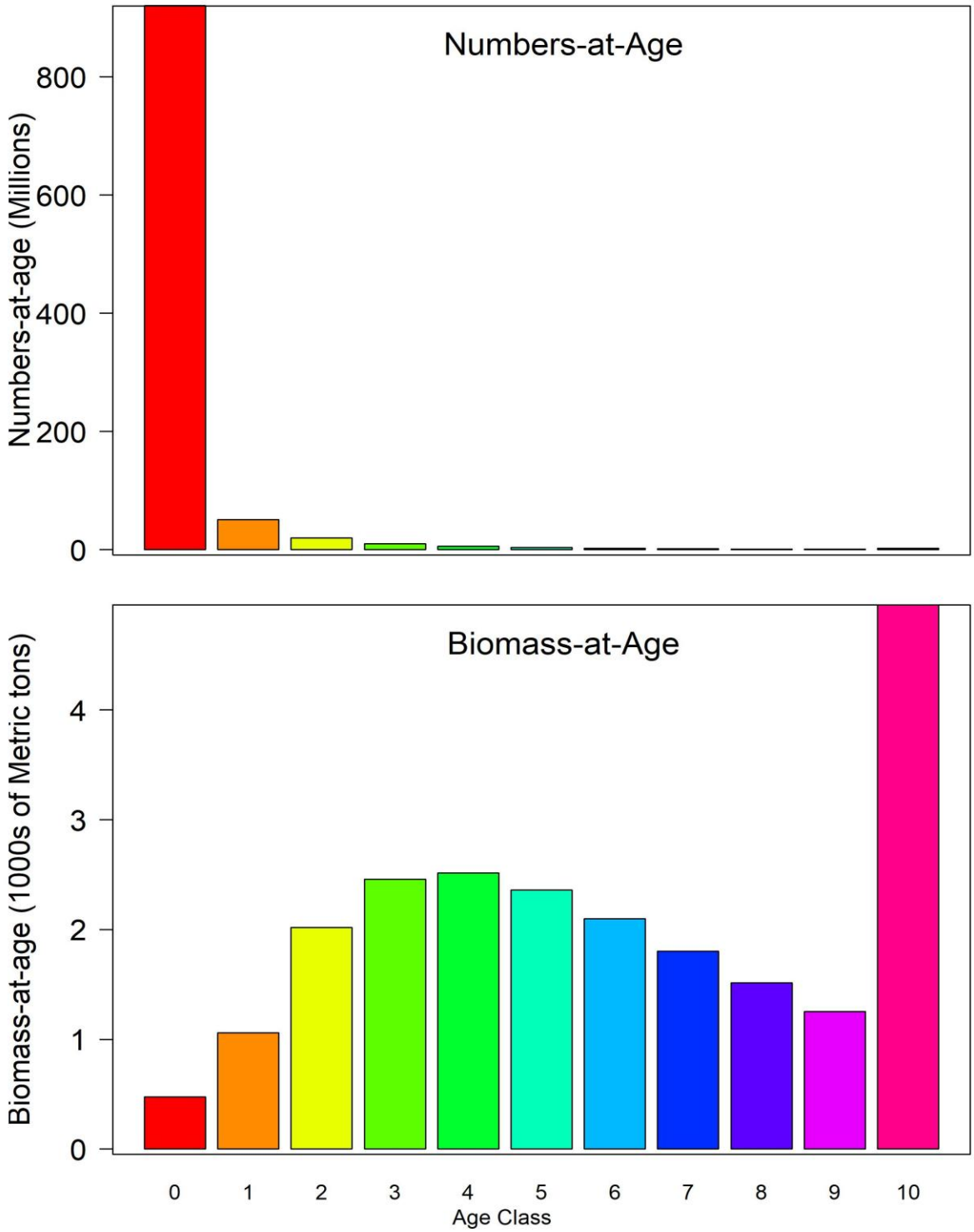


Figure RW45. Expected numbers-at-age and biomass-at-age at virgin stock conditions.

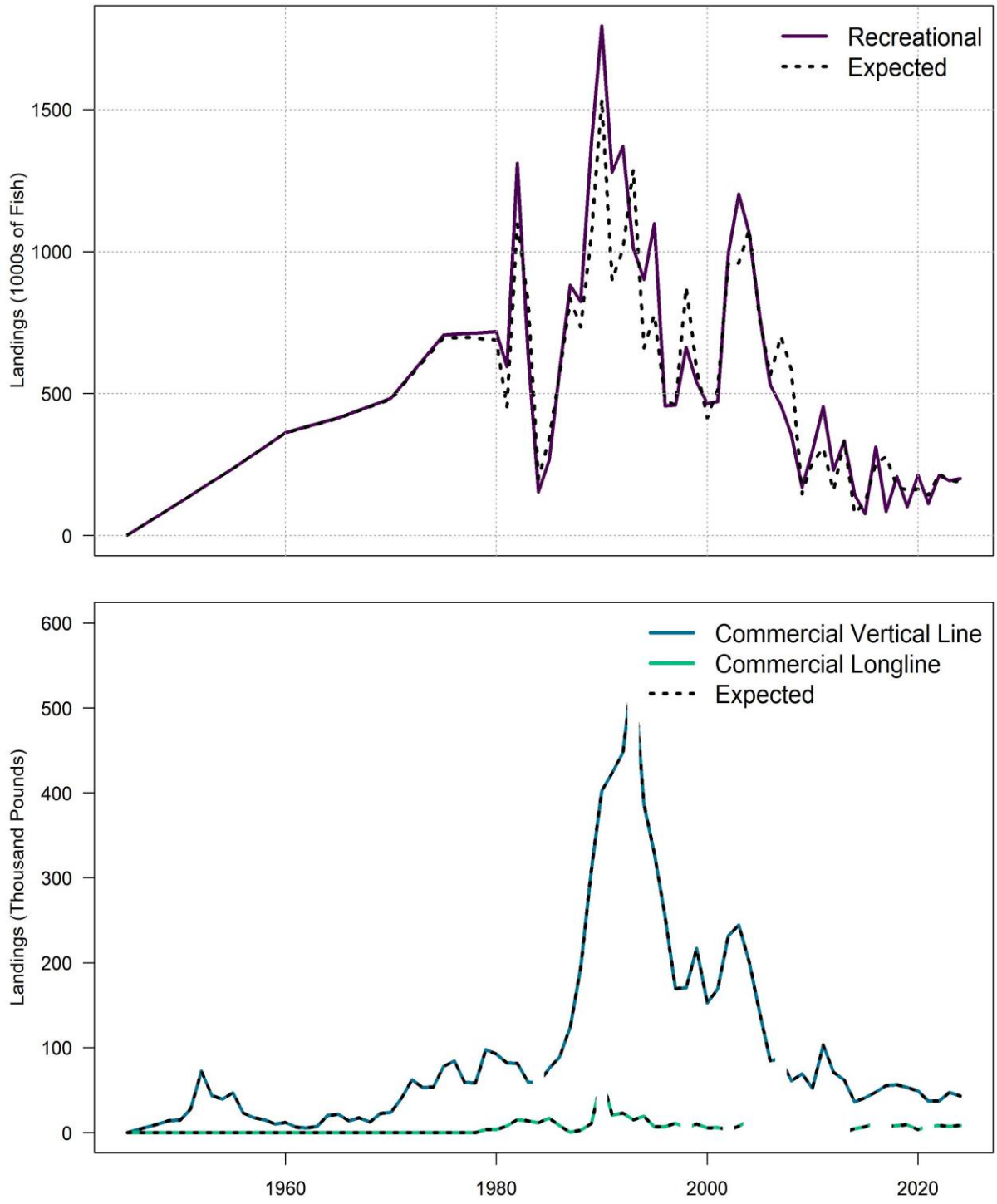


Figure RW46. Observed (thick colored lines) and expected (dashed lines) landings by fleet. Commercial landings were input into the stock assessment model as metric tons in whole weight, and are shown in thousands of pounds. Associated log-scale standard errors are provided in ***Tables RW21-23****. Confidential data have been excluded.*

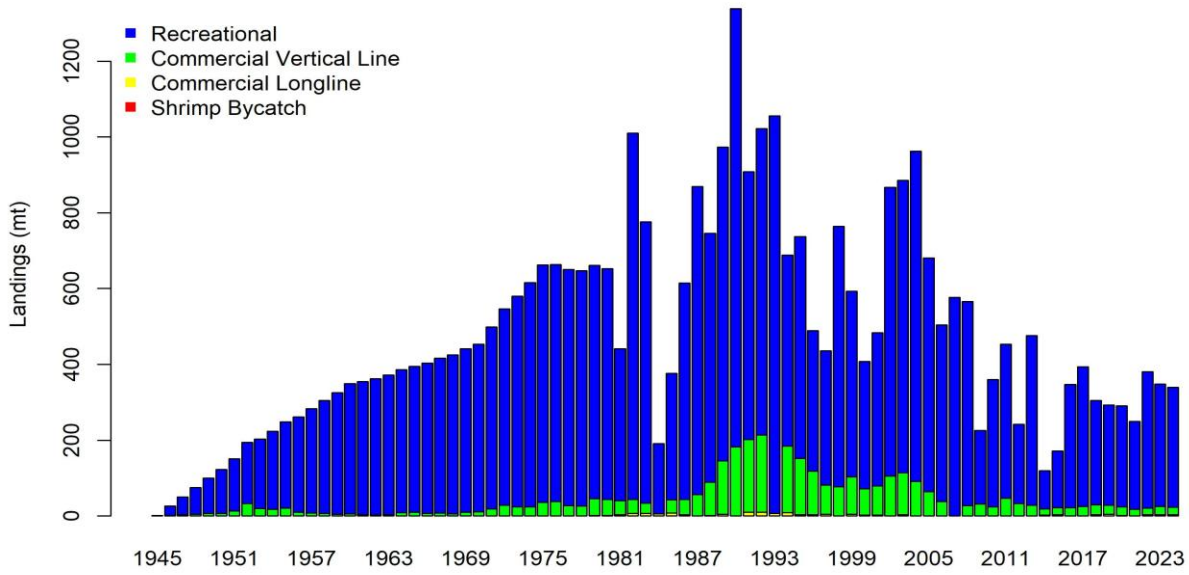


Figure RW47. Expected landings (metric tons, mt) by fleet for the SEDAR 100 RW Model. Confidential data for SEDAR 100 have been excluded for the Commercial Vertical Line and Commercial Longline fleets.

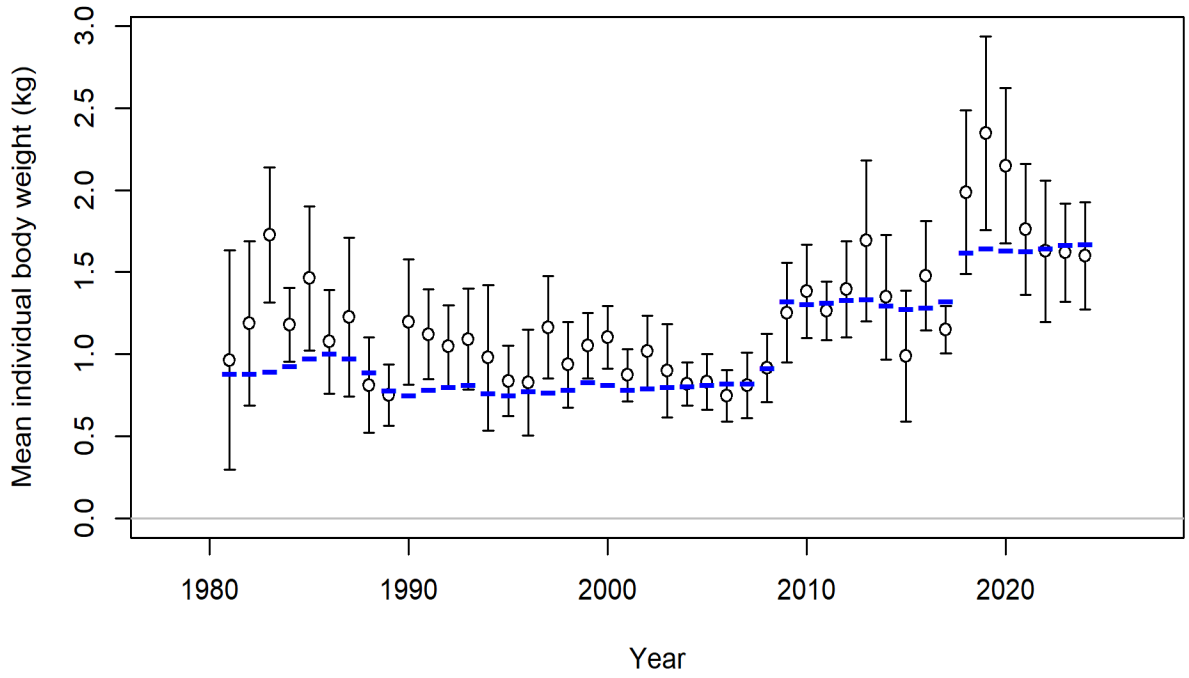


Figure RW48. Input (dots with 95% confidence intervals) and expected (blue dashes) mean weight (kg, whole weight) of Gray Triggerfish landed by the Recreational fleet.

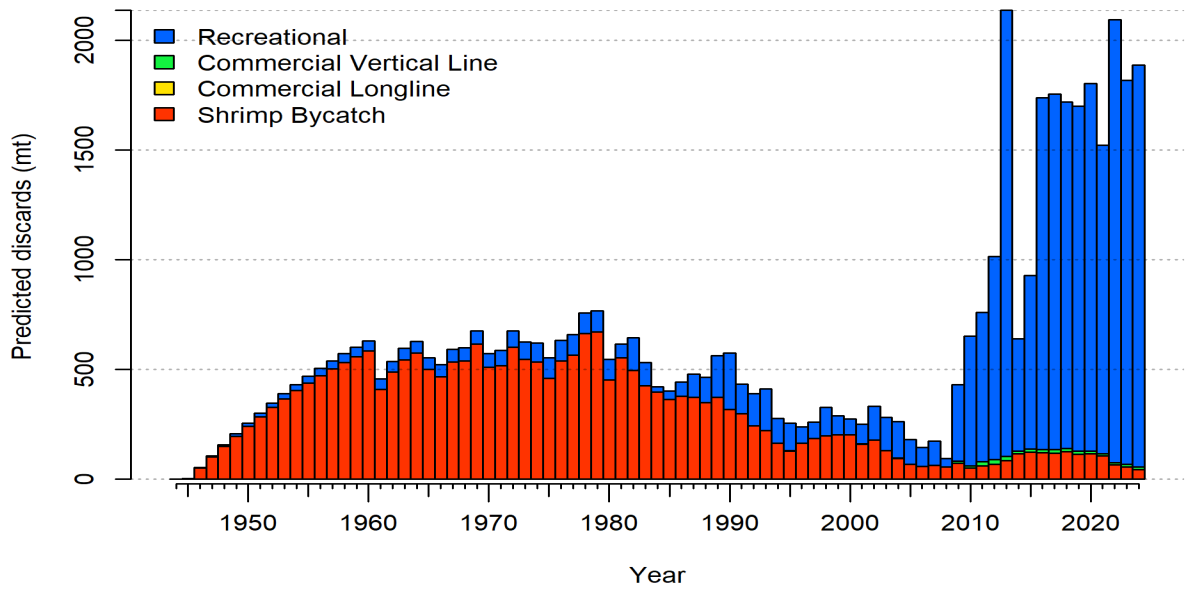


Figure RW49. Expected discards (metric tons, mt) by fleet for the SEDAR 100 RW Model.

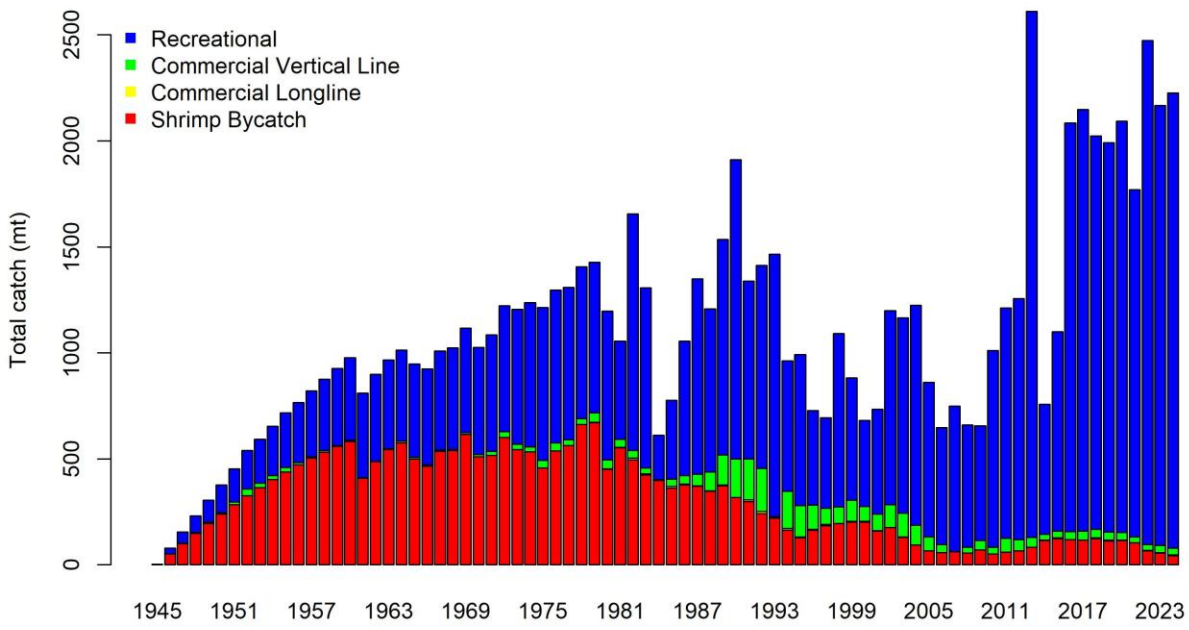


Figure RW50. Expected total catch (landings + discards in metric tons, mt) by fleet for the SEDAR 100 RW Model. Confidential data for SEDAR 100 have been excluded for the Commercial Vertical Line and Commercial Longline fleets.

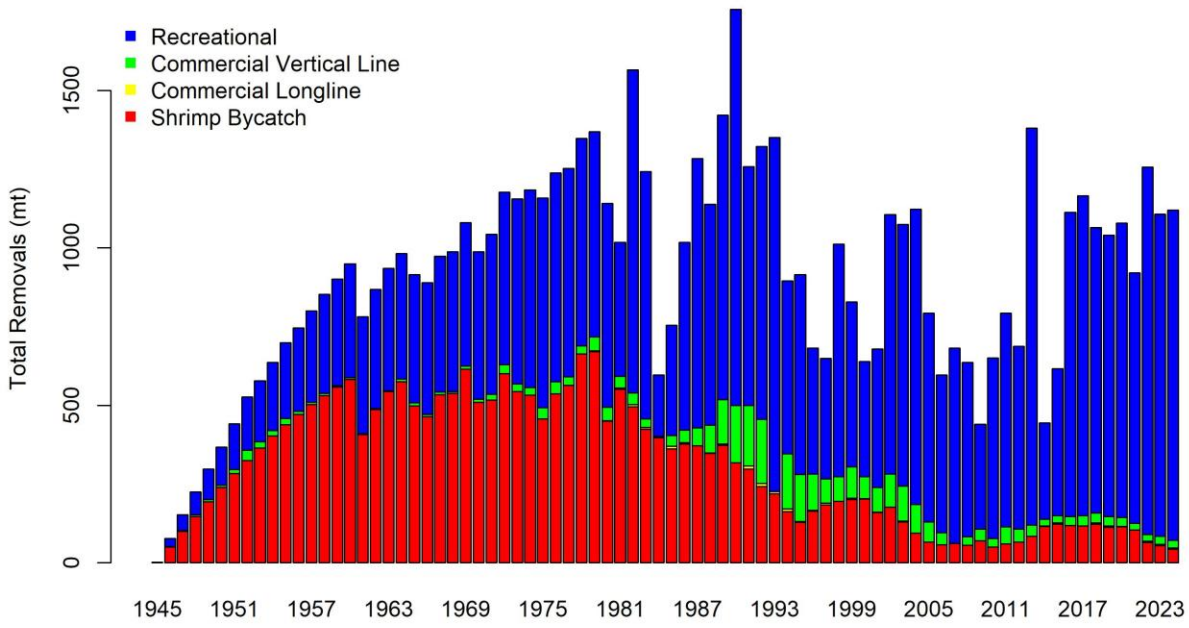


Figure RW51. Expected total removals (landings + dead discards in metric tons, mt) by fleet for the SEDAR 100 RW Model. Confidential data for SEDAR 100 have been excluded for the Commercial Vertical Line and Commercial Longline fleets.

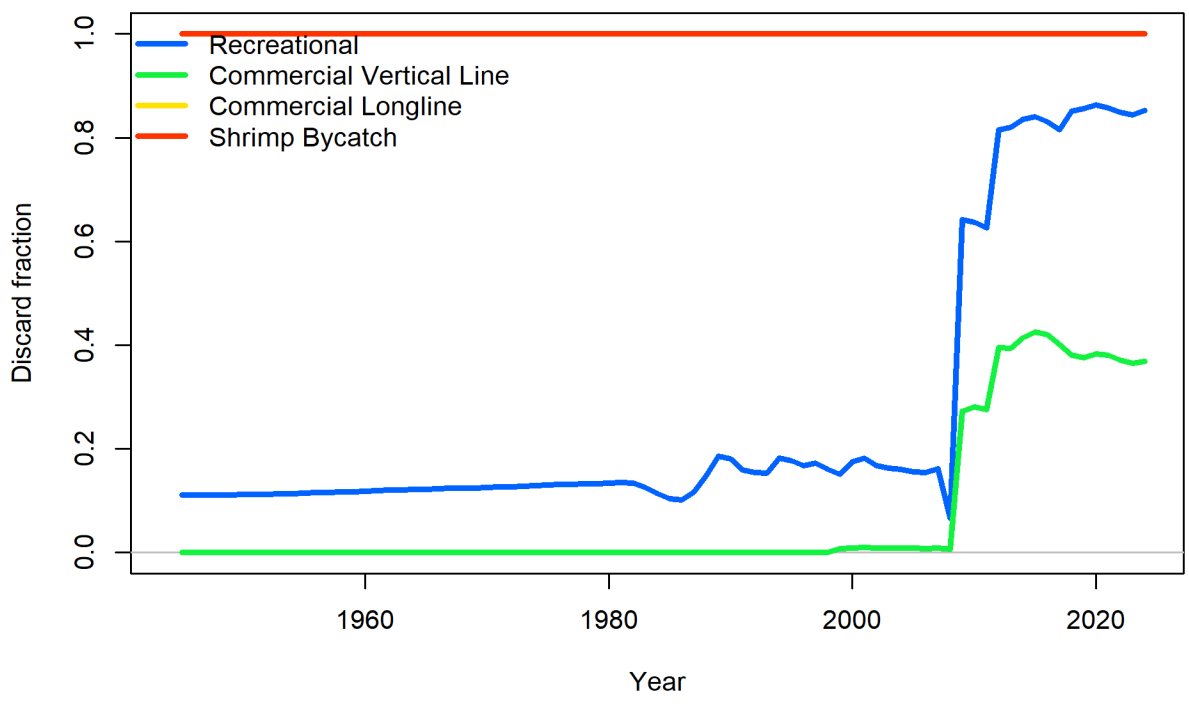


Figure RW52. Discard fraction by fleet for the SEDAR 100 RW Model.

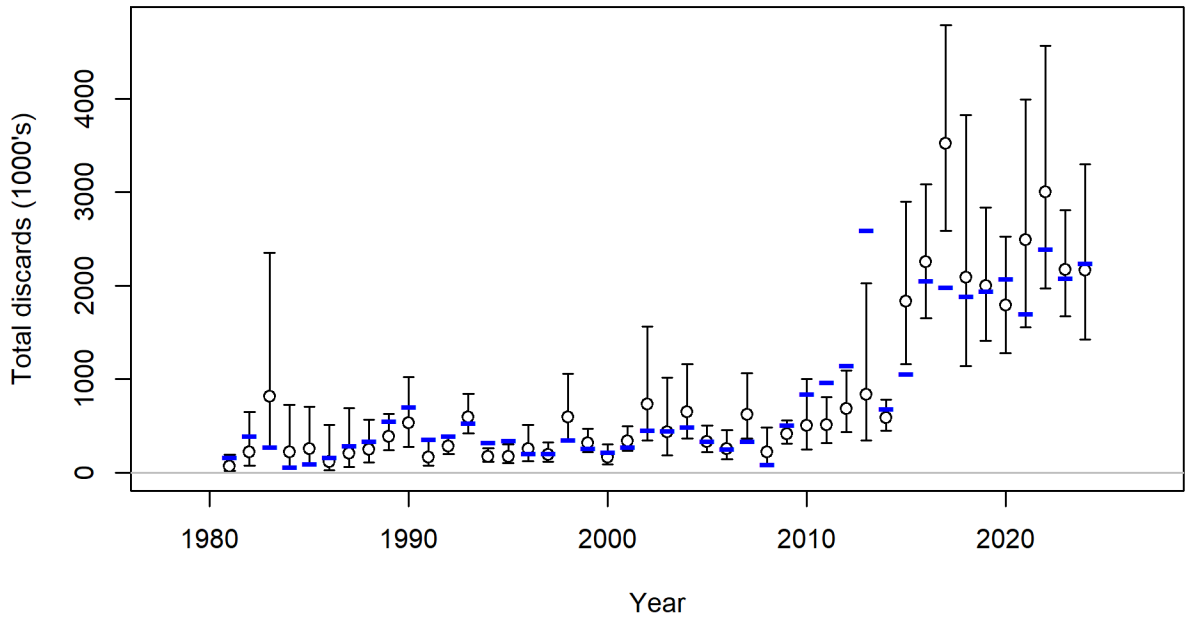


Figure RW53. Observed (dots with 95% confidence intervals) and expected (blue lines) discards by the Recreational fleet. Discards are in numbers of fish (1,000s) and reflect released fish (i.e., before discard mortality has been applied).

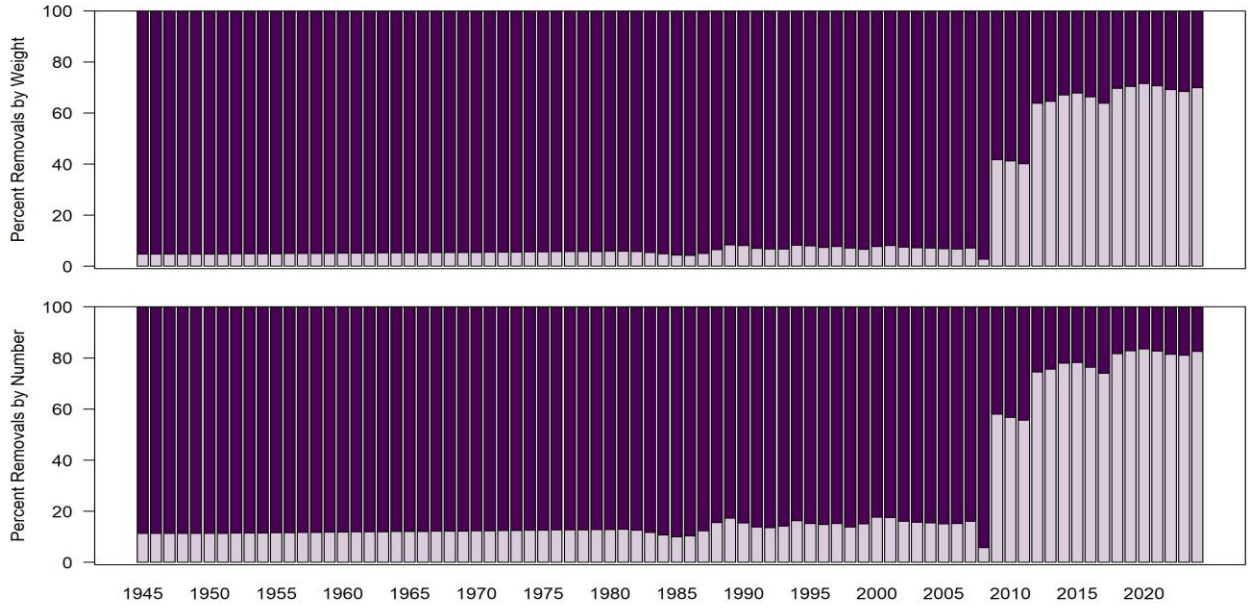


Figure RW54. Comparison of landings (dark bars) and dead discards (light bars) for weights (top panel) and numbers of fish (bottom panel) for the Recreational fleet. Estimates of dead discards in both numbers and weights are provided in ***Table RW24****.*

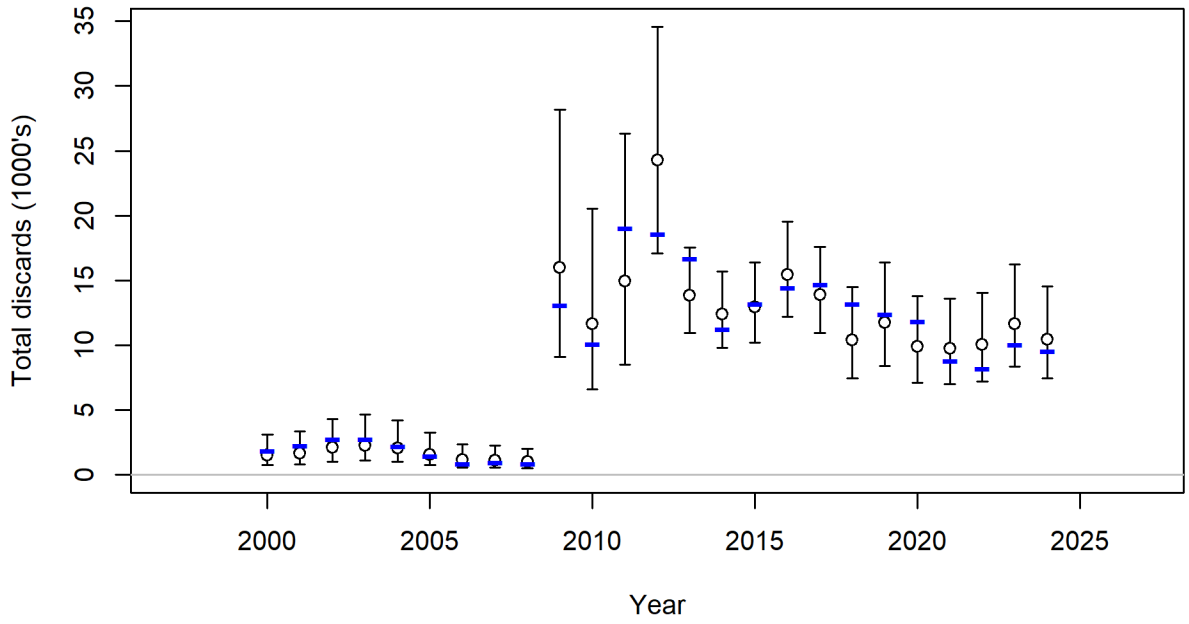


Figure RW55. Observed (dots with 95% confidence intervals) and expected (blue lines) discards by the Commercial Vertical Line fleet. Discards are in numbers of fish (1,000s) and reflect released fish (i.e., before discard mortality has been applied).

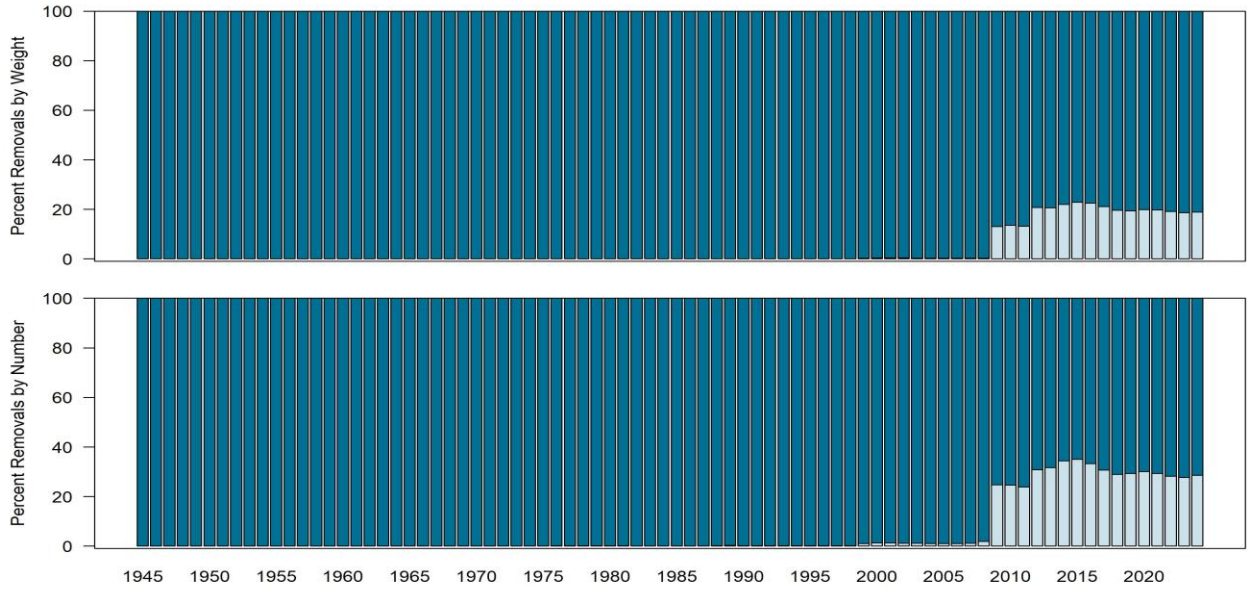


Figure RW56. Comparison of landings (dark bars) and dead discards (light bars) for weights (top panel) and numbers of fish (bottom panel) for the Commercial Vertical Line fleet. Estimates of dead discards in both numbers and weights are provided in ***Table RW25****.*

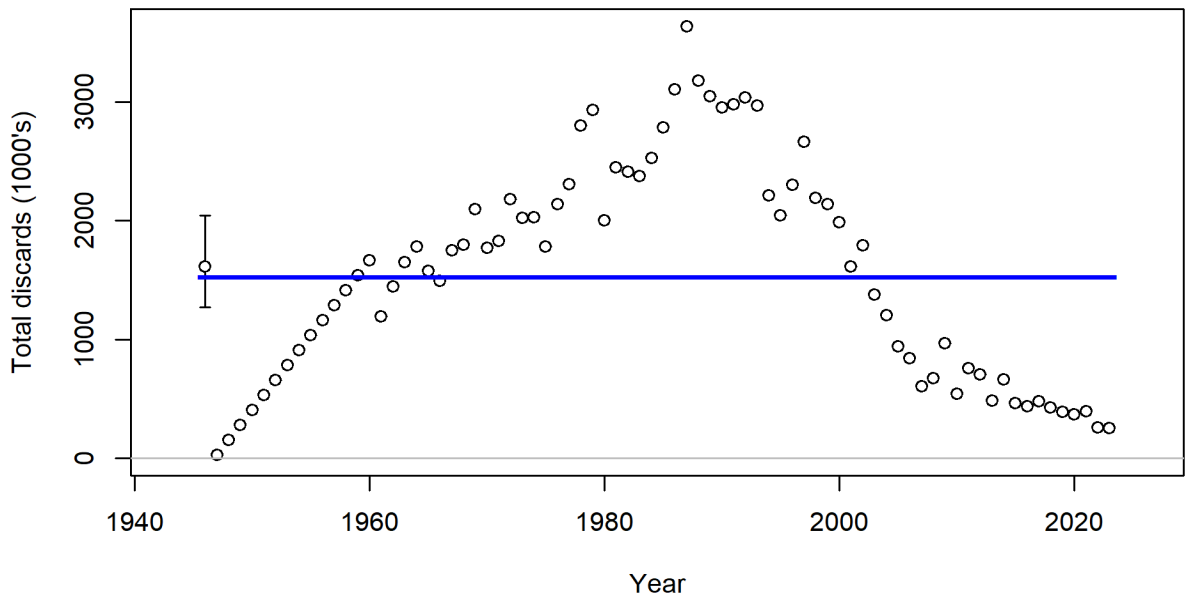


Figure RW57. Observed (dots with 95% confidence intervals) and expected (blue lines) discards by the Shrimp Bycatch fleet. Discards are in numbers of fish (1,000s) and all fish are assumed dead. Estimates of dead discards in both numbers and weights are provided in ***Table RW26****.*

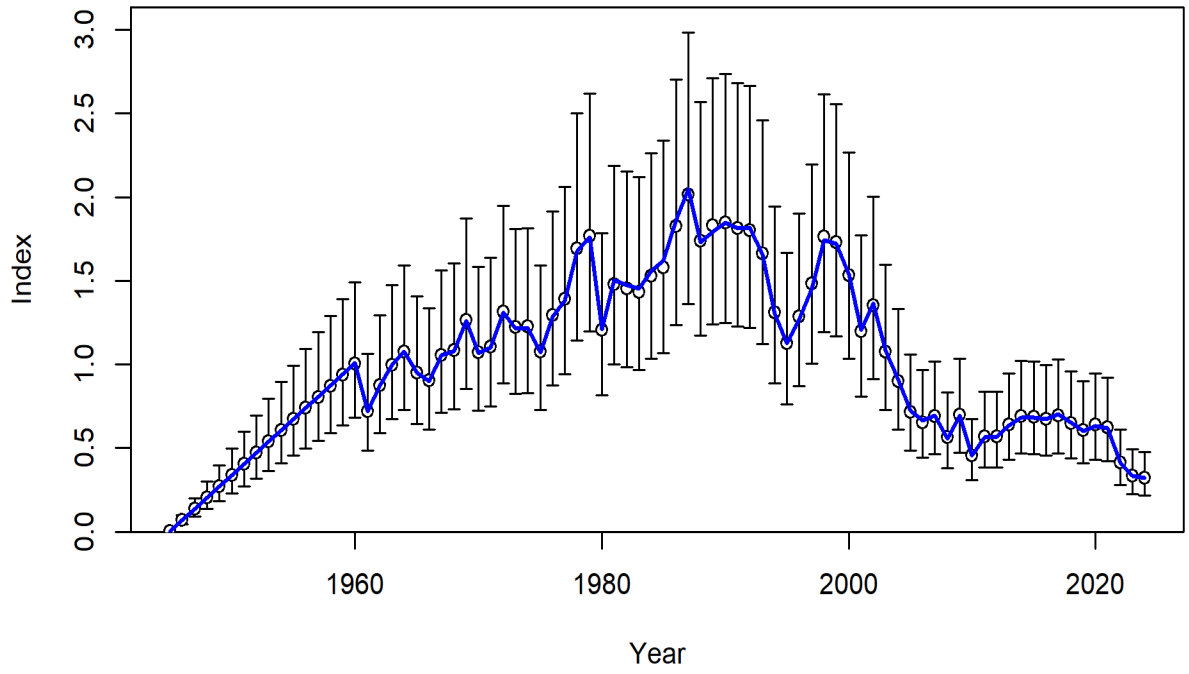


Figure RW58. Observed (dots with 95% confidence intervals) and expected (blue lines) indices of fishing effort for the Gulf Shrimp fishery. The stock assessment model assumes lognormal error around the standardized index.

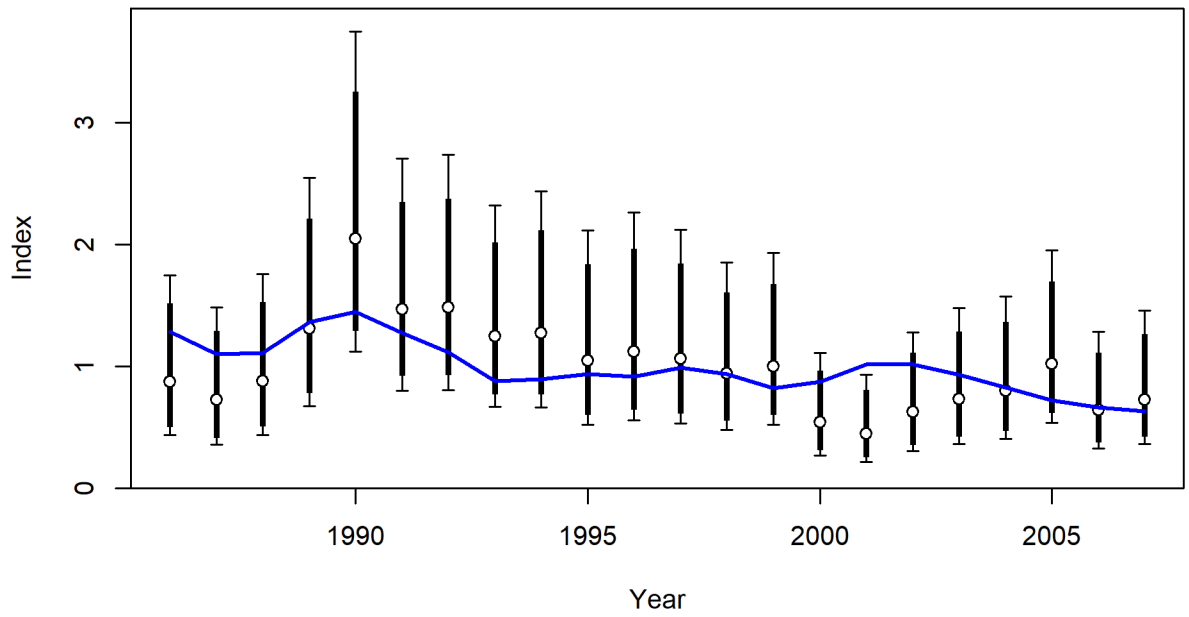


Figure RW59. Observed (dots with 95% confidence intervals) and expected (blue lines) indices of relative abundance from the Recreational (SRHS) CPUE. The stock assessment model assumes lognormal error around the standardized index. Thicker lines indicate input uncertainty before addition of the estimated additional uncertainty parameter (0.073).

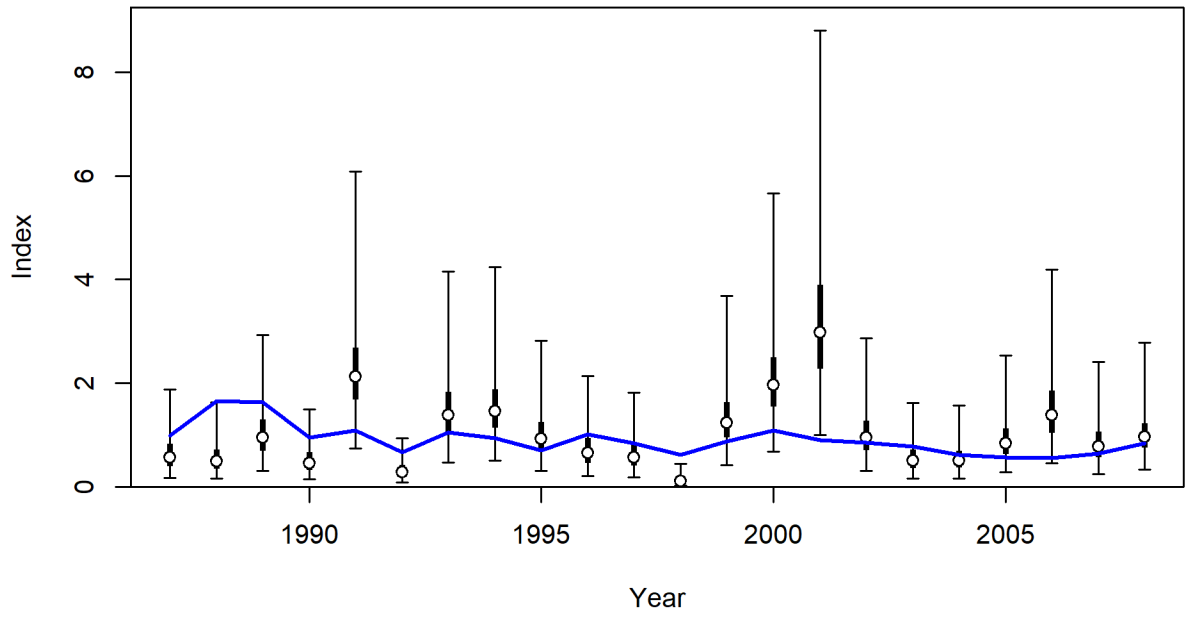


Figure RW60. Observed (dots with 95% confidence intervals) and expected (blue lines) indices of relative abundance from the SEAMAP Trawl Early Survey. The stock assessment model assumes lognormal error around the standardized index. Thicker lines indicate input uncertainty before addition of the estimated additional uncertainty parameter (0.417).

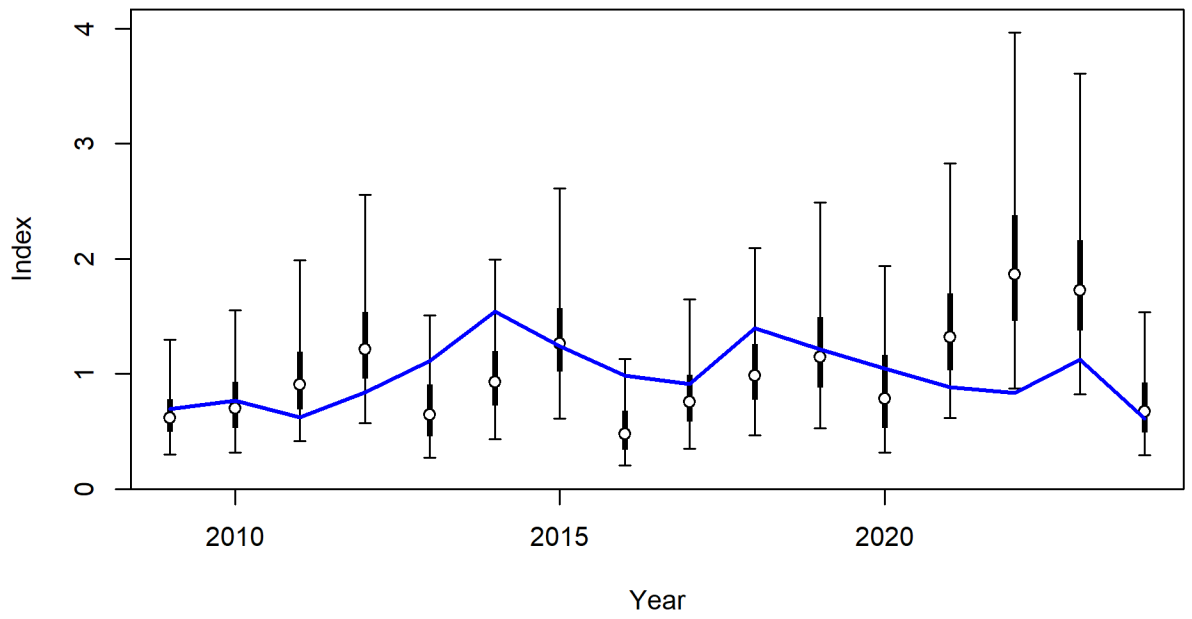


Figure RW61. Observed (dots with 95% confidence intervals) and expected (blue lines) indices of relative abundance from the SEAMAP Trawl Late Survey. The stock assessment model assumes lognormal error around the standardized index. Thicker lines indicate input uncertainty before addition of the estimated additional uncertainty parameter (0.261).

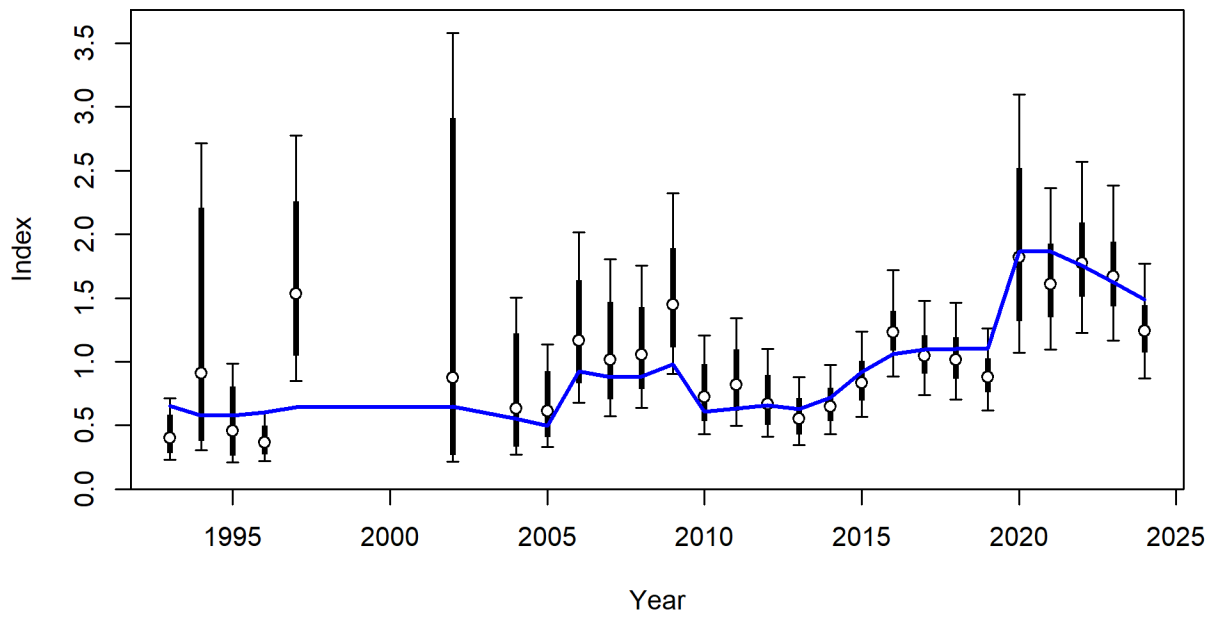


Figure RW62. Observed (dots with 95% confidence intervals) and expected (blue lines) indices of relative abundance from the Combined Video Survey. The stock assessment model assumes lognormal error around the standardized index. Thicker lines indicate input uncertainty before addition of the estimated additional uncertainty parameter (0.105).

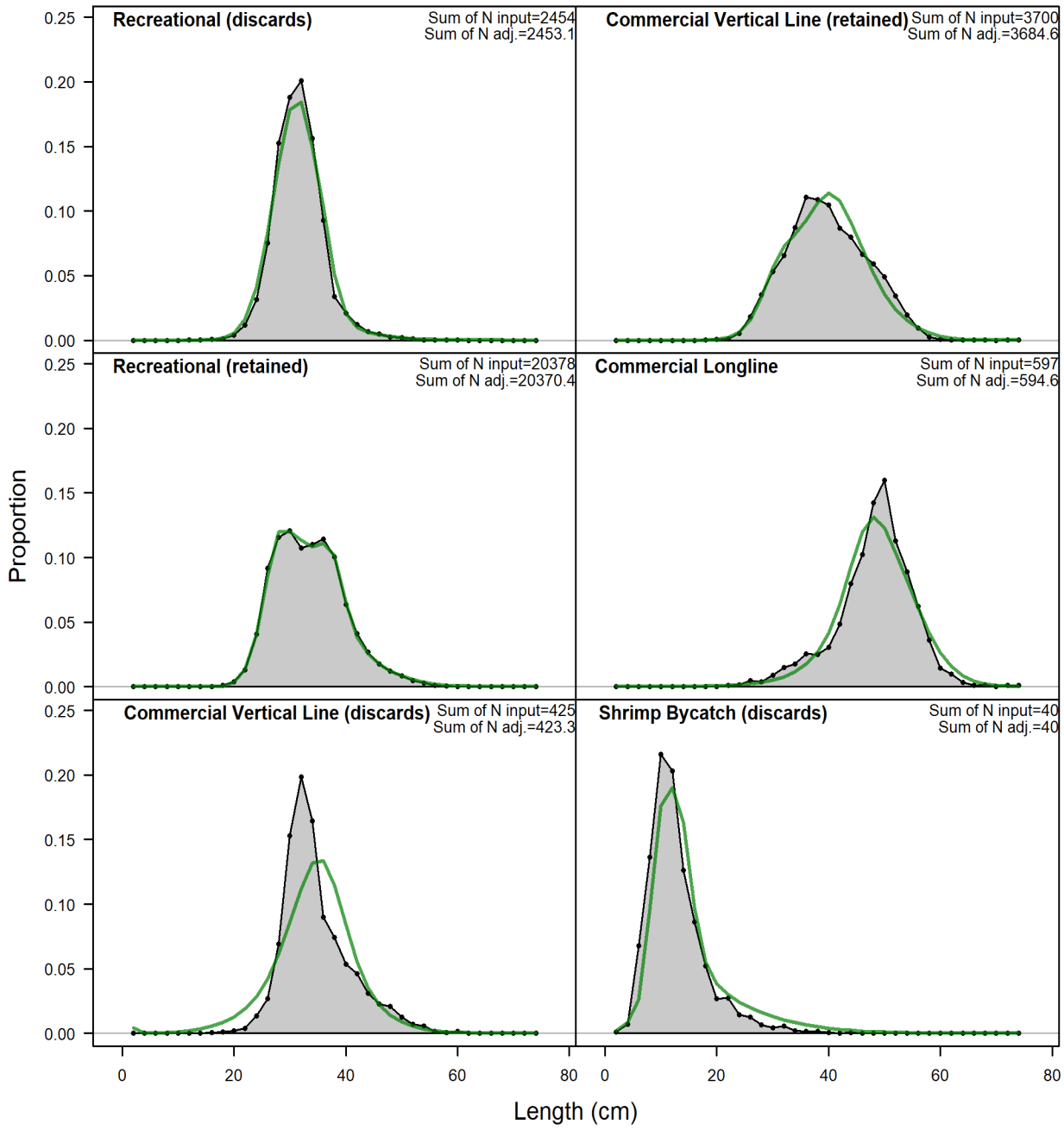
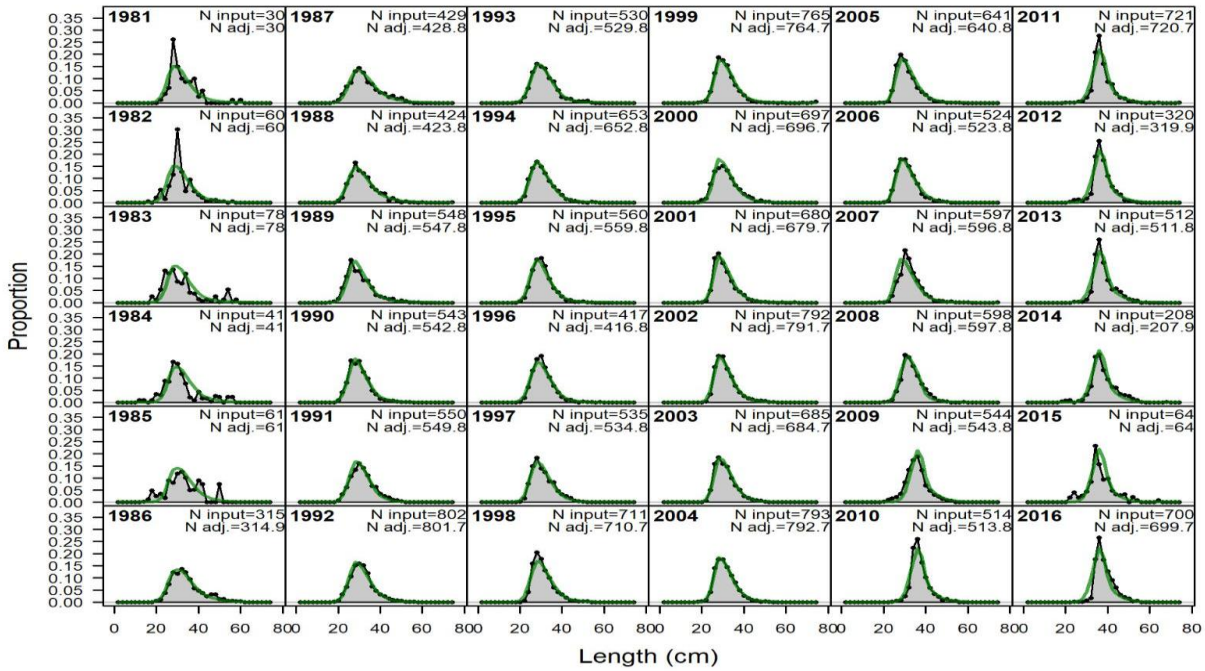


Figure RW63. Model fits to the length composition of landed (i.e., retained) or discarded catch aggregated across years for each fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. The input (N input) and adjusted (N adj) sample sizes are provided in the upper right corner of each panel.



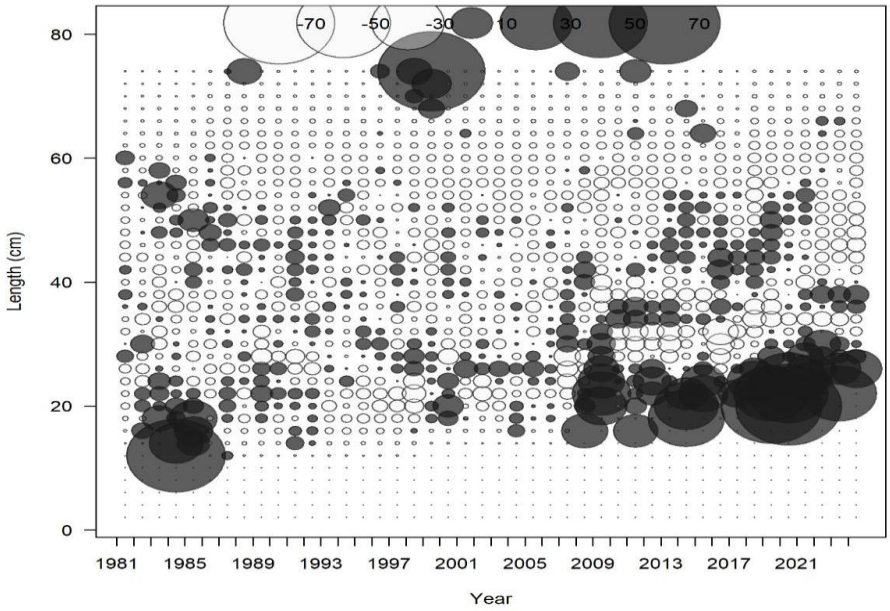
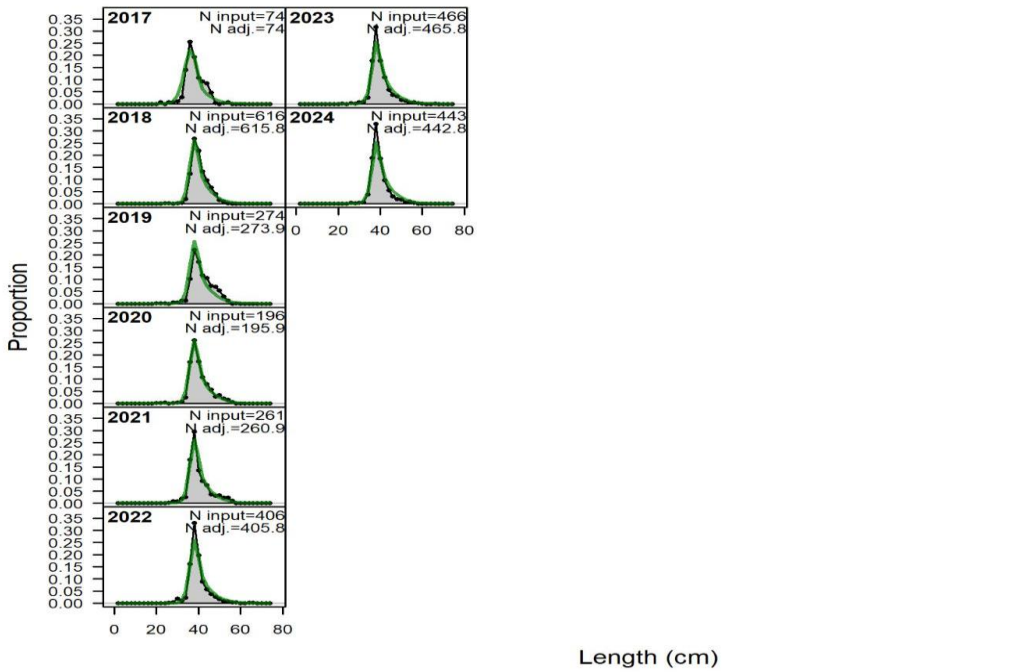


Figure RW64. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish landed by the Recreational fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



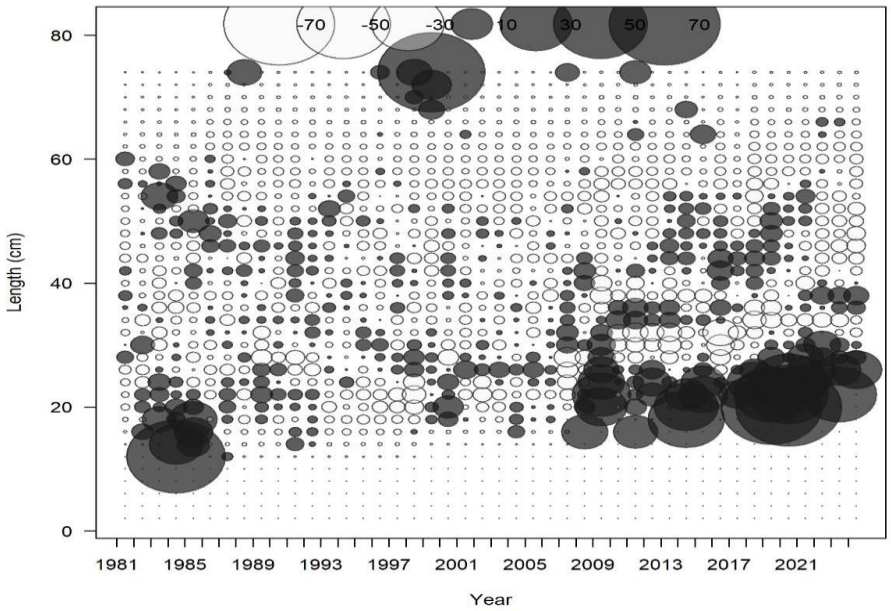
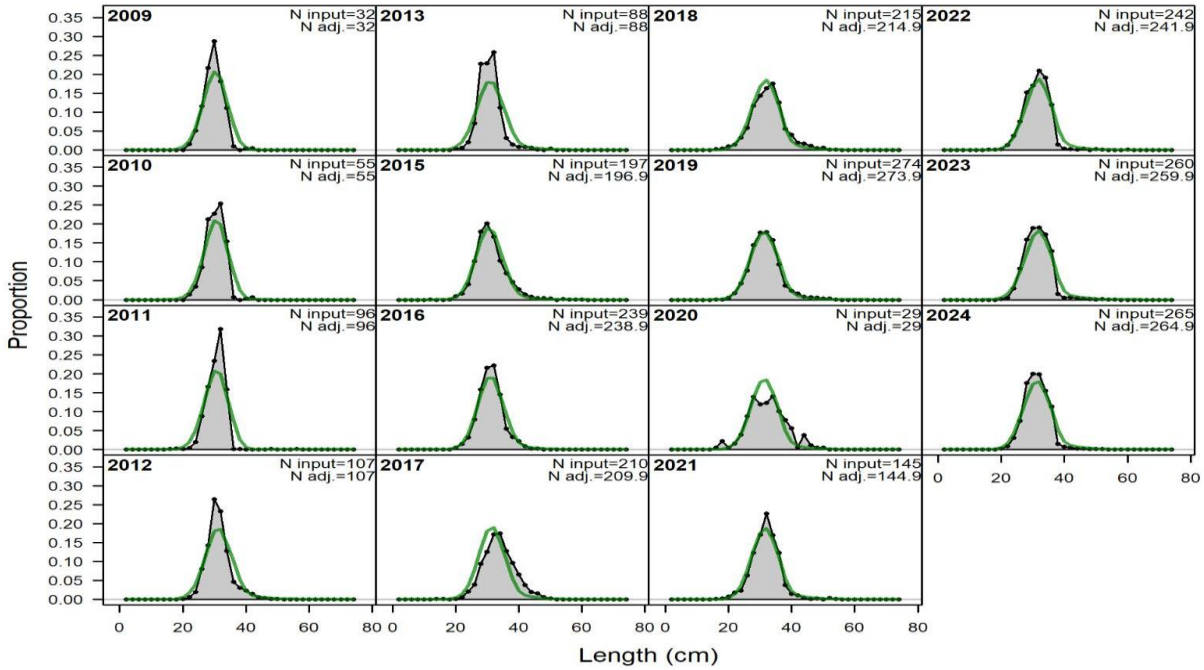


Figure RW64 Continued. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish landed by the Recreational fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



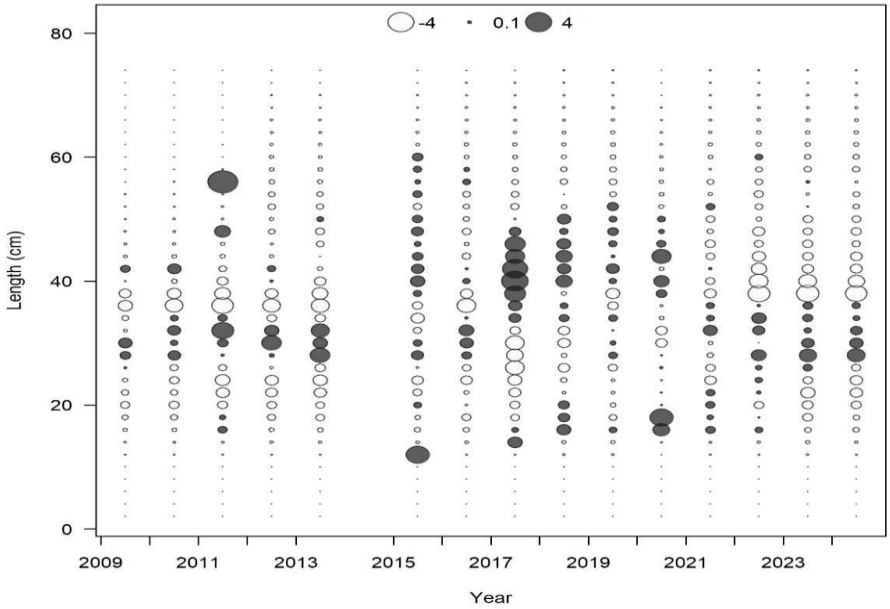
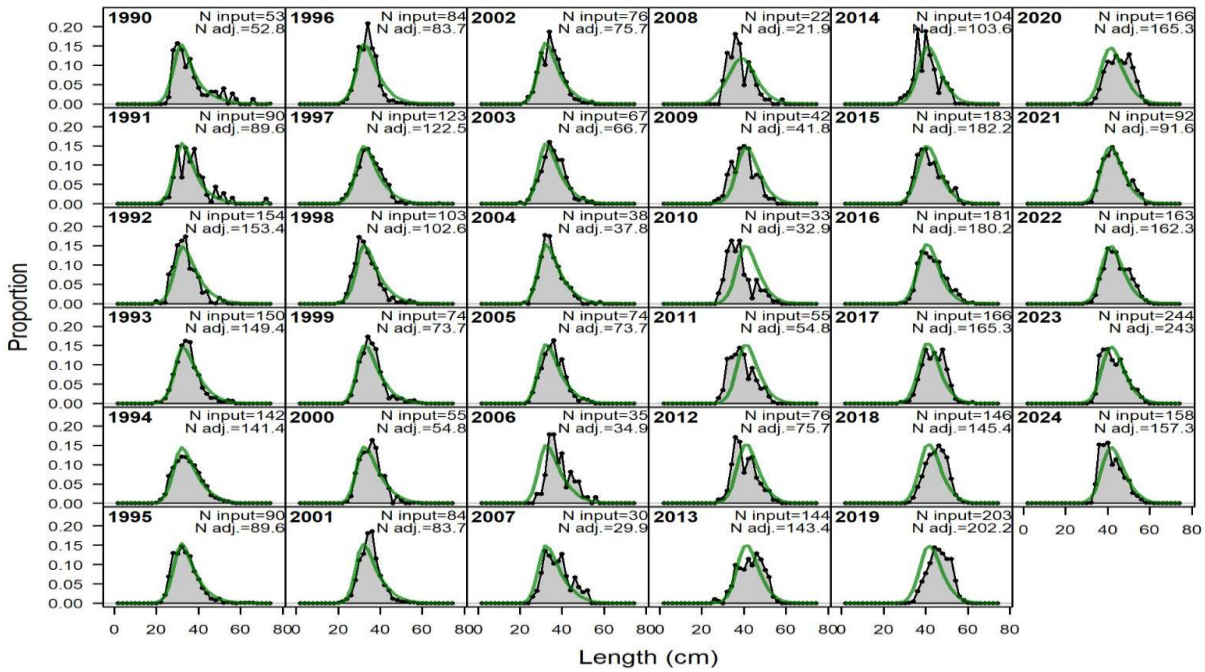


Figure RW65. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish discarded by the Recreational fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



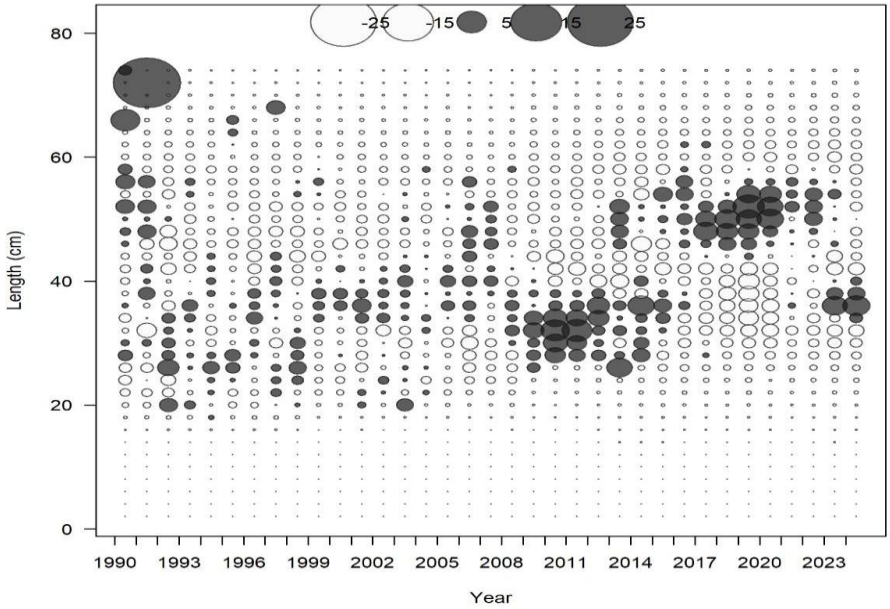
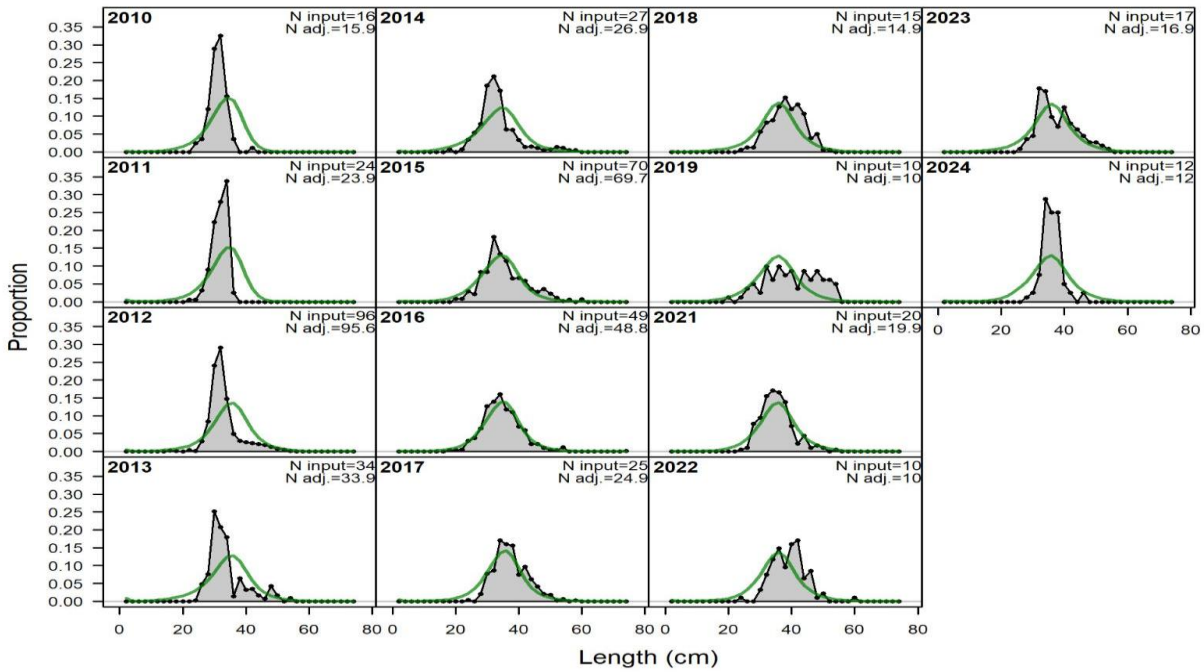


Figure RW66. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish landed by the Commercial Vertical Line fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



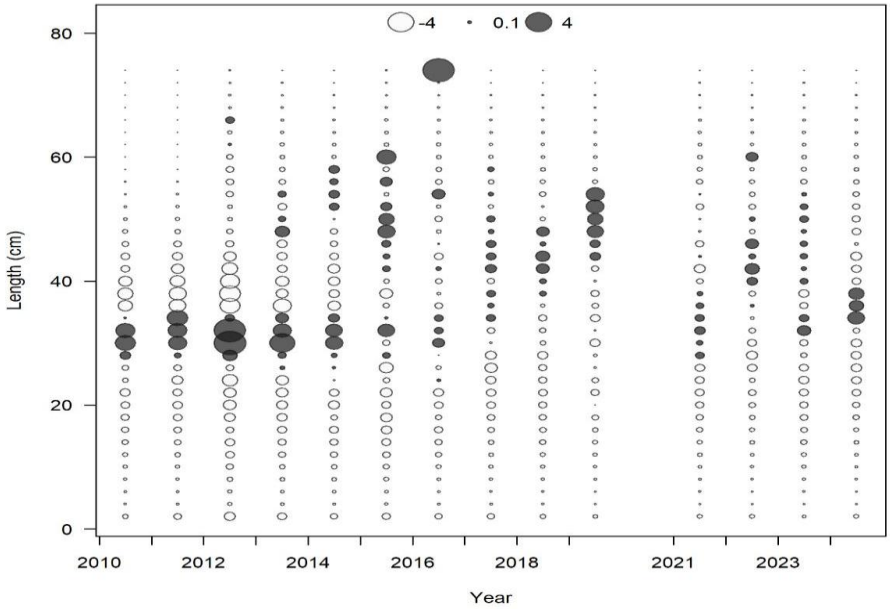
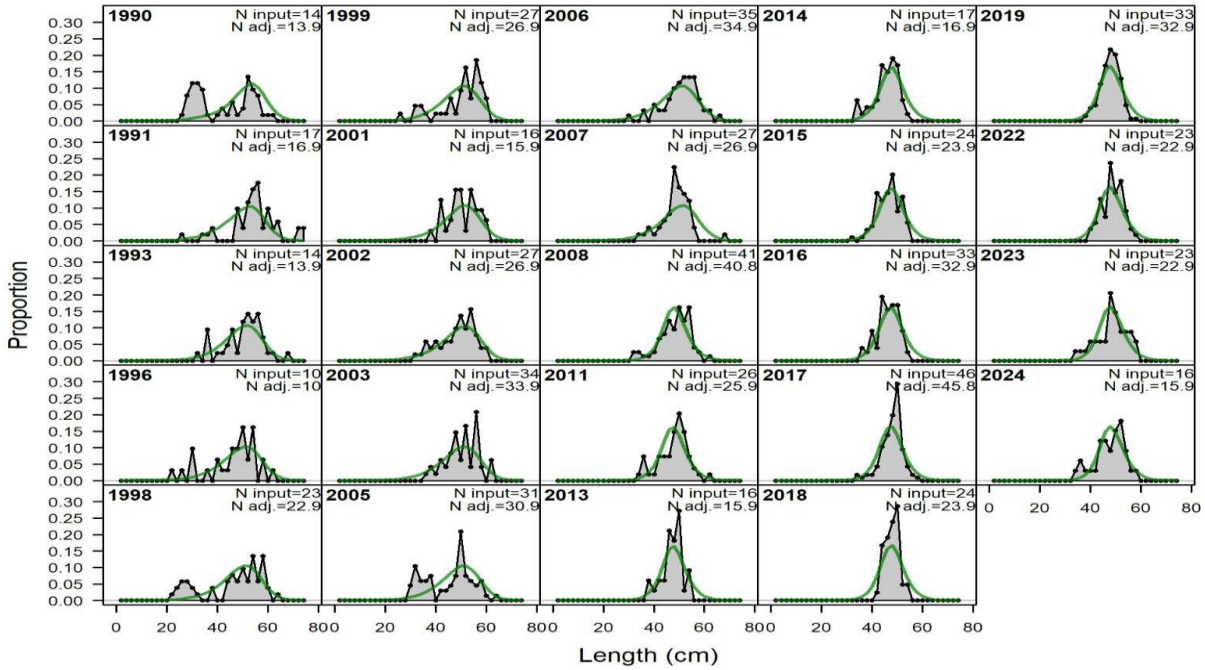


Figure RW67. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish discarded by the Commercial Vertical Line fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



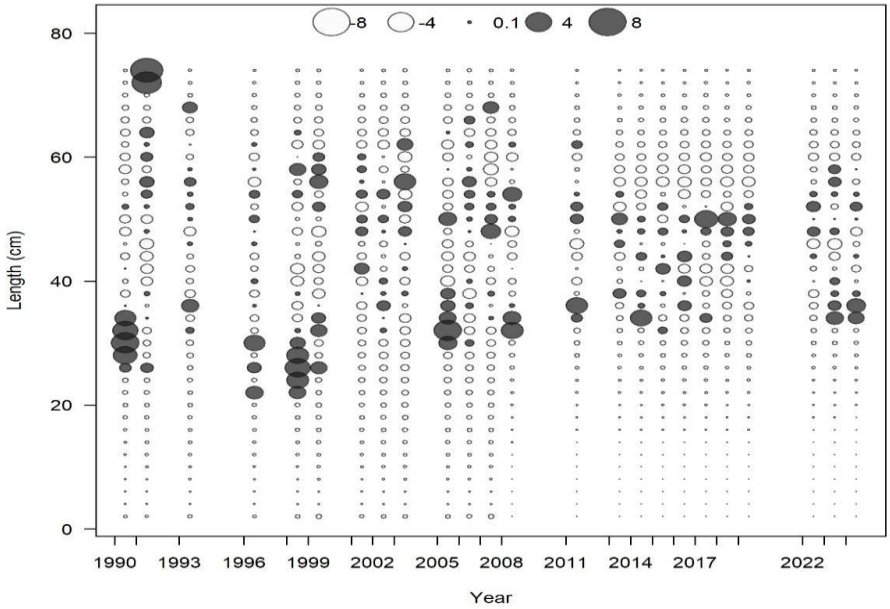
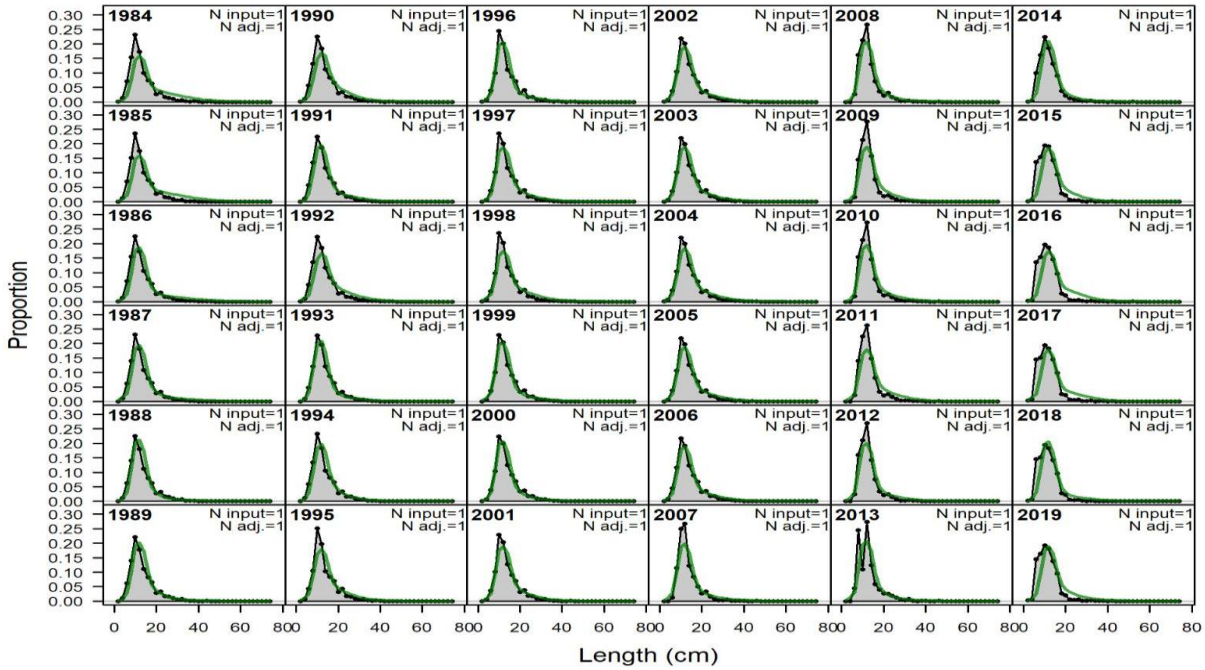


Figure RW68. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish landed by the Commercial Longline fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



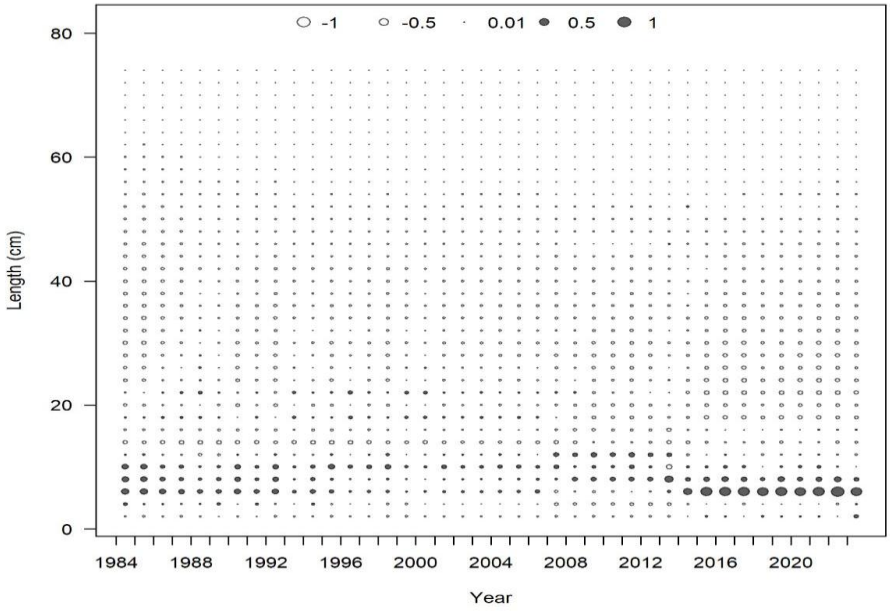
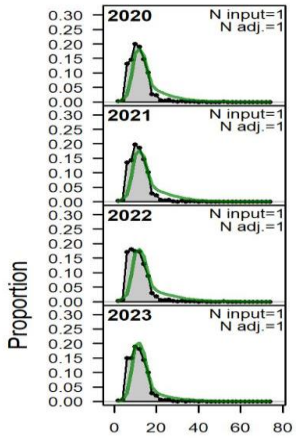


Figure RW69. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish discarded by the Shrimp Bycatch fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) are reported but were not adjusted, as this input was not included in the likelihood. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



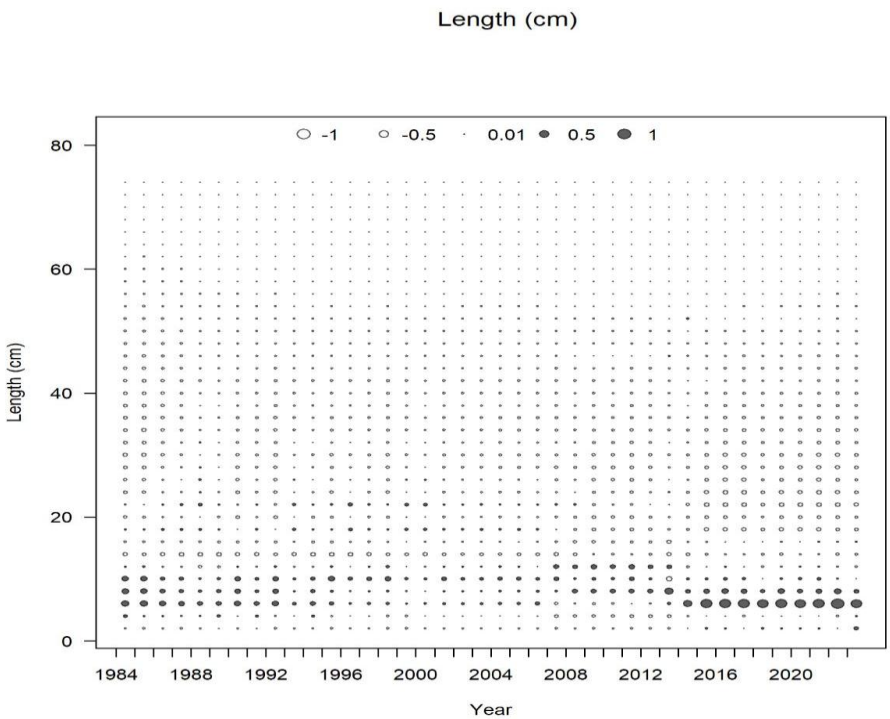


Figure RW69 Continued. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish discarded by the Shrimp Bycatch fleet. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) are reported but were not adjusted, as this input was not included in the likelihood. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

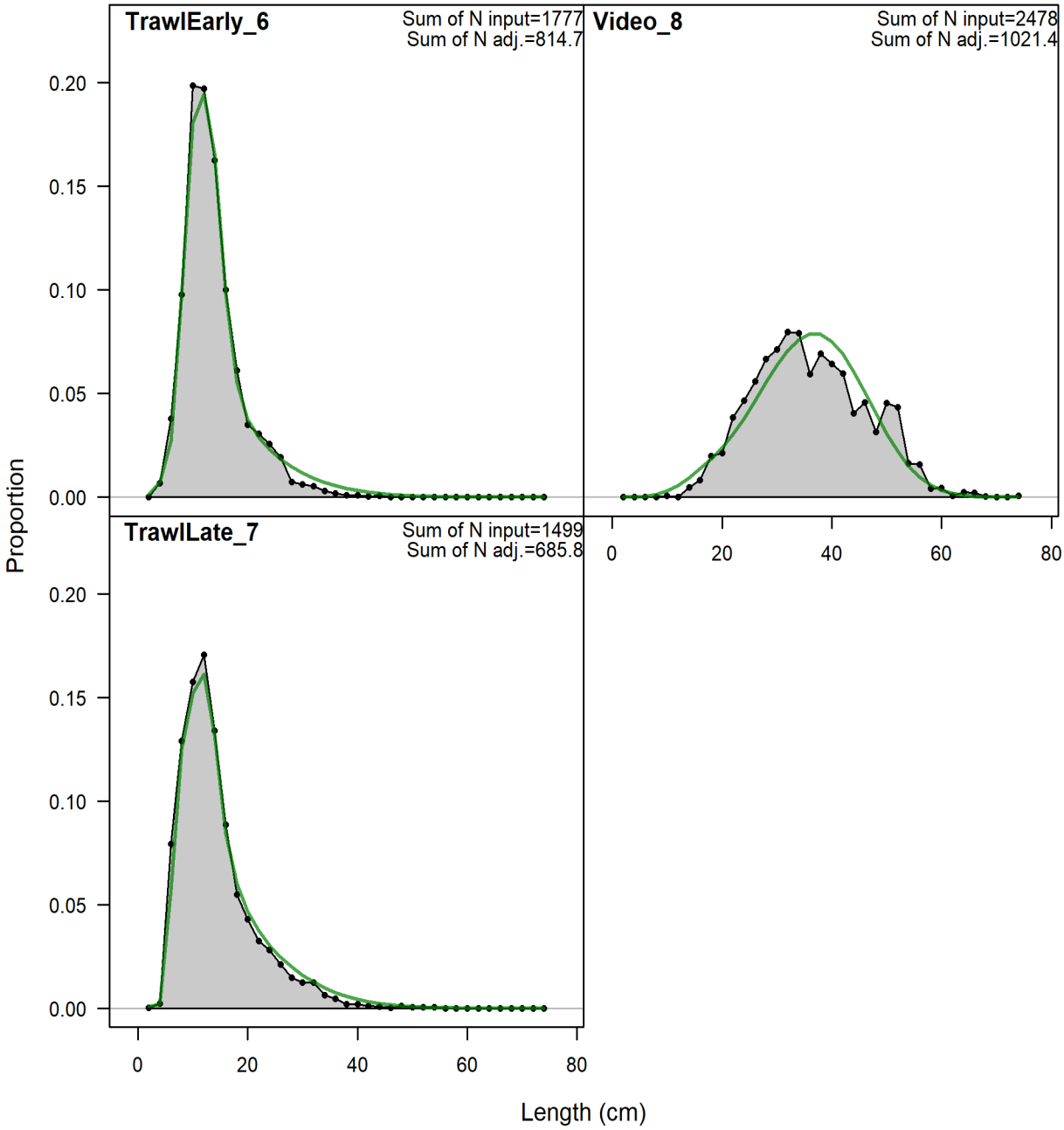


Figure RW70. Model fits to the length composition of catch aggregated across years for each survey. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. The input (N input) and adjusted (N adj) sample sizes are provided in the upper right corner of each panel.

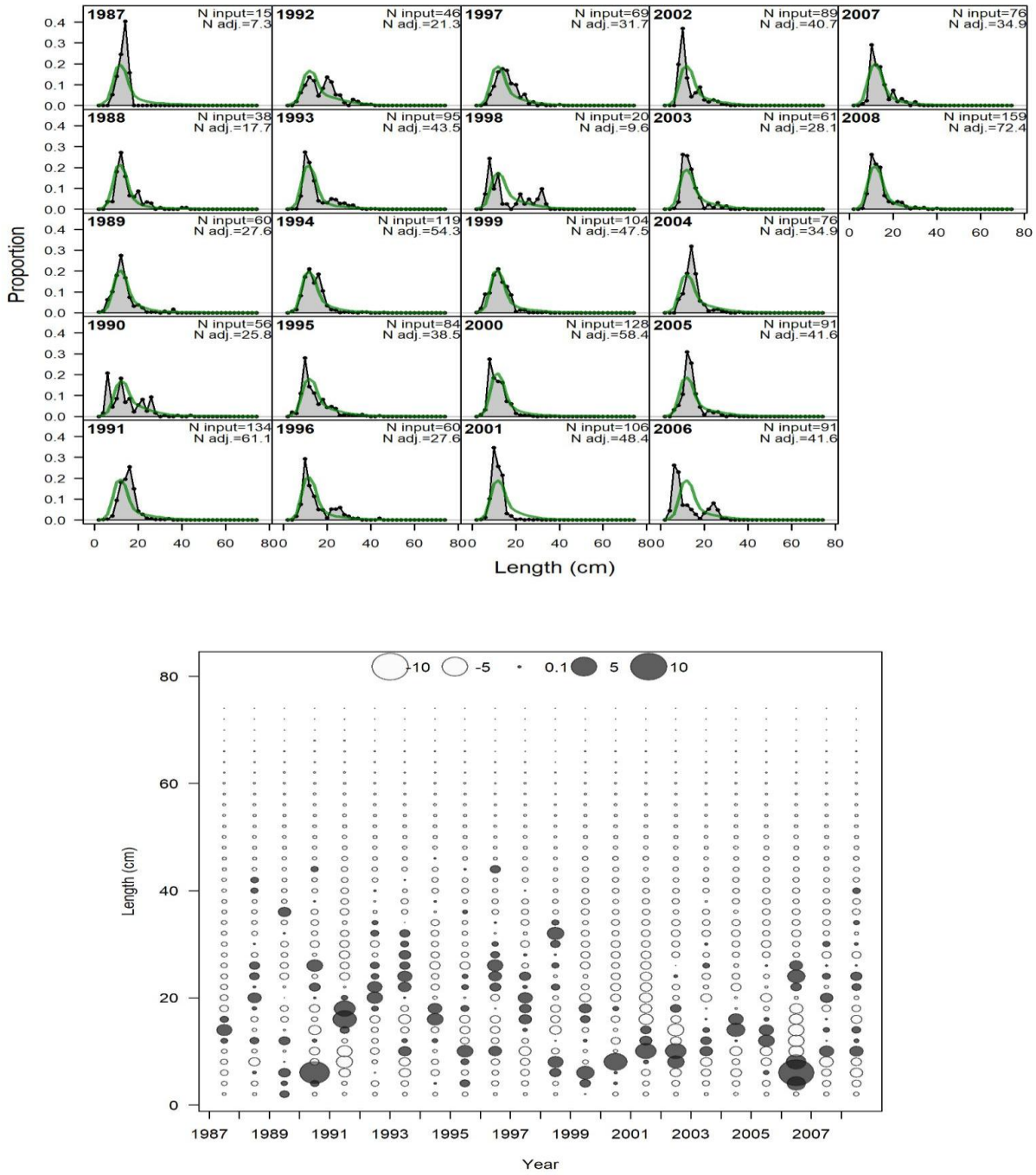


Figure RW71. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish in the SEAMAP Trawl Early Survey. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

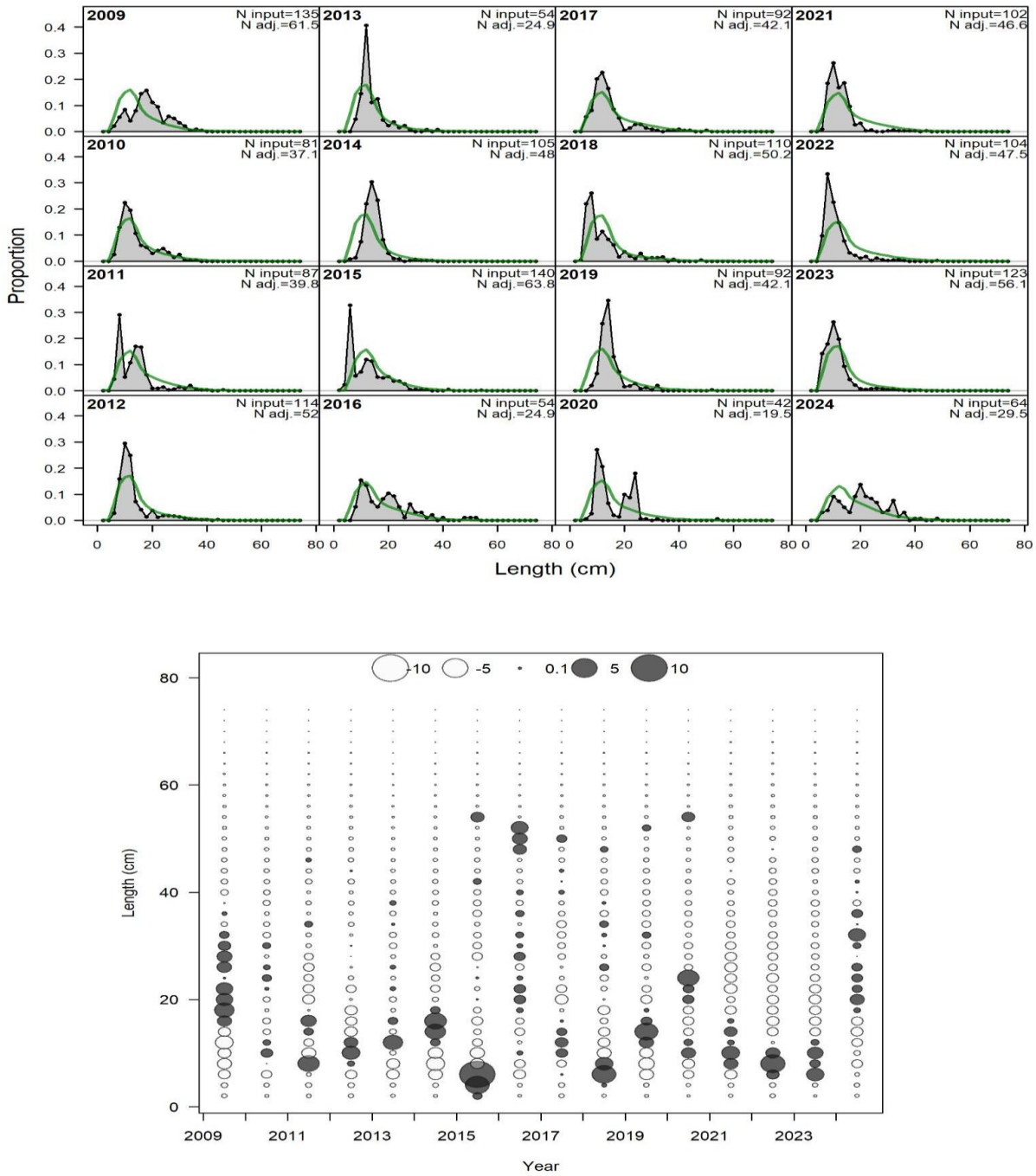
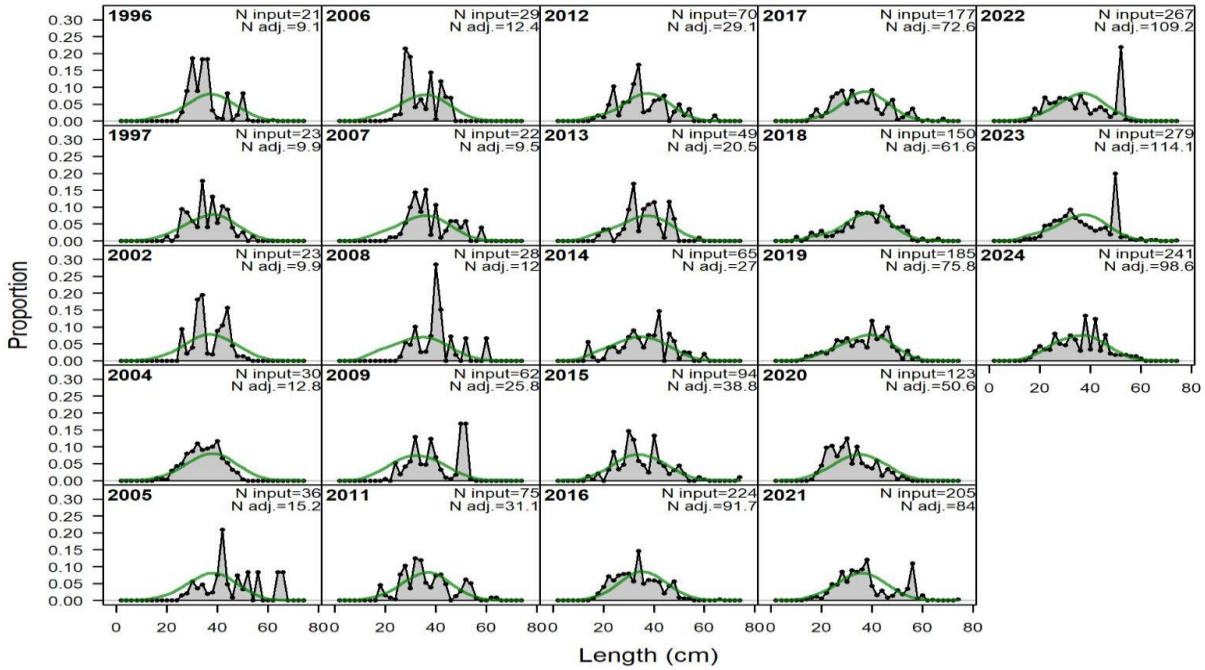


Figure RW72. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish in the SEAMAP Trawl Late Survey. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).



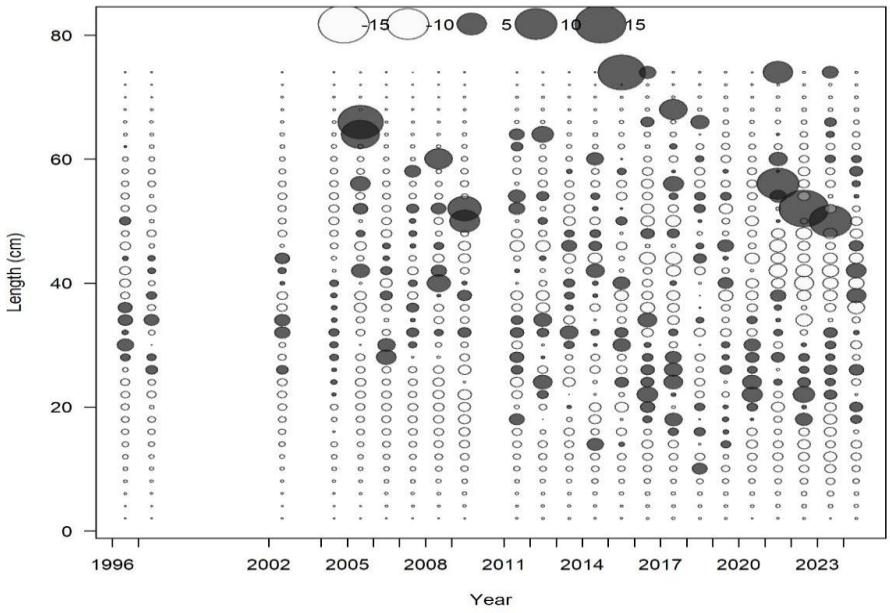


Figure RW73. Observed and expected length compositions (top) and Pearson residuals (bottom) for Gray Triggerfish in the Combined Video Survey. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. Input sample sizes (N input) and adjusted sample sizes (N adj) estimated by Stock Synthesis are also reported. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

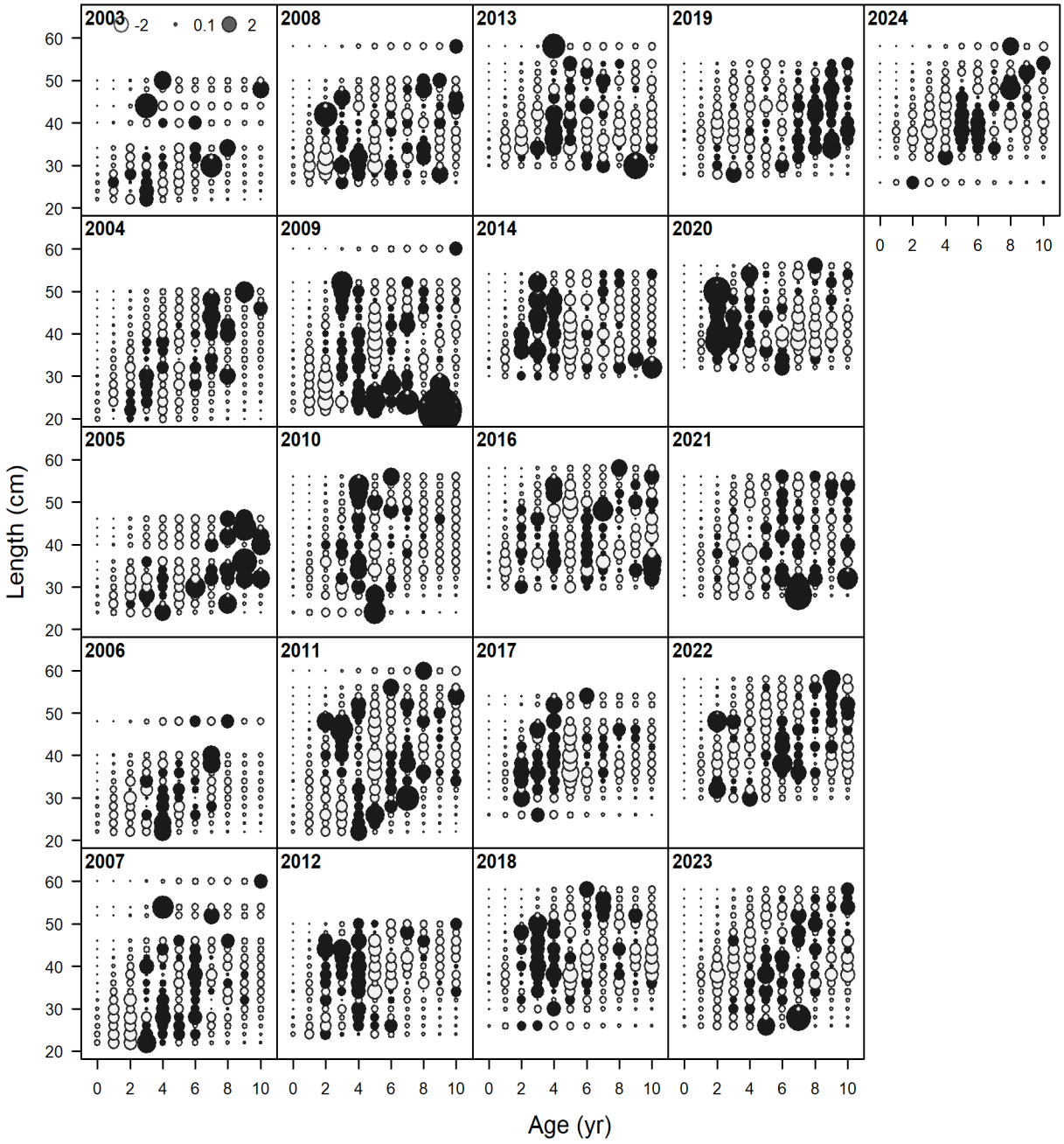


Figure RW74. Pearson residuals for the conditional age-at-length compositions for Gray Triggerfish landed by the Recreational fleet. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

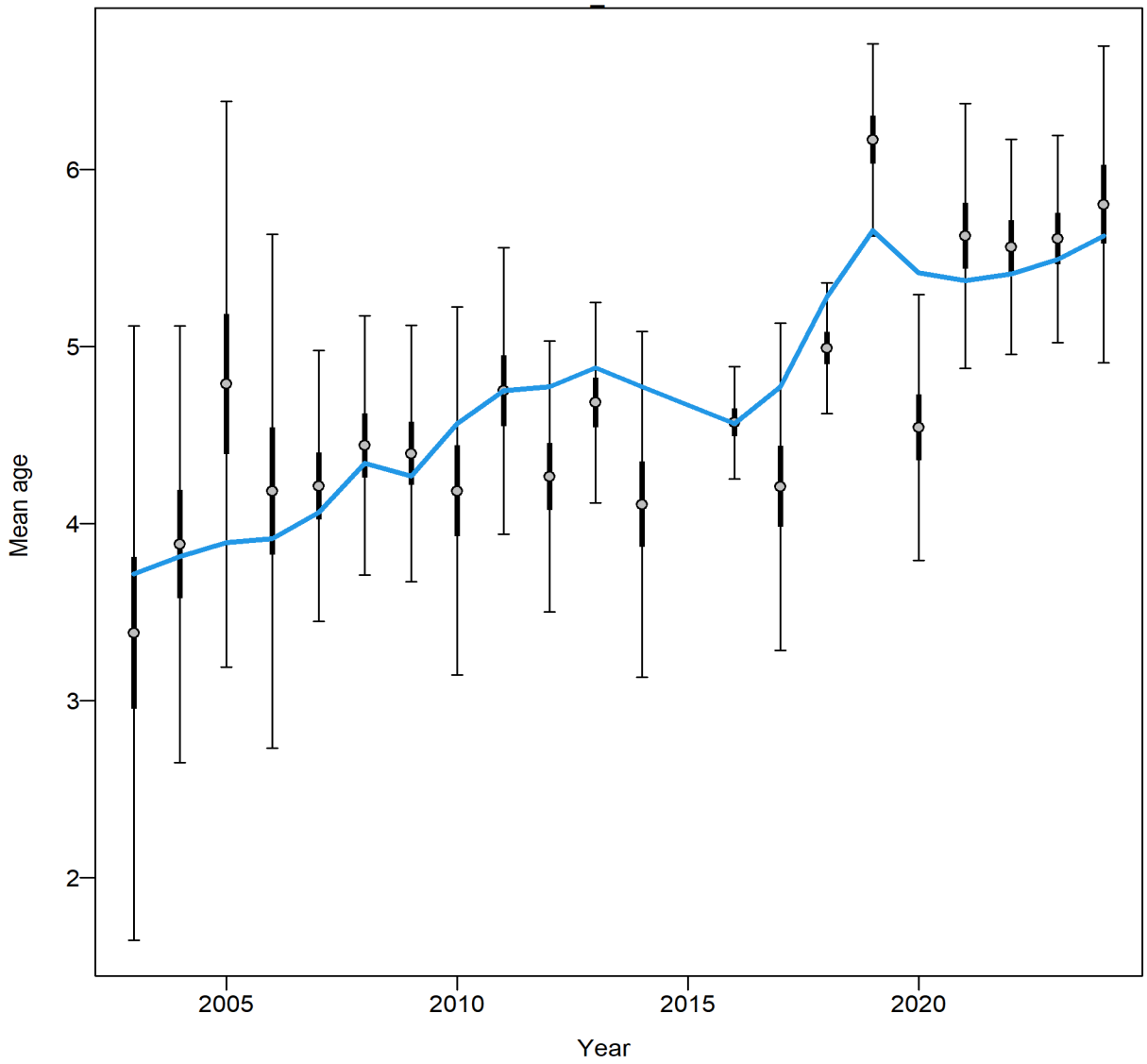


Figure RW75. Mean age of Gray Triggerfish landed by the Recreational fleet from conditional data (aggregated across length bins) with 95% confidence intervals (thick bars). Thinner intervals (with capped ends) show the result of further adjusting sample sizes based on the Francis data weighting method, which was not used here.

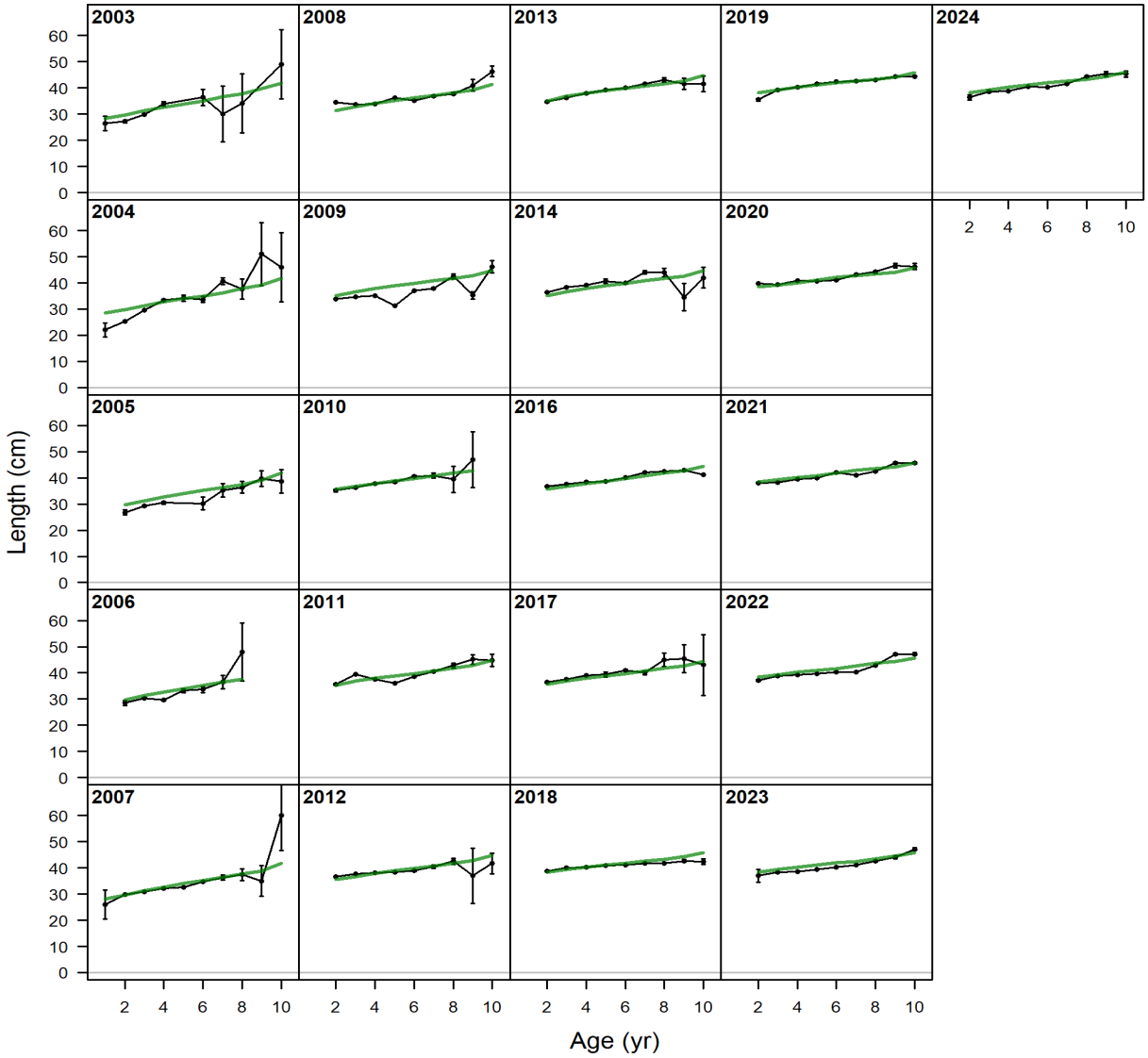


Figure RW76. Observed and expected mean length-at-age for Gray Triggerfish landed by the Recreational fleet. Mean length-at-age is provided for comparison of trends and was not included in the likelihood.

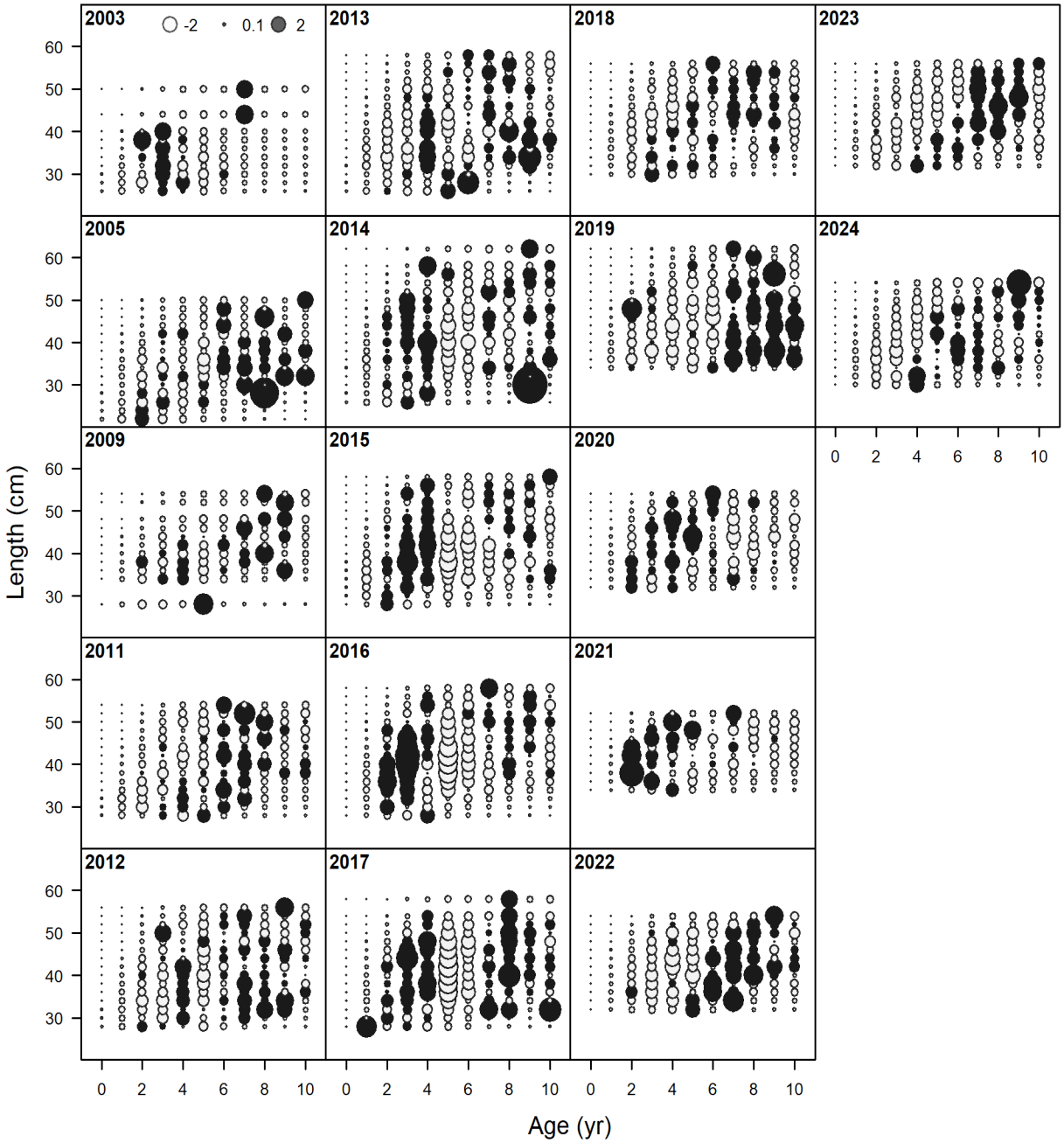


Figure RW77. Pearson residuals for the conditional age-at-length compositions for Gray Triggerfish landed by the Commercial Vertical Line fleet. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

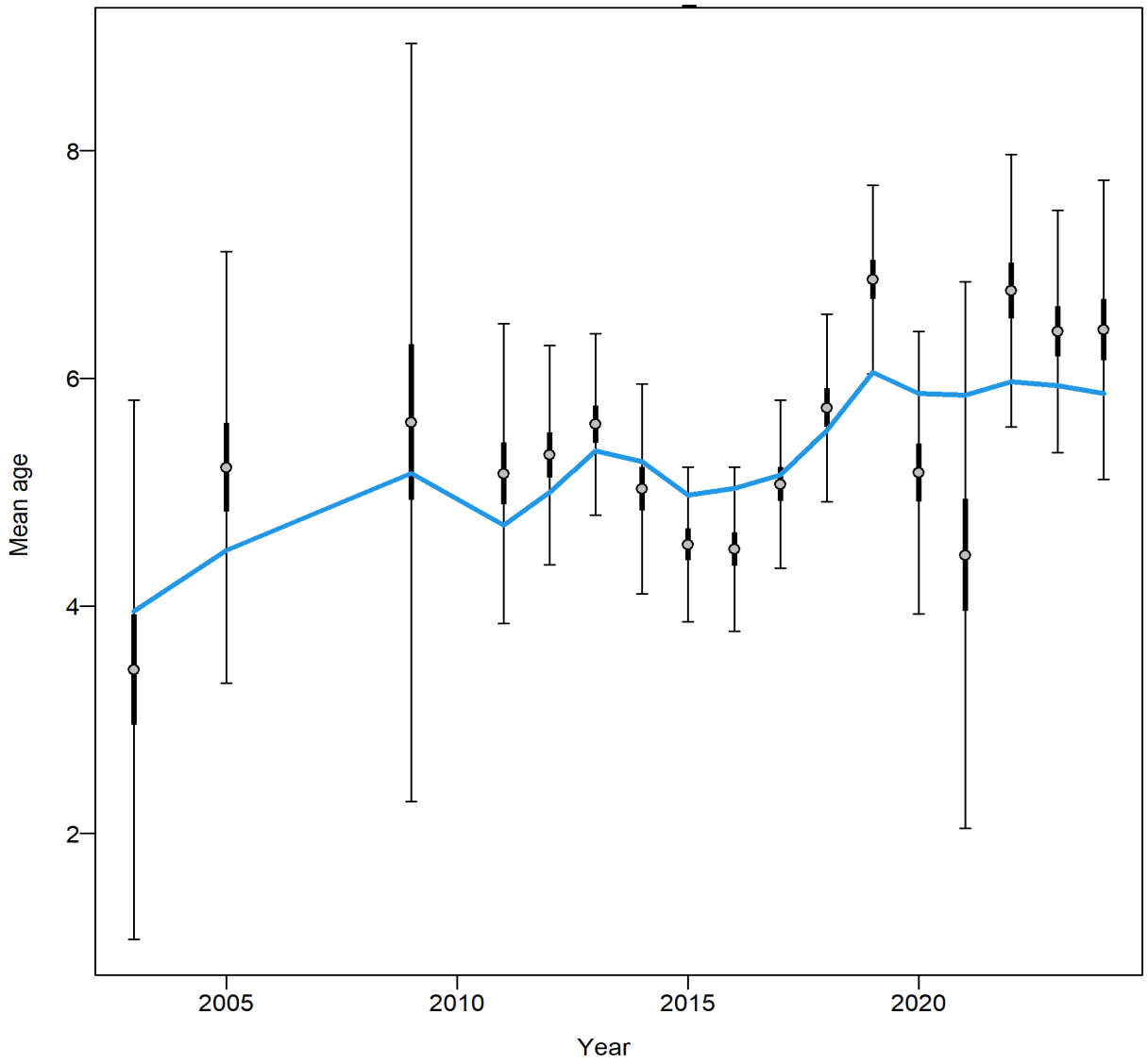


Figure RW78. Mean age of Gray Triggerfish landed by the Commercial Vertical Line fleet from conditional data (aggregated across length bins) with 95% confidence intervals (thick bars). Thinner intervals (with capped ends) show the result of further adjusting sample sizes based on the Francis data weighting method, which was not used here.

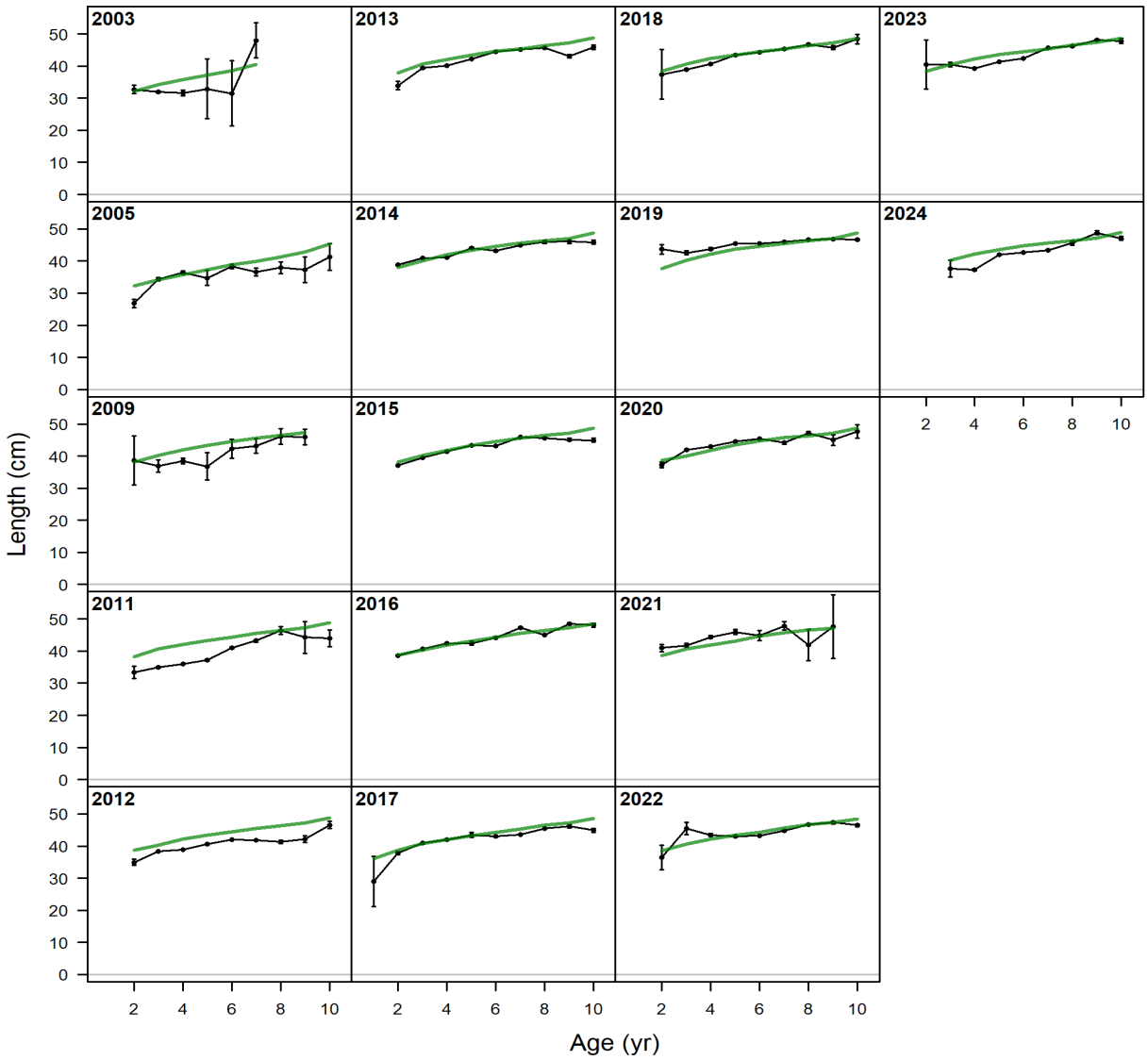


Figure RW79. Observed and expected mean length-at-age for Gray Triggerfish landed by the Commercial Vertical Line fleet. Mean length-at-age is provided for comparison of trends and was not included in the likelihood.

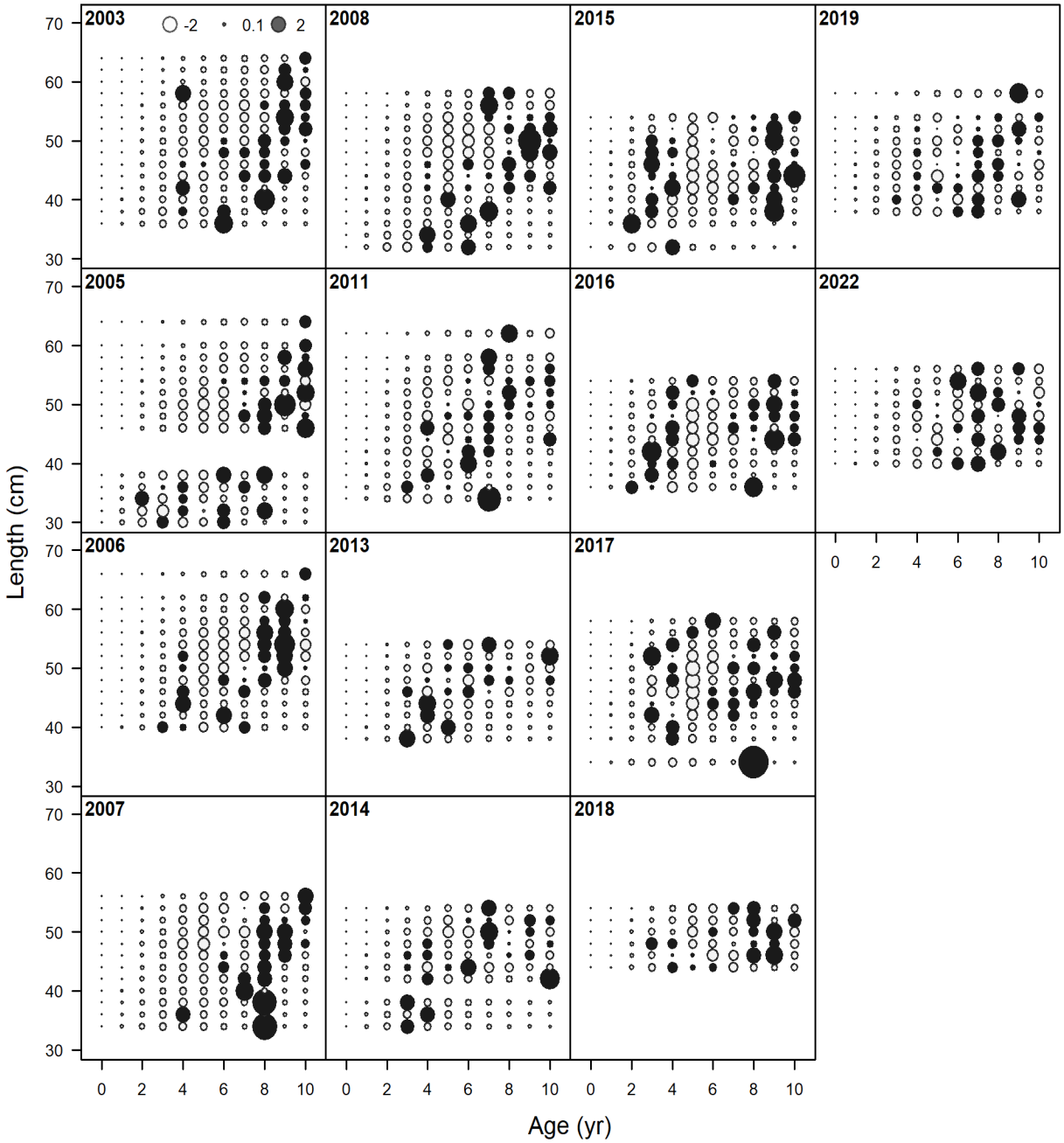


Figure RW80. Pearson residuals for the conditional age-at-length compositions for Gray Triggerfish landed by the Commercial Longline fleet. Closed bubbles are positive residuals (Obs > Exp) and open bubbles are negative residuals (Obs < Exp).

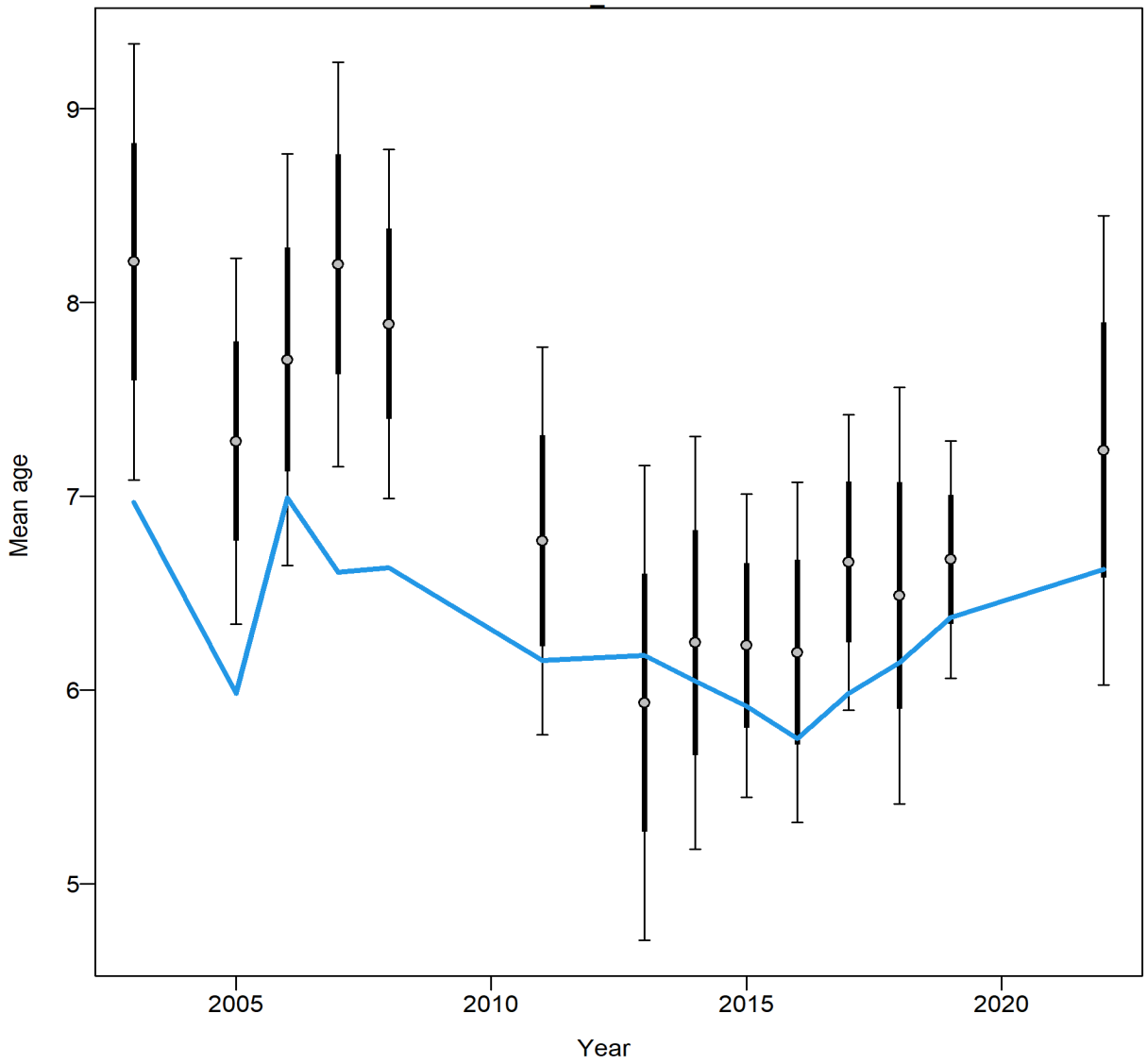


Figure RW81. Mean age of Gray Triggerfish landed by the Commercial Longline fleet from conditional data (aggregated across length bins) with 95% confidence intervals (thick bars). Thinner intervals (with capped ends) show the result of further adjusting sample sizes based on the Francis data weighting method, which was not used here.

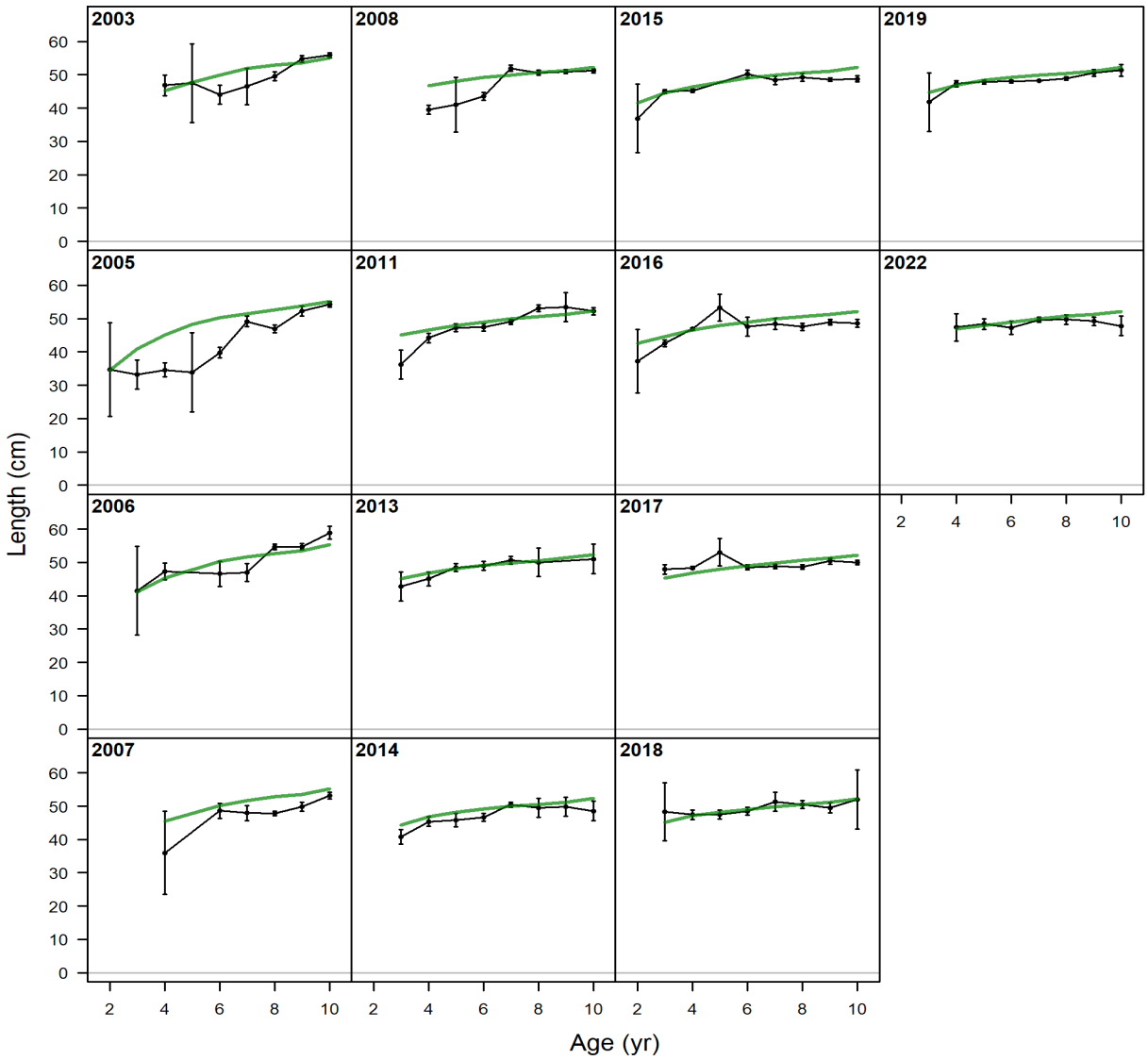


Figure RW82. Observed and expected mean length-at-age for Gray Triggerfish landed by the Commercial Longline fleet. Mean length-at-age is provided for comparison of trends and was not included in the likelihood.

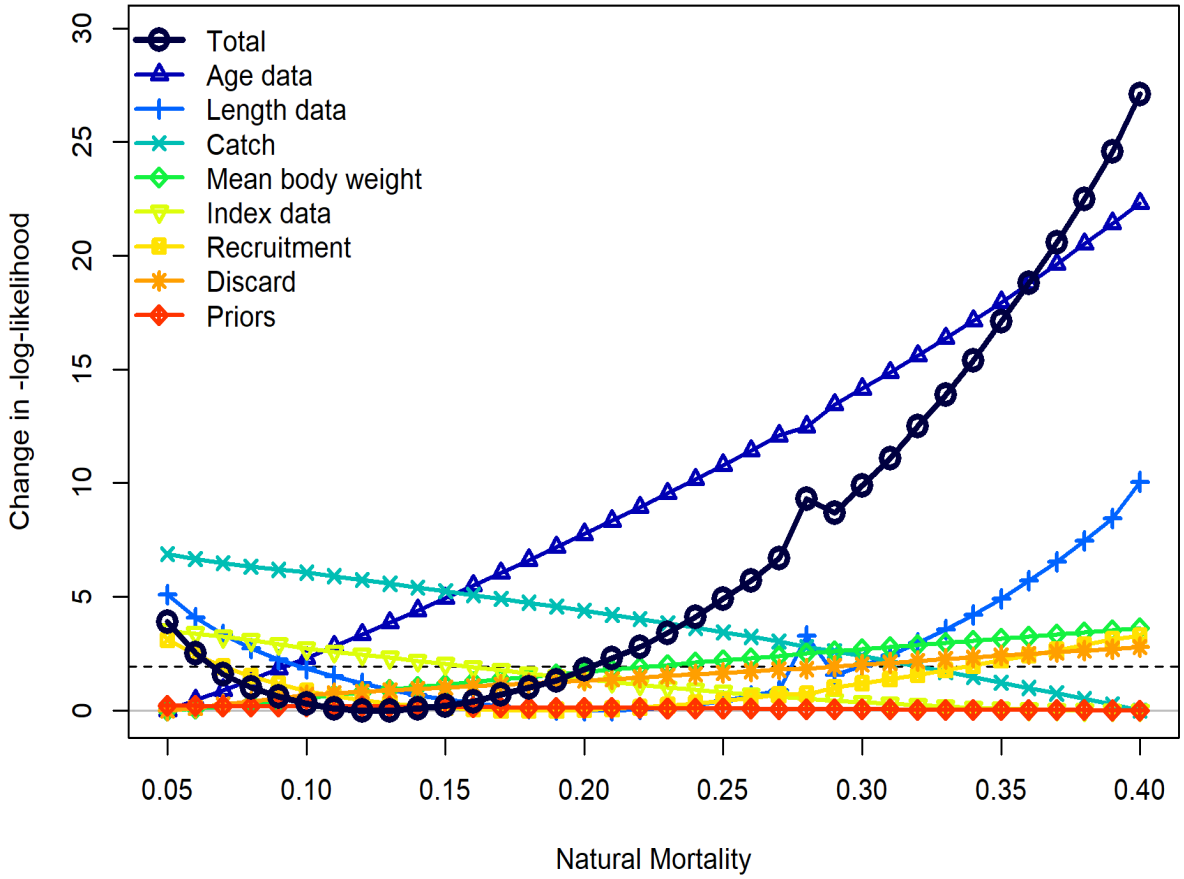


Figure RW83. The likelihood profile for the natural mortality parameter. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested. The natural mortality parameter was fixed at 0.36 in the SEDAR 100 RW Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

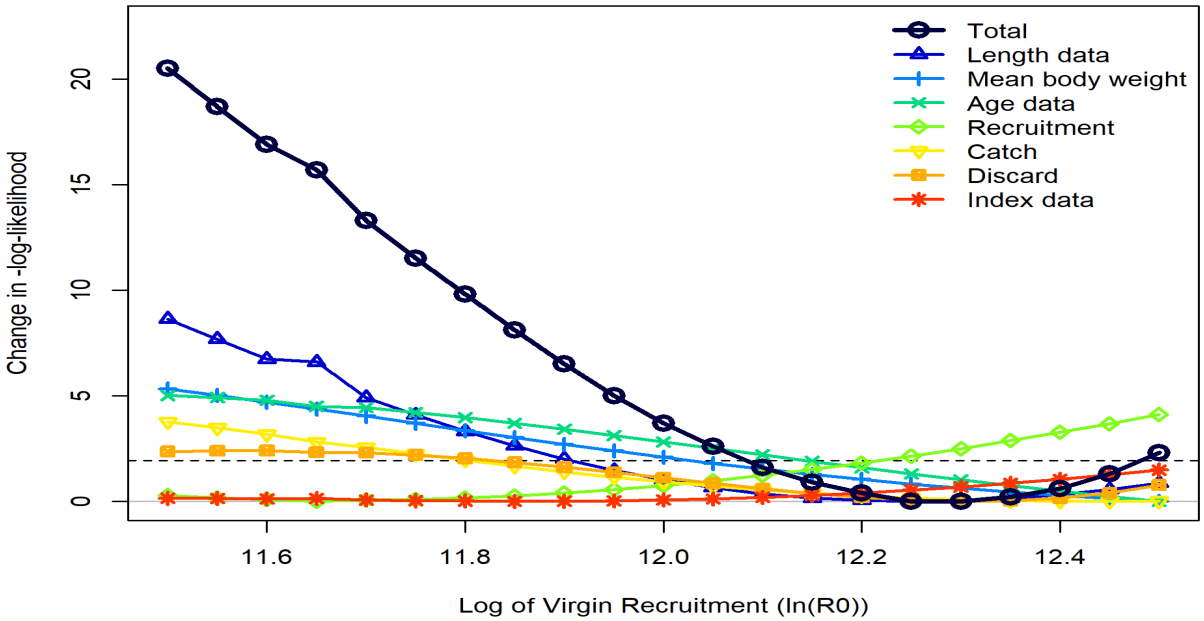


Figure RW84. The likelihood profile for the natural log of the virgin recruitment parameter (ln(R_0)) of the Beverton – Holt stock-recruit function. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested. The MLE (CV) for the SEDAR 100 RW Model was 12.288 (0.008). The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

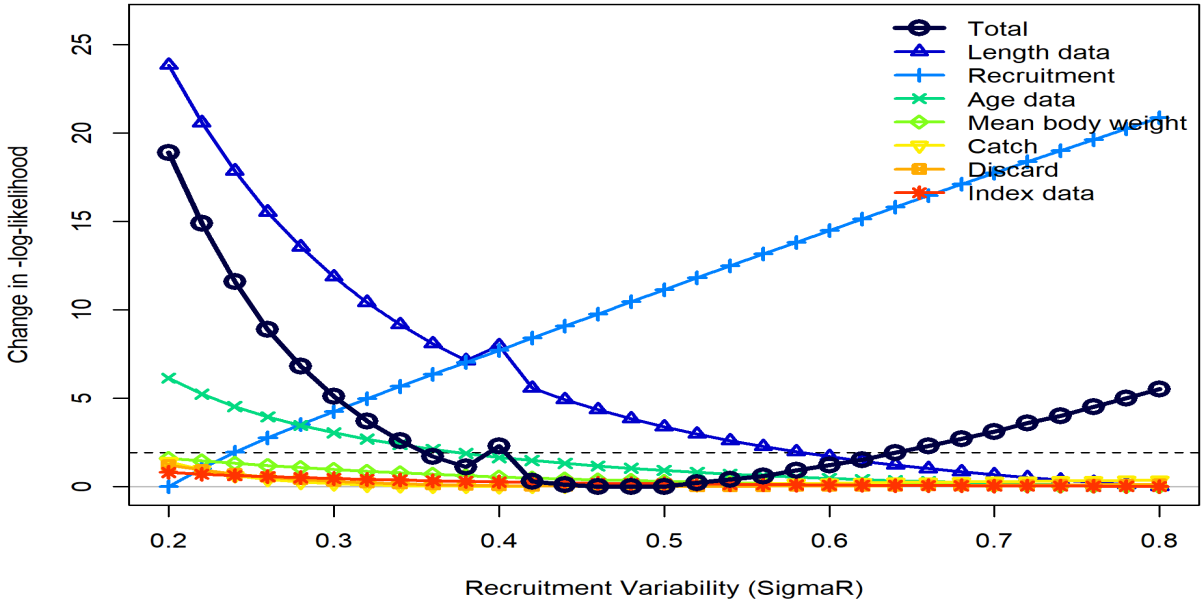


Figure RW85. The likelihood profile for the recruitment variability (SigmaR) parameter of the Beverton – Holt stock-recruit function. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested. SigmaR was fixed at 0.6 in the SEDAR 100 RW Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

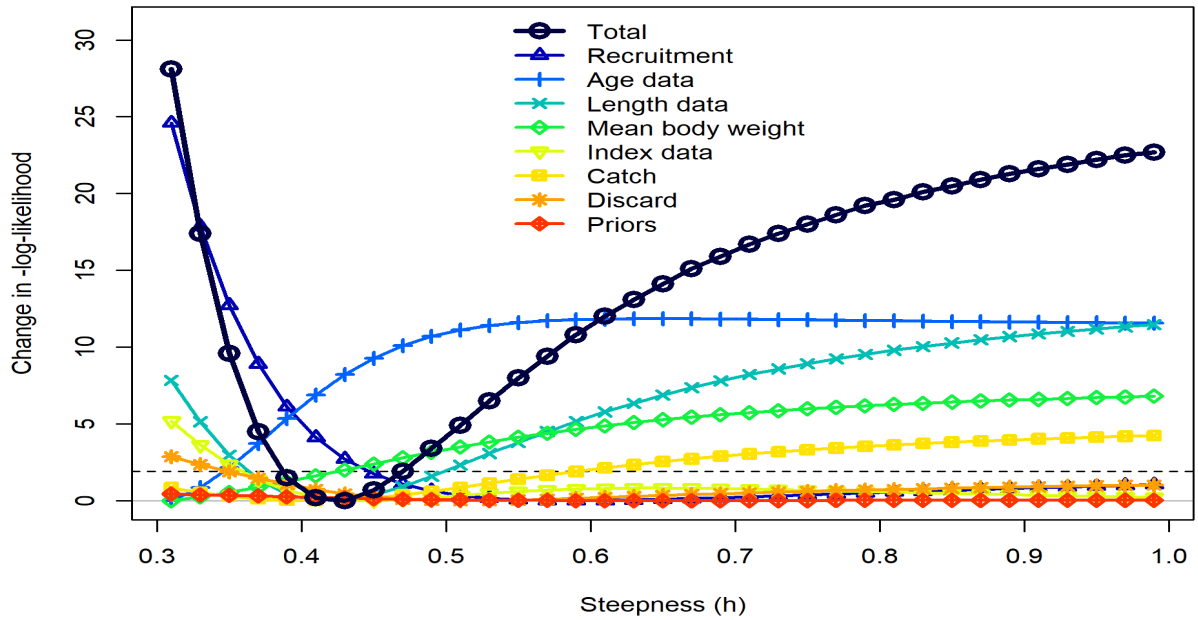


Figure RW86. The likelihood profile for the steepness parameter of the Beverton – Holt stock-recruit function. Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested. Steepness was estimated at 0.422 (0.049) in the SEDAR 100 RW Model. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

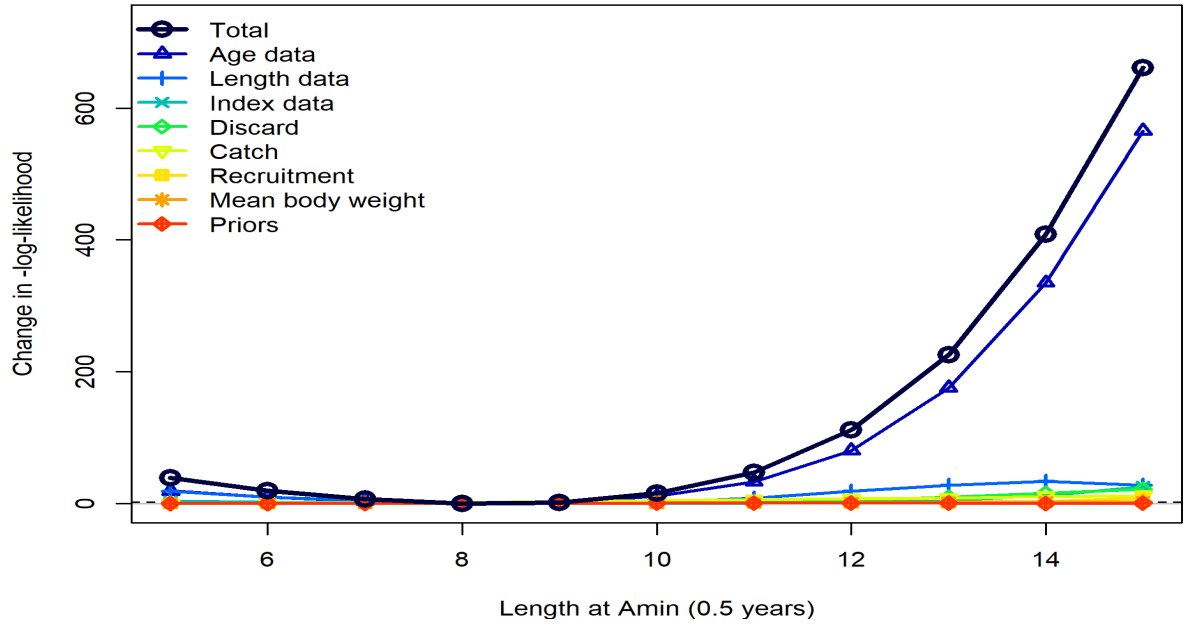


Figure RW87. The likelihood profile for the length at the minimum age (0.5 year) parameter (L_{Amin}). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The MLE (CV) for the SEDAR 100 RW Model was 8.628 (0.037). The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

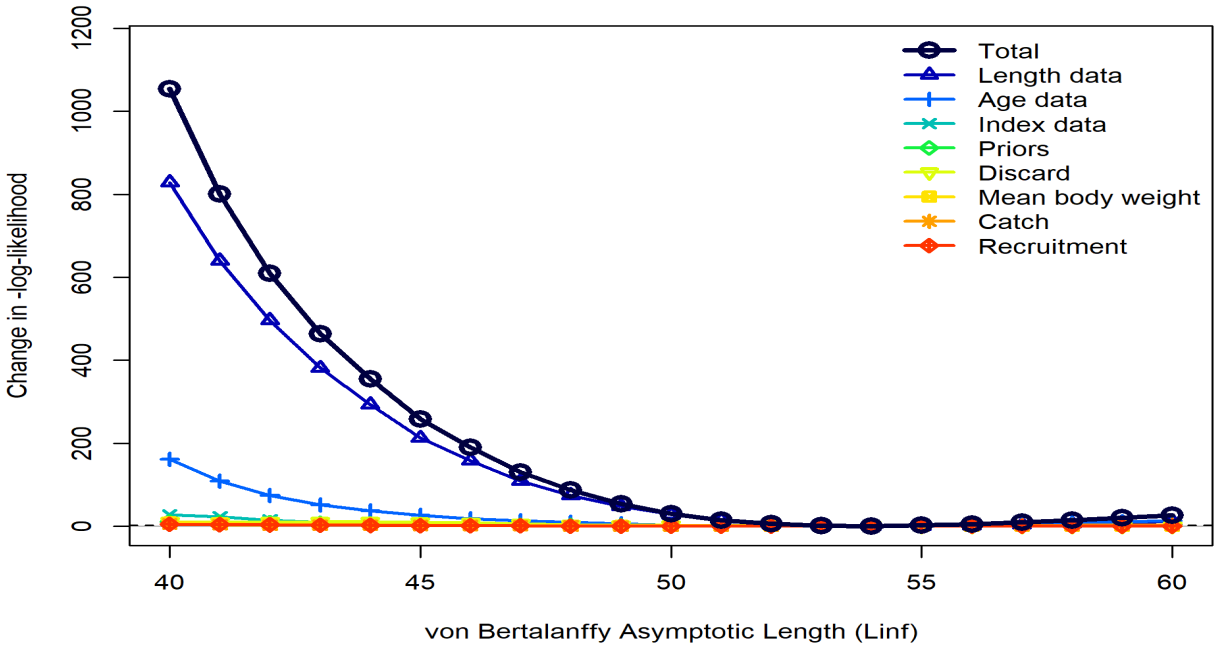


Figure RW88. The likelihood profile for the von Bertalanffy asymptotic length parameter (L_{Amax} [i.e., L∞]). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The MLE (CV) for the SEDAR 100 RW Model was 53.846 (0.012). The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

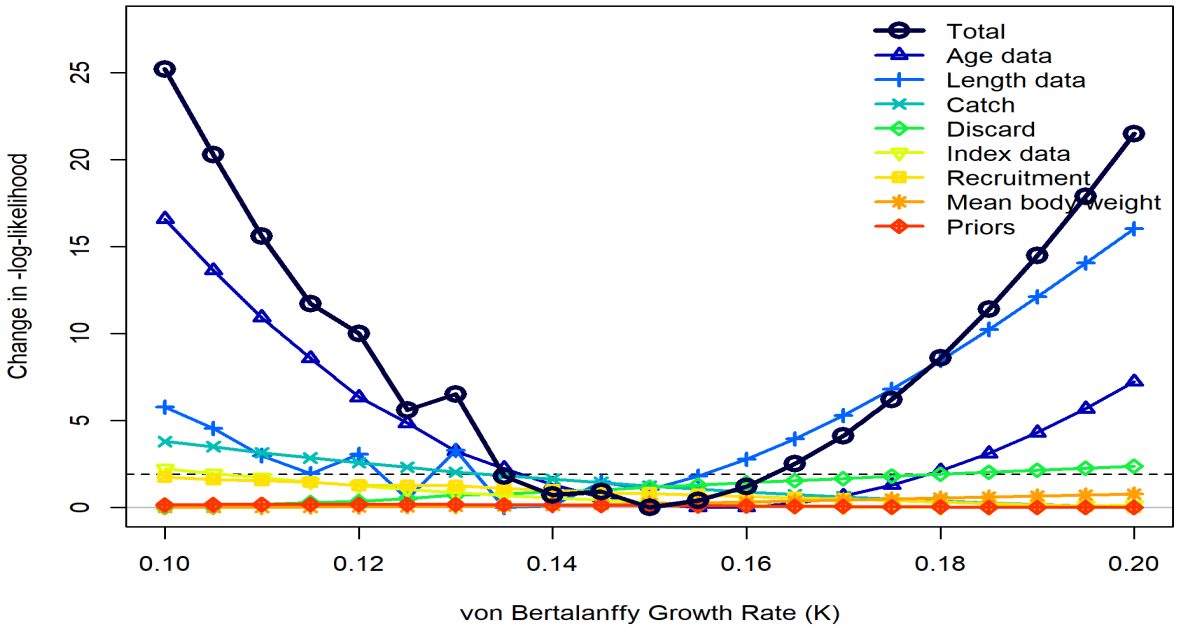


Figure RW89. The likelihood profile for the von Bertalanffy growth rate parameter (K). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The MLE (CV) for the SEDAR 100 RW Model was 0.149 (0.049). The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

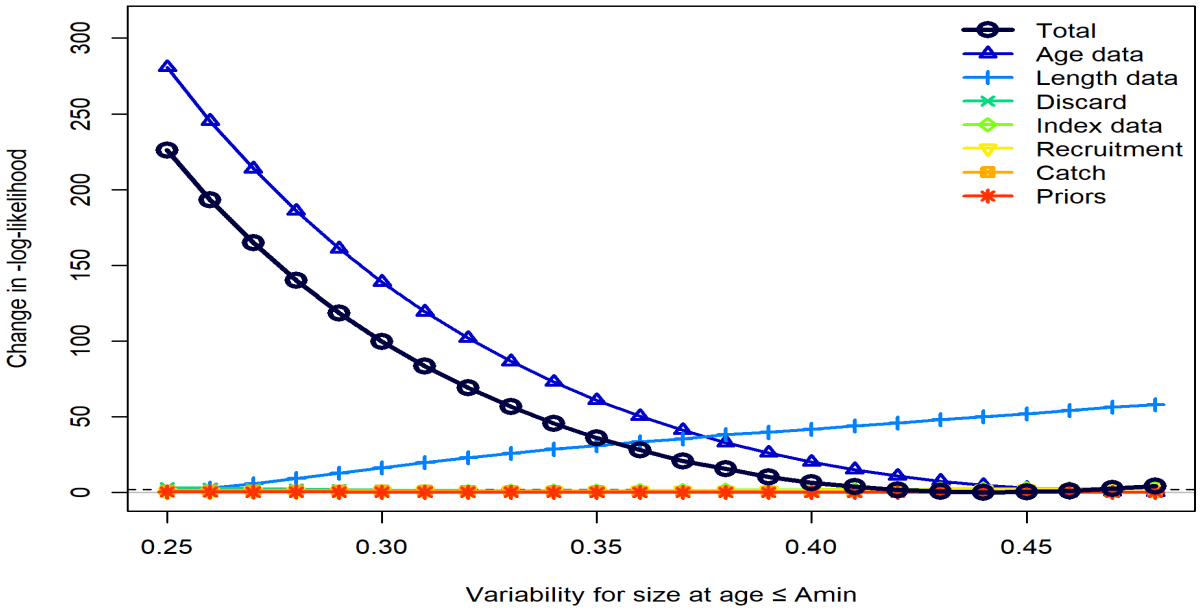


Figure RW90. The likelihood profile for the variability for size-at-age ≤ Amin (CV_{Amin}). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The CV_{Amin} parameter was fixed at 0.437 for the SEDAR 100 RW Model after estimating it in an intermediate run. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

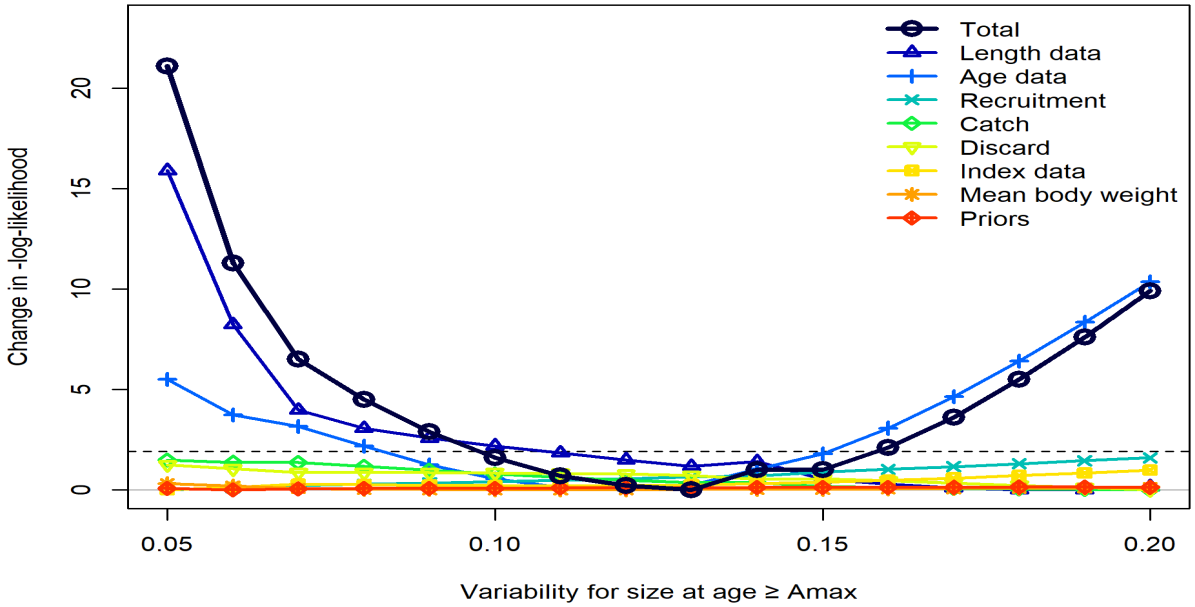


Figure RW91. The likelihood profile for the variability for size-at-age ≥ Amax (CV_{Amax}). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed values tested in the profile diagnostic run. The CV_{Amax} parameter was fixed at 0.124 for the SEDAR 100 RW Model after estimating it in an intermediate run. The dashed horizontal line at ~1.92 indicates the 95% confidence interval.

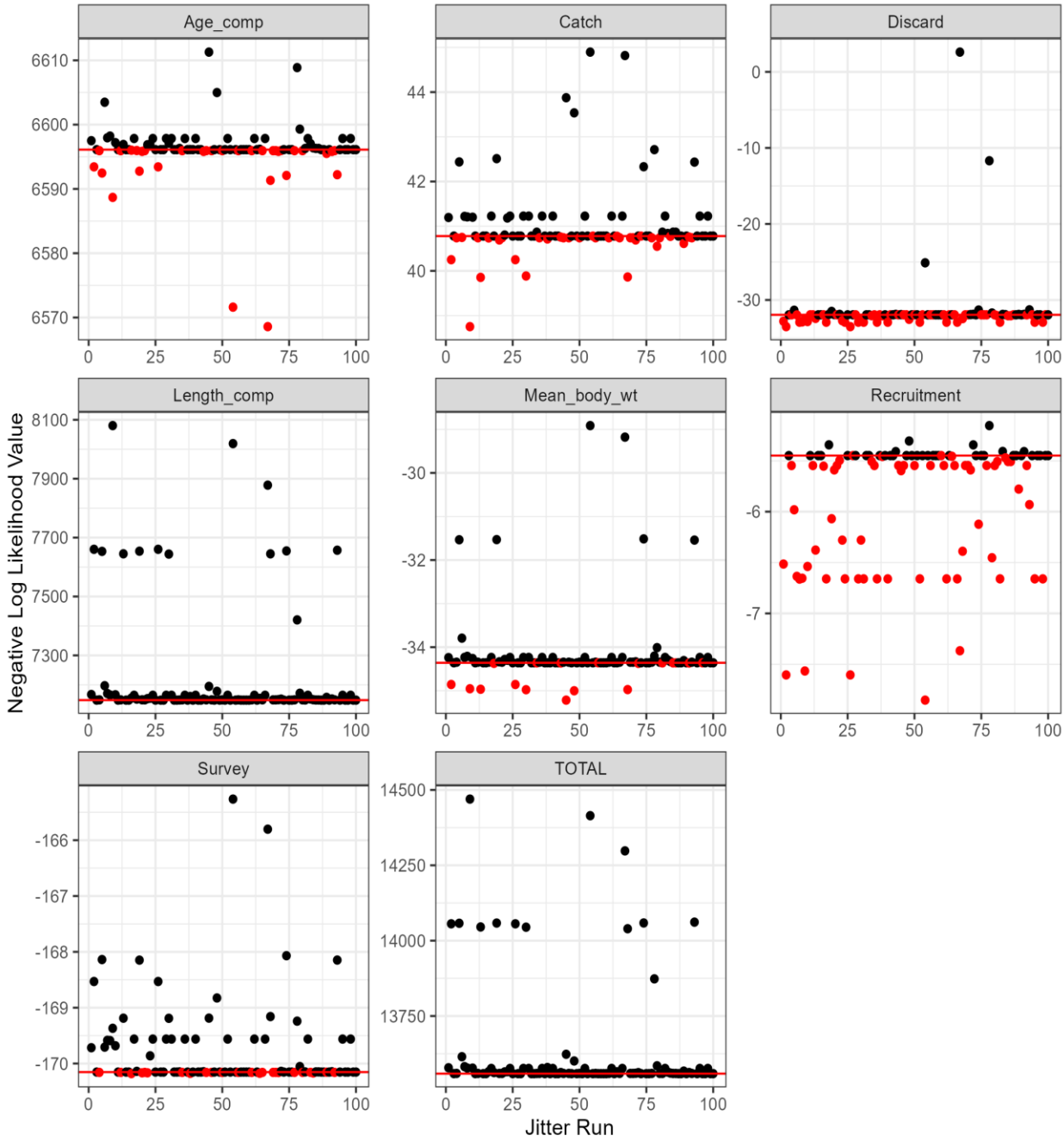


Figure RW92. Results of the jitter analysis for various likelihood components for the SEDAR 100 RW Model. Each panel gives the results of 100 model runs where the starting parameter values for each run were randomly changed ('jittered') by 10% from the SEDAR 100 RW Model best fit values. Note that the y-axes differ between panels. Negative log-likelihood components shown from top left through bottom right include: conditional age-at-length (Age_comp), catch, discards, length composition (length_comp), mean weight of landings (Mean_body_wt), recruitment, survey, and total.

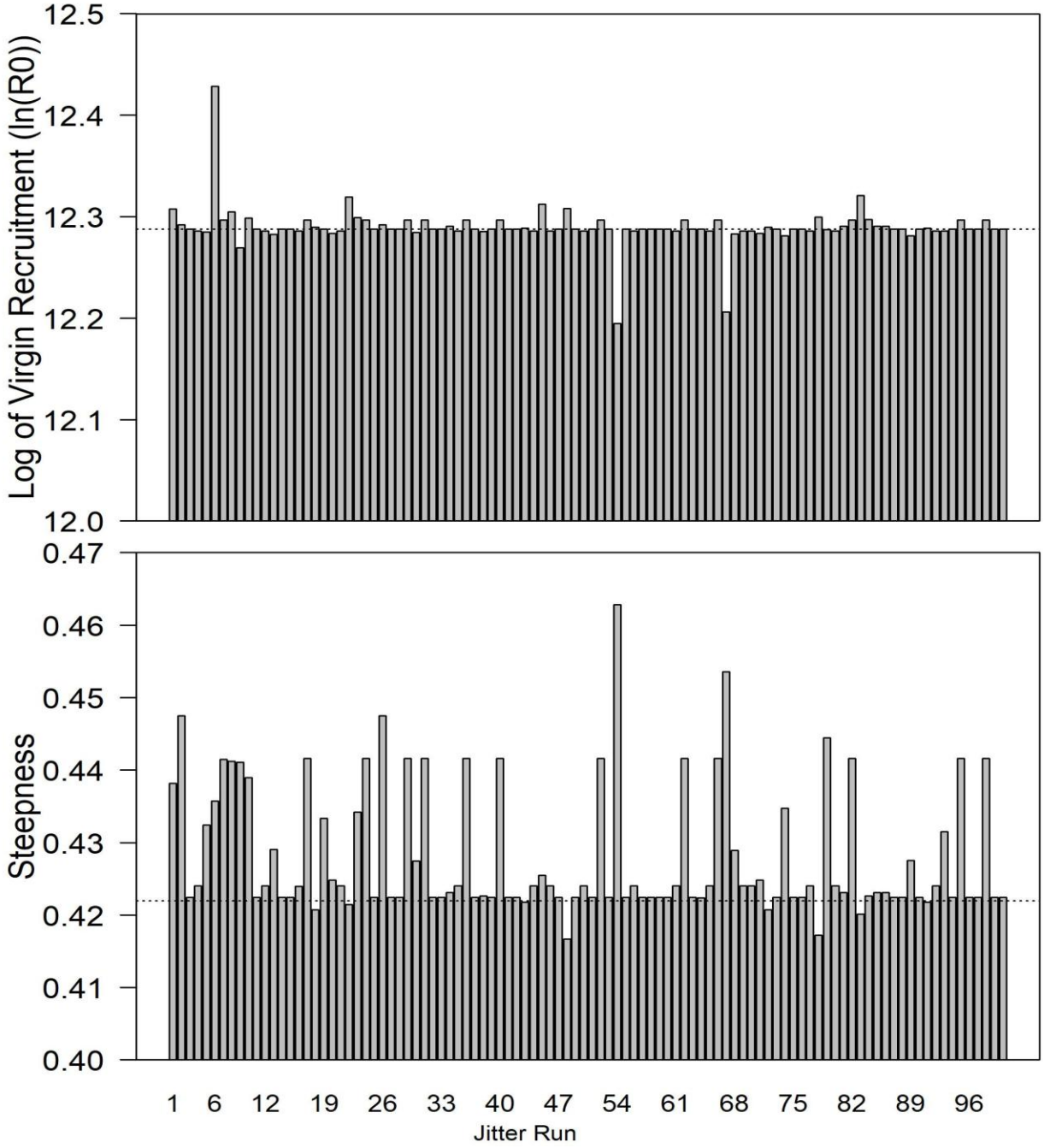


Figure RW93. Results of the jitter analysis for the natural log of the virgin recruitment parameter (ln(R_0)) and steepness for the SEDAR 100 RW Model from 100 model runs where the starting parameter values for each run were randomly changed ('jittered') by 10% from the SEDAR 100 RW Model best fit value (dashed horizontal line).

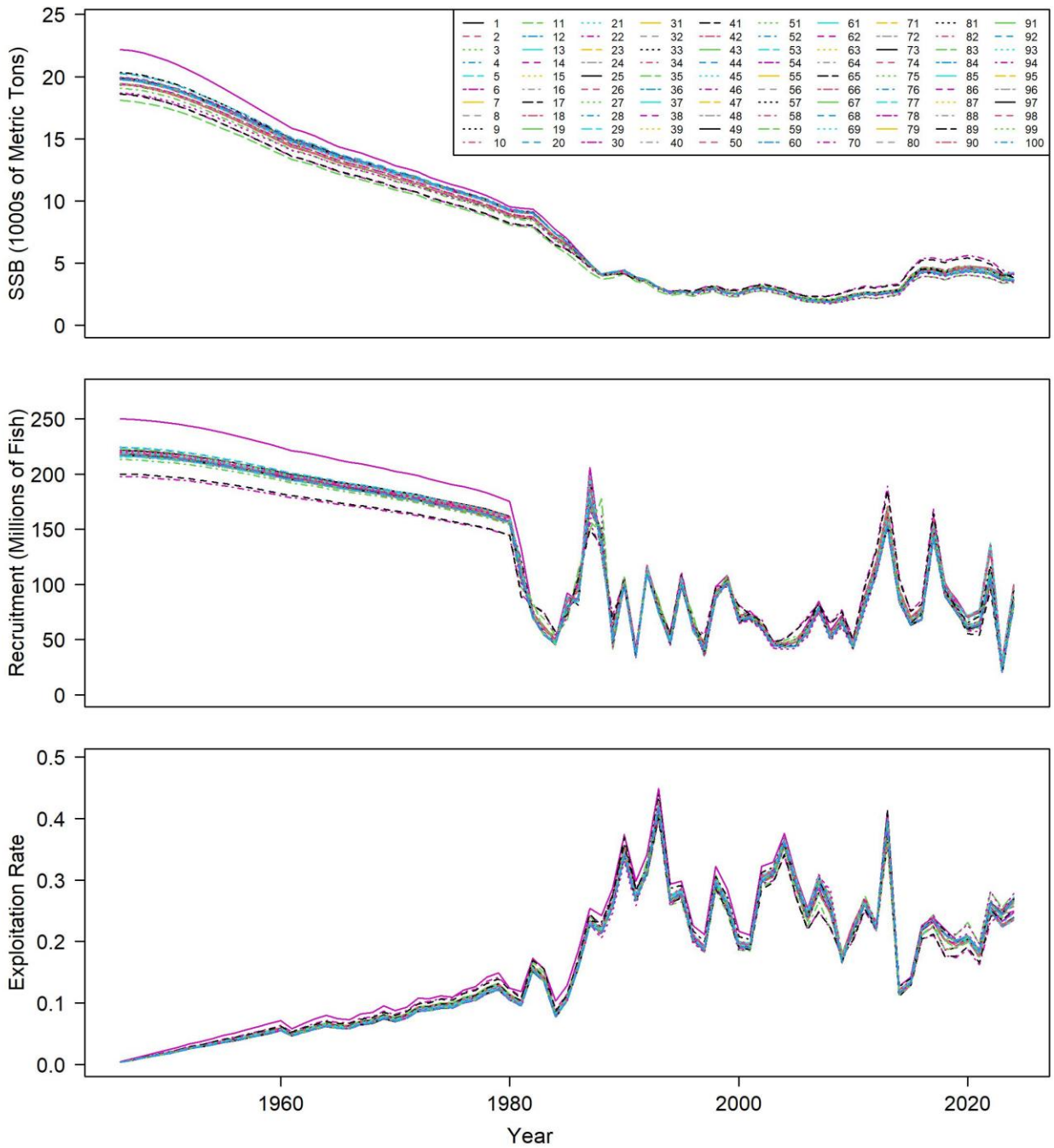


Figure RW94. Estimated trajectories for spawning stock biomass (SSB in 1,000s of metric tons; top panel), recruitment (millions of age-0; middle panel), and fishing mortality (as an exploitation rate in total biomass killed all ages / total biomass age 1+; bottom panel) for the SEDAR 100 RW Model.

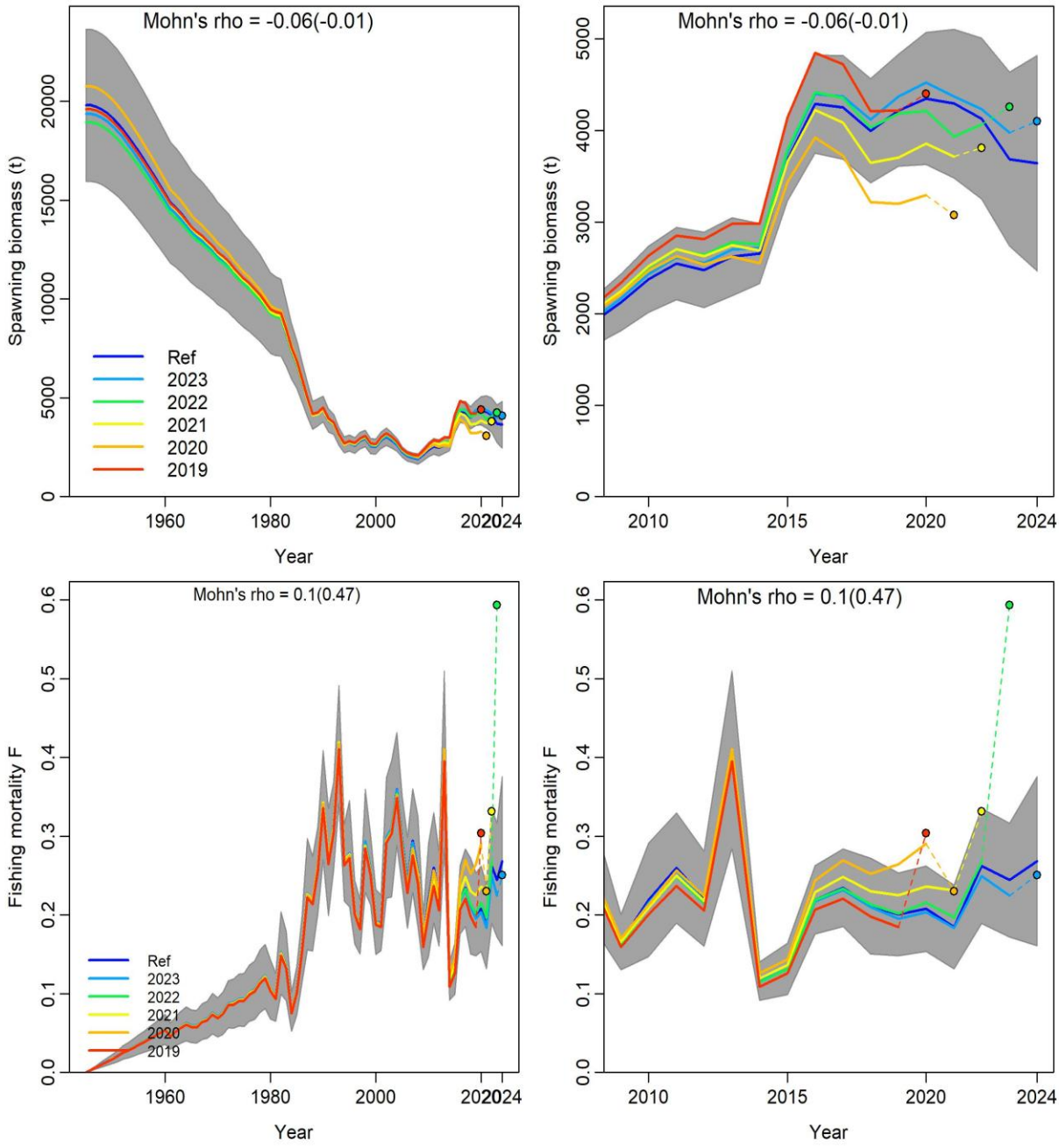


Figure RW95. Retrospective analysis of spawning stock biomass (SSB, top panels) and fishing mortality (F, bottom panels) estimates by re-fitting each reference model (Ref) after removing five years of observations, one year at a time sequentially. The retrospective results are shown for the entire time series and for the most recent years only. Mohn's Rho statistic and the corresponding 'hindcast rho' values (in brackets) are printed at the top of each panel. One-year-ahead projections denoted by color-coded dashed lines with terminal points shown for each model. Grey shaded areas are the 95% confidence intervals from the reference model. See Carvalho et al. (2021) for additional details.

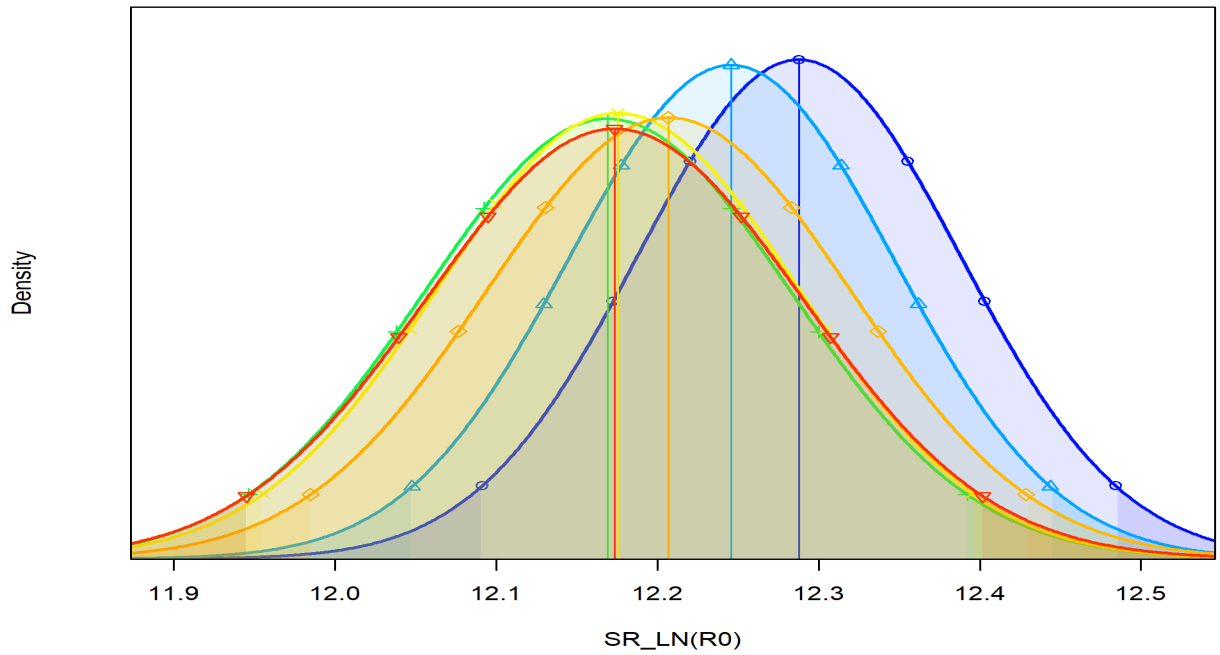


Figure RW96. Results of a five year retrospective analysis for the natural log of the virgin recruitment parameter (ln(R_0)) for the SEDAR 100 RW Model.

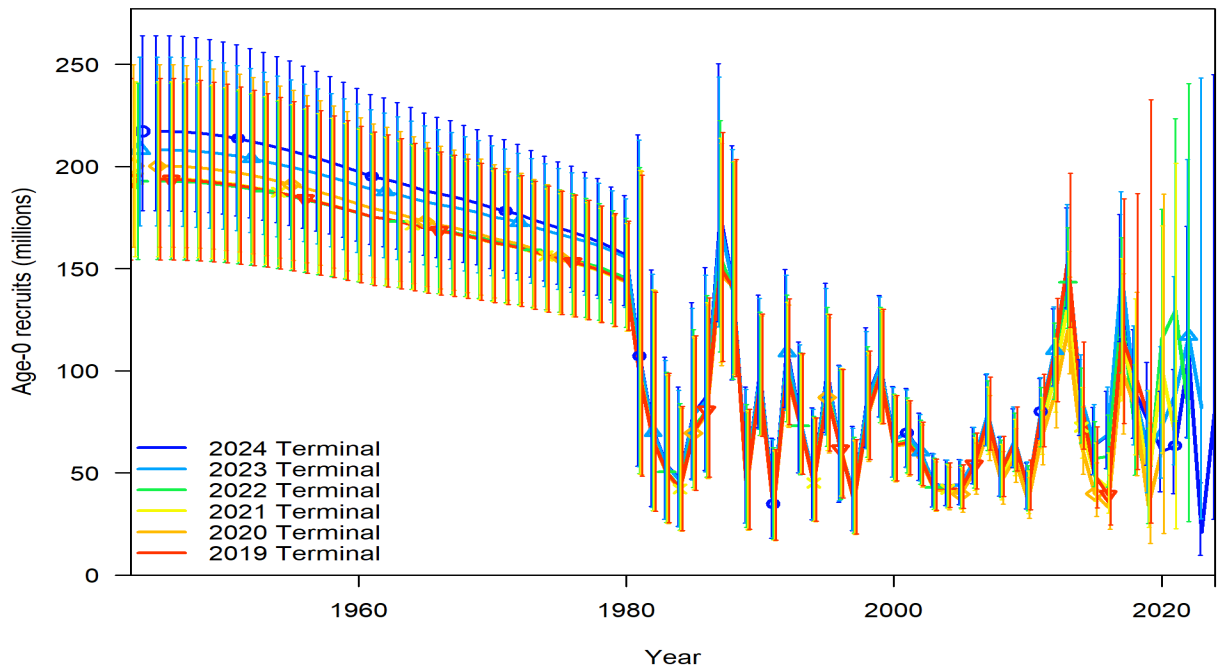


Figure RW97. Results of a five year retrospective analysis for recruitment (millions of fish) for the SEDAR 100 RW Model.

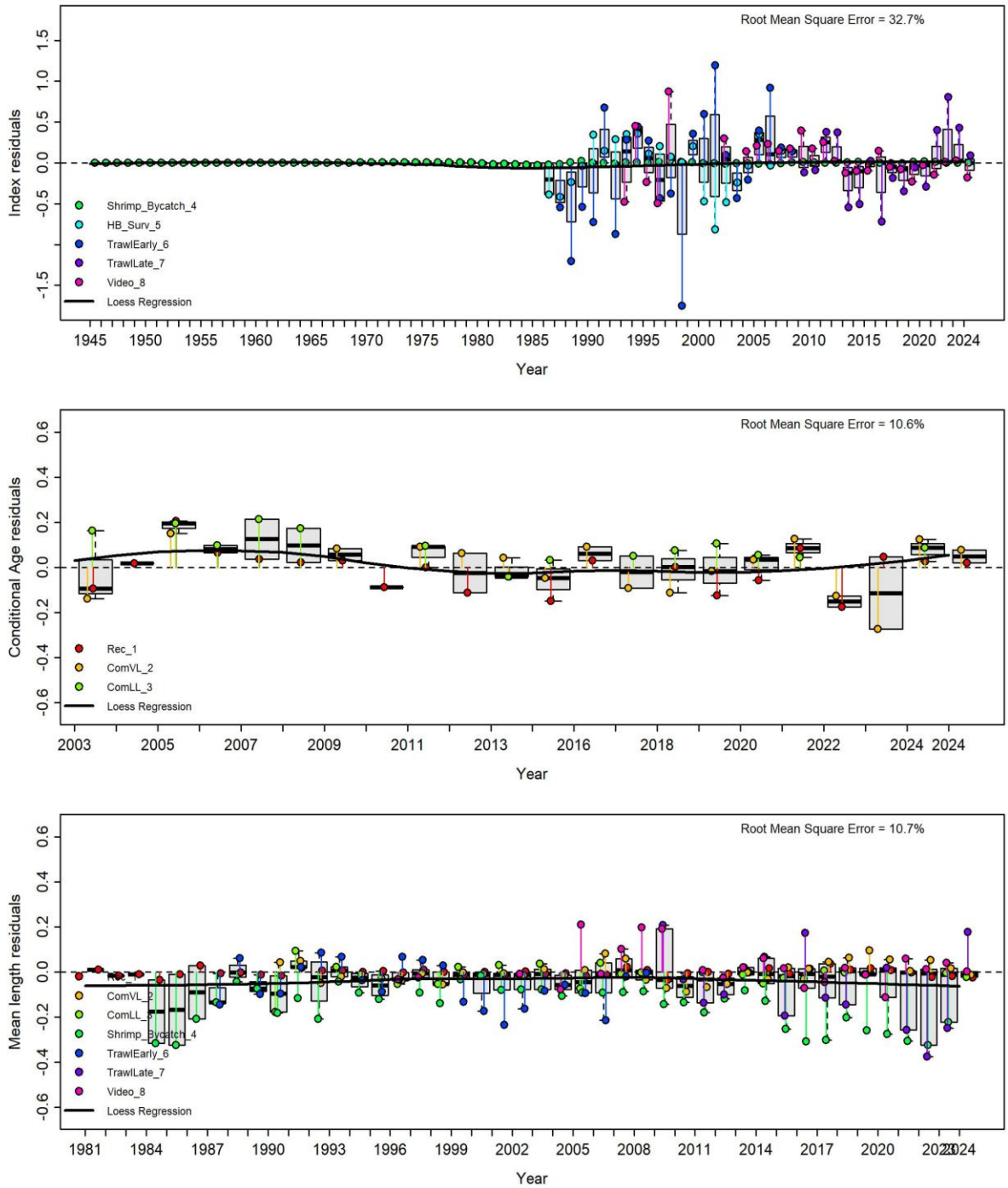


Figure RW98. Joint residual plots for indices of abundance fits (top panel), fits to conditional at-age-length (middle panel), and fits to annual mean length estimates (bottom panel). Vertical lines with points show the residuals (in colors by index), and solid black line reflects the loess smoother through all the residuals. Boxplots indicate the median and quantiles in cases where residuals from the multiple indices are available for any given year. Root-mean squared errors (RMSE) are included in the upper right-hand corner of each plot. See Carvalho et al. (2021) for additional details.

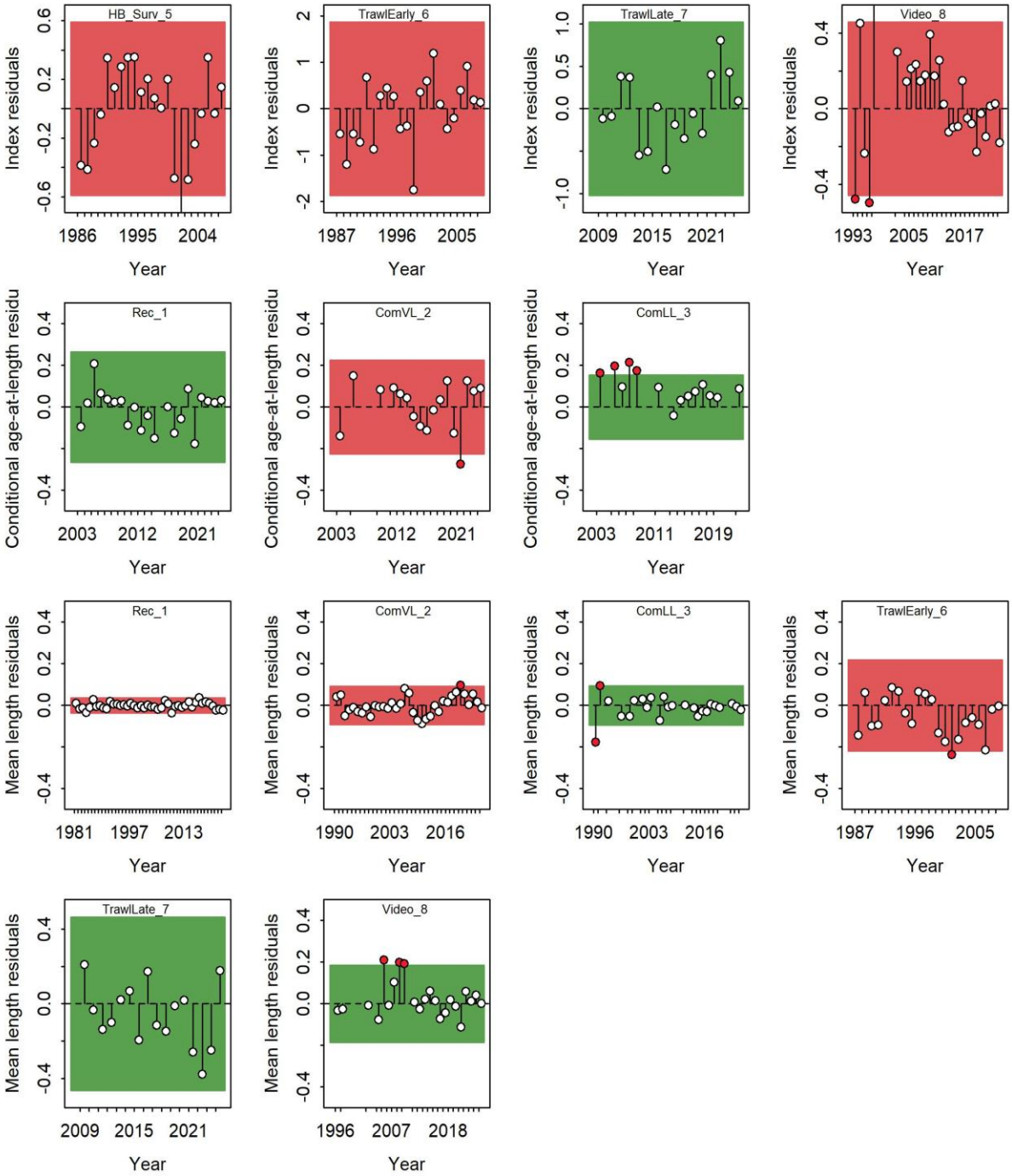


Figure RW99. Runs tests results for indices of abundance, conditional age-at-length, and mean length. Green shading indicates no evidence (p >= 0.05) and red shading evidence (p < 0.05) to reject the hypothesis of a randomly distributed time series of residuals, respectively. The shaded (green/red) area spans three residual standard deviations to either side from zero, and the red points outside of the shading violate the 'three-sigma limit' for that series. See Carvalho et al. (2021) for additional details.

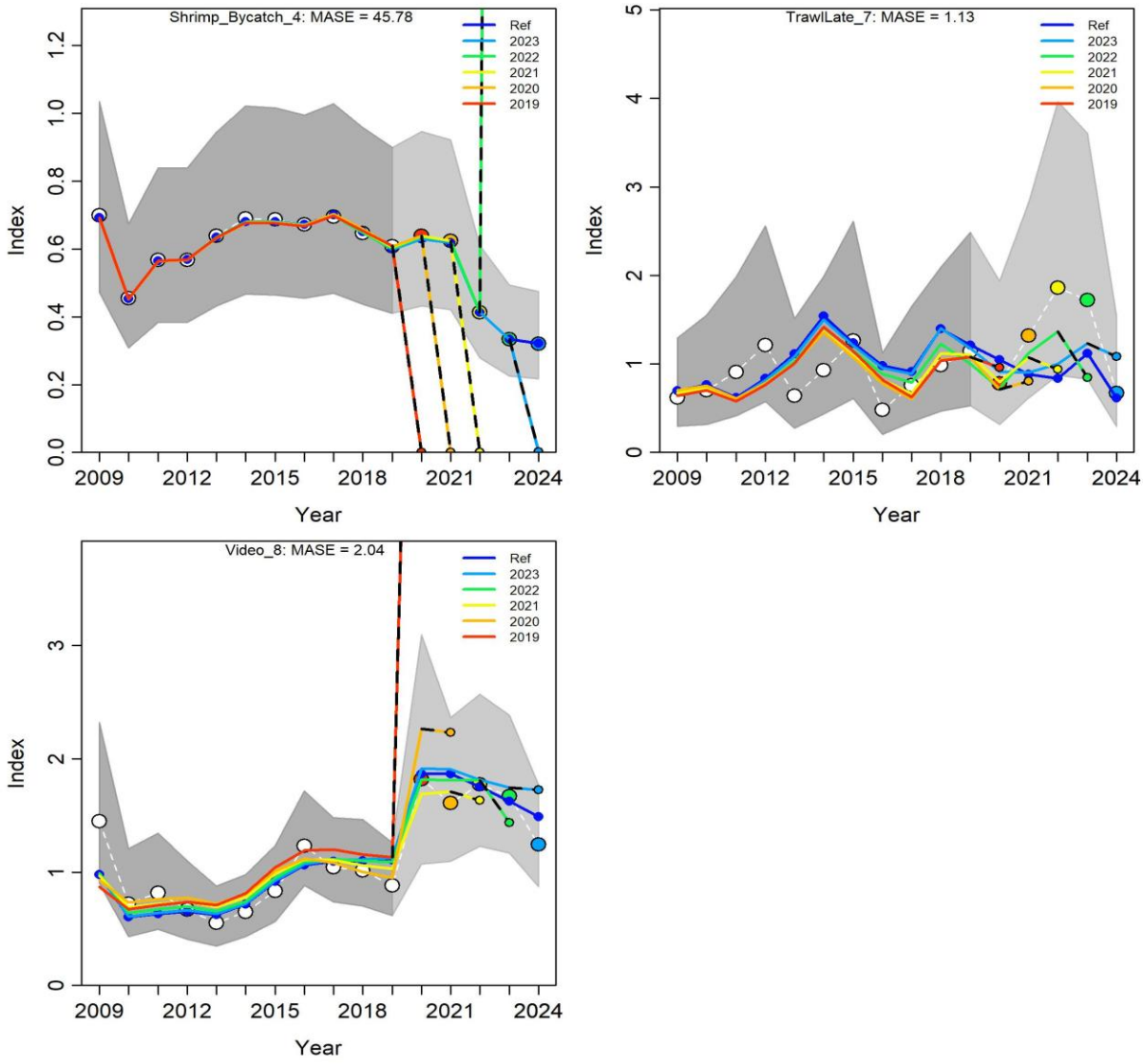


Figure RW100. Hindcasting cross-validation (HCxval) results for indices of abundance fits. Shown are observed (large points connected with dashed line), fitted (solid lines) and one-year ahead forecast values (small terminal points). HCxval was performed using one reference model (Ref) and five hindcast model runs (solid lines) relative to the expected index. The observations used for cross validation are highlighted as color-coded solid circles with associated 95% confidence intervals (light-grey shading). The model reference year refers to the endpoints of each one-year-ahead forecast and the corresponding observation (i. e., year of peel + 1). The mean absolute scaled error (MASE) score associated with each index time series is denoted in each panel. See Carvalho et al. (2021) for additional details.

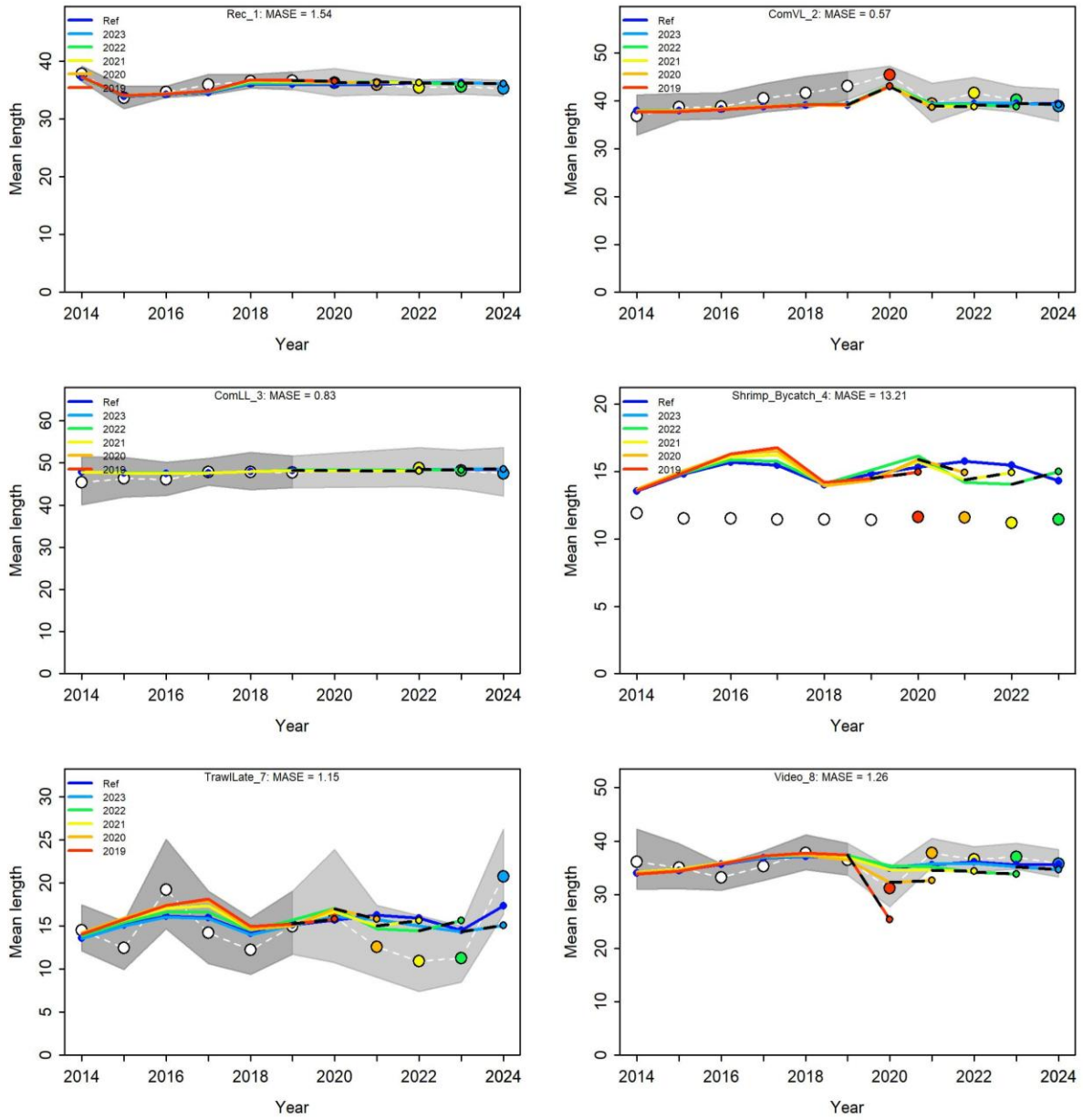


Figure RW101. Hindcasting cross-validation (HCxval) results for fits to annual mean length estimates. Shown are observed (large points connected with dashed line), fitted (solid lines) and one-year ahead forecast values (small terminal points). HCxval was performed using one reference model (Ref) and five hindcast model runs (solid lines) relative to the expected mean length. The observations used for cross-validation are highlighted as color-coded solid circles with associated 95% confidence intervals (light-grey shading). The model reference year refers to the endpoints of each one-year-ahead forecast and the corresponding observation (i. e., year of peel + 1). The mean absolute scaled error (MASE) score associated with each size composition time series is denoted in each panel. See Carvalho et al. (2021) for additional details.

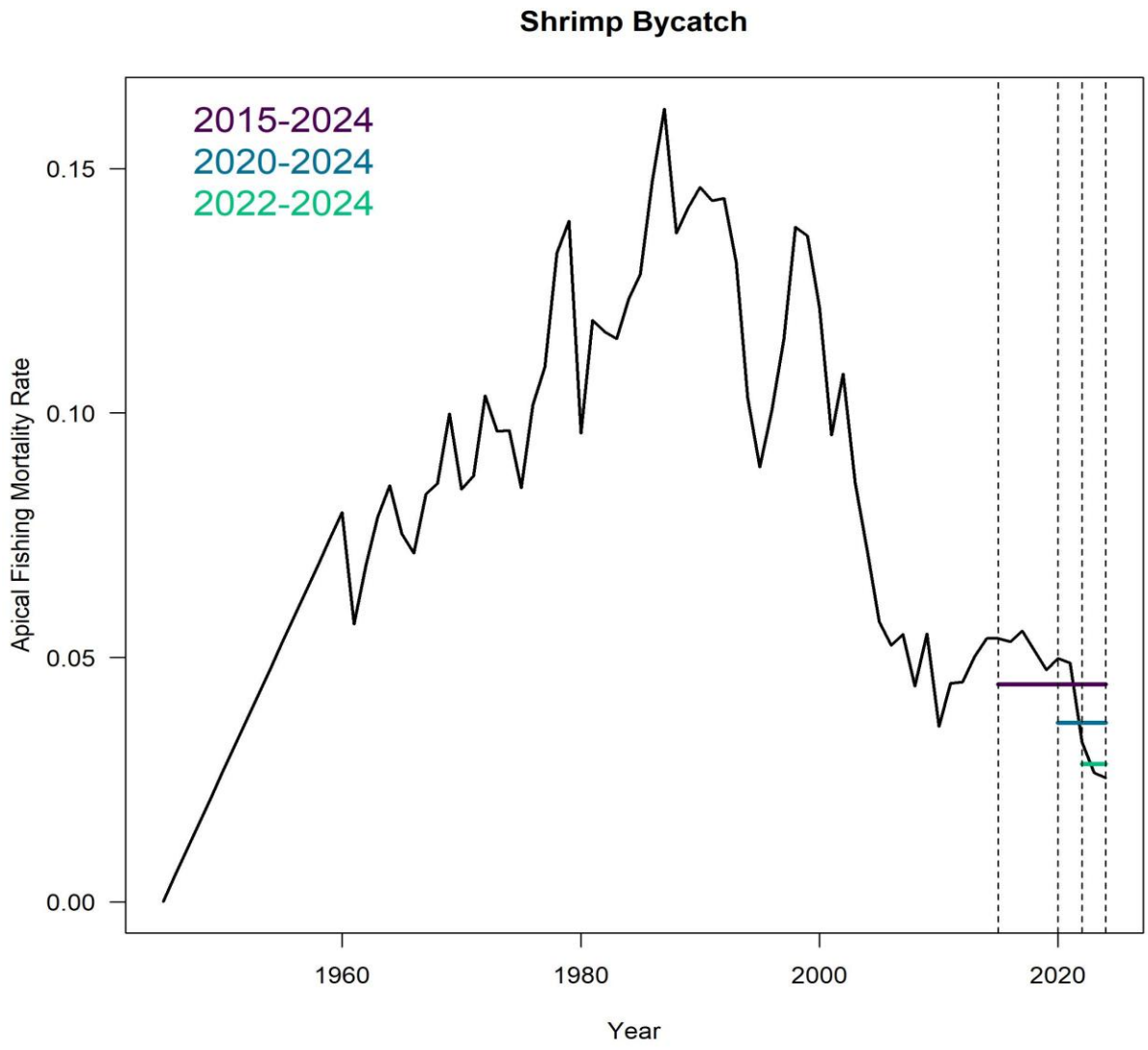


Figure RW102. Time series of apical fishing mortality rate for the Shrimp Bycatch fleet. 3, 5 and 10 year averages are shown. The 3-year average was used in projections.

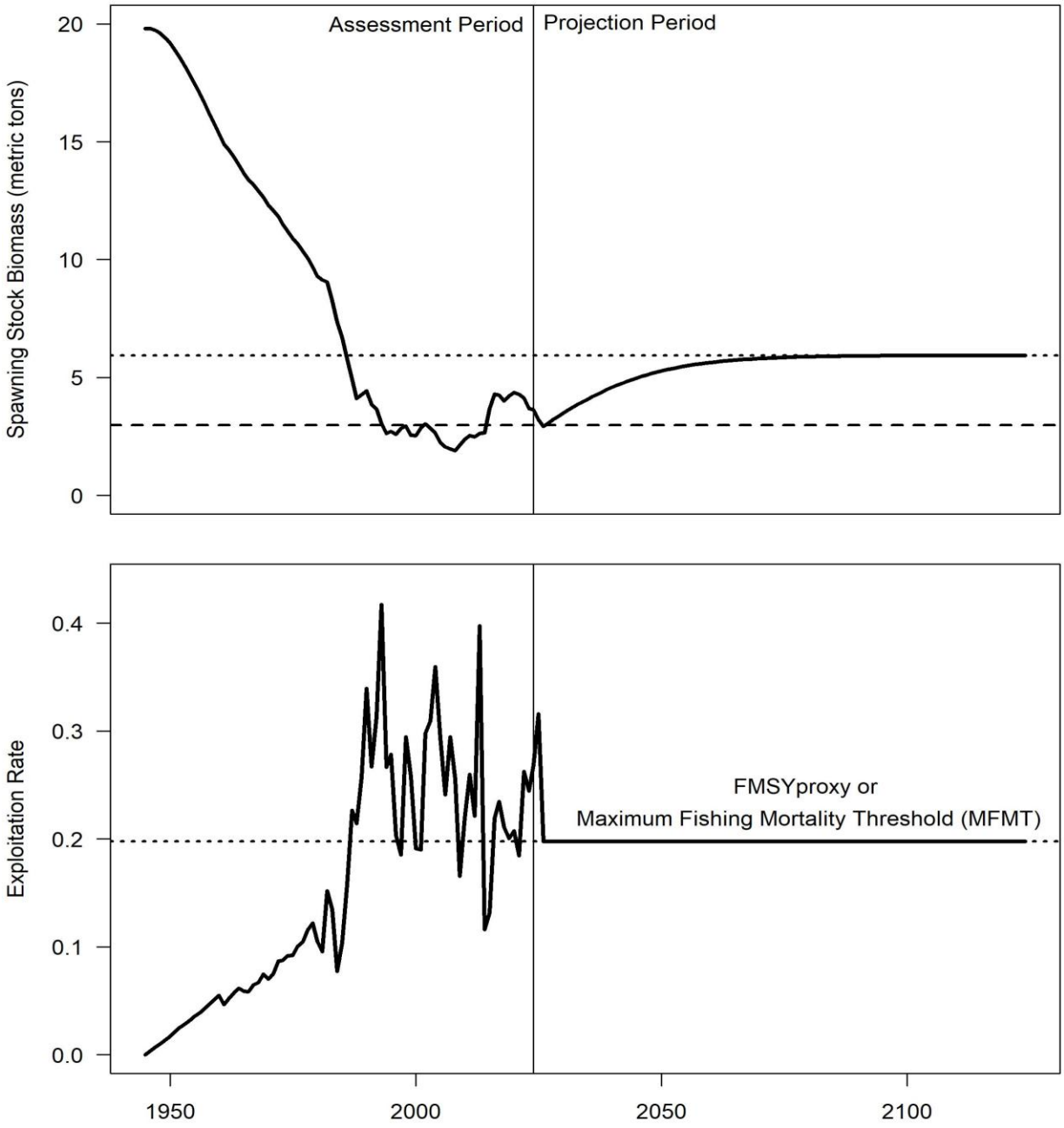


*Figure RW103. Time series of SSB (1,000s of metric tons) and fishing mortality (as an exploitation rate in total biomass killed all ages / total biomass age 1+) with respect to status determination criteria throughout the projection period. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (**Section 1.2 in the Assessment Process Report**), and was approximated for this model using an SSB ratio of 30%.*

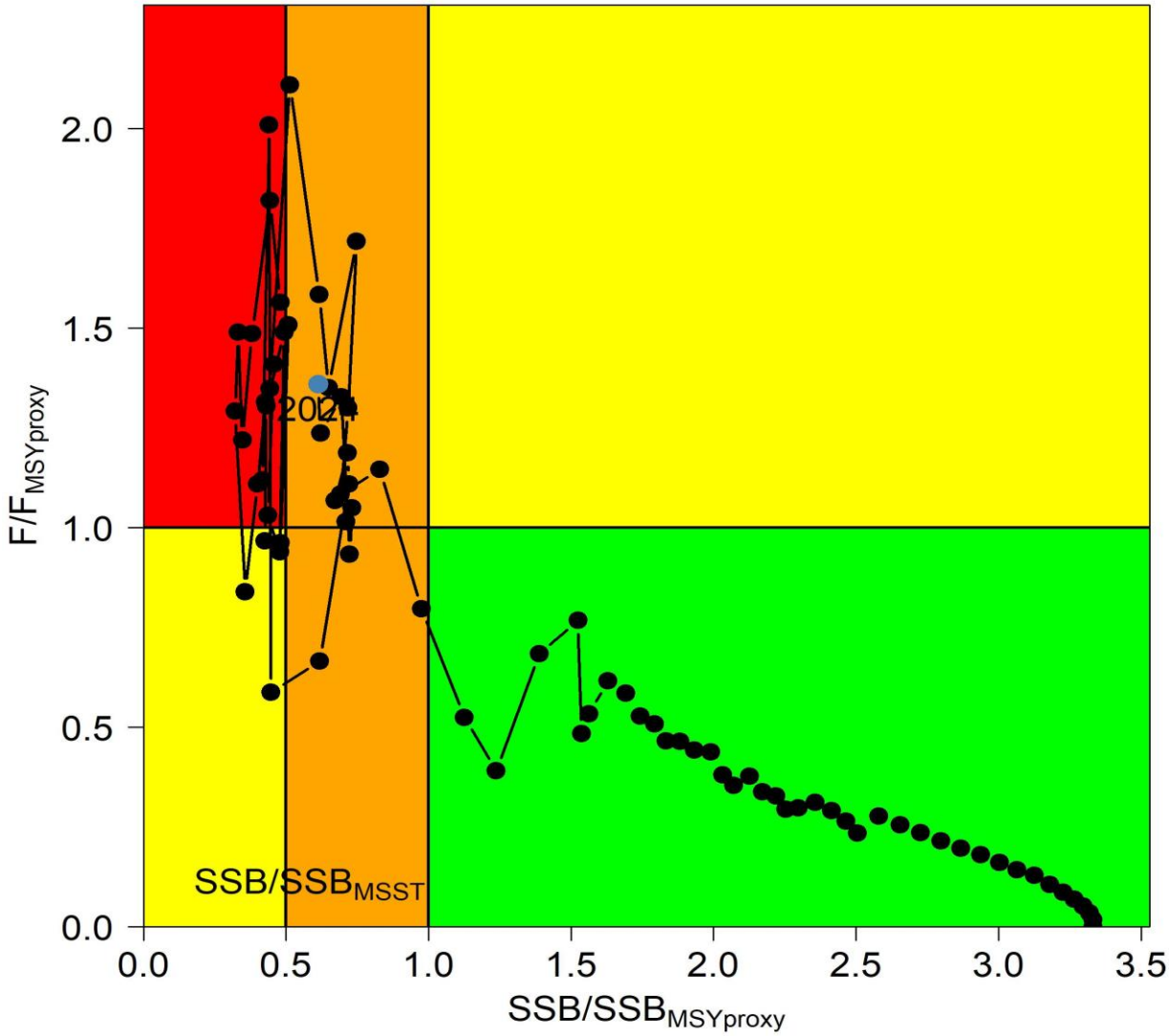


Figure RW104. Kobe plot illustrating the trajectory of stock status throughout the projection period. The orange coloring indicates regions where the stock is below the biomass target but above the biomass threshold (MSST = 0.5 x $SSB_{30\%SPR}$). The 2024 terminal year stock status is indicated by the gray dot. See ***Table RW42*** *for values. SSB is in metric tons. An SPR proxy of 30% was specified in the SEDAR 100 AP Terms of Reference (****Section 1.2 in the Assessment Process Report****), and was approximated for this model using an SSB ratio of 30%.*

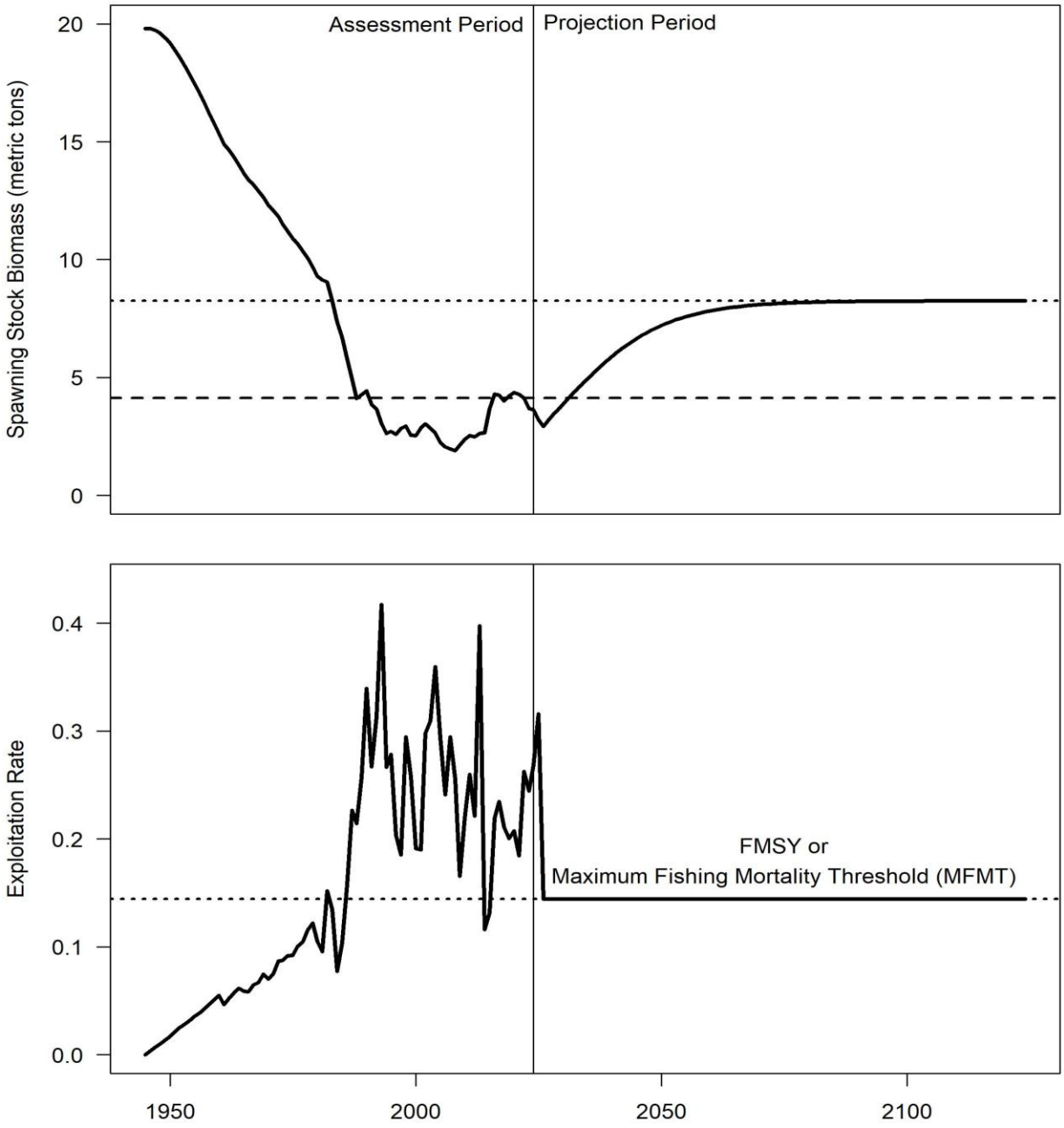


Figure RW105. Time series of SSB (1,000s of metric tons) and fishing mortality (as an exploitation rate in total biomass killed all ages / total biomass age 1+) with respect to status determination criteria for the MSY projection throughout the projection period.

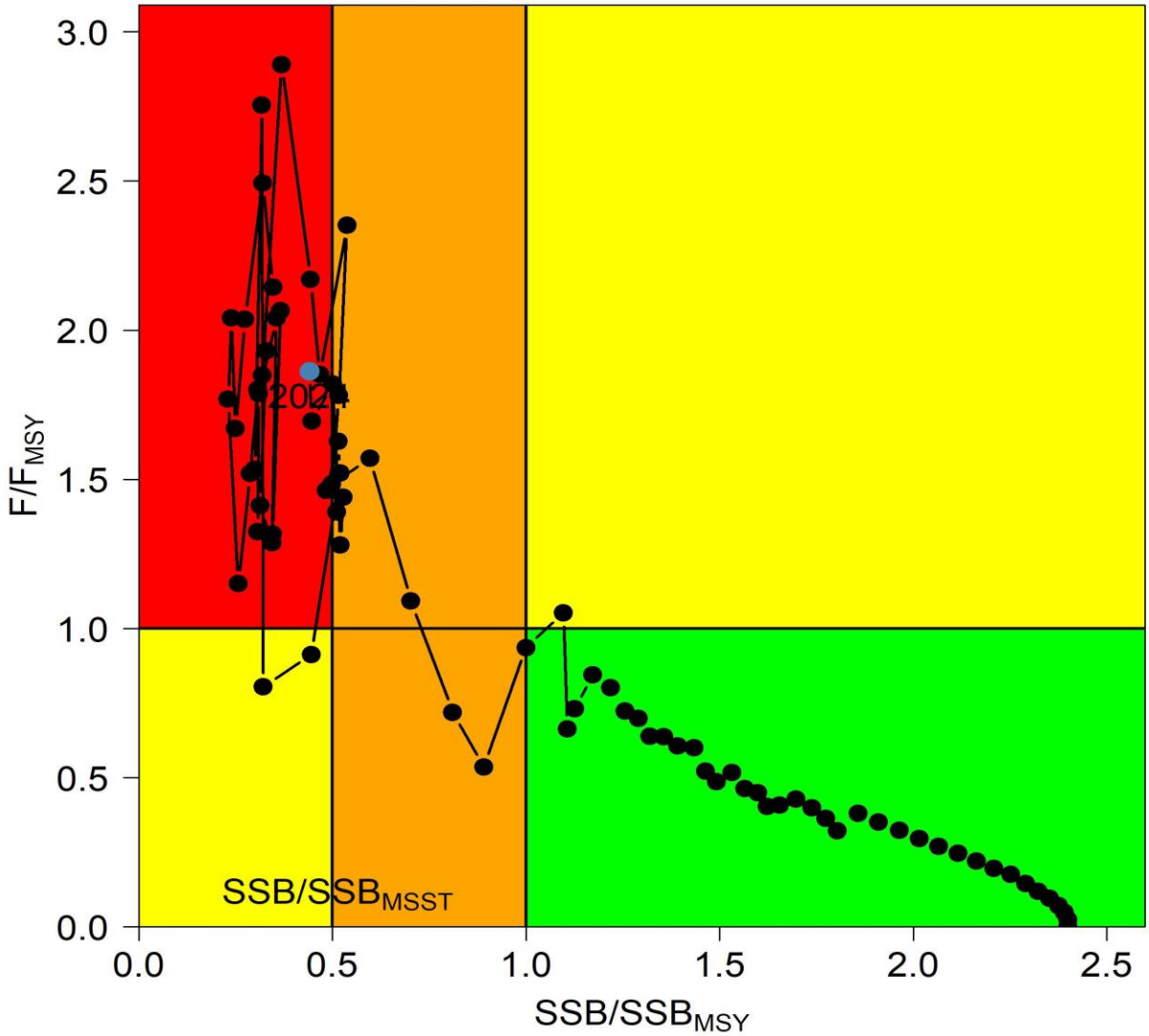


Figure RW106. Kobe plot illustrating the trajectory of stock status for the MSY projection throughout the projection period. The orange coloring indicates regions where the stock is below the biomass target but above the biomass threshold (MSST = 0.5 x SSB_{MSY}). The 2024 terminal year stock status is indicated by the gray dot. See ***Table RW44*** *for values. SSB is in metric tons.*

RW Appendix

Table A1. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_1_YR_1945_s_1	1.17e-04	(0,4)	3.41e-05	0.292		1
F_fleet_1_YR_1946_s_1	0.002	(0,4)	6.75e-04	0.293		1
F_fleet_1_YR_1947_s_1	0.005	(0,4)	0.001	0.293		1
F_fleet_1_YR_1948_s_1	0.007	(0,4)	0.002	0.293		1
F_fleet_1_YR_1949_s_1	0.009	(0,4)	0.003	0.293		1
F_fleet_1_YR_1950_s_1	0.011	(0,4)	0.003	0.293		1
F_fleet_1_YR_1951_s_1	0.014	(0,4)	0.004	0.293		1
F_fleet_1_YR_1952_s_1	0.017	(0,4)	0.005	0.293		1
F_fleet_1_YR_1953_s_1	0.019	(0,4)	0.006	0.294		1
F_fleet_1_YR_1954_s_1	0.022	(0,4)	0.006	0.294		1
F_fleet_1_YR_1955_s_1	0.025	(0,4)	0.007	0.294		1
F_fleet_1_YR_1956_s_1	0.028	(0,4)	0.008	0.294		1
F_fleet_1_YR_1957_s_1	0.032	(0,4)	0.009	0.294		1
F_fleet_1_YR_1958_s_1	0.035	(0,4)	0.010	0.295		1
F_fleet_1_YR_1959_s_1	0.039	(0,4)	0.011	0.295		1
F_fleet_1_YR_1960_s_1	0.043	(0,4)	0.013	0.295		1
F_fleet_1_YR_1961_s_1	0.045	(0,4)	0.013	0.295		1
F_fleet_1_YR_1962_s_1	0.047	(0,4)	0.014	0.295		1
F_fleet_1_YR_1963_s_1	0.049	(0,4)	0.014	0.295		1
F_fleet_1_YR_1964_s_1	0.051	(0,4)	0.015	0.295		1
F_fleet_1_YR_1965_s_1	0.054	(0,4)	0.016	0.295		1
F_fleet_1_YR_1966_s_1	0.056	(0,4)	0.017	0.295		1
F_fleet_1_YR_1967_s_1	0.059	(0,4)	0.017	0.295		1
F_fleet_1_YR_1968_s_1	0.062	(0,4)	0.018	0.295		1
F_fleet_1_YR_1969_s_1	0.065	(0,4)	0.019	0.295		1
F_fleet_1_YR_1970_s_1	0.068	(0,4)	0.020	0.294		1
F_fleet_1_YR_1971_s_1	0.075	(0,4)	0.022	0.294		1
F_fleet_1_YR_1972_s_1	0.083	(0,4)	0.025	0.294		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_1_YR_1973_s_1	0.092	(0,4)	0.027	0.294		1
F_fleet_1_YR_1974_s_1	0.101	(0,4)	0.030	0.294		1
F_fleet_1_YR_1975_s_1	0.109	(0,4)	0.032	0.293		1
F_fleet_1_YR_1976_s_1	0.111	(0,4)	0.033	0.293		1
F_fleet_1_YR_1977_s_1	0.114	(0,4)	0.033	0.292		1
F_fleet_1_YR_1978_s_1	0.118	(0,4)	0.034	0.291		1
F_fleet_1_YR_1979_s_1	0.121	(0,4)	0.035	0.290		1
F_fleet_1_YR_1980_s_1	0.124	(0,4)	0.036	0.288		1
F_fleet_1_YR_1981_s_1	0.082	(0,4)	0.022	0.269		1
F_fleet_1_YR_1982_s_1	0.206	(0,4)	0.053	0.259		1
F_fleet_1_YR_1983_s_1	0.171	(0,4)	0.043	0.249		1
F_fleet_1_YR_1984_s_1	0.047	(0,4)	0.012	0.258		1
F_fleet_1_YR_1985_s_1	0.095	(0,4)	0.024	0.248		1
F_fleet_1_YR_1986_s_1	0.197	(0,4)	0.041	0.210		1
F_fleet_1_YR_1987_s_1	0.351	(0,4)	0.088	0.250		1
F_fleet_1_YR_1988_s_1	0.332	(0,4)	0.076	0.229		1
F_fleet_1_YR_1989_s_1	0.405	(0,4)	0.068	0.168		1
F_fleet_1_YR_1990_s_1	0.528	(0,4)	0.082	0.156		1
F_fleet_1_YR_1991_s_1	0.339	(0,4)	0.075	0.221		1
F_fleet_1_YR_1992_s_1	0.431	(0,4)	0.059	0.137		1
F_fleet_1_YR_1993_s_1	0.701	(0,4)	0.099	0.141		1
F_fleet_1_YR_1994_s_1	0.377	(0,4)	0.053	0.142		1
F_fleet_1_YR_1995_s_1	0.412	(0,4)	0.077	0.186		1
F_fleet_1_YR_1996_s_1	0.257	(0,4)	0.040	0.154		1
F_fleet_1_YR_1997_s_1	0.231	(0,4)	0.031	0.135		1
F_fleet_1_YR_1998_s_1	0.448	(0,4)	0.074	0.165		1
F_fleet_1_YR_1999_s_1	0.356	(0,4)	0.044	0.124		1
F_fleet_1_YR_2000_s_1	0.250	(0,4)	0.041	0.164		1
F_fleet_1_YR_2001_s_1	0.267	(0,4)	0.035	0.131		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_1_YR_2002_s_1	0.479	(0,4)	0.092	0.191		1
F_fleet_1_YR_2003_s_1	0.516	(0,4)	0.106	0.205		1
F_fleet_1_YR_2004_s_1	0.650	(0,4)	0.091	0.140		1
F_fleet_1_YR_2005_s_1	0.518	(0,4)	0.068	0.132		1
F_fleet_1_YR_2006_s_1	0.423	(0,4)	0.067	0.159		1
F_fleet_1_YR_2007_s_1	0.565	(0,4)	0.084	0.148		1
F_fleet_1_YR_2008_s_1	0.684	(0,4)	0.123	0.180		1
F_fleet_1_YR_2009_s_1	0.560	(0,4)	0.082	0.147		1
F_fleet_1_YR_2010_s_1	0.825	(0,4)	0.170	0.206		1
F_fleet_1_YR_2011_s_1	0.920	(0,4)	0.161	0.175		1
F_fleet_1_YR_2012_s_1	0.960	(0,4)	0.174	0.181		1
F_fleet_1_YR_2013_s_1	2.269	(0,4)	0.414	0.183		1
F_fleet_1_YR_2014_s_1	0.497	(0,4)	0.071	0.142		1
F_fleet_1_YR_2015_s_1	0.553	(0,4)	0.094	0.171		1
F_fleet_1_YR_2016_s_1	0.935	(0,4)	0.119	0.128		1
F_fleet_1_YR_2017_s_1	0.960	(0,4)	0.128	0.133		1
F_fleet_1_YR_2018_s_1	0.971	(0,4)	0.181	0.187		1
F_fleet_1_YR_2019_s_1	0.970	(0,4)	0.162	0.167		1
F_fleet_1_YR_2020_s_1	0.963	(0,4)	0.159	0.165		1
F_fleet_1_YR_2021_s_1	0.796	(0,4)	0.145	0.182		1
F_fleet_1_YR_2022_s_1	1.240	(0,4)	0.209	0.168		1
F_fleet_1_YR_2023_s_1	1.229	(0,4)	0.214	0.174		1
F_fleet_1_YR_2024_s_1	1.353	(0,4)	0.325	0.240		1
F_fleet_4_YR_1945_s_1	8.78e-05	(0,4)	2.01e-05	0.229		1
F_fleet_4_YR_1946_s_1	0.005	(0,4)	0.001	0.225		1
F_fleet_4_YR_1947_s_1	0.011	(0,4)	0.002	0.226		1
F_fleet_4_YR_1948_s_1	0.016	(0,4)	0.004	0.226		1
F_fleet_4_YR_1949_s_1	0.021	(0,4)	0.005	0.226		1
F_fleet_4_YR_1950_s_1	0.027	(0,4)	0.006	0.226		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_4_YR_1951_s_1	0.032	(0,4)	0.007	0.226		1
F_fleet_4_YR_1952_s_1	0.037	(0,4)	0.008	0.226		1
F_fleet_4_YR_1953_s_1	0.043	(0,4)	0.010	0.226		1
F_fleet_4_YR_1954_s_1	0.048	(0,4)	0.011	0.225		1
F_fleet_4_YR_1955_s_1	0.053	(0,4)	0.012	0.225		1
F_fleet_4_YR_1956_s_1	0.058	(0,4)	0.013	0.225		1
F_fleet_4_YR_1957_s_1	0.064	(0,4)	0.014	0.225		1
F_fleet_4_YR_1958_s_1	0.069	(0,4)	0.016	0.225		1
F_fleet_4_YR_1959_s_1	0.074	(0,4)	0.017	0.225		1
F_fleet_4_YR_1960_s_1	0.080	(0,4)	0.018	0.224		1
F_fleet_4_YR_1961_s_1	0.057	(0,4)	0.013	0.225		1
F_fleet_4_YR_1962_s_1	0.069	(0,4)	0.016	0.225		1
F_fleet_4_YR_1963_s_1	0.079	(0,4)	0.018	0.224		1
F_fleet_4_YR_1964_s_1	0.085	(0,4)	0.019	0.224		1
F_fleet_4_YR_1965_s_1	0.075	(0,4)	0.017	0.224		1
F_fleet_4_YR_1966_s_1	0.071	(0,4)	0.016	0.224		1
F_fleet_4_YR_1967_s_1	0.083	(0,4)	0.019	0.224		1
F_fleet_4_YR_1968_s_1	0.086	(0,4)	0.019	0.224		1
F_fleet_4_YR_1969_s_1	0.100	(0,4)	0.022	0.223		1
F_fleet_4_YR_1970_s_1	0.084	(0,4)	0.019	0.223		1
F_fleet_4_YR_1971_s_1	0.087	(0,4)	0.019	0.223		1
F_fleet_4_YR_1972_s_1	0.104	(0,4)	0.023	0.222		1
F_fleet_4_YR_1973_s_1	0.096	(0,4)	0.021	0.223		1
F_fleet_4_YR_1974_s_1	0.096	(0,4)	0.021	0.222		1
F_fleet_4_YR_1975_s_1	0.085	(0,4)	0.019	0.223		1
F_fleet_4_YR_1976_s_1	0.102	(0,4)	0.023	0.222		1
F_fleet_4_YR_1977_s_1	0.109	(0,4)	0.024	0.221		1
F_fleet_4_YR_1978_s_1	0.133	(0,4)	0.029	0.220		1
F_fleet_4_YR_1979_s_1	0.139	(0,4)	0.031	0.219		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_4_YR_1980_s_1	0.096	(0,4)	0.021	0.222		1
F_fleet_4_YR_1981_s_1	0.119	(0,4)	0.026	0.222		1
F_fleet_4_YR_1982_s_1	0.117	(0,4)	0.026	0.223		1
F_fleet_4_YR_1983_s_1	0.115	(0,4)	0.026	0.224		1
F_fleet_4_YR_1984_s_1	0.123	(0,4)	0.028	0.225		1
F_fleet_4_YR_1985_s_1	0.128	(0,4)	0.029	0.226		1
F_fleet_4_YR_1986_s_1	0.148	(0,4)	0.033	0.225		1
F_fleet_4_YR_1987_s_1	0.162	(0,4)	0.036	0.224		1
F_fleet_4_YR_1988_s_1	0.137	(0,4)	0.030	0.221		1
F_fleet_4_YR_1989_s_1	0.142	(0,4)	0.031	0.219		1
F_fleet_4_YR_1990_s_1	0.146	(0,4)	0.033	0.223		1
F_fleet_4_YR_1991_s_1	0.143	(0,4)	0.032	0.223		1
F_fleet_4_YR_1992_s_1	0.144	(0,4)	0.032	0.224		1
F_fleet_4_YR_1993_s_1	0.131	(0,4)	0.029	0.223		1
F_fleet_4_YR_1994_s_1	0.103	(0,4)	0.023	0.224		1
F_fleet_4_YR_1995_s_1	0.089	(0,4)	0.020	0.225		1
F_fleet_4_YR_1996_s_1	0.101	(0,4)	0.022	0.223		1
F_fleet_4_YR_1997_s_1	0.115	(0,4)	0.026	0.222		1
F_fleet_4_YR_1998_s_1	0.138	(0,4)	0.031	0.223		1
F_fleet_4_YR_1999_s_1	0.136	(0,4)	0.031	0.224		1
F_fleet_4_YR_2000_s_1	0.122	(0,4)	0.027	0.225		1
F_fleet_4_YR_2001_s_1	0.096	(0,4)	0.022	0.226		1
F_fleet_4_YR_2002_s_1	0.108	(0,4)	0.024	0.226		1
F_fleet_4_YR_2003_s_1	0.086	(0,4)	0.019	0.226		1
F_fleet_4_YR_2004_s_1	0.072	(0,4)	0.016	0.227		1
F_fleet_4_YR_2005_s_1	0.057	(0,4)	0.013	0.228		1
F_fleet_4_YR_2006_s_1	0.053	(0,4)	0.012	0.228		1
F_fleet_4_YR_2007_s_1	0.055	(0,4)	0.012	0.226		1
F_fleet_4_YR_2008_s_1	0.044	(0,4)	0.010	0.225		1

Table A1 Continued. Annual fishing mortality parameters estimated by Stock Synthesis. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard deviations (SD) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and phases.

Label	Value	Range	SD	CV	Prior	Phase
F_fleet_4_YR_2009_s_1	0.055	(0,4)	0.012	0.225		1
F_fleet_4_YR_2010_s_1	0.036	(0,4)	0.008	0.226		1
F_fleet_4_YR_2011_s_1	0.045	(0,4)	0.010	0.226		1
F_fleet_4_YR_2012_s_1	0.045	(0,4)	0.010	0.226		1
F_fleet_4_YR_2013_s_1	0.050	(0,4)	0.011	0.225		1
F_fleet_4_YR_2014_s_1	0.054	(0,4)	0.012	0.224		1
F_fleet_4_YR_2015_s_1	0.054	(0,4)	0.012	0.225		1
F_fleet_4_YR_2016_s_1	0.053	(0,4)	0.012	0.226		1
F_fleet_4_YR_2017_s_1	0.055	(0,4)	0.013	0.227		1
F_fleet_4_YR_2018_s_1	0.051	(0,4)	0.012	0.226		1
F_fleet_4_YR_2019_s_1	0.047	(0,4)	0.011	0.224		1
F_fleet_4_YR_2020_s_1	0.050	(0,4)	0.011	0.224		1
F_fleet_4_YR_2021_s_1	0.049	(0,4)	0.011	0.225		1
F_fleet_4_YR_2022_s_1	0.033	(0,4)	0.007	0.227		1
F_fleet_4_YR_2023_s_1	0.026	(0,4)	0.006	0.227		1
F_fleet_4_YR_2024_s_1	0.025	(0,4)	0.006	0.227		1