SEDAR

Southeast Data, Assessment, and Review

SEDAR 79

Southeastern US Mutton Snapper

SECTION III: Assessment Process Report

August 2024

Revised September 2024

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

CHANGE LOG

August 27, 2024 - Original release

September 3, 2024 – Revision

*Changes are in bold

- Page 20 - Reported discards from any other gear **(including longlines)** were minimal and lacked sufficient data to calculate a discard rate.
- Page 33 – Added '**Uncertainty, however, was not considered so it is unknown if there is a statistically significant difference from a 1:1 sex ratio**.'
- Page 39 - # of dead fish $= \sum_{\boldsymbol{fleets}} \boldsymbol{N_a} \text{selectivity}_{\boldsymbol{fleet,age}} * (\text{retention}_{\boldsymbol{fleet,age}} + (1 - \text{retention}_{\boldsymbol{fleet,age}}) * \text{release mortality rate}_{\boldsymbol{fleet}})$
- Page 41 – changed 'the number of fish independently and randomly sampled' to '**the number independent and random samples'**
- Page 51 – Added Section: **3.4.11 Per-recruit Analysis**
- Page 51 – Changed Section '3.4.11 Stock Status Determination' to '**3.5 Stock Status Determination**'.
- Page 53 – Referred to age 1 recruits instead of age 0 recruits in the projection methods and results. Changed 'with the recent mean recruitment (average of last 5 years of recruitment data, 2018-2022)' to '**with the recent mean age 1 recruitment (geometric mean of the last 5 years of recruitment data; 2019-2023)**'
- Page 53 – Changed Section '3.4.11.1 Projections' to '**3.5.1 Projections**'
- Page 54 – Removed '(or constant catch)', added '**The TORs also state to evaluate the projected spawning stock biomass when catch is held constant at the equilibrium yield at $F_{40\%SPR}$, however, $F_{40\%SPR}$ is nearly equivalent to 75% of $F_{30\%SPR}$**', and changed 'For short-term projections, the recruitment in the first year of the projection (2024) was equal to the recent average (2018-2022)' to '**For short-term projections, age-1 recruitment in all projection years was equal to the recent geometric mean (2019-2023)**'.
- Page 63 – Added '**This may suggest the index demonstrated hyperstability from 1993 to 2000, so that the CPUE remained elevated even though the true abundance was depressed.**'
- Page 75 – Added results of per-recruit analysis to section '**4.7.11 Per-recruit Analysis**'. Added Table 24 and Figure 87.

- Page 75 – Changed Section '4.7.11 Stock Status' to '**4.8 Stock Status**'. Changed numbering of tables and figures from (Table 24; Figures 87-88) to (**Table 25**; **Figures 88-89**)
- Page 76 - Changed section '4.7.11.1 Projections' to '**4.8.1 Projections**'.
- Page 76 – Added '**Several short-term projection scenarios explored the effects of various fishing mortality conditions. The scenarios investigated when fishing mortality rates were either held constant at $F_{30\%SPR}$ (MFMT=0.149), 75% of $F_{30\%SPR}$ (= 0.112), or $F_{current}$ (=0.08). The TORs also state to evaluate the projected spawning stock biomass when catch is held constant at the equilibrium yield at $F_{40\%SPR}$, however, $F_{40\%SPR}$ is nearly equivalent to 75% of $F_{30\%SPR}$'**. Changed 'Short term (i.e., 5 year) projections were produced assuming predicted recruitment was equal to the average of base model estimates from 2018-2022 (3.284 million fish).' to '**Short term (i.e., 10 year) projections were produced assuming predicted age 1 recruitment was equal to the geometric mean of base model estimates from 2019-2023 (3.284 million fish)'.** Changed 'While only the first 5 years of the short-term projection are recommended for use, projections were extended into the future (i.e., until 2123) with recruitment following the stock-recruit relationship' to '**While only the first 5 years of the short-term projection are recommended for use, projections were extended into the future (i.e., until 2033)**'. Removed 'The equilibrium fishing mortality rates that achieve 30%SPR ($F_{MSYproxy}$, $F_{30\%SPR}$) were used to project the Mutton Snapper population into the future with recent average recruitment from 2024 to 2029, followed by recent long-term recruitment from 2030 to 2123'.
- Page 77 – Changed 'Short term projections under $F_{30\%SPR}$ were compared to long term projections that assumed recruitment followed the stock-recruit relationship in *all* projection years (i.e., 2024 – 2123)' to '**Short term projections were compared to long term projections that assumed recruitment followed the stock-recruit relationship in *all* projection years (i.e., 2024 – 2033)**'. Referred to Figures 90 – 92 instead of Figures 89 – 91. Removed 'from 2024 – 2029'. Removed 'As shown, both scenarios converge to the same long-term value (3,352 mt)'. Referred to **Figure 93 and Table 26** instead of Figure 92 and Table 25. Changed 'The retained yield (in pounds) for the short-term scenario was well beyond historical yields, as projected yields ranged from 3.3 million pounds to 3.6 million pounds and historical yields averaged 1.1 million pounds with a maximum of 2.4 million pounds in 2008' to '**From 2024 – 2028, retained yield (in pounds) for the short-term scenario was well beyond historical yields, as projected yields ranged from 3.27 million pounds to 3.38 million pounds and historical yields averaged 1.1 million pounds with a maximum of 2.4 million pounds in 2008'**. Added '**Retained yield (in pounds) for the other short-term projection scenarios associated with 75% of $F_{30\%SPR}$ and $F_{current}$ averaged 2.68 million pounds and 2.05 million pounds, respectively (Figure 94)'**.

Removed 'Additional short-term projection scenarios specified in the TORs (i.e., F= $F_{Current}$, F at 75% of F_{MSY}, $F_{40\%SPR}$), as well as projections requested by the SSCs (e.g., Pstar, alternative recruitment assumptions in the forecast period) will be included in an addendum report'.

- Page 82 – Added reference 'Haddon, M., 2001. Modelling and Quantitative Methods in Fisheries. Chapman and Hall, New York, 450 pp
- Page 85 – Added reference 'Walters, C.J. and Martell, S.J., 2004. Fisheries ecology and management. Princeton University Press.'
- Page 109 – Table 14: changed '2024 to 2029: Average from 2018 – 2022' to '**2024 to 2033: Average from 2019 – 2023'.** Removed '2030 to 2123: Beverton-Holt stock-recruit relationship' and 'Derived from the model estimated Beverton-Holt stock-recruit relationship'.
- Page 117 – Added '**Table 24. The yield-per-recruit (YPR), spawner-per-recruit (SSB/R), static spawning potential ratio (SPR), and total equilibrium yield in metric tons computed over a range of instantaneous fishing mortality rates (F) on age-3 Mutton Snapper**.' Changed Table 24 to **Table 25**.
- Page 118 – Changed 'Table 25. Results of the short- and long-term projections when age-3 fishing mortality rates = F30%SPR (0.149) for Southeastern US Mutton Snapper. assuming predicted recruitment from the spawner-recruit curve. Recruitment (Recruits) is in 1,000s of age-0 fish, F is age-3 instantaneous fishing mortality rate, SSB is in metric tons (female SSB), Retained Yield is in millions of pounds whole weight, and Retained Num is in thousands of fish' to **'Table 26. Results of the short- and long-term projections when age-3 fishing mortality rates = $F_{30\%SPR}$ (0.149) for Southeastern US Mutton Snapper. Long-term projections assume predicted recruitment follows the spawner-recruit curve. Short-term projections assume predicted age 1 recruitment is equal to the geometric mean from 2019 to 2023 (3.284 million). Recruitment (Recruits) is in millions of age-1 fish, F is age-3 instantaneous fishing mortality rate, SSB is in metric tons (female SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.'**
- Page 118 - Added **'Table 27. Results of the short-term projections when age-3 fishing mortality rates equal 75% $F_{30\%SPR}$ (0.112) and $F_{current}$ (0.08) for Southeastern US Mutton Snapper assuming predicted age 1 recruitment is equal to the geometric mean from 2019 to 2023 (3.284 million). Recruitment (Recruits) is in millions of age-1 fish, F is age-3 instantaneous fishing mortality rate, SSB is in metric tons (female SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.'**
- Page 207 – Added '**Figure 87. The a) yield-per-recruit, b) spawner-per-recruit, c) spawning potential ratio, and d) total equilibrium yield computed as a function of the instantaneous**

fishing mortality rate on age-3 Mutton Snapper.' Renumbered Figures 87 – 88 to **Figures 88 – 89**.

- Page 209 – Renumbered Figure 89 to Figure 90 and updated caption to '**Figure 90. Historical and projected age-3 fishing mortality rates for the long- and short-term projections when constant fishing mortality rates equal $F_{30\%SPR}$ for the SEDAR 79 Southeastern US Mutton Snapper Assessment. The green shaded area identifies the first 5 years of the projections (2024-2028).**'
- Page 210 – Renumbered Figure 90 to Figure 91 and updated caption to '**Figure 91. Historical and projected age 1 recruitment for the long- and short-term projections when constant fishing mortality rates equal $F_{30\%SPR}$ for the SEDAR 79 Southeastern US Mutton Snapper Assessment. The green shaded area identifies the first 5 years of the projections (2024-2028).**'
- Page 211 - Renumbered Figure 91 to Figure 92 and updated caption to '**Figure 92. Historical and projected spawning stock biomass for the long- and short-term projections when constant fishing mortality rates equal $F_{30\%SPR}$ for the SEDAR 79 Southeastern US Mutton Snapper Assessment. The green shaded area identifies the first 5 years of the projections (2024-2028).'**
- Page 213 - Renumbered Figure 92 to Figure 93 and updated caption to '**Figure 93. Historical and projected retained yield in millions of pounds (a) and 1000s (b) for the long- and short-term projections when constant fishing mortality rates equal $F_{30\%SPR}$ for the SEDAR 79 Southeastern US Mutton Snapper Assessment. The green shaded area identifies the first 5 years of the projections (2024-2028).'**
- Page 213 – Added **Figure 94.**

Table of Contents

1. INTRODUCTION

1.1 Workshop Time and Place

The SEDAR 79 Southeastern U.S. Mutton Snapper assessment workshop process was conducted through a series of four webinars between November 2023 to July 2024.

1.2 Terms of Reference

<u>Assessment Workshop Terms of Reference</u>

1. Review any changes in data and data sources following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.
2. Develop population assessment models that are compatible with available data and document input data, model assumptions and configuration, and equations for each model considered.
    - Fully document and describe the impacts (on population parameters and management benchmarks) of any changes to the model structure, methods, application or fitting procedures made between this assessment and the prior update assessment (SEDAR 15AU).
    - Provide a continuity model consistent with the prior assessment configuration, if one exists, updated to include the most recent observations. Alternative approaches to a strict continuity run that distinguish between model, population, and input data influences on findings, may be considered. Another continuity model will include the prior assessment configuration and terminal year with MRIP-FES landings and discards.
3. Provide estimates of stock population parameters, if feasible:
    - Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship (if applicable), and other parameters as necessary to describe the population.
    - Include appropriate and representative measures of precision for parameter estimates.
    - Compare and contrast population parameters and time series estimated in this assessment with values from the previous (SEDAR 15AU) update assessment, and comment on the impacts of changes in data, assumptions or assessment methods on estimated population conditions.
4. Characterize uncertainty in the assessment and estimated values.
    - Consider uncertainty in input data, modeling approach, and model configuration.
    - Consider and include other sources as appropriate for this assessment.
    - Provide appropriate measures of model performance, reliability, and ‘goodness of fit.’

- Provide measures of uncertainty for estimated parameters

5. Provide estimates of yield and productivity.
    - Include yield-per-recruit, spawner-per-recruit, and stock-recruitment models
6. Provide estimates of population benchmarks or management criteria consistent with available data, applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards. Include values for fishing mortality (including assumed discard mortality if appropriate), spawning stock biomass, fishery yield, SPR and recruitment for potential population benchmarks.
    - Evaluate existing or proposed management criteria as specified in the management summary.
    - Recommend proxy values (e.g. MSY) when necessary and provide appropriate justification.
    - Compare and contrast reference values (e.g. equilibrium yield at $F_{MSYProxy}$) estimated in this assessment with values from the previous (SEDAR 15AU) update assessment, and comment on the impacts of changes in data, assumptions or assessment methods on reference point differences.
    - Define recent fishing mortality rates ($F_{Current}$) and recent spawning stock biomass ($SSB_{Current}$) that will be compared to management benchmarks as the geometric mean of the most recent three years and the terminal data year, respectively.
7. Incorporate known applicable environmental covariates into the selected model and provide justification for why any of those covariates cannot be included at the time of the assessment.
8. Provide declarations of stock status relative to management benchmarks or alternative data poor approaches if necessary.
9. Provide uncertainty distributions of proposed reference points, stock status, and yield.
    - Provide the probability of overfishing at various harvest or exploitation levels.
    - Provide a probability density function for biological reference point estimates.
    - If the stock is overfished, provide the probability of rebuilding within mandated time periods as described in the management summary or applicable federal regulations.
    - Characterize the differences in fishing mortality, virgin biomass, terminal total biomass, terminal spawning stock biomass, and equilibrium yield at $F_{MSYProxy}$ as a result of updating recreational catch and effort data from MRIP-CHTS to MRIP-FES by comparing SEDAR 15AU to a continuity model with MRIP-FES landings and discards and SEDAR 15AU configuration and terminal year.
10. Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time.
    - Request estimates of retained landings in numbers and biomass from data providers for interim years between the terminal year and first year of the projections, if available, to be used to project future stock conditions. If estimates of retained landings are unavailable, use the average of the previous three years.

- Recommend levels of recruitment to be used in the projections.
- Stock projections (including yields) shall be developed in accordance with the following ($F_{Current}$ is the geometric mean of the most recent three years of data):
    - A) If stock is overfished:

      F=0, $F_{Current}$, F= F_{MSY}, F at 75% of F_{MSY}, $F_{40\%SPR}$ (current definition of F_{OY})

      F=$F_{Rebuild}$ (max exploitation that rebuild in greatest allowed time)
    - B) If overfishing is occurring:

      F= $F_{Current}$, F= F_{MSY}, F at 75% of F_{MSY}, $F_{40\%SPR}$
    - C) If stock is neither overfished nor undergoing overfishing:

      F= $F_{Current}$, F= F_{MSY}, F at 75% of F_{MSY}, $F_{40\%SPR}$
    - D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternative models to provide management advice.

11. Provide recommendations for future research and data collection.
    - Be as specific as practicable in describing sampling design and sampling intensity.
    - Emphasize items that will improve future assessment capabilities and reliability.
    - Consider data, monitoring, and assessment needs.
12. Review, evaluate, and report on the status and progress of all research recommendations listed in the last assessment, peer review reports, and SSC report concerning this stock.
13. Complete the Assessment Workshop Report in accordance with project schedule deadlines (Section III of the SEDAR Stock Assessment Report).

1.3 List of Participants

Assessment Process Participants

Shanae Allen (Lead Analyst)	FWC/FWRI
Halie O’Farrell	FWC/FWRI
Dustin Addis	FWC/FWRI
Jie Cao	SAFMC SSC
Dave Chagaris	GMFMC SSC
Robert Muller	FWC/FWRI
Joe O’Hop	FWC/FWRI
Steven Saul	GMFMC SSC
Fred Serchuk	SAFMC SSC
Chris Swanson	FWC/FWRI
Steve Turner	SAFMC SSC

Council Representation

Jessica McCawley	SAFMC
CJ Sweetman	GMFMC

Staff

Julie Neer	SEDAR
Judd Curtis	SAFMC Staff
Ryan Rindone	GMFMC Staff
Mike Schmidtke	SAFMC Staff

Data Process Webinar Observers

Kelly Adler	NMFS/SEFSC
Chris Bradshaw	FWC/FWRI
Matthew Bunting	FWC
Heather Christiansen	FWC/FWRI
Manuel Coffill-Rivera	
Michael Drexler	Ocean Conservancy
Kristin Foss	FWC/DMFM
Janette Huber	FWC
Brian Klimek	FWC/FWRI
Maria McGirl	FWC
Max Lee	Mote Marine Lab
Rich Malinowski	NMFS
Genine McClair	FWC
Ariel Poholek	NMFS/SEFSC
Chloe Ramsey	FWC
Marcel Reichert	SAFMC SSC
Eric Schmidt	GMFMC Industry Rep
Rebecca Scott	FWC
Jim Tolan	Texas

1.4 List of Assessment Workshop Working Papers and Reference Documents

<table>
<tr><th>Document #</th><th>Title</th><th>Authors</th><th>Date Submitted</th></tr>
<tr><td colspan="4">Documents Prepared for the Assessment Process</td></tr>
<tr><td>SEDAR79-AP-01</td><td>Weighted Length Compositions for U.S. Mutton Snapper (<i>Lutjanus analis</i>)</td><td>Shanae D. Allen</td><td>18 June 2024</td></tr>
<tr><td>SEDAR79-AP-02</td><td>A ratio-based method for calibrating MRIP-SRFS recreational fisheries estimates for southeastern US Mutton Snapper (<i>Lutjanus analis</i>)</td><td>Chloe Ramsay, Tiffanie A. Cross, Colin P. Shea, and Beverly Sauls</td><td>22 July 2024</td></tr>
<tr><td colspan="4">Reference Documents</td></tr>
<tr><td>SEDAR79-RD09</td><td>Certification Review of Florida’s Proposed MRIP-SRFS Calibration Methodology for Mutton and Yellowtail Snapper</td><td colspan="2">NOAA Fisheries Office of Science and Technology and the Southeast Fishery Science Center</td></tr>
<tr><td>SEDAR79-RD10</td><td>Transition Plan for Gulf State Recreational Fishing Surveys</td><td colspan="2">Gulf of Mexico Subgroup of the MRIP Transition Team</td></tr>
<tr><td>SEDAR79-RD11</td><td>SSC Catch Level Projections Workgroup Final Report</td><td colspan="2">SAFMC SSC Catch Level Projections Workgroup</td></tr>
</table>

2. DATA REVIEW AND UPDATE

A detailed review of the data sources used in the SEDAR 79 Benchmark Assessment is presented in the Data Workshop report; however, there were a few new or revised data sets:

1) For the development of conditional-age-at-length data, additional otoliths were matched with lengths adding 318 age-length pairs, 56 ages were corrected, and 382 age-length pairs were removed.
2) Commercial landings estimates
   a) Removed several duplicate records from the NMFS Accumulative Landings System (ALS) prior to 1988.
   b) Added Florida Fish and Wildlife Conservation Commission trip ticket (TTK) landings estimates for 2023. Landings estimates outside of Florida from ALS and the Atlantic Coastal Cooperative Statistics Program (ACCSP) were unavailable for 2023.
3) Recreational landings and releases estimates
   a) Florida Fish and Wildlife Conservation Commission State Reef Fish Survey (SRFS) landings and releases estimates for the recreational private mode in Florida waters from 2021 – 2023 replaced estimates from National Marine Fisheries Service’s (NMFS) Marine Recreational Information Program Fishing Effort Survey (MRIP-FES).
   b) MRIP (FCAL) landings and releases estimates for the recreational private mode in Florida waters from 1981- 2020 were updated by calibrating these estimates to Florida Fish and Wildlife Conservation Commission State Reef Fish Survey (SRFS) currency.
   c) Estimates of landings and releases for headboats were updated using the Southeast Region Headboat Survey through 2023.
   d) Landings and releases for charterboats, shore and non-Florida private recreational modes through 2023 were updated using MRIP (FCAL) estimates.
4) Fleet-specific length compositions were weighted by landings or releases according to SEDAR79-AP01.
5) Commercial longline index
   a) The commercial longline index from 1993 – 2010 presented in Table 5.8.1 was mistakenly copied from a previous data submission, however the correct index was presented and discussed at the Data Workshop.

6) Combined Gulf video survey index
   a) The Data and Assessment panels recommended the removal of years 2010-2015 from the FWRI survey and years 1993-1995, 2013, and 2015 from the SRFV survey, as well as the addition of 2022 data. The removal of these years was recommended because the core Mutton Snapper habitat (i.e., the Dry Tortugas) was not sampled.

The following list summarizes the main data inputs used in the SEDAR 79 assessment model:

- Stock structure and management unit
- Life history
    - Age and growth
    - Natural mortality
    - Maturity
    - Fecundity
    - Sex ratio
- Landings
    - Commercial Longline (metric tons): 1981 – 2023
    - Commercial Other (metric tons): 1981 – 2023
    - Recreational East (thousands of fish): 1981 – 2023
    - Recreational West (thousands of fish): 1981 – 2023
- Releases (thousands of fish)
    - Release mortality
    - Commercial Other: 1993 – 2023
    - Recreational East: 1981 – 2023
    - Recreational West: 1981 – 2023
- Length composition of landings (8:96 cm Maximum Total Length [Max TL], 4 cm Max TL bins)
    - Commercial Longline: 1991 – 2022
    - Commercial Other: 1989 – 2022
    - Recreational East: 1981 – 2022
    - Recreational West: 1981 – 2022
- Conditional age-at-length (1-year age bins starting at age 1, plus group for ages 40 and older)
    - Commercial Longline landings: 2001 – 2022
    - Commercial Other landings: 1992 – 2022
    - Recreational East: 1981 – 2022
    - Recreational West: 1981 – 2022
    - Fishery-independent sources: 1998-2002, 2021-2022
- Length composition of releases (8:96 cm Maximum Total Length [Max TL], 4 cm Max TL bins)
    - Commercial Other: 2013-2017
    - Recreational East: 2005 – 2023
    - Recreational West: 2005 – 2023
- Abundance indices
    - Fishery-independent

        - RVC Dry Tortugas: 1999-2000, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2021, 2023
        - RVC FL Keys: 1997, 2000 – 2012, 2014, 2016, 2018, 2022
        - RVC SE FL: 2013 – 2016, 2018, 2021-2022
        - FIM YOY: 1999 – 2022
        - Combined Gulf Video: 1996-1997, 2002, 2004-2012, 2014, 2016-2022
        - SERFS Video: 2011-2019, 2021-2022
    - Fishery-dependent
        - Commercial longline: 1993 – 2010
- Length composition from abundance indices (8:96 cm Maximum Total Length [Max TL], 4 cm Max TL bins)
    - Fishery-independent
        - GOM Combined Video: 2004-2021
- Length composition from abundance indices (10:95 cm Maximum Total Length [Max TL], 5 cm Max TL bins)
    - Fishery-independent
        - RVC Dry Tortugas: 1999-2000, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2021, 2023
        - RVC FL Keys: 1997, 2000 – 2012, 2014, 2016, 2018, 2022
        - RVC SE FL: 2013 – 2016, 2018, 2021-2022

The data sources and their corresponding temporal scale are presented in **Figure 1.**

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.

Data Component	**Data Type**	**Contributing Organizations**	**Data Providers**	**Contact Information**
Landings & Releases	Headboat Landings & Releases	SEFSC	Rob Cheshire	rob.cheshire@noaa.gov
	General Recreational (MRIP, TPWD, LACreel) Landings & MRIP Releases	SEFSC	Matt Nuttall	matthew.nuttall@noaa.gov
	FL FWC State Reef Fish Survey Private Landings & Releases	FWRI	Chloe Ramsay	chloe.ramsay@myfwc.com
	Commercial Landings – ALS	SEFSC	Alan Lowther Michael Judge	alan.lowther@noaa.gov michael.judge@noaa.gov

	Commercial Landings – Logbook	SEFSC	Sydney Alhale	sydney.alhale@noaa.gov
	Commercial Landings - Florida	FWRI ACCSP	Chris Bradshaw Mike Rinaldi	chris.bradshaw@myfwc.com mike.rinaldi@accsp.org
	Commercial Discards	SEFSC	Sarina Atkinson	sarina.atkinson@noaa.gov
Indices	Commercial Longline (pre-IFQ) Logbook Index	SEFSC	Micki Pawluk Kevin Thompson	michaela.pawluk@noaa.gov kevin.thompson@noaa.gov
	Combined Gulf Video Index	FWRI	Heather Christiansen	heather.christiansen@myfwc.com
	RVC Indices	FWRI	Robert Muller	robert.muller@myfwc.com
	Southeast Reef Fish Survey	SEFSC	Nathan Bacheler	nate.bacheler@noaa.gov
	FWRI FIM Inshore Seine Survey	FWRI	Brian Klimek	brian.klimek@myfwc.com
Length Comps	Commercial length raw data	SEFSC FWRI	Larry Beerkircher Chris Bradshaw	lawrence.beerkircher@noaa.gov chris.bradshaw@myfwc.com
	MRIP length raw data	SEFSC	Matt Nuttall	matthew.nuttall@noaa.gov
	Headboat length raw data	SEFSC	Rob Cheshire	rob.cheshire@noaa.gov
	Combined Video length comps	FWRI	Heather Christiansen	heather.christiansen@myfwc.com
	RVC length comps	FWRI	Robert Muller	robert.muller@myfwc.com
	Commercial discard length comps from reef fish observer data	SEFSC	Sarina Atkinson Gary Decossas	sarina.atkinson@noaa.gov gary.decossas@noaa.gov
	Recreational discard length comps	FWRI	Ellie Corbett	ellie.corbett@myfwc.com
	Recreational length comp development	FWRI	Shanae Allen	shanae.allen@myfwc.com
	Commercial length comp	FWRI	Shanae Allen	shanae.allen@myfwc.com

	development			
Conditional Age-at-length	Raw age data	FWRI	Jessica Carroll	jessica.carroll@myfwc.com
			Jesse Secord	jesse.secord@myfwc.com
			Bridget Cermak	bridget.cermak@myfwc.com
			Erick Ault	Erick.Ault@MyFWC.com
		SEFSC	Jennifer Potts	jennifer.potts@noaa.gov
		NC DENR	McLean Seward	mclean.seward@ncdenr.gov
		SC DNR	Michelle Willis	willisc@dnr.sc.gov
	Conditional age-at-length development	FWRI	Shanae Allen	shanae.allen@myfwc.com
Life History	Reproduction	FWRI	Susan Lowerre-Barbieri	susan.lowerre-barbieri@myfwc.com
	At-sea Tagging and Immediate Release Mortality Data	FWRI	Maria McGirl	maria.mcgirl@myfwc.com
	External Growth and Natural Mortality	FWRI	Chris Swanson	chris.swanson@myfwc.com
	Morphometrics	FWRI	Shanae Allen	shanae.allen@myfwc.com

2.1 Stock Structure and Management Unit

The Mutton Snapper fishery is managed in the U.S. by the South Atlantic Fishery Management Council (SAFMC) and the Gulf of Mexico Fishery Management Council (GMFMC) as separate stock units with the boundary being U.S. Highway 1 in the Florida Keys west to the Dry Tortugas (**Figure 2.14.2** in the Data Workshop Report). The State of Florida also participates in the management of this species in state waters, while other states in the SAFMC and GMFMC jurisdictions defer to the federal management regulations for this species. The stock is predominantly concentrated in south Florida but extends west to Texas in the Gulf of Mexico and north to North Carolina on the Atlantic coast; yet, Mutton Snapper have been detected as far north as Maryland in the recreational landings. Based on the recommendations of the LHW, SEDAR 79 assumes a single closed population in the SAFMC and GMFMC jurisdictions for the purpose of stock assessment and management. This assumption is consistent with previous assessments (SEDAR 15A 2008, SEDAR 15AU 2015).

2.2 Life History Parameters

For the development of conditional-age-at-length data, additional otoliths were matched with lengths which added 318 age-length pairs, 56 ages were corrected, and 382 age-length pairs were removed due to missing auxiliary information. **Table 1** displays the updated number of age-length pairs of Mutton Snapper (n = 25,522) by year, fishery, and region. Ages sampled from tournaments or recreational longline were not included.

Beyond the addition, removal, or correction of some age-length pairs, there were no further modifications to life history parameters. These include length-length, weight-weight, and length-weight relationships, as well as average natural mortality (ages 3-42), release mortality, logistic parameters for maturity-at-age, and sex ratios. A detailed review of life history data used in the SEDAR 79 Benchmark Assessment are presented in the Data Workshop Report, and additional details on life history inputs and configurations as specified in the stock assessment model are presented in Section 3.1.3.

2.3 Fishery-Dependent Data

2.3.1 Commercial Landings

The recommendation from the Commercial Workgroup (CWG) was to combine commercial landings data of Southeastern U.S. Mutton Snapper from NMFS Accumulated Landings System (ALS) for all states (1981-1986), Florida trip ticket (TTK; 1986-2022), NMFS ALS for states west of Florida (1981-2022), and Atlantic Coastal Cooperative Statistics Program (ACCSP) for states north of Florida (1981-2022) to establish final commercial landings by region fished and gear.

Following the Data Workshop, several erroneous NMFS ALS records prior to 1988 were found and removed. Additionally, FL TTK landings estimates were compiled for 2023. Landings estimates outside of Florida from NMFS ALS and ACCSP were unavailable for 2023, however in past years these have contributed at most 11.87% of the landings with an average contribution of 2.33%.

The CWG recommended five gear groupings to characterize the Mutton Snapper fishery: hook and line, longline, trap, diving, and other. However, commercial landings were predominantly from longline and hook and line gear types (~90%, Section 3.3.1 in the Data Workshop Report). Also, further examination of lengths sampled from these gear types revealed similarities between hook and line, trap, diving, and other, although there was a paucity of lengths from trap, diving, and other gears (SEDAR 79-AP-01). Thus, commercial landings were categorized into two gear groups: longline and other. While landings in pounds (lb) were presented in the Data Workshop Report Section 3, they were converted here to metric tons (mt) for use as model inputs (**Table 2** and **Figure 2**).

The CWG estimated uncertainty in commercial fishery landings by using a similar methodology and modifying the uncertainty estimates used in SEDAR 64 (Yellowtail Snapper) and SEDAR 82 (South Atlantic Gray Triggerfish). These estimates of uncertainty are not coefficients of variation but are estimates of possible reporting error such that they represent the range in actual commercial landings relative to the reported landings. Uncertainty estimates are provided by state and time block in Table 3.10.3 in the Data Workshop Report.

Since standard errors (in log space) of landings are a necessary model input, CVs were first approximated by using the "variance sum law" to combine estimates of uncertainty across states (described in SEDAR 68-DW-31). CVs were then transformed to standard errors in log space using the approximation: $log_e(SE) = \sqrt{log_e(1 + CV^2)}$ provided in Methot et al. (2023).

While the treatment of these uncertainty estimates is slightly inconsistent, the standard errors of commercial landings are effectively ignored because the model is configured to fit the commercial landings exactly (additional details are presented in Section 3.2.3). Final commercial landings in metric tons by gear group and year, along with associated standard errors, are presented in **Table 2**.

2.3.2 Recreational Landings

Sources of recreational landings data reviewed during the Data Workshop included the Southeast Region Headboat Survey (SRHS), Marine Recreational Information Program (MRIP), Texas Parks and Wildlife Department (TPWD), and Louisiana Creel survey program (LA Creel). Landings of Mutton Snapper were compiled from 1981 through 2022 for the U.S. Atlantic and

Gulf of Mexico for four recreational fishing modes: headboats, charterboats, private and rental boats, and fishing from shore.

According to these data, the recreational landings outside of Florida comprise less than 0.2% of the total recreational landings. Recreational landings are primarily from private and shore modes, however the MRIP CV values are relatively high when split by mode, particularly for the shore mode. Length distributions appear to differ starkly by region with eastern areas catching smaller fish than western Florida (SEDAR 79-AP-01). Within regions all modes have similar length compositions, indicating that all modes catch similarly sized fish (Figures 4.11.1 and 4.11.2 in the Data Workshop Report and SEDAR 79-AP-01). Size compositions of landed fish in the Florida Keys were determined to be more similar to western Florida than the Atlantic coast. Considering this, the recommendation from the Recreational Workgroup (RWG) was to combine all fishing modes into a single “recreational” fleet, but with separate regions defined for the East (Southeast Florida, Northeast Florida, and North of Florida) and West (Florida Keys, Southwest Florida, Northwest Florida, and West of Florida).

After the Data Workshop, Mutton Snapper landings and releases by the recreational private mode in Florida waters became available from 1981 through 2023 as estimated by the Florida FWC State Reef Fish Survey (SRFS). The SRFS data for Mutton Snapper passed external peer review and was approved for use by the SEDAR 79 Assessment Panel.

This required replacing MRIP (FCAL) estimates of the landings, releases, and CVs for the recreational private mode in Florida waters (FL PR mode) from 2021 – 2023 with those from SRFS. Then, MRIP estimates from 1981 – 2020 were calibrated to SRFS currency for the FL PR mode. The SRFS survey design and calibration methods are fully documented in SEDAR 79-RD-09 (2024). Estimates of landings and releases for headboats were updated using the SRHS through 2023, whereas landings and releases for charterboats, shore, and non-Florida private (non-FL PR) recreational modes through 2023 were updated using MRIP (FCAL) estimates.

2.3.2.1 Headboat Landings

Estimates of headboat landings (in thousands of fish) of Mutton Snapper from 1981 – 2023 from the U.S. South Atlantic and the Gulf of Mexico were obtained from the SRHS (**Table 3, Figures**

3 and **5**). Data through 2022 were reviewed at the Data Workshop and documented in a working paper (SEDAR 79-DW-06).

Uncertainty estimates were also updated through 2023 using the same methodology approved by the RWG (**Table 4**). The SRHS design prevents direct estimates of variance, however a proxy CV method refined for the SEDAR 82 Gray Triggerfish research track assessment was used to spatially weight the compliance rates by the associated landings.

Relative to MRIP landings, headboat landings for Mutton Snapper comprise a small portion (between 1% and 16%) of the total recreational landings, but biological samples from dockside intercepts of headboats account for the majority of the length and age information for the recreational sector.

2.3.2.2 MRIP Landings

Marine Recreational Information Program (MRIP) estimates of recreational landings (in thousands of fish) of Mutton Snapper from 1981 – 2023 from the U.S. Atlantic and Gulf of Mexico by mode (FL PR, Non-FL PR, Shore, Charter) and region (East and West) are presented in **Table 3** and **Figure 3**. Estimates through 2023 differed very little, if at all, from what was reviewed at the Data Workshop (**Figure 4**).

Estimates of uncertainty (CVs) around landings (in numbers) by mode and region are shown in **Table 4**. Since estimates of uncertainty were not provided by mode and state and the Non-FL Private mode landings are minimal, the CVs for the private mode were attributed to the FL Private mode and uncertainty was ignored for the Non-FL Private mode.

The RWG investigated the time series to identify relatively high/low estimates of recreational landings as compared to adjacent time periods. The group investigated the high landings estimate for the East region in 2008, the majority of which comes from a single stratum: ~64% of the annual landings estimate is from the eastern Florida shore mode in wave 4 (July-August) and ocean <= 3 miles (SEDAR 79-DW-02). The estimate for this stratum was informed by intercepts from 36 angler trips, and not the result of one or two intercepts reporting relatively high landings. The group further found that this estimate coincides with strong tropical storm activity (Fay) and a strong recruitment class in 2007 (as supported by the Indian River YOY Index and age comps from the commercial and recreational sectors). Anglers report more encounters of Mutton Snapper closer to shore immediately following tropical storm activity. The group also investigated the relatively low landings in 2010-2011, which coincided with the 2010 Deepwater Horizon Oil Spill (which resulted in reduced effort and potential biological effects) and unseasonably cold temperatures experienced throughout the state of Florida in January 2010 that resulted in widespread fish kills.

Catch estimates from the early years of the MRIP survey (e.g., 1981-1985) are highly variable and tend to result in higher CVs than those estimated in subsequent years. Coupled with the relatively large landings estimates for Eastern Florida Mutton Snapper caught by the shore mode, the RWG discussed a potential recommendation to start the assessment model in 1986, as has been done in other SEDAR stock assessments. The group had no particular concerns with retaining and using the recreational data in these early years as inputs into the assessment model but recognizes that the above reasons could be used for justification of removal.

2.3.2.3 SRFS and SRFS-Calibrated Landings

Florida FWC State Reef Fish Survey (SRFS) landings were estimated for 2021-2023, while 1981 through 2020 MRIP estimates for the FL PR mode were calibrated to SRFS currency. SRFS and SRFS-calibrated landings of Mutton Snapper from 1981 – 2023 from the U.S. Atlantic and Gulf of Mexico for the FL private mode by region are shown in **Table 5** and **Figure 5**.

Landings were combined across modes and data sources by summing over headboat landings from SRHS, charter landings from MRIP (FHS), shore mode landings from MRIP (FES), non-FL private mode landings from MRIP (FES), and FL private mode landings from either SRFS (2021-2023) or SRFS calibrated to MRIP-FES (1981-2020). Estimates of uncertainty were combined in a similar manner by using the variance sum law. CVs were then transformed to standard errors (in log space) using the formula in Section 2.3.1. Landings by mode and region are shown in **Figure 5**. Landings (in 1000s of fish) and standard errors (in log space) after combining all recreational modes by region were used as model inputs and are presented in **Table 8**.

2.3.3 Commercial Releases

Mutton Snapper commercial releases were calculated using self-reported discard logbook data from the SEFSC coastal fisheries logbook program (CFLP). Discards from the vertical line (handline and electric/hydraulic "bandit" gear) fishery were calculated for fish reported as discarded alive or discarded dead. Reported discards from any other gear (including longlines) were minimal and lacked sufficient data to calculate a discard rate.

Due to limited available discard data, the methods of SEDAR32 were followed with discard rates calculated as the mean nominal discard rate among all trips that reported to the discard logbook program over the period 2002-2022 by minimum size limit. Minimum size limits changed over time with slight differences between the Gulf of Mexico and South Atlantic regions. Discard logbook data were available for only the 16" and 18" total length size limit. Those discard rates were then multiplied by the yearly fishing effort (total hook-hours fished) reported to the coastal logbook program by region (Gulf of Mexico FL Keys, Southwest FL, South Atlantic FL Keys, Southeast FL, and Northeast FL). Effort data were available for the period 1993-2022. Therefore, discards could not be estimated from 1990 to 1992. When a 12" total length size limit was in effect (South Atlantic: 1/1992 – 1/1995, Gulf: 2/1990 – 11/1999), the discard rate for the 16" size limit was used indicating a possible overestimation of discards for this management regime.

Calculated discards (in numbers) of Mutton Snapper from the commercial vertical line fishery from 1993-2022 and related standard errors are presented by subregion in Table 7 in SEDAR-79-07. Commercial discard estimates were not able to be updated through 2023 after the Data Workshop. Since landings and discard information are necessary model inputs, the commercial discard estimate for 2023 was extrapolated as the average from 2020-2022.

For the assessment model, these estimated discards and standard errors are aggregated over subregions and applied to the commercial 'Other' (i.e., non-longline) fleet. Total commercial discards (in thousands of fish) and standard errors (SEs) from 1993 – 2023 are presented in **Table 2**.

After the Data Workshop, the discard logbook for use in commercial discard estimates in the South Atlantic were deemed unreliable (Alhale et al. 2024). In lieu of alternative estimates of discards, the base model was configured to essentially ignore the fit to the commercial discards (see Section 3.2).

2.3.4 Recreational Releases

The RWG reviewed recreational releases of Mutton Snapper that were compiled from 1981 through 2022 for four recreational fishing modes: headboats, charterboats, private and rental boats, and fishing from shore in the U.S. Atlantic and Gulf of Mexico. Sources for discards include the Southeast Region Headboat Survey (SRHS) and Marine Recreational Information Program (MRIP). Discard data from Texas Parks and Wildlife Department (TPWD) and Louisiana Creel survey program (LA Creel) are not available and are assumed to be negligible.

As previously stated, Mutton Snapper landings and releases by the recreational private mode in Florida waters from 1981 through 2023 from SRFS became available after the Data Workshop. The SRFS data for Mutton Snapper passed external peer review and was approved for use by the SEDAR 79 Assessment Panel.

This required replacing MRIP (FCAL) estimates of the landings, releases, and CVs for the recreational private mode in Florida waters (FL PR mode) from 2021 – 2023 with those from SRFS. Then, MRIP estimates from 1981 – 2020 were calibrated to SRFS currency, again only for the FL PR mode. The SRFS survey design and calibration methods are fully documented in SEDAR 79-RD09 (2024). Estimates of landings and releases for headboats were updated using the SRHS through 2023; whereas landings and releases for charterboats, shore, and non-Florida private (non-FL PR) recreational modes through 2023 were updated using MRIP (FCAL) estimates.

2.3.4.1 Headboat Releases

Headboat releases (SRHS) from 2008 – 2023 were estimated according to methods in the Discards section from the working paper (SEDAR 79-DW-06), while releases from 1992-2007 were estimated as described in Appendix 1. Prior to the 1992 size limit increase, there were few or no MRIP Charter discards (SEDAR 79-DW-02, Table 2). The Results and Appendix sections present annual discards-in-numbers from 1992 – 2022 by region in Tables A1 and Figure A3. Variance estimates for headboat releases are unavailable, however the magnitude of releases is very low relative to the releases of other modes. Uncertainty estimates of headboat releases were therefore ignored. Headboat releases (in 1000s of fish) by region from 1992 – 2023 are presented in **Table 6** and **Figures 6-7**.

2.3.4.2 MRIP Releases

Released alive fish, compiled from MRIP for years 1981 – 2022, were reviewed and accepted by the Data Workshop. Mode-specific discard rates are based on dockside interviews (intercepts) of anglers and represent the self-reported number of fish discarded alive. The summary figures in the MRIP and headboat working papers (SEDAR 79-DW-02 and SEDAR 79-DW-06, respectively) show that the vast majority of releases originate from the private and shore modes operating in Florida.

Total discards (in thousands of fish) for shore, private, and charter modes from 1981 – 2023 are presented by region in **Table 6** and **Figure 6**, while associated measures of uncertainty (CVs) are tabulated in **Table 7**.

2.3.4.3 SRFS and SRFS-Calibrated Releases

Florida FWC State Reef Fish Survey (SRFS) releases were estimated for 2021-2023, while from 1981 through 2020 MRIP estimates for the FL PR mode were calibrated to SRFS currency. SRFS and SRFS-calibrated releases of Mutton Snapper from 1981 – 2023 from the U.S. Atlantic and Gulf of Mexico for the FL private mode by region are shown in **Table 5** and **Figure 7**.

Releases were combined across modes and data sources by summing over headboat releases from SRHS, charter releases from MRIP (FHS), shore mode releases from MRIP (FES), non-FL private mode releases from MRIP (FES), and FL private mode releases from either SRFS (2021-2023) or SRFS calibrated to MRIP-FES (1981-2020). Estimates of uncertainty were combined in a similar manner by using the variance sum law. Then CVs were transformed to standard errors (in log space) using the formula in Section 2.3.1. Releases by mode and region are shown in **Figure 7.** Releases (in 1000s of fish) and standard errors (in log space) after combining all recreational modes by region were used as model inputs and are presented in **Table 8**.

2.3.5 Fishery-Dependent Length Compositions

Weighted length compositions for SEDAR 79 were compiled for catch (landings and releases) of Mutton Snapper in the South Atlantic and Gulf of Mexico by fishery and primary gear type. Raw length composition data from fishery dependent sources may be a biased reflection of the length composition of the catch due to uneven sampling in space and time. Therefore, when calculating landings- and releases-at-length (fish landed or released per length bin in numbers), it is recommended to weight the sampled lengths of landed or released fish at the finest possible scale by the inverse of sampling proportion (SEDAR 2016; Maunder et al. 2020).

Weighted length compositions of the landings and releases are described in detail in SEDAR 79-AP-01. In brief, length compositions of landings and releases were catch-weighted according to scales that generally satisfied a minimum level of sampling and captured key differences in sampled lengths. Input sample sizes for length were initially equal to the number of trips with at least one measured Mutton Snapper. They were then down weighted using the Francis (2011) iterative procedure to estimate effective sample sizes (for additional details refer to Section 3.2).

Length compositions of landed and released alive Mutton Snapper used in the assessment model are summarized by fleet in **Figure 8**. Length samples were assigned to have occurred mid-year (July) and were not separated by sex (see Section 3.1.3). Due to time constraints, weighted length compositions were unavailable for 2023.

2.3.6 Fishery-Dependent Conditional Age-at-Length

Conditional age-at-length inputs by fleet are presented in **Figures 9-12**. This input allows the integrated models to use the information from sparse age-length data without assuming that the data was representative of ages across the full range of sizes. Effective sample sizes for the number of ages sampled in a given length bin by year were initially equal to the number of aged fish but were later down-weighted according to Francis (2011). Age samples were assigned to have occurred mid-year (July) and were not separated by sex. Age samples were unavailable for 2023.

2.3.7 Catch Per Unit of Effort Index

The Index Workgroup (IWG) recommended a single fishery-dependent biomass index of catch per unit effort from the commercial longline fishery for use in the assessment model. This index is briefly summarized below but is explained in greater detail in the Data Workshop Report Section 5 and SEDAR 79-DW-08. No changes to this index were made after the Data Workshop.

2.3.7.1 Coastal Fisheries Logbook Program Commercial Longline Index

Coastal Fisheries Logbook Program (CFLP) data were used to construct a standardized index of biomass for Mutton Snapper (see Data Workshop Report Section 5.5.3). The index was constructed using data from commercial longline trips between 1993 – 2022. Because the longline fishery operates almost exclusively in the Gulf of Mexico, only those trips occurring in the Gulf of Mexico were included. Data from all months were used to construct the index and the timing of the index was assigned to mid-year (July) in the assessment model. Index units were in whole weight per number of sets divided by the number of hooks per set and the uncertainty in the index observations was estimated through the standardization techniques used to determine the final observed index values.

The index of abundance created from the commercial logbook data was considered by the IWG to be suitable when truncated to 2010 and was recommended for use in the assessment. The reason for truncating the index was that the implementation of IFQs and the Red Snapper closure led to changes of fisher behavior, such that the Stephens and MacCall (2004) subsetting procedure was no longer identifying species relationships reliably. Additionally, because this index covers a size range not covered by other indices, in particular larger, older fish, it was determined that the benefit of including this index outweighed potential issues the index may have. Lengths of Mutton Snapper characterizing the commercial longline index were assumed to match those of commercial longline landings.

Index values and their CVs are presented in **Table 9.** No changes to this index were made after the Data Workshop, however this index differs slightly from the erroneous index in Table 5.8.1 in the Data Workshop Report. The commercial longline index that was presented in Table 5.8.1 was mistakenly copied from a previous data submission, but the correct index was presented and discussed at the Data Workshop. The corrected index, along with other fishery independent indices in the Gulf of Mexico, is shown in **Figure 13**.

2.4 Fishery-Independent Surveys

The Index Workgroup (IWG) recommended six fishery-independent abundance indices for use in the assessment model. These indices are briefly summarized below but are explained in greater detail in the Data Workshop Report Section 5 and corresponding working papers. Indices in each region are shown collectively in **Table 9** and **Figures 13-15,** and associated CVs are presented in **Figure 16**.

2.4.1 Gulf of Mexico Combined Stereo Video Survey

The Gulf of Mexico Combined Stereo Video Survey Index combines data from two stationary video surveys of reef fishes in the Gulf of Mexico; the NMFS SEAMAP reef fish video survey (SRFV) carried out by NMFS Mississippi Laboratory, which has the longest running time series (1992-1997, 2002, and 2004+), followed by the Florida Fish and Wildlife Research Institute survey (FWRI, starting year 2008).

The video surveys and index development are fully described in the Data Workshop Report Section 5.4.4 and SEDAR 79-DW-21, however several modifications to this index were made after the Data Workshop.

2.4.1.1 Gulf of Mexico Combined Stereo Video Survey Index

The Data and Assessment panels recommended the removal of years 2010-2015 from the FWRI survey and years 1993-1995, 2013, and 2015 from the SRFV survey, as well as the addition of 2022 data. The removal of these years was recommended because either the core Mutton Snapper habitat (i.e., the Dry Tortugas) was not sampled or there were no Mutton Snapper sampled.

The updated index presented in **Figure 13** shows a highly variable but stable trend from 1996 – 2010, followed by an abrupt increase in 2011, a general decline through 2019, and then a sharp decrease from 2020-2022. The index is approximately 37% of the mean from 2020-2022, whereas other indices are at least 1.5 times the mean for same period. However, trends in nominal survey means differed considerably from the combined index, leading the Assessment Panel to recommend allowing for a decrease in survey catchability (*q*) to account for the increased spatial coverage in mostly poor Mutton Snapper habitat in the FWRI and GFISHER surveys (see Section 3.1.11).

Sampling occurs April through October, therefore the timing of this index specified in the base model is mid-year (July 1st). Index values and their CVs are presented in **Table 9.**

2.4.1.2 Gulf of Mexico Combined Stereo Video Survey Length Composition

For the Gulf Combined Video survey, only 295 Mutton Snapper were measured for length. Thus, only a single length distribution of the number sampled by length is used as a model input (see Table 17 and Figure 45 in SEDAR 79-AP-01).

2.4.2 NMFS Reef Visual Census (RVC, Dry Tortugas and FL Keys) and Southeast Florida Coral Reef Initiative (SEFCRI/RVC, SE FL)

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

Separate indices were developed for Southeast Florida, the Florida Keys, and the Dry Tortugas because there are clear differences in the lengths observed by region and there were only three years for which sampling occurred in all regions. Lengths of the Mutton Snapper observed in the Dry Tortugas were typically larger and those observed in Southeast Florida were smaller than the lengths from the Florida Keys.

2.4.2.1 RVC Indices

The IWG approved three RVC indices for use in the assessment: Southeast Florida (2013 – 2022), Florida Keys (1997 – 2022), and Dry Tortugas (1999 - 2021), but oftentimes sampling occurred in non-consecutive years.

After the Data Workshop, data for 2023 in the Dry Tortugas was approved for use by the Assessment Panel. The updated index compared to that reviewed by the IWG was very similar and showed a continued increase in 2023 (**Figure 13**). Index values and the associated CVs are presented in **Table 9** and **Figures 13-14.**

Data from months with few observations were deleted such that the Florida Keys only included data from June through September, the Dry Tortugas only included data from May through July, and southeast Florida included data from June through October. For simplicity, the timing of all indices was assigned to mid-year (July 1^{st}) in the base model.

2.4.2.2 RVC Length Compositions

The RVC divers estimate fork lengths to the nearest cm in situ, but variability in the observed fork lengths necessitates binning the fork lengths in 5 cm bins ([0,5), [5,10), [10,15), etc.). To make length types consistent with management regulations, binned fork lengths are converted to binned maximum total lengths (max TL) by first converting the midpoint of each 5 cm fork length bin to maximum total length in cm using the equation max TL = 1.071*FL + 1.552 (df = 2886, MSE = 35.41, R2 = 0.998, SEDAR 79). These maximum total lengths are then put into 5 cm max TL bins ([0,5], [5,10], [10,15], etc.). Converting fork lengths to maximum total lengths in this fashion preserves the shape of the distribution of binned fork lengths.

Length compositions weighted by index values for each of the RVC regions (Dry Tortugas, FL Keys, and SE FL) are presented in Tables 14-16 and Figures 42-44 in SEDAR 79-AP-01. Length samples were assigned to have occurred mid-year (July) and were not separated by sex. Input sample sizes for length were set equal to the number of observations of Mutton Snapper per secondary sampling unit. Effective sample sizes were then estimated using the Francis (2011) iterative re-weighting procedure.

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

The Southeast Reef Fish Survey is a collaborative trap and video survey conducted by NOAA Fisheries and the South Carolina Department of Natural Resources. SERFS has been conducted since 1990 using baited chevron traps, and video cameras were attached to traps regionwide in 2011. The spatial extent of the survey ranges from Cape Hatteras, NC, to St. Lucie Inlet, FL, from approximately 15 to 115 m deep. The survey uses a simple random sampling design, selecting approximately 1,500 stations to sample out of a sampling universe of approximately

4,300 stations, all on reef habitat. Mutton Snapper were rarely caught in traps, so only video counts were used to develop an index of abundance and a calibration factor was included to account for a change in camera type after 2014.

The SERFS index from 2011-2022 (no sampling occurred in 2020 due to COVID-19) was approved by the IWG. Index values and the associated CVs are presented in **Table 9** and **Figure 14**. SERFS is conducted from mid-April through October each year, but for simplicity the timing of the survey was specified as July 1st. Since size or age data from videos were not available for this assessment, the IWG recommended using age-based knife edge selectivity between ages 2 and 3.

2.4.4 FWRI FIM Inshore Seine Survey (Indian River Lagoon, FL)

The Florida Fish and Wildlife Conservation Commission's Fisheries Independent Monitoring (FIM) program monitors seven estuaries throughout Florida (Apalachicola Bay, Cedar Key, Tampa Bay, Charlotte Harbor, Northeast Florida, Northern Indian River Lagoon and Southern Indian River Lagoon). Sampling within each estuary is stratified by habitat and gear type proportional to the available sampling area. The primary gear type used to sample juvenile and adult sportfishes is a 183 x 2.5 m center bag haul seine that has a stretched mesh length of 38 mm (183-m seine). Mutton Snapper were most commonly encountered by the two labs that sample the Indian River Lagoon; Indian River (IR) and Tequesta (TQ).

The IWG approved the standardized index using data from the Indian River Lagoon (1999 - 2022). Index values and the associated CVs are presented in **Table 9** and **Figure 15**. The size cutoff for primarily age-0 fish was chosen as 19 cm standard length (SL) and months were limited to July-December to capture the recruitment window. Therefore, the timing of the index was assigned near the middle of the recruitment window (mid-September) in the base model.

2.4.5 Additional Fishery-independent Sources

Conditional age-at-length data from fishery independent sources (Vose and Shank [2003], FWRI Fisheries-Independent Monitoring, MARMAP, SERFS, South Atlantic Deepwater Longline Survey, and SFR [extension of the Vose and Shank 2003 study]) were used within the model to estimate growth but were not linked to any existing fleet or survey. These samples are summarized as conditional age-at-length by year in **Figure 17**. Input sample sizes for the number of ages sampled in a given length bin by year were set equal to the number of aged fish but were later down-weighted according to Francis (2011) to estimate effective sample sizes. These samples were assigned to have occurred mid-year (July) and were not separated by sex.

3. STOCK ASSESSMENT MODEL CONFIGURATION AND METHODS

3.1 Stock Synthesis Base Model Configuration

The base model for the SEDAR 79 southeastern U.S. Mutton Snapper stock assessment (SEDAR 79 Base Model) was developed in Stock Synthesis (SS) version 3.30.22.1. Stock Synthesis is an integrated statistical catch-at-age model that can accommodate age-structured, size-structured, and age-aggregated data (Methot and Wetzel 2013). It has 1) a population sub-model that simulates growth, maturity, fecundity, recruitment, movement, and mortality processes, 2) an observation sub-model which predicts values for the input data, 3) a statistical sub-model which characterizes goodness of fit and obtains best-fitting parameters and their associated variance via maximum likelihood, and 4) a forecast sub-model which projects various user-determined management quantities (Methot et al. 2024). Projections in Stock Synthesis start from the year following the terminal year of the assessment model utilizing the same population dynamics equations and modeling assumptions. Further descriptions of SS options, equations, and algorithms can be found in the SS user's manual (Methot et al. 2024), the NOAA Fisheries Toolbox website (http://nft.nefsc.noaa.gov/), and Methot and Wetzel (2013).

The SEDAR 79 Base Model was of moderate complexity - informed by catch data from two commercial fleets and two recreational fleets (including landings, discards, landings-at-length, conditional age-at-length), a fishery-dependent index of biomass (including length compositions), six fishery-independent abundance indices (including length compositions where available), and fishery-independent conditional age-at-length composition data that were not associated with any fleet or survey.

The model estimated 202 out of the 242 parameters including, but not limited to, growth parameters (asymptotic length [L_{inf}], von Bertalanffy growth coefficient [*k*], and the reference length for the start of von Bertalanffy growth [L_{min}]), virgin recruitment (*ln(R0)*), steepness (*h*), variability in recruitment (*sigmaR*), time-varying stock-recruit deviations, fishing mortality rates for each fleet and year that it was operational, length-based selectivity parameters for fleets, landings, discards, retention and indices with length composition data. Model-derived estimates include maximum sustainable yield (MSY) and MSY-proxy reference points (e.g., $F_{30\%SPR}$), and a full time series of population abundance-at-age (units: 1,000s of fish) and biomass (female spawning stock biomass, total, and exploitable in metric tons). The r4ss (Taylor et al. 2021) and ss3diags (Carvalho et al. 2021) software packages were utilized extensively to summarize and plot model outputs and perform diagnostic runs.

3.1.1 Temporal Structure

Based on elevated gonadosomatic indices and the proportion of spawning capable females, April through July is considered to be the core spawning season (SEDAR 79-DW-12). From July through December, young-of-year Mutton Snapper less than 20 cm standard length (SL) are encountered in the 183-m seine in Indian River Lagoon (SEDAR 79-DW-18). However, data limitations precluded the use of multi-season model.

Therefore, the Southeastern US Mutton Snapper population was modeled with a single season timestep, starting on January 1^{st} as age 1, spawning on June 1^{st}, and aging one year each January 1^{st} through age 40+, which represents a plus group (only accounts for 1.6% of otoliths). Catch, length, conditional-age-at-length, and index data were fit from 1981 – 2023. Since there was insufficient data to include more than one season, fisheries were assumed to operate continuously throughout the year.

3.1.2 Spatial Structure

Sufficient data informing the movement of Mutton Snapper were unavailable, therefore a single area model was implemented such that fish were assumed to homogeneously settle as recruits and spawn as adults across the entire Gulf of Mexico and South Atlantic regions.

3.1.3 Life History

3.1.3.1 Morphometric and Conversion Factors

Morphometric and conversion factors that were used to produce data inputs or that were specified as model inputs were not updated after the Data Workshop. The relationship between whole weight (WW in kilograms) and maximum total length (MaxTL in centimeters; $WW = aMaxTL^b$) for both sexes combined was specified as a fixed model input (**Table 10, Figure 18**).

Although not a direct input into the model, the gutted weight (GW) to whole weight (WW) conversion (GW = 1.10*WW, NMFS ALS) was used to convert the commercial landings from gutted weight to whole weight prior to input into the model (Section 2.4 in the Data Workshop Report).

3.1.3.2 Growth

There did not appear to be regional differences in growth, nor evidence of sexual dimorphism (SEDAR 79-DW-22 and see Data Workshop Report Section 2.5.5); therefore, a single growth pattern was assumed. Growth was estimated within Stock Synthesis according to the von Bertalanffy growth function where initial values for the asymptotic length ($L\infty$), the von Bertalanffy growth coefficient (k), and the CV as a linear function of length-at-age were initially based on the external size-truncated model results (Section 2.5.5 in the Data Workshop Report, SEDAR 79-DW-22), but then were updated according to a jitter analysis (Section 3.5.1, **Table 12**).

Lmax was specified as equivalent to $L\infty$. The CV parameters were used in SS to describe the variability in length-at-age for the minimum (CVyoung) and the maximum (CVold) observed ages. The CV of mean length-at-age for intermediate ages was linearly interpolated. In the base model, growth was configured such that fish grew according to the von Bertalanffy growth model immediately upon ‘settlement’ at age-1 on January 1 (Amin = 0), beginning at a length of 28 cm (L_{min}), but L_{min} was freely estimated (**Figure 18, Tables 10-11**).

3.1.3.3 Natural Mortality

The LHW recommended Mutton Snapper natural mortality-at-age be estimated with the assumption that the instantaneous natural mortality, based on the longevity model updated by Hamel and Cope (2022), should be inversely related to fish length (Lorenzen 2022) and held constant over time (see Data Workshop Report Section 2.6).

The instantaneous natural mortality estimate was 0.129 yr^{-1} using the Hamel and Cope (2022) longevity equation with t_{max} = 42 yr (**Table 10**). Following Lorenzen (2022), age-specific natural mortality rates were derived using this estimate as the target-M (scaled between ages 3 – 42) and with the size-truncated von Bertalanffy growth model results (**Table 11**, Data Workshop Report Section 2.5.5). However, to maintain consistency with growth parameters estimated by the base model, age-specific natural mortality was specified in the base model using the Lorenzen option in Stock Synthesis scaled between ages 3 – 40. Estimated age-specific natural mortality rates were found to range from 0.30 yr^{-1} to 0.118 yr^{-1} for ages 1 to 40 years (**Table 11**, **Figure 18**).

3.1.3.4 Maturity, Fecundity, and Spawning Stock Biomass

The base model was configured as a single gender model (Ngenders = -1) where the spawning biomass is multiplied by a user-defined fraction female to produce estimates of female-specific spawning stock biomass. An analysis of biological data collected for Mutton Snapper indicated that the overall male:female sex ratio was 1.19:1.00, slightly biased toward the number of males (Section 2.8.5 in the Data Workshop Report). Uncertainty, however, was not considered so it is unknown if there is a statistically significant difference from a 1:1 sex ratio. For simplicity, the user-defined fraction female in the base model was defined as 0.50. Maturity-at-age followed a logistic equation based on parameters documented in SEDAR 79-DW-12 (**Table 5**) that included all sampling months and spawning capable or actively spawning females assigned through histology and macroscopic staging in the mature group. Parameters for the logistic function were treated as a fixed input within the SS base model **(Table 10**, **Figure 18**). Fecundity was configured as linear eggs/kg on body weight ($eggs=b+m*wt$) and parameterized such that the number of eggs was equivalent to spawning biomass by fixing b=0 and m=1 (**Table 10**).

3.1.4 Initial Conditions

Stock Synthesis requires initial equilibrium catch values as fixed inputs and the estimation of initial fishing mortality rates for each fleet. Initial equilibrium catches represent catches from a stock exhibiting a balance of removals and natural mortality by stable recruitment and growth. However, the Mutton Snapper population was not assumed to be in equilibrium prior to the assessment's start year (1981) given the reported fishing history. Initial equilibrium catches for each fleet were therefore estimated within the base model. Specified initial equilibrium catches for the commercial fleets were equal to the total reported landings in the first year (1981). For the recreational fleets, equilibrium catches were equal to the average of the reported landings in the first five years. Due to the high uncertainty associated with these starting values, coupled with the unknowable nature of initial equilibrium catches, the Assessment Panel supported setting the lambdas associated with the fits to the initial equilibrium catches to 0, thereby removing goodness of fit of the equilibrium catches from the objective function.

Initial fishing mortality rates for each fleet were freely estimated, but diffuse symmetric beta priors were applied to keep model estimates in a plausible space. Model sensitivity to equilibrium catch values and initial fishing mortality rates was evaluated via parameter profiling, and the model did not appear sensitive.

Due to model instability, steepness was assumed to be 1 in the equilibrium time period but was freely estimated thereafter. Therefore, the initial equilibrium is calculated from a recruitment level unaffected by steepness and initial age composition adjustments are applied after the initial equilibrium calculation.

The model first applies the initial fishing mortality rates to an equilibrium age composition to arrive at a preliminary initial age composition. Since the emphasis on fitting the equilibrium catch values was removed (i.e., lambda = 0), initial fishing mortality rates are informed by early length and age information. A non-equilibrium initial age composition was then achieved by applying early recruitment deviations prior to the model start year.

3.1.5 Recruitment Dynamics

The Stock Synthesis base model used the Beverton-Holt stock-recruitment model. In SS, this stock-recruitment function uses three parameters which can be simultaneously estimated: 1) steepness (*h/BH_steep*; the recruitment obtained at 20% of the virgin biomass), 2) the virgin recruitment estimated in log-space (*ln(R0)*), and 3) the standard deviation of the natural log of recruitment (*sigmaR*). *SigmaR* penalizes deviations from the spawner-recruitment curve (calculated from *ln(R0)* and steepness) and defines the difference between the arithmetic mean spawner-recruitment curve and the expected geometric mean (Methot et al 2019). All three stock-recruitment parameters were estimated within the base model.

Simple annual deviations from the stock-recruitment function, which were not constrained to sum to zero, were estimated assuming a lognormal error structure. The main recruitment deviations were estimated for the time period of greatest data-richness (1986 – 2023), which corresponds to when age data for the fleets largely became available. Additionally, early recruitment deviations were estimated for 1970 – 1985 and were informed by length composition data, a small amount of age data, and removals from natural mortality and fishing.

Expected recruitments need to be bias adjusted in SS because of its assumed lognormal error structure. The adjustment is accomplished by applying a full-bias correction to the recruitment deviations which have enough data to inform the model about the range of recruitment variability (Methot et al. 2019). Following the recommendation from Methot and Taylor (2011) to use the full bias adjustment on data-rich years, the SS base model used full bias adjustment between 1986 – 2018 after which it decreased the full bias adjustment to no bias adjustment by 2029.

3.1.6 Fleet and Survey Configuration

The fleet configuration in the base model was informed by the amount of available length and age data, observed differences in sampled lengths and ages (SEDAR 79-AW-01), and Workgroup recommendations. Four fishing fleets were included in the base model: Commercial Longline (Com LL), Commercial Other (Com Other), Recreational East (Rec E, SE FL and North), and Recreational West (Rec W, FL Keys and Gulf). The recreational fleet structure for SEDAR 79 differed from that in SEDAR 15AU, wherein the defined recreational fleets were headboat and other (shore, charter, private).

All fleets in the SEDAR 79 Base Model had associated length compositions and conditional age-at-length data; however, only the Com LL fleet had a linked CPUE index (units: whole weight per number of sets divided by the number of hooks per set). As described in Section 2.3.7.1, the index was truncated to 2010 because of the changes in fisher behavior due to the implementation of IFQs and the Red Snapper closure. As such, the CPUE was treated as an index of biomass from 1993-2010 and was assumed to reflect trends in population biomass over this time. Since the index was only based on landings, the selectivity of the index was assumed to match the retention of the commercial longline fleet.

A single fishery-independent young-of-year (YOY) survey and five fishery-independent post-YOY surveys were modeled, some with associated length compositions. The surveys were: FIM Inshore Seine Survey (FIM YOY), Gulf Combined Video Survey (Gulf Video), Reef Visual Census Dry Tortugas (RVC DT), Reef Visual Census FL Keys (RVC Keys), Reef Visual Census SE FL (RVC SE FL), and the Southeast Reef Fish Survey (SERFS).

3.1.7 Selectivity

Selectivity patterns describe the probability of capture-at-length or -age by a given fishery or gear. Selectivity can be used to model different gear types, targeting, and fish availability according to the spatial utilization of fish and/or fishery. Stock Synthesis allows selectivity to differ by length, age, or both. The SEDAR 79 Base Model was configured using length-based selectivity for all fleets, as well as the Gulf Video and RVC indices. Age-based selectivity was assumed for the SERFS index and the FIM YOY index was specified as a recruitment index. All selectivity parameters were freely estimated, except where noted (**Table 12**).

Selectivity patterns across fleets and indices were configured to be constant over time, thereby assuming that major changes in the availability of Mutton Snapper and/or changes to management regulations have not occurred so as to alter these patterns since the model's start year.

Length- or age-based selectivity can be specified in various ways in Stock Synthesis (Methot et al. 2024), however for the SEDAR 79 Base Model only one of the following three selectivity forms were applied to each fleet/index: a two-parameter single logistic function (i.e., flat-topped), a six-parameter double normal function (i.e., dome-shaped), and user-specified selectivity at age. 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. Six parameters describing the double normal function: 1) peak selectivity: beginning size (or age) for the plateau (in cm or age), 2) top: width of plateau, as logistic between peak and maximum length (or age), 3) ascending width: parameter value is ln(width), 4) descending width: parameter value is ln(width), 5) initial: selectivity at first bin, as logistic between 0 and 1, and 6) final: selectivity at last bin, as logistic between 0 and 1.

3.1.7.1 Length-based Selectivity

The SEDAR 79 Base Model was configured using length-based selectivity for all fleets, as well as the Gulf Video and RVC indices.: 1) Commercial Longline (single logistic), 2) Commercial Other (single logistic), 3) Recreational West (double normal), 4) Recreational East (double normal), 5) Gulf Video index (single logistic), and 6) RVC indices (double normal).

Double normal (i.e., dome-shaped) selectivity was implemented for the recreational fleets because limited availability of large Mutton Snapper was evident in the length composition data (SEDAR 79-AW-01) and recreational anglers may generally fish in shallower depths compared to the commercial fleets. The recreational fleets also contain landings and releases from anglers fishing from shore which invariably fish in relatively shallow depths.

Logistic selectivity (i.e., flat-topped) was modeled for the Gulf Video index because although length data are sparse, the survey encapsulates a wide range of depths and distance from shore. Dome-shaped selectivity was modeled for the RVC surveys, as it is a visual survey and operates in safe diving depths of 30-m or less.

3.1.7.2 Age-based Selectivity

Only a single index, the SERFS index, was modeled with age-based selectivity. Since sampled lengths and ages were not available for this survey, full selectivity for ages 3+ and zero selectivity otherwise was assumed for the SEDAR 79 Base Model based on IWG recommendations. The FIM YOY index assumed full selectivity at age 0 (representative of age 1 in year y+1) as it was specified as a recruitment index.

3.1.8 Length-based Retention

All fleets with releases (i.e., all except the Commercial Longline fleet) were assumed to release fish in accordance with the minimum size limit. In Stock Synthesis, retention is defined as a logistic function of size or age (Methot et al 2019). Since size regulations for southeastern U.S. Mutton Snapper are in the form of a minimum size limit in maximum total length, as opposed to a slot limit, retention was modeled as an asymptotic function with length and consisted 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). The asymptote was fixed at 100% retention since larger Mutton are rarely released, even with enacted bag limits. Therefore, only the inflection point and slope were freely estimated for all retention functions, except where noted below and in **Table 12**.

Time-varying retention functions were used to allow the lengths of releases to change according to increases in the minimum size limits. To capture discernable shifts in release lengths and to reduce the number of time blocks, time blocks for the retention functions were based only on changes in the federal minimum size limits in the South Atlantic (i.e., the jurisdiction that accounts for most of the landings) listed below.

South Atlantic Federal (3 - 200 Miles)

- 12” (305mm) TL (1/1992 – 1/1995)
- 16” (406mm) TL (1/1995 – 2/2018)
- 18” (457mm) TL (2/2018 – present)

Prior to the implementation of the size limit in the South Atlantic (i.e., pre-1992), all fish caught were assumed to be retained (i.e., landed) for the Commercial Other fleet as estimates of releases were unavailable prior to 1993. For the recreational fleets, releases were available for the entire time series (1981 – 2023) and therefore retention was not forced to align with selectivity prior to 1992. Shifts in retained and/or released lengths differed by fleet; to favor model parsimony, time-varying retention was treated differently by fleet as identified below.

Time-Varying Retention for the Commercial Other Fleet

Time Block	Inflection	Slope	Asymptote
1981 - 1991	Fixed at 10 cm MaxTL	Fixed at 1 (knife-edge)	Fixed at Maximum
1992 - 2017	Estimated	Estimated	Fixed at Maximum
2018 - 2023	Estimated	Estimated	Fixed at Maximum

Time-Varying Retention for the Recreational East and West Fleets

Time Block	Inflection	Slope	Asymptote
1981 - 1994	Estimated	Estimated	Fixed at Maximum
1995 - 2017	Estimated	Estimated	Fixed at Maximum
2018 - 2023	Estimated	Estimated	Fixed at Maximum

3.1.9 Landings

The uncertainty associated with landings and releases for the recreational fleets was much greater than that for the commercial fleets (**Table 2** and **Table 8**), leading to a different treatment in the estimation of fishing mortality rates between these two sectors. For the commercial fleets, the fishing mortality rates were specified using the ‘hybrid F’ option, wherein the estimated landings were practically an exact fit to the observed landings. For the recreational fleets, the fishing mortality rates were specified as parameters, allowing a reduced fit to observed landings in order to better fit other data sources (e.g., discards, indices). Treating fishing mortality rates as parameters is preferred when catch is known imprecisely and when it is acceptable to have a solution in which the estimated fishing mortality rates do not reproduce the input catch levels exactly.

3.1.10 Releases

Live and dead releases for each fleet were calculated and fit within the base model. Live releases were estimated by applying the converse of the retention function to the total catch, while dead releases were the result of assumed release mortality rates (Methot and Wetzel 2013). The total mortality can then be expressed as:

$$\text{\# of dead fish } = \sum_{fleets} N_a \text{selectivity}_{fleet,age} * (\text{retention}_{fleet,age} + (1 - \text{retention}_{fleet,age}) * \text{release mortality rate}_{fleet}).$$

Fleet-specific release mortality rates were treated as fixed model inputs (see above Section 2.2.3) and configured in SS using the following formula:

$$\text{Release Mortality Rate} = \left(1 - \frac{1-P3}{1+e^{\frac{-(L-(P1+P4*male))}{P2}}}\right).$$

The four parameters describe 1) the descending inflection point, 2) the descending slope, 3) the maximum release mortality, and 4) the male offset inflection. The fourth parameter was not applicable to this model and fixed at zero. Therefore, releases mortality rates are a logistic function of size such that mortality declines from 1.0 to an asymptotic level as fish get larger. For all fleets, the release mortality rates were treated as constant across sizes by setting a very large positive value for the descending slope (i.e. 1E+06), resulting in a denominator approximately equal to 2, and a negative value for P3 that produces a specified release mortality rate. Release mortality rates were assumed constant throughout time.

Mutton Snapper exhibit similar body size (< 100 cm total length) and life history strategies (adults reside on marine reefs) to Red Snapper and are collected with similar gear types (hook and line). Due to these similarities and a lack of data informing Mutton Snapper release mortality, release mortality estimates of Red Snapper from Ramsay et al. (2022) that included delayed mortality rather than just immediate mortality at the surface were used as proxy for the release mortality of Mutton Snapper. The Workgroup considered the primary capture depth range of Mutton Snapper to be in shallow waters of 30 meters or less for all fleets and referred to Figure 4B in Ramsay et al. (2022) to determine a release mortality at 30-meter depth to be approximately 30%. The Workgroup then decided on a 15% lower bound for a sensitivity run applied to both commercial handline and recreational fisheries to be consistent with the previous assessment, and an upper bound of 45% for symmetry.

3.1.11 Catchability

Constant catchability was assumed for all surveys except for the Combined Gulf Video Index. As discussed in Section 2.4.1.1, the Assessment Panel recommended the estimation of three catchability levels coinciding with changes to the survey design. Catchability coefficients for the Gulf Video index were estimated for a base period from 1996 – 2015, a secondary period from 2016 – 2019 (when both SRFV and FWRI survey data overlapped), and a third period from 2020 – 2022 (the unification of both surveys under GFISHER). These catchability coefficients were freely estimated and were allowed to either increase or decrease between time blocks.

3.2 Goodness of Fit and Assumed Error Structure

A maximum likelihood approach is used in Stock Synthesis to evaluate the overall goodness of fit to each data source (i.e., landings, discards, indices, length compositions, and conditional-age-at-length). Datasets contained an assumed error distribution (e.g. lognormal) and an associated likelihood determined by the difference between observed and predicted values and the variance of the error distribution. The total likelihood is the sum of the individual components' likelihoods. The global best fit to all the data was determined using a nonlinear iterative search algorithm to minimize the total negative loglikelihood across the multidimensional parameter space.

Several model components were not given any weight in the loglikelihood function (i.e., the likelihood component multiplied by the weight (lambda) value was set to zero). These zero weight components included initial equilibrium catch values for each fleet and a near-zero weight (lambda = 0.01) for the releases from the Commercial Other fleet. Setting the weight in the loglikelihood function to zero (or near zero) reflects a lack of confidence in values for these components and they were not used for fitting the model to the data and parameters.

The error structure for landings, indices, and discards was assumed to be lognormal, except where noted. For most data sources, the variance of the observations was available only as a coefficient of variation (CV). In SS, if lognormal error structures were required, CVs were converted to a standard error (SE) in log-space using the following formula:

$$SE = \sqrt{ln\,(1 + CV^2)}.$$

Within the landings data, commercial landings contained the least amount of uncertainty (**Table 2**) because the programs which collect those data consider it a census (assumed to be complete or nearly so) rather than a survey (which is from a sample). Estimates of uncertainty for recreational landings and discards varied by year and were calculated according to Sections 2.3.2 and 2.3.4 (**Table 8**).

Releases from the Commercial Other fleet were assumed to have a normal error structure with specified CVs as CVs and standard deviations provided by SEFSC applied to discard rates on the arithmetic scale (as opposed to discards on the logarithmic scale) (**Table 2**). Uncertainty in the index observations was estimated through the standardization or design-based techniques used to determine the final observed index values (**Table 9**).

Multinomial distributions were assumed for the length composition data of the landings, discards, and indices as well as the conditional age-at-length composition data of the landings and fishery-independent dataset, which have variances estimated by the input effective sample sizes. The variance of the multinomial distribution is a function of true probability and sample size; thus, an increase in sample size represents lower variance and vice versa. The effective sample size is meant to represent the number of independent and random samples each year to determine the length or age composition. The assumption of independent and random sampling is typically violated because fish caught in the same tow or set tend to be more similar to each other in length or age than are fish from different catches, and this can extend to fish caught by the same vessel. In addition, the assumption of random sampling can be violated (e.g. by sampling vessels non-randomly or by under-sampling nighttime trips or fishing areas).

The variance associated with each data source can be highly influential, especially when there are conflicts among data sources. Because true effective sample sizes are unknown, effective sample sizes for length compositions were initially set to the number of trips from which samples of Mutton Snapper were obtained to avoid over-weighting observations of lengths in the likelihoods. The effective sample sizes for conditional age-at-length were set to the number of Mutton Snapper sampled because there are fewer fish aged at a given length.

Francis (2011) and Punt (2017) have developed re-weighting procedures to adjust the effective sample sizes of length and conditional age-at-length data iteratively until the multipliers reached a stable value. Multipliers are calculated so that variability of model inputs is consistent with the model fits to mean length or mean age (Francis 2011). It was verified that weighting factors did not exceed 1, meaning that the adjusted effective sample sizes were no more than the number of sampled trips (or number aged).

A new feature available in Stock Synthesis is to apply Francis weights separately to length or age data from each fleet/survey and partition (released or landed). This allows for different weighting factors between released lengths and retained lengths, which comparatively have a much greater input effective sample size.

An alternative weighting method for composition data is to use the Dirichlet-Multinomial distribution which estimates a parameter (theta) that internally scales the input sample size (Thorson et al. 2017; Methot et al. 2023). This method was attempted but most theta parameters were poorly estimated leading to model nonconvergence; the iterative Francis method was therefore utilized.

3.3 Estimated Parameters and Derived Quantities

A total of 202 out of 242 parameters were estimated within the SEDAR 79 Base Model for southeastern U.S. Mutton Snapper (Table 12). Of the 242 total parameters, 19 were used to describe life history components, 11 estimated deviations from the initial age composition, 43 estimated annual recruitment dynamics, 4 estimated initial fishing mortality rates, 86 estimated fishing mortality rates, 9 were related to index catchabilities, and 70 described selectivity, retention and discard mortality for the four fleets and six indices. Included in Table 12 are estimated parameter values from Stock Synthesis, the range of values a parameter could take, their initial starting values, their associated standard deviations and CVs, the prior type and its standard deviation (where applicable), and the phase the parameter was either estimated (positive phase) or fixed (negative phase). Most parameter bounds were set extremely wide and may include unrealistic values, however this was intentional as it reduced the gradient and allowed the search algorithm to adequately explore the solution space to avoid finding a local minimum. The SEDAR 79 Base Model also used the soft bounds option which moves parameters away from the bounds with a weak penalty (Methot et al. 2019).

Derived quantities include annual numbers- and biomass-at-age, spawning stock biomass, fishing mortality rates-at-age, and internally calculated reference points (e.g., $F_{MSYproxy}$, $SSB_{MSYproxy}$, MSY_{proxy}). Also, recent fishing mortality rates ($F_{Current}$) and recent spawning stock biomass ($SSB_{Current}$) as the geometric mean of the most recent three years were compared to management benchmarks to determine stock status.

3.3.1 Uncertainty of Parameters and Derived Quantities

Approximate uncertainty estimates for estimated and derived quantities were calculated after model fitting based on the asymptotic standard errors from the covariance matrix determined by inverting the Hessian matrix (i.e., the matrix of second derivatives was used to determine the level of curvature in the parameter phase space and to calculate parameter correlations; Methot and Wetzel 2013). Asymptotic standard errors provided a minimum estimate of uncertainty in parameter values.

In addition, Monte Carlo Markov Chain (MCMC) analyses provided posterior distributions of model parameters and selected derived quantities. MCMC allows probabilistic reporting of the uncertainty associated with the estimated values. Estimates of population values in the terminal year of the stock assessment are often the most uncertain. Assuming the MCMC posterior distributions provide reliable estimates of model uncertainty, the probability that the estimated terminal year value is above or below the overfished/overfishing reference points can be calculated. In this way, a level of risk associated with failing to reach the reference points can be quantitatively specified. Posterior distributions of current spawning stock biomass ($SSB_{Current}$) and fishing mortality rates ($F_{Current}$) as the geometric mean of the most recent three years (2021-2023) were compared to associated reference points (i.e., MSST, MFMT).

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

3.4 Model Diagnostics

Model diagnostics of the SEDAR 79 Base Model were performed in R using the 'r4ss' and 'ss3diags' (github.com/JABBAmodel/ss3diags) packages and largely follow the recommendations put forth in the Carvalho et al. (2021) 'cookbook' for integrated stock assessment models. While we briefly summarize each diagnostic here, further descriptions can be found in Carvalho et al. (2021) and references therein.

3.4.1 Model Convergence

Several approaches were used to assess convergence of the base model. First, the Hessian matrix must be invertible (i.e., there are valid solutions for all the parameters in the model). Next, the maximum gradient component (a measure of the degree to which the model converged to a local or global minimum) was compared to the final convergence criteria (0.0001, common default value). Ideally, the maximum gradient component will be less than the criterion.

Once these two criteria were met, a jitter analysis was performed on the parameter's starting values to suggest whether the base model had converged on a global solution instead of a local minimum. For this analysis, initial values were jittered by up to 10% and 200 iterations were performed.

3.4.2 Correlation Analysis

High correlation among parameters was also assessed as it can lead to poor model stability along with flat likelihood response surfaces. While some parameters will always be correlated due to their structural nature (e.g., growth and stock-recruitment parameters), many highly correlated parameters may warrant reconsideration of modeling assumptions and parameterization. Therefore, correlation among parameters was examined and any correlations with an absolute value greater than 0.7 were reported.

3.4.3 Residual Analysis

Poor overall fits and patterns in residuals were assessed in a variety of ways to identify potential model misspecification. First, model fits to landings, discards, indices, length compositions, and conditional age-at-length were evaluated via visual inspection of residuals. Overall residual patterns for each model component (indices, length compositions, and conditional age-at-length) were identified through joint residual plots (Winker et al. 2018; Carvalho et al. 2021). These plots include a Loess smoother to detect auto-correlation of residual patterns and data conflicts, as well as indicate outliers that were beyond the 3-sigma limit. Then, a non-parametric runs test (Wald and Wolfowitz, 1940) was performed on the indices, length compositions, and conditional age-at-length data to test for randomness and the presence of temporal autocorrelation in residuals. Combined root mean square error (RMSE) values were also calculated for the indices and length composition data to evaluate goodness-of-fit. Generally, undesirably high RMSEs exceed 30%.

3.4.4 Likelihood Profiles

Parameter profiling was used to elucidate model support for a range of parameter values, particularly for parameters that are often unknown or ill-informed by data (e.g., steepness, unfished recruitment, variation of recruitment deviations, natural mortality). This type of analysis can identify data conflicts and broad, not well-informed likelihood surfaces. Parameter profiling entails holding a parameter value constant at a chosen value while estimating the remaining parameters, and then evaluating the associated marginal log-likelihood (either in totality or for each data source).

Ideally, the plotted relationship between negative marginal likelihood values and the range of parameter values yields a well-defined minimum that aligns with that estimated by the base model. If a given parameter is not well estimated, the profile plot may show conflicting signals across data sources and/or a flat marginal likelihood surface. This indicates that multiple parameter values are equally likely given the data. In such instances, the parameter may not be influential in the model, or the model shows instability and model assumptions may need to be reconsidered. Likelihood profiles were done for several stock-recruitment parameters estimated in the base model (steepness and virgin recruitment [*R0*]) and the fixed average natural mortality rate.

3.4.5 Model Consistency

To measure model consistency, the base model was first subject to a retrospective analysis that removed successive years of data from the model for seven years (i.e. seven peels). Iteratively removing data from the final model year reveals the effect of a single or successive years of data on model results. If the results of this analysis show a retrospective bias (consistent patterns of increasing or decreasing model estimates and related derived quantities with each retrospective peel), it can be an indication of model misspecification of temporal dynamics. It is preferable for estimates associated with each retrospective peel to be randomly distributed around base model results. Model performance was evaluated by visual inspection of retrospective patterns and the Mohn's Rho (ρ) metric (Mohn 1999, Hurtado-Ferro et al. 2015). Based on simulation studies, a Mohn's Rho value between -0.15 to 0.2 is generally considered acceptable for long-lived species (Hurtado-Ferro et al. 2015; Carvalho et al. 2021). This work also suggested that positive values of Mohn's Rho for biomass and negative values for fishing mortality imply consistent overestimation of biomass and the highest risk for overfishing.

Additionally, an age-structured production model (ASPM) and an ASPM with estimated recruitment deviations (ASPMdev) were also developed in Stock Synthesis to investigate which processes were influencing the shape of the production function and whether composition data was influencing the variability in recruitment. For the ASPM, this was completed first by fixing all parameters to those values estimated by the base model except for the R0 parameter and the initial fishing mortality parameters. Next, the likelihood components (i.e., lambdas) for the length and age composition data were set to zero along with the recruitment deviations for both the early and main periods such that only the catch and indices of abundance were fit by the model. For the ASPMdev, recruitment deviations were also estimated and the bias-correction factor was re-adjusted following Methot and Taylor (2011). Trends in both spawning stock biomass and fishing mortality were compared between the base model, the ASPM, and the ASPMdev.

3.4.6 Model Validation (Prediction Skill)

Model validation was assessed by the predictive skill of the base model. This diagnostic evaluated whether the model's predictive capacity is consistent with the future reality. First, a one-year-ahead forecast was done on 9 retrospective model peels. Then, a forecast bias, which is an average relative error corresponding to the retrospective bias (i.e., Mohn's Rho (ρ) metric) was computed to gauge model performance and consistency with realized data in the following year.

Prediction skill of the model was gauged using the hindcasting cross-validation approach of Kell et al. (2021), which compares observations to their predicted future values. Predictive skill was evaluated for the indices, length compositions, and conditional age-at-length data. Mean absolute scaled error (MASE) is calculated as the average ratio of mean absolute error of prediction residuals and the mean absolute error of the naïve in-sampled prediction. This metric indicates whether the average model forecasts are better or worse than a random walk. For example, MASE scores >1 indicate average model forecasts are worse than a random walk (i.e., no predictive skill). However, a MASE score of 0.5 would indicate that the model forecasts twice as accurately as a naïve baseline prediction, thereby demonstrating predictive skill.

3.4.7 Sensitivity Runs

Sensitivity runs were conducted to investigate the impact of alternative assumptions or data sets on model fits and results. Key sensitivity runs are described below, but many additional exploratory runs were also implemented.

3.4.7.1 Remove S-R curve (Steepness ≈ 1)

The stock-recruitment relationship is frequently poorly estimated or can be biased due to patterns in recruitment caused by other factors. Thus, Maunder and Thorson (2019) recommend that assessments using a stock-recruitment relationship compare the performance with a model that avoids specifying such a relationship (i.e., steepness = 0.99). Due to time constraints, two selectivity parameters had to be fixed (peak selectivity for the Rec East and Rec West fleet) for this sensitivity run to improve convergence (i.e., lower the gradient). Since these selectivity parameters were not correlated with any life history or stock-recruit parameters, it should only lead to improved convergence without affecting the results of this sensitivity run.

3.4.7.2 Release Mortality

In accordance with Data Workshop recommendations (see Data Workshop Report Section 2.7), sensitivity runs examining the effect of alternative release mortality rates were performed. This was completed by configuring the fixed parameter inputs in the release mortality equation (Section 3.1.10 above) to produce the respective release mortality rates for each fleet. For all fleets, the upper bound sensitivity was set at 45% and the lower bound was set at 15%, so that the release mortality assumption in the base model of 30% is an intermediary estimate.

3.4.7.3 MRIP-FES Private Mode Landings & Releases

The sensitivity of model results to MRIP FES estimates of private mode landings and releases in Florida in lieu of SRFS estimates was also evaluated. Based on recent and on-going pilot studies, MRIP FES estimates may potentially be skewed based on the way questions were asked during the interview process (Andrews et al. 2018; Andrews 2022). Florida estimates ranged from 32% lower to 20% higher (Andrews 2022). Andrews (2022) reported that these estimates would be altered in magnitude but not in overall trends.

3.4.7.4 Jack-Knife Analysis on Indices of Abundance

A jack-knife approach to data exclusion analysis was performed wherein individual indices were removed and the model was rerun with the remaining data. The goal was to determine if any single index has an undue influence on the model. This approach is especially useful for identifying indices that may be giving conflicting abundance trend signals compared to the other indices. If notably different results are produced by removing an index, the index may not be applied appropriately given the model structure or sampling procedures may be inconsistent (e.g., an index may only be representative of a sub-unit of the stock and therefore may only reflect trends in a local sub-population rather than the entire stock). Therefore, a full index jack-knife was done for the survey data where each survey index was removed (including associated length or age composition data) and the model rerun. When an index was removed, any associated estimated parameters (e.g., selectivity parameters) were no longer estimated. To aid convergence, peak selectivity parameters for the Rec East and Rec West fleets were fixed at base model estimated values.

3.4.8 SEDAR 79 Base Model and SEDAR 15AU Comparison

To satisfy TOR 2a and 3c, results of the SEDAR 79 Base Model were compared to the previous assessment, SEDAR 15A Update 2015 (SEDAR 15AU), which had a terminal year of 2013 and was conducted in ASAP version 3. Annual values of recruits, fishing mortality rates, and spawning stock biomass were compared, as well as reference points as defined for SEDAR 79 (see Section 3.5.10). In the interest of time, reference points were internally calculated within the SEDAR 15AU Final Model (in ASAP 3) or the SEDAR 79 Base Model (in Stock Synthesis), rather than through projections.

3.4.9 SEDAR 15AU with MRIP-FES Data

In accordance with TORs 2b and 9c, SEDAR 15AU results are compared to an exploratory model with charter, private and shore mode landings and releases provided for SEDAR 79 in MRIP-FES currency. The first model retained the SEDAR 15AU configuration, all other data inputs, and terminal year (model name =’S15AU_MRIPcatch’). The goal of this sensitivity run was to capture the effect of updating recreational catch data from MRIP-CHTS to MRIP-FES units.

SEDAR 15AU base model had a terminal year of 2013 and configured the recreational fleets as “Headboat” and “MRFSS.” For the first exploratory run (’S15AU_MRIPcatch’), all inputs from SEDAR 15AU were kept unchanged except for the recreational landings and discards. While the SEDAR 79 data combines Headboat and MRIP-FES into one “Recreational” fleet, the SEDAR 15AU configuration requires them to be separated. The total MRFSS landings and discards by year were replaced with the 1981-2013 MRIP-FES landings and discards (and associated CVs) provided for SEDAR 79. All other data, including Headboat landings and discards and associated CVs, remained unchanged. The average ratios of MRIP-FES to MRFSS landings and discards are 2.05 and 3.39, respectively.

For the next exploratory model, all remaining ASAP model components related to the MRFSS fleet were updated using SEDAR 79 data (model name =’S15AU_MRIPcatch_plus’). This included the MRIP-FES landings and discards, in addition to updated catch and discard proportion catch at age and updated catch and discard weight-at-age. The SEDAR 15AU weights-at-age were configured as constant over time while those values vary over time in SEDAR 79. To adjust, the SEDAR 79 weights-at-age were averaged over time by age. It should be noted that in SEDAR 15AU, there is a single weight-at-age matrix used for all fleet catch and discards. This configuration is retained here with the updated matrix applied to all fleet catch and discards not just recreational. Every other aspect and all other data from the original SEDAR 15AU model were retained.

3.4.10 Model Bridging

A model bridging exercise was undertaken to explore differences in model results between the SEDAR 15AU Final Model and the SEDAR 79 Base Model. The goal of this exercise was to gauge the effect of configuration differences between the SEDAR 15AU Final Model and the SEDAR 79 Base Model by using the original SEDAR 15AU data with a configuration in ASAP 3 that closely resembled the SEDAR 79 Base Model configuration in Stock Synthesis.

The evaluation was conducted in a hierarchy of three steps. The first step was to evaluate the effect of using fleet-specific mean weights by age and year; the next step replaced the separate landings for the headboat and MRFSS/MRIP fleets with the Recreational East and West fleets which combined the headboat and MRFSS/MRIP landings by coast. The final step was to configure the model with the same set of indices as SEDAR 79 as much as possible. All model bridging exercises retained the same fixed natural morality-at-age, maturity-at-age, and fleet-specific release mortality as the SEDAR 15AU Final Model. **Table 13** lists the configuration in each model bridging stage.

The SEDAR 15AU Base Model assumed the same constant mean weights-at-age for all fleets (commercial longline, commercial hook and line, headboat, and MRFSS) and partitions (i.e., landings versus releases). Applying a single weight-at-age matrix may have impacted the results of the Yellowtail Snapper SEDAR 27A assessment by estimating fishing mortality rates for Yellowtail Snapper that were too low and corresponding spawning biomasses that were too high (see Section 3.4.2 in SEDAR 64). When weights-at-age matrices were restructured in SEDAR 27A to vary by fleet, partition, and year, results resembled those of the SEDAR 64 Base Model, suggesting that this configuration difference may have driven the notable differences between SEDAR 27A and SEDAR 64.

The data preparation for estimating the mean weight-at-age by year and the landings involved tallying the SEDAR 15AU recreational lengths, weights and landings for the headboats and for MRFSS/MRIP fleets by region and then recombining them into the Recreational East fleet (headboat and MRFSS/MRIP landings from north of the Florida Keys on the Atlantic) and the Recreational West fleet (headboat and MRFSS/MRIP landing from the Florida Keys and west in the Gulf of Mexico). The individual fish lengths were standardized to maximum total length prior to processing and if a fish lacked a weight, an estimated weight was calculated using the length-weight equation from SEDAR 15AU (Table 2.12). The fleet lengths and weights were grouped into 25 mm length bins as used in SEDAR 15AU, weighted by their landings and converted to ages using the SEDAR 15AU stochastic age-length key.

After the lengths and weights were converted to age frequencies by headboat and MRFSS/MRIP by coast, they could be added to produce the numbers of fish by age and year and the weight of those fish by age and year for the Recreational East and Recreational West fleets. Landings were tallied for the new fleet definitions.

The SEDAR 79 Data Working group did not retain many of the SEDAR 15AU indices and two of the accepted indices were not available in the 1981-2013 period, the Gulf of Mexico video index and the Southeast Reef Fish Survey video index). Also, they only accepted the Reef Visual Census from the Dry Tortugas and because of the individual quotas the years 2011-2013 were removed from the commercial longline index. Therefore, the final configuration bridging model included four fleets: Commercial other, Commercial longline, Recreational East, and Recreational West; three indices: commercial longline, Fishery Independent Monitoring Age-0 applied to Age-1 a year later, and the Dry Tortugas Reef Visual Census index, and fleet specific mean weight-at-age by year matrices.

3.4.11 Per-recruit Analysis

Equilibrium based yield per recruit (YPR) methods (Walters and Martell 2004) estimate the fishing mortality rate that optimizes the yield under the assumption that there is no stochasticity and the fishery has reached an equilibrium with the fishing mortality it exerts. It also assumes characteristics of natural mortality, growth, and recruitment are constant with stock size (Haddon 2001). The expected results of a yield-per-recruit (YPR) analysis are to obtain targets of fishing mortality and age at first capture in effort to evaluate regulations regarding gear types (e.g. hook/mesh sizes and minimum sizes), fishing seasons, or fishing effort (e.g. harvest strategies; Haddon 2001).

3.5 Stock Status Determination

The jurisdictional allocation of the Mutton Snapper acceptable biological catch (ABC) is 82% to the South Atlantic and 18% to the Gulf of Mexico. This was established using 50% of the mean of the catch history from 1990-2008 plus 50% of the mean of the catch history from 2006-2008 (GMFMC 2011). Therefore, the overfishing and overfished criterion for Mutton Snapper is in accordance with SAFMC definitions.

In 1998, the South Atlantic Fishery Management Council (SAFMC) passed Amendment 11 which established the proxy for optimum yield (OY) at 40% SPR for snappers and groupers. In 2018, the South Atlantic Fishery Management Council (SAFMC) passed Amendment 41 that enacted additional management measures (e.g., increasing the minimum size limit to 18 inches [45.7 cm] TL, commercial trip limits during spawning months, year-round recreational bag limits), specified the maximum sustainable yield (MSY) and minimum stock size threshold (MSST) definitions, and revised the ABC, the commercial and recreational annual catch limits (ACLs) and recreational annual catch targets (ACTs) for Mutton Snapper. Amendment 41 also designated April through June as ‘spawning months’ for Mutton Snapper in the South Atlantic, and enacted commercial trip limits during this time. These spawning months closely align with the April through July core spawning season determined by the updated maturity analysis (SEDAR 79-DW-12).

Amendment 41 changed the MSY definition to the yield produced by the fishing mortality rate at MSY (F_{MSY}) or the $F_{MSYproxy}$ (where F equals fishing mortality that, if applied constantly, would achieve MSY under equilibrium conditions). The $F_{MSYproxy}$ is $F_{30\%SPR}$, or the fishing mortality that will produce a static spawning per recruit equal to 30 percent. Amendment 41 also changed the MSST definition to 75 percent of the spawning stock biomass at MSY or MSYproxy. The South Atlantic Council set their portion of the ABC for Mutton Snapper equal to the OY (i.e., the optimum yield at 40% SPR).

For this assessment, the equilibrium fishing mortality rates that achieve 30%SPR ($F_{MSYproxy}$, $F_{30\%SPR}$) and 40%SPR (FOY, $F_{40\%SPR}$), as well as the associated reference spawning stock biomasses ($SSB_{30\%SPR}$, $SSB_{40\%SPR}$), were determined through long-term 100-year projections, assuming that equilibrium was obtained in the final 10 years of the projection (2114-2123; see Section 3.4.10.1). These long-term projections assume that recruitment in the first year and every year thereafter follows the stock-recruit curve, as recommended by Van Beveren et al. (2021). Then, short-term projections for the next 10 years (2024-2033) were used to forecast annual MSY (or OFL) values. For the short-term projections, the $F_{30\%SPR}$ that was determined for the long-term projection was applied to the stock starting in 2024 with the recent mean age 1 recruitment (geometric mean of the last 5 years of recruitment data; 2019-2023), as suggested by Van Beveren et al. (2021).

The maximum fishing mortality threshold (MFMT) is defined for the Southeastern US Mutton Snapper population as $F_{30\%SPR}$, and the minimum stock size threshold (MSST) as 75% of $SSB_{30\%SPR}$. Overfishing is defined as F > MFMT and overfished as SSB < MSST. The current condition of the stock is represented by the geometric mean of SSB ($SSB_{current}$) from the last three years (2021–2023), and the current condition of the fishery is represented by the geometric mean of F ($F_{current}$) from the last three years (2021–2023). These benchmarks are conditional on the estimated selectivity functions and the relative contributions of each fleet’s fishing mortality averaged over the last three years (2021 – 2023).

3.5.1 Projections

The method to project the assessment results was developed in the R statistical computing environment by SEFSC assessment scientists (https://github.com/SEFSC/SFD-

AllocationForecasting). Deterministic projections were performed under several assumed conditions. Growth and stock-recruit parameters were kept constant as estimated by the SEDAR 79 Base Model. Also, projections were run assuming that relative F, selectivity, discarding and retention associated with the last three years (2021-2023) would remain the same into the future. Table 14 provides a summary of projection settings.

Long-term deterministic projections were first conducted to determine the equilibrium fishing mortality rates that achieve 30%SPR ($F_{MSYproxy}$, $F_{30\%SPR}$) and 40%SPR (F_{OY}, $F_{40\%SPR}$), as well as the associated reference spawning stock biomasses ($SSB_{30\%SPR}$, $SSB_{40\%SPR}$). These were 100-year projections, assuming that equilibrium was obtained in the final 10 years of the projection (2114-2123), and that recruitment in the first year and every year thereafter follows the model-estimated Beverton-Holt stock-recruitment relationship, as recommended by Van Beveren et al. (2021). Long-term projection methods use an iterative process to set fishing mortality rates each year to ensure that 1) the MSY proxy (i.e. SPR30% or $SSB_{30\%SPR}$) is achieved at equilibrium (~100yrs), and 2) annual relative fishing mortality between fleets is maintained at the average of recent years (2021-2023).

Short-term deterministic projections for OFL and ABC determination were then conducted to estimate Mutton Snapper spawning stock biomass and yield under a range of harvest scenarios given a constant fishing mortality rate scenario was achieved. Several short-term projection scenarios use a similar iterative process to explore the effects of holding fishing mortality rates constant at $F_{30\%SPR}$ (MFMT), 75% of $F_{30\%SPR}$, and recent fishing mortality rates ($F_{current}$). The TORs also state to evaluate the projected spawning stock biomass when catch is held constant at the equilibrium yield at F40%SPR, however, F40%SPR is nearly equivalent to 75% of F30%SPR. For short-term projections, age-1 recruitment in all projection years was equal to the recent geometric mean (2019-2023), as recommended by Schueller et al. (2022) and Van Beveren et al. (2021).

An additional option is to achieve fixed catch allocations (in percentage of pounds) between sectors in every year of the forecast. However, this was not applied since the SEDAR 79 model structure does not allow for allocations to be specified by jurisdiction (i.e., South Atlantic versus Gulf of Mexico). The acceptable biological catch (ABC) is apportioned 82% to the South Atlantic and 18% to the Gulf of Mexico. The South Atlantic Council then further allocated the total ACL (in numbers) between the commercial sector (17.02 percent) and recreational sector (82.98 percent). Sector allocations are not currently specified in the Gulf. Therefore, the decision as to how to determine sector allocations for an ABC (in percentage of pounds) encompassing the entire southeastern US was unclear.

4. STOCK ASSESSMENT MODEL RESULTS

4.1 Estimated Parameters and Derived Quantities

The SEDAR 79 Base Model estimated most parameters reasonably well (i.e., |CV| < 1; **Table 12**). Of the 202 active parameters, 31 exhibited poor estimation (i.e., |CV| > 1); including 8 initial age composition adjustments (associated with ages 3,4, and 6-11), 11 recruitment deviations, the initial fishing mortality rates for the commercial longline and commercial other fleets, and 10 parameters describing selectivity (i.e., the top and ascending width of the Rec East fleet selectivity, the top and ascending width of the Rec West fleet selectivity, as well as the selectivity at the last length bin, the top of the RVC Dry Tortugas index selectivity, and the top and ascending width of the RVC FL Keys index selectivity, as well as the associated selectivity at the initial and final length bins). No parameters were estimated near bounds. **Figure 19** shows parameter distribution plots along with starting values, bounds, and non-uniform priors (if applicable).

4.2 Selectivity and Retention

Estimated length-based selectivity functions for each fleet are plotted in **Figure 20a**. Mutton Snapper were fully selected at larger sizes for the commercial fleets relative to the recreational fleets. The Commercial Longline fleet reached 50% selectivity at 61 cm MaxTL, while the Commercial Other fleet reached 50% selectivity at 36 cm MaxTL. Smaller Mutton Snapper were encountered by the recreational fleets. Selectivities for both recreational fleets start around 35% for 8 – 26 cm MaxTL. The selectivity of the Recreational West fleet gradually declines after the peak at 30.01 cm MaxTL (32 cm bin), whereas the peak for the Rec East fleet falls within the 36 cm bin and quickly declines to near zero by the 64 cm bin.

The derived age-based selectivity for each fleet (via model estimated growth and population dynamics), along with the maturity-at-age ogive, show the Commercial Longline fleet generally encounters older, mature Mutton Snapper compared to the other fleets (**Figure 20b**). The recreational fleets both select ages 1 and 2 much more frequently than the commercial fleets. The Rec East fleet selects far fewer age 4+ fish compared to the Rec West and Commercial Other fleet, while the Rec West fleet selects far fewer age 6+ fish relative to the Commercial Other fleet.

Length-based selectivities of indices occurring in the Gulf (i.e., Gulf Combined Video index, Commercial Longline index, and RVC Dry Tortugas) in **Figure 21a** illustrate that similar lengths are generally encountered in the Gulf Combined Video index and the RVC Dry Tortugas until about the 58 cm MaxTL bin, but then the RVC Dry Tortugas selects fewer larger Mutton Snapper. The selectivity of the Commercial Longline index is the same as the Commercial Longline fleet selectivity.

Derived age-based selectivity for each of the Gulf indices similarly show the RVC Dry Tortugas and Gulf Combined Video as having comparable selectivity until age 7 (**Figure 21b**). Also, very few younger ages are encountered by the Commercial Longline fleet.

Estimated length-based selectivities associated with RVC indices that occur in the South Atlantic (RVC FL Keys and RVC SE FL; **Figure 22a**) and the related age-derived selectivities (**Figure 22b**) indicate that these indices encounter much smaller/younger Mutton Snapper relative to the Gulf indices, and far fewer larger/older fish. The fixed selectivity-at-age for the SERFS index shows a different pattern with knife-edge selectivity at age 3, particularly when compared to the inverse logistic estimated for the RVC SE FL index. For the RVC SE FL index, ages 1 and 2 are fully selected, age 5 is 50% selected, and ages 10+ have negligible selectivity. The selectivity of the SERFS index is unknown and was therefore based on the SERFS survey design and IWG recommendations.

Parameters related to retention are estimated for fleets with releases (Commercial Other, Rec East, and Rec West). These retention functions are time-varying; generally coinciding with changes to the minimum size limit. The changes to retention over time for each fleet are illustrated in **Figures 23a, 24a, and 25a**. Then, fleet-specific terminal year (2023) selectivity, retention, discard mortality (constant at 0.30), along with the fraction of fish kept, dead and discarded are shown in **Figures 23b, 24b, and 25b.**

Retention functions for each fleet were configured according to specifications in Section 3.1.8. For the Commercial Other fleet, releases were unavailable prior to 1993 so prior to the implementation of the minimum size limit in the South Atlantic (1981-1991) all Mutton Snapper caught were assumed to be retained and landed (**Figures 23a).** From 1992 – 2017, the model estimated an inflection point of 38.1 cm MaxTL, which was between the 12-inch TL (30.5 cm) size limit enacted from 1992-1994 and the 16-inch TL (40.6 cm) size limit enacted from 1995 - 2017. Then the estimated reflection point of 49.2 cm MaxTL from 2018-2023 aligns with the current 18-inch TL (45.7 cm) size limit.

The Rec West fleet had minimal releases estimated prior to the 1992 16-inch TL size limit, thus retention was not forced to match selectivity during that time. Due to limited data, a separate time block encapsulating only the 12-inch minimum size limit was not feasible. Therefore, the same retention function was applied from 1981 – 1995 that had an estimated inflection point at 37.3 cm MaxTL, which was greater than the 12-inch minimum size (30.5 cm). The following time period (1995 – 2017), estimated a slightly larger inflection at 42 cm MaxTL that was similar to the 16-inch minimum size limit. The final time period (2018 -2023) estimated a 46 cm inflection point, on par with the 18-inch TL (45.7 cm) size limit (**Figures 24a)**.

Lastly, the retention for Rec East fleet applied the same time blocks as the Rec West fleet. Again, due to limited data, the same retention function was applied from 1981 – 1995 that had an estimated inflection point at 33.2 cm MaxTL, which was slightly greater than the 12-inch minimum size (30.5). The following time period (1995 – 2017), estimated a slightly larger inflection at 40.6 cm MaxTL matching the 16-inch minimum size limit. The final time period (2018 -2023) estimated a 48.8 cm inflection point, which was greater than the 18-inch TL (45.7 cm) size limit (**Figures 25a)**. This may suggest that more undersized Mutton Snapper are being retained in SE FL and areas north of SE FL compared to the FL Keys and Gulf.

Compared to the Commercial Other fleet, in recent years (2018-2023) the Rec West and particularly the Rec East fleet discard more fish (grey lines in **Figures 24b** and **Figure 25b**) than are kept (purple lines in **Figures 24b** and **Figure 25b**).

4.3 Fishing Mortality

The SEDAR 79 Base Model estimates of annual instantaneous fishing mortality rates on age-3 Mutton Snapper are presented in Table 15 and Figure 26. Age-3 was based on the mid-point of the relative fleet-specific maximum selectivities. Considering fishing mortality rates of a single age allows for a comparison of fishing mortality rates across time by reducing the variability of fishing mortality rates caused by differing levels of fishing pressure across ages and years. Nonetheless, fleet-specific fishing mortality rates (i.e., instantaneous apical rates representing the fishing mortality level on the most vulnerable age class) are also presented in Table 15 and Figure 27.

The annual fishing mortality rates on age-3 Mutton Snapper have been variable but stable from 1981 - 2017 (mean age-3 F = 0.162 yr-1) but have been notably lower since 2018 (mean age-3 F = 0.073 yr-1), coinciding with additional management regulations (Figure 26a). The current fishing mortality rate (Fcurrent), calculated as the geometric mean of 2021-2023 estimates, is 0.08 yr-1.

In 2008, the age-3 fishing mortality rate was estimated to be the highest in the timeseries at 0.41 yr-1. There were very high estimated landings and releases from the recreational shore mode in 2008, as well as a marked increase in the FIM YOY index in the fall of 2007. The estimated age-3 fishing mortality rate was the lowest in the time series in 2011 at 0.04 yr-1, perhaps impacted by a cold kill in the FL Keys in January of 2010 which most likely impacted Mutton Snapper habitat, although no specific reports on Mutton Snapper mortalities were reported (Hallac et al. 2010).

Apical fishing mortality rates were minor for the commercial fleets, while the apical fishing mortality rate for the Rec West fleet generally declined since the early 1990s and those for the Rec East fleet increased but remained highly variable (Figure 27). Since the early 1990s, the apical fishing mortality rates continued to be the highest for the Rec East fleet, particularly in 2008, despite estimated declines in 2010-2011 and 2019-2020.

4.4 Recruitment

Steepness was estimated in the SEDAR 79 Base Model at 0.644 and the corresponding Beverton-Holt stock recruit relationship is shown in **Figure 28**. The estimate of sigmaR was 0.55 and ln(*R0*) at 7.83 (**Table 12**), which equates to 2.51 million age-1 Mutton Snapper.

The number of age-1 recruits remained fairly stable at nearly 1 million fish from 1981 – 2005. Then, the first peak in recruitment as estimated by the SEDAR 79 Base Model occurred during 2006 (2.6 million age-1s; **Table 16**; **Figures 29**). This peak was followed by a general decline until 2010 (347 thousand age-1s), which was the lowest in the time series. However, estimated recruitment quickly recovered thereafter and almost reached or exceeded unfished recruitment levels from 2015 – 2020 (around 2.5 million age-1s). Then, recruitment peaked at approximately 4.3 million age-1s in 2021 and 2022 before declining slightly to 3.1 million age-1s in 2023.

Recruitment deviations were generally characterized by a period of below average recruitment between 1976 and 1998 followed by above average recruitment from 2003 – 2008, then a steep decline from 2009-2011 and above average recruitment from 2012 to 2023, although the confidence intervals for some years overlapped with zero (**Figure 30**). The estimated (and applied) recruitment bias adjustment ramp is shown in **Figure 31**.

4.5 Biomass and Abundance Trajectories

Predicted total biomass (metric tons, pounds), spawning stock biomass (SSB; metric tons, pounds), abundance (1000s of fish), age-1 recruits (1000s of fish), and depletion (SSB/SSB0) for Southeastern U.S. Mutton Snapper from the SEDAR 79 Base Model from 1981 to 2023 are provided in **Table 16**. Total biomass averaged 6,455 metric tons, ranging from 3,784 metric tons in 1999 to 15,132 metric tons in 2023 (**Figure 32**). Estimates of SSB averaged 2,565 metric tons and ranged from 1,502 metric tons in 1999 to 5,898 metric tons in 2023 (**Figure 33**). The geometric mean from 2021-2023 was 5,403 metric tons ($SSB_{current}$). Both total biomass and SSB declined from 1981 to 1999, then increased gradually through 2008. While biomasses slightly declined in 2009, they quickly recovered thereafter and have accelerated rapidly in recent years (2019 – 2023).

Depletion (SSB/virgin SSB) ratio averaged 0.14 and ranged from 0.08 in 1999 to 0.33 in 2023 (**Table 16**). The mean age of Mutton Snapper was nearly 4.5 years from 1981 until 1999, then declined to age 3 in 2006, but has since increased to almost 3.5 years in recent years (**Figure 34**).

4.6 MCMC Analysis

Uncertainty estimates based on the asymptotic standard errors from the covariance matrix only provide a minimum estimate of uncertainty in parameter values and derived quantities. Therefore, Monte Carlo Markov Chain (MCMC) analyses were applied to produce posterior distributions of model parameters and selected derived quantities.

However, due to time constraints, only a single converged chain of MCMC draws was able to be produced. Out of the original 5,000 iterations, an added burn-in of 500 iterations and additional thinning (i.e., saving every 1 out of 8 iterations) resulted in 563 total iterations. For most parameters and derived quantities of interest, Geweke's diagnostic did not suggest that the mean of the first 10% of the chain was significantly different from the last 50% of the chain (**Table 17**). **Figure 35** displays trace plots for several parameters and derived quantities. In the future, it would be beneficial to explore the No-U-Turn sampler (NUTS), a Bayesian algorithm recently added to ADMB that produces chains with low autocorrelation (Monnahan et al. 2019).

Posterior distributions for steepness, ln(*R0*), unfished SSB, retained yield associated with the internally calculated $F_{30\%SPR}$ were produced, as well as the geometric mean of SSB from 2021-2023 [$SSB_{current}$] and geometric mean of age-3 fishing mortality rates from 2021-2023 [$F_{current}$] (**Figure 36**). SEDAR 79 Base Model results mostly fall outside the interquartile range of posterior distributions, especially for $SSB_{current}$ and $F_{current}$, warranting caution on the use of these MCMC results (**Figure 36**).

4.7 Model Diagnostics

4.7.1 Model Convergence

The SEDAR 79 Base Model converged with a total objective function of 1488.01, with length compositions and conditional age-at-length from the catch and indices contributing the most to the magnitude of the likelihood function (**Figure 37**). The model contained no parameters on the bounds, had a small final gradient <0.0001, and had a positive definite Hessian matrix.

The results of the jitter analysis suggested that the SEDAR 79 Base Model had converged on a global solution but was sensitive to the initial parameter values. Of the 200 jittered runs, only 5 runs had maximum gradient < 0.0001 and 95 runs (48%) had a maximum gradient < 0.05. No jittered runs were found to contain a total likelihood lower than the base model. The range of log-likelihood values associated with only runs that had a maximum gradient < 0.05 is presented in **Figure 38**.

4.7.2 Correlation Analysis

Correlation among parameters is common in highly parametrized models but should be investigated as it can lead to poor model stability along with flat likelihood response surfaces. Several selectivity and retention parameters were highly correlated (> 90%, **Table 18**). These parameters defined the inflection points of the Rec East and Rec West during the base time period and that in the first time block (1995-2018). This may suggest there is little contrast between the base period and the first time block. Additionally, parameters defining the peak and width of the ascending limb of the double normal selectivity for the RVC Dry Tortugas were highly correlated. However, all correlated parameters were found to be structurally correlated and did not suggest model instability.

4.7.3 Residual Analysis

Joint residual patterns and overall root mean squared error (in percentage) for indices of abundance, mean length (in 4 cm bins), mean length for the RVC surveys (5 cm bins) and mean conditional age-at-length are shown in **Figure 39** and **Table 19**. Patterns in residuals across model components did not suggest any major data conflict but there does appear to be overestimation of indices from 1993 to 2000, as well as from 2010 to 2022. Mean conditional age-at-length residuals also suggest overestimation of age at length from 1981 to 2007. However, the RMSE values were below or near maximum acceptable levels (30%) for most model components (**Table 19**).

RMSE values for the FIM YOY and SERFS surveys were extremely high (74% and 85%, respectively). The CVs (i.e., uncertainty) of the SERFS index from 2011 to 2013 were approximately 50%, and the CVs associated with the FIM YOY were near 40% (**Figure 16**). Furthermore, the FIM YOY index may have low power to detect changes in abundance of Mutton Snapper as was revealed by an exploratory simulation-based power analysis (SEDAR 79-DW-18, Appendix A). The poor fit to both of these indices led to elevated overall RMSE for the indices (RMSE combined= 51.2%; **Table 19**)

While an analysis of joint residuals is useful to compare across model components, a thorough description of residual analyses for each model component and data source follows.

4.7.3.1 Landings

Except for unknown equilibrium catch values, the landings data for the commercial fleets (in metric tons) were fit exactly due to the minimal associated uncertainty in the observed values, while the predicted landings for the recreational fleets (in 1000s) were allowed to differ from the observed values (**Figure 40** and **Figure 41**, total negative log-likelihood = 55.9). The fits to the landings were comparable among the recreational fleets. The standardized residuals ranged from -1.2 to 1.5 for the Rec East fleet and -1 to 1.8 for the Rec West fleet (**Figure 41)**. Predicted landings tended to underestimate the observed values prior to the early-1990s and overestimate the observed landings starting in the mid-2000s. The landings for the Rec West fleet were particularly overestimated in recent years (2017-2023).

4.7.3.2 Releases

Estimates of releases for the Commercial Other (i.e., primarily hook and line) fleet were recently deemed unreliable (Alhale et al. 2024). However, the scale of the commercial releases is negligible relative to the recreational fleets (**Figure 42**), making this data source less consequential to model results. Nevertheless, the likelihood component for the commercial releases was considerably down-weighted (lambda =0.01) to further reduce the impact of this data source on the fits to other model components. As a result, the model fits the commercial releases poorly in some years, especially from 2018 to 2020 (**Figure 42** and **Figure 43**),

Releases from the recreational fleets were characterized by high uncertainty in most years and have generally increased throughout the time series, however low values occurred in 2010 and 2011 (**Figure 42**). For both the Rec East and Rec West fleets, the model largely overestimated releases in the 1980s and underestimated releases in following years, except for a period of underestimation during the late-1990s to mid-2000 (**Figure 43**). The model predicts releases from the Rec East fleet slightly better than those for the Rec West fleet, as standardized residuals for the Rec East fleet releases ranged from -2.2 to 0.8 whereas those for the Rec West fleet ranged from -2.4 to 2.0 (**Figure 43**).

Model estimated discard rates show a similar pattern across all fleets with releases with increases in recent years corresponding to increases in the minimum size limit for Mutton Snapper (**Figure 44**). The pattern in residuals for the recreational releases is the contrary to those for the recreational landings in some years, suggesting that the realized discard rates may be lower than the model estimated discard rate in early years and higher in later years.

4.7.3.3 Indices

As noted, most indices were fit reasonably well by the SEDAR 79 Base Model (**Figures 45-46**; **Table 19**). The model fit best to the RVC Keys index (RMSE = 20.8%; **Table 19**). The model fit the increasing trend from 1997 to 2007 well but subsequently underestimated the rate of decline from 2008 to 2011. Both the expected and observed index values increased thereafter and were in general agreement, however the expected value in 2022 overestimated the observed value.

The second-best fit index was the RVC Dry Tortugas index (RMSE = 30.4%; **Table 19**). This index increased from the start of the index in 1999 to 2010. The model overestimated the observed values in 1999 and 2000, leading to an underestimation of the rate of increase in those years. The observed index was then stable from 2010 to 2014 and increased thereafter, which was matched well by the expected values.

The Gulf Combined Video and the RVC SE FL indices had comparable fits (RMSE ≈ 35%; **Table 19**). The fit to the Gulf Combined Video was aided in large part by estimated time-varying catchability that decreased in each time block (**Figure 45h**); yet the model did not capture the decrease in the observed Gulf Video index from 2007 to 2010. The expected values for the RVC SE FL index from 2013 to 2015 overestimated the observed values and underestimated the observed values in 2018, therefore the base model underestimated the rate of increase from 2013 to 2018.

The FIM YOY index was specified as a recruitment index (in Stock Synthesis this applies to age 0s), therefore the FIM YOY index in a particular year is representative of age 1s the following year. High relative abundances of age 0s were observed in 2007 and to a lesser degree in 2008. The model grossly underestimated these high values and conversely overestimated the lowest observed index values in 2016 and 2019. The model generally overestimated age 0 relative abundances from 2015 to 2022.

The base model fit the SERFS Video index reasonably well from 2014 to 2022, however the peak in 2019 was underestimated. The observed index values for the first three years of the time series (2011-2013) were severely overestimated by the base model, however these years corresponded to very high CVs (approximately 50%). Relatedly, there was change in the camera gear in 2015 (from Canon to GoPro, SEDAR 79-DW-10) and the observed index values in years prior to 2015 were subject to calibration.

Lastly, the base model did not fit the pre-IFQ Commercial Longline CPUE particularly well (RMSE = 38.3%; **Table 19**), as observed index values from 1993 to 2000 were overestimated and observed values from 2002 to 2007 were underestimated. This may suggest the index demonstrated hyperstability from 1993 to 2000, so that the CPUE remained elevated even though the true abundance was depressed.

4.7.3.4 Length Composition

Overall, the SEDAR 79 Base Model fit the observed length compositions with 4 cm bins reasonably well, as RMSE ranged from 1.9% to 5.2% and the combined RMSE was 4% (**Table 19).** Aggregated across years, the expected length compositions were similar to the observed compositions for most fleets and surveys (**Figure 47**). The overall observed length compositions for the Commercial Other and Rec West fleets are slightly bimodal, but the assumed selectivity patterns for these fleets (single logistic and double normal, respectively) cannot accommodate bimodality. Therefore, for the Commercial Other fleet lengths between 52 cm and approximately 60 cm are overestimated in many years, whereas the surrounding peaks are underestimated (**Figure 48**). This pattern is less apparent for the Rec West fleet, but lengths included in the second peak beyond 60 cm are underestimated in most years (**Figure 48**). Additionally, the Commercial Longline retained lengths tended to be underestimated beyond 76 cm MaxTL in some years, particularly from 1996 - 2004. Otherwise, Pearson residuals did not show concerning patterns or magnitudes (**Figures 48-49**).

Fits to retained length compositions were often better than fits to discarded length compositions for each fleet, although sample sizes were notably smaller for discard length compositions. Also, sampled lengths for the Commercial Other fleet releases and the Gulf Combined Video Index.

were aggregated over several years, resulting in only a single year of input length compositions for these data sources (**Figures 48-49**).

Length compositions associated with the RVC indices used a 5 cm MaxTL bin width. The quality of fits was slightly poorer than those above, as RMSE values ranged from 6.8% to 11.2%, with a combined RMSE value of 9.3% (**Table 19**). Aggregated across years, the expected length compositions mostly aligned with the observed compositions (**Figure 50**). For the RVC Dry Tortugas, some misfitting is apparent in 2010 and 2012 as lengths less than 50 cm are underestimated, while larger lengths are overestimated (**Figure 51a**). The base model underestimated lengths from the RVC FL Keys greater than 40 cm in some years (**Figure 51b**). For lengths associated with RVC SE FL, 30 – 40 cm are underestimated in some years, and in recent years (2018-2022), 40 cm and above are overestimated (**Figure 51c**).

4.7.3.5 Conditional Age-at-Length

RMSE values associated with SEDAR 79 Base Model fits to the conditional age-at-length data for the retained catch and fishery-independent data are deemed to be acceptable (ranging from 6.3% for the Commercial Longline to 11.3% for the fishery independent data, with an overall RMSE of 8.2%).

The base model fits to mean age by year for each data source are presented in **Figure 52**. Most fits were generally acceptable, however the mean age for the Rec East fleet was generally overestimated and conversely the mean age retained by the Rec West fleet was slightly underestimated in some years. Predicted mean ages largely fell within the uncertainty bounds after down weighting input sample sizes according to Francis (2011).

The patterns in the residuals of fits to mean age were investigated further by inspecting the base model fits to age-at-length by year and data source. As shown in **Figures 53-57,** ages did not appear to be consistently under- or overestimated for a given length bin, even for the Rec East and Rec West fleets.

4.7.4 Likelihood Profiles

Likelihood profiles were used to examine the change in log-likelihood for selected model across a range of values in order to gauge the model support of a given parameter estimate and to identify conflicts among log-likelihood values of different data components. Likelihood profiles were done for two stock-recruitment parameters (*steepness* and virgin recruitment [*R0*]) and the assumed natural mortality averaged over ages 3-40 (*Average M*).

For this analysis, each profiled parameter was held constant at a chosen value and the remaining parameters were estimated. To improve convergence, the peak selectivity parameters for the Rec East and Rec West fleets were fixed at values estimated by the base model. These selectivity parameters were not correlated with any of the profiled parameters, nor should they be influenced by population dynamics. In the interest of time, all runs were considered, even those that had high gradients or non-positive definite hessians.

4.7.4.1 Steepness

Profiled values of steepness varied from 0.5 to 0.99 in increments of 0.01. The effect of varying fixed *steepness* values on the total log-likelihood (LL) value is presented in **Figure 58**. The jaggedness of the curve suggests that some runs did not converge to a global minimum. The base run estimated steepness (=0.64) resulted in the lowest LL value, however the change in LL values is less than two for a wide range of steepness values from approximately 0.54 to 0.85 (**Figure 58**).

There was some observed conflict among model components (**Figure 59**). Recruitment was the most informative model component, followed by fits to the indices. Fits to landings favored lower *steepness* values, while fits to age data improved with higher steepness values. Fits to length compositions and discards were largely uninformative of *steepness*.

However, there was little model sensitivity to changes in *steepness* values as characterized by model estimates of spawning stock biomass and particularly age-3 fishing mortality rates (**Figure 60**). For *steepness* values greater than 0.60, there were modest differences in spawning stock biomass relative to $SSB_{30\%SPR}$ and age-3 fishing mortality rates relative to $F_{30\%SPR}$ (**Figure 61**).

4.7.4.2 Unfished Recruitment

Profiled values of unfished recruitment (ln(*R0*)) ranged from 6 to 11 in increments of 0.05. The total LL value is the lowest for the base run estimated unfished recruitment ln(*R0*) (7.83; **Figure**

62), however this analysis suggests there is equal model support for unfished recruitment values between 7.25 and 8.50. Yet, there is undoubtedly poor convergence for some values of ln(*R0)* as shown by the high variability in log-likelihood values. As with *steepness*, recruitment is the most informative of ln(*R0)* (**Figure 63**). Except for particularly low values of ln(*R0*) (i.e., less than 7.10), changes in ln(R0) do not appear to affect the log-likelihood of other model components (**Figure 63**).

Derived model quantities such as spawning stock biomass and fishing mortality rates were moderately sensitive to intermediate values of unfished recruitment (**Figure 64**). Model runs with low values of ln(*R0)* less than 7.25 may have not converged as suggested by outlying high or low values of spawning stock biomass and fishing mortality rates. Base model estimates of spawning stock biomass relative to $SSB_{30\%SPR}$ ranged from nearly 1.5 to over 2.5 in the 2023 terminal year across profiled values of ln(*R0*) (**Figure 65**), however the range of age-3 fishing mortality rates relative to $F_{30\%SPR}$ was comparatively narrow for most runs (**Figure 65**).

4.7.4.3 Average Natural Mortality

Natural mortality relates directly to stock productivity and reference points, making it one of the most influential parameters in fisheries stock assessment and management. Yet, it is difficult to estimate and remains a large source of uncertainty within most stock assessment models (Maunder et al. 2023). The parameterization of natural morality-at-age in the SEDAR 79 Base Model (via the Lorenzen option) allows the average natural mortality for ages 3-40 (*Base M*) to be profiled upon to gauge the influence of this largely unknown value on model results.

Profiled values of average natural mortality for ages 3-40 (*Base M*) ranged from 0.05 to 0.50 in increments of 0.01. The total LL value was marginally improved when *Base M* was slightly less than the assumed fixed value of 0.129 (0.11 or 0.12), however there was essentially equal model support for a wide range of *Base M* values between 0.05 and 0.18 (**Figure 66**). Conversely, the model did not support *Base M* values beyond 0.20, indicating that there was some degree of information on natural mortality across all data sources.

The resulting change in log-likelihood values by model component suggests there is some data conflict between the length, age, and index information versus the landings and discards, as fits to the landings and discards were improved with higher *Base M* values (**Figure 67**).

The high level of influence of *Base M* was evident by the exceptionally wide range of spawning stock biomass estimates and fishing mortality rates across the profiled runs (**Figure 68**). There appears to be a stark bifurcation of spawning stock biomass estimates once *Base M* exceeds 0.19. Correspondingly, spawning stock biomass relative to $SSB_{30\%SPR}$ and age-3 fishing mortality rates relative to $F_{30\%SPR}$ also exhibit wide ranges (**Figure 69**). Once Base M approaches 0.17, spawning stock biomass relative to $SSB_{30\%SPR}$ becomes exceedingly high ($SSB/SSB_{30\%SPR} > 6$).

4.7.5 Model Consistency

To measure model consistency, the SEDAR 79 Base Model was first subject to a retrospective analysis that removed successive years of data from the model for seven years (i.e., removing data for 2023, 2022-2023…, and lastly 2017 - 2023) to determine the effect of recent years on model results. This analysis was also paired with one-year-ahead projections (see Carvalho et al. (2021) for additional details).

Mohn’s Rho is a measure of the severity of bias in the retrospective patterns and the forecast bias is an estimate of bias in the forecasted quantities when years of data were removed. The rule of thumb proposed by Hurtado-Ferro et al. (2015) is that for long-lived species, Mohn’s Rho values should fall between -0.15 and 0.20.

A retrospective plot of spawning stock biomass indicated a minor retrospective pattern, as estimates of spawning stock biomass based on data through 2021 were slightly higher than those estimated with additional data from 2022 and 2023 (**Figure 70**). Likewise, the retrospective plot of age-3 fishing mortality rates displayed slightly higher rates from 2012-2016 when data through 2022 or 2023 were incorporated (**Figure 70**).

According to the rule of thumb, the results of the retrospectives illustrated acceptable levels of retrospective bias and forecasting bias in spawning stock biomass (Mohn’s Rho of 0.12 and Forecasting Bias of 0.13) and age 3 fishing mortality rates (Mohn’s Rho of 0.02 and Forecasting Bias of -0.17; **Table 20** and **Figure 70**). The forecasting bias in fishing mortality rates was elevated (-0.17), which suggests that forecasts of fishing mortality rates were consistently less than realized values.

The results from the ASPM indicate that, for at least some of the timeseries, there is enough information in both the catch and index data for the production function to largely drive the stock dynamics as the general trends and scale of the ASPM and the SEDAR 79 Base Model align after 1998, when many of the indices become available (**Figure 71**). Early in the timeseries, the ASPM estimates a pronounced increase in spawning stock biomass from 1981 to 1991 followed by a steep decline through 1999, whereas the base model estimates remain mostly flat through 1991 and decrease slightly through 1999 (**Figure 71**). Fits to the indices were overall much worse by the ASPM compared to the SEDAR 79 Base Model (**Table 21**), highlighting the reliance on recruitment deviations to fit the indices. The only index that showed a substantially better fit by the ASPM was the FIM YOY index (RMSE = 74% for the base model and RMSE = 58.4% for the ASPM; **Table 21**). This may be due to the high variability in the FIM YOY index so that it is better fit by a slightly increasing constant trend and may suggest that variability in the FIM YOY index is at odds with the signal from the other indices.

When recruitment deviations were included in an ASPM (i.e., ASPMdev), fits to most indices were improved and were even comparable or superior to the index fits associated with the base model (**Table 21**). The trends in the estimated spawning stock biomass, recruitment, and fishing mortality rates closely resembled those estimated by the base model, however the ASPMdev model estimated higher spawning stock biomass and recruitment and lower fishing mortality rates than the base model (**Figure 71**). This may suggest the early length and age information informs the scale of the base model and without it, initial apical fishing mortalities rates are lower in the age-structured production models, particularly for the initial fishing mortality rate for the Rec East fleet (**Figure 72**).

4.7.6 Model Validation (Prediction Skill)

Prediction skill of the SEDAR 79 Base Model was assessed using the hindcasting cross-validation approach of Kell et al. (2021), which compares observations to their predicted future values. Mean absolute scaled error (MASE) of prediction residuals of indices, length compositions, and conditional age-at-length was calculated using nine one-step ahead hindcasting cross-validations.

MASE values for the RVC Dry Tortugas and FIM YOY indices were near 0.50 (MASE = 0.47 and 0.54, respectively; **Table 22**) which implies the base model predicts these indices about twice as accurately as a naïve baseline prediction. The SERFS video index also had a MASE score < 1 suggesting some predictive capacity of the base model. Both the RVC FL Keys and Gulf Combined Video indices had MASE scores slightly higher than 1 (MASE = 1.16 and 1.17, respectively; **Table 22**), while the RVC SE FL index was not predicted well by the base model (MASE = 1.88). Overall, the base model outperformed a naïve forecast (joint MASE = 0.81; **Table 22**).

MASE values for length compositions were generally very high, typically indicating poor predictive capacity. However, since the mean absolute errors of the prediction residuals are all minimal (< 0.05), the predictions by the base model are accurate (**Table 22**). Similarly, the MASE values for the conditional age-at-length (CAAL) data also demonstrated low mean absolute errors and all CAAL data sources were better predicted by the base model than a naïve baseline prediction (joint MASE = 0.58; **Table 22**).

4.7.7 Sensitivity Runs

Sensitivity runs were conducted to investigate the impact of alternative assumptions or data sets on model fits and results. Results for key sensitivity runs are presented below, but many additional exploratory runs were also implemented.

4.7.7.1 Remove S-R curve (Steepness ≈ 1)

Due to the inherent uncertainties surrounding the stock-recruitment relationship, Maunder and Thorson (2019) recommend that assessments using a stock-recruitment relationship compare the performance with a model that avoids specifying such a relationship and instead assumes a relationship functioning as average recruitment across time (i.e., fixing steepness at 0.99). For this sensitivity run, the peak selectivity parameters for the Rec East and Rec West fleets were fixed to improve convergence (i.e., lower the gradient). Since these selectivity parameters were not correlated with any life history or stock-recruit parameters, it should only lead to improved convergence without affecting the results of this sensitivity run.

Assuming constant mean recruitment throughout the time series led to a 2.82-point increase in the overall log-likelihood (1490.83), suggesting essentially equal model support as when estimating steepness. However, the trend in recruitment deviations increased from 1993 to 2021 which may indicate model misspecification (Merino et al. 2022), and the uncertainty associated with derived quantities decreased (e.g., retained yield at $F_{30\%SPR}$). **Figure 73** illustrates that most derived quantities for this sensitivity run (i.e., recruitment deviations, spawning stock biomass, fishing mortality rates, and reference points) remained within the confidence intervals of estimates from the SEDAR 79 Base Model. Fishing mortality rates were largely unaffected by fixing steepness at 0.99, while spawning stock biomass and $SSB_{F30\%SPR}$ decreased slightly. Recruitment deviations were modestly lower from 1993 to 2003, and somewhat higher in 2020 and 2021, while estimates of retained yield at $F_{30\%SPR}$ decreased slightly and was associated with much less uncertainty (**Figure 73)**.

4.7.7.2 Release Mortality

Sensitivity runs examining the effect of alternative release mortality rates were performed. This was completed by configuring the fixed parameter inputs in the release mortality equation (Section 3.1.10 above) to produce the respective release mortality rates for each fleet. For all fleets, the upper bound sensitivity was set at 45% and the lower bound was set at 15%, so that the release mortality assumption in the base model of 30% is an intermediary estimate.

As evidenced in **Figure 74,** the greatest change as a result of alternative release mortality rates occurred for estimates of $F_{30\%SPR}$, 75%$SSB_{30\%SPR}$, and recent fishing mortality rates since 2018 (coinciding the with 18-inch minimum size limit). Assuming a release mortality rate of 15% lowered recent fishing mortality rates and $F_{30\%SPR}$, while conversely assuming a release mortality rate of 45% increased recent Fs and $F_{30\%SPR}$ relative to the base model. There was less sensitivity in the $SSB_{30\%SPR,}$ annual spawning stock biomass, and recruitment deviations. As expected, the base model results were intermediate between these two sensitivity runs.

4.7.7.3 MRIP-FES Private Mode Landings & Releases

The sensitivity of model results to MRIP FES estimates of private mode landings and releases in Florida in lieu of SRFS estimates was also evaluated. The MRIP FES estimates of private mode landings and releases in Florida were on average nearly twice (1.89) as high as SRFS estimates in the East region (SE FL and North) and those in the West region (FL Keys and Gulf) were almost three times (2.78) as high as SRFS estimates. All other data inputs remained the same between the base model and the 'MRIP-FES' sensitivity run.

The effect of solely increasing the scale of landings and releases on model results was as expected. Estimated fishing mortality rates, $F_{30\%SPR}$, and recruitment deviations were largely unaffected and were therefore comparable between the two models, while spawning stock biomass and $SSB_{F30\%SPR}$ increased in tandem (**Figure 75**). The retained yield at $F_{30\%SPR}$ also increased relative to the base model estimate (**Figure 75**). Hence, fishing mortality rates relative to $F_{30\%SPR}$ and spawning stock biomass relative to $SSB_{F30\%SPR}$ were effectively equivalent among the two models (**Figure 76**).

4.7.7.4 Jack-Knife Analysis on Indices of Abundance

The effect of each index of abundance on the SEDAR 79 Base Model estimates was evaluated by removing indices one at a time and refitting the base model. This analysis identified the fishery independent RVC FL Keys index as having a dampening effect on the magnitude of spawning stock biomass, as without it, the rate of increase in spawning stock biomass estimates from 2009 to 2012 was greater relative to the base model (**Figure 77**) On the other hand, if either the fishery-dependent commercial longline index or the fishery independent RVC SE FL and Dry Tortugas indices were removed, the spawning stock biomass decreased relative to the base model. Estimates of $SSB_{F30\%SPR}$ were marginally sensitive to the removal of indices. The removal of the FIM YOY index resulted the greatest increase in $SSB_{F30\%SPR}$, while the removal of either the RVC Keys or Gulf Combined Video led to slight increases in $SSB_{F30\%SPR}$. Fishing mortality rates showed an opposite but less pronounced pattern, whereby the removal the RVC Keys index reduced fishing mortality rates slightly since 2006 and vice versa when the RVC SE FL or commercial longline indices were removed. Estimates of $F_{30\%SPR}$ were largely unaffected by the removal of indices (**Figure 77**).

Note, however, that many of the jack-knife runs fell within the bounds of uncertainty of the base model (**Figure 77**). Also, most runs had a maximum gradient > 0.0001 and extensive tests of model convergence (e.g., jitter analysis) were not performed.

4.7.8 SEDAR 79 Base Model and SEDAR 15AU Comparison

While there are substantial differences in the configuration of the SEDAR 79 Base Model in Stock Synthesis and SEDAR 15AU implemented in ASAP, the magnitude of the landings is very similar even though the recreational landings are in two different currencies (MRFSS versus MRIP-FES & SRFS).

The estimated selectivity at age is overall similar between the two assessments for the Commercial Longline and Commercial Other/H&L fleets (**Figure 78**). Likewise, the selectivity-at-age for the Rec East fleet estimated by the SEDAR 79 Base Model resembles that of the MRFSS and Headboat fleet in SEDAR 15AU. However, the selectivity-at-age for the Rec West fleet in the SEDAR 79 Base Model is much higher at older ages compared to the MRFSS and Headboat fleet selectivities in SEDAR 15AU (**Figure 78**).

A comparison of the SEDAR 79 Base Model to SEDAR 15AU shows comparable magnitudes of spawning stock biomass estimates, especially from 1996 to 2013 (**Figure 79**), but SEDAR 15AU predicts somewhat lower spawning stock biomass prior to 1996. According to the SEDAR 79, the stock began to recover in 2001 from an all-time low in 1999 - 2000, whereas the SEDAR 15AU model predicted an earlier start to the recovery (1995). The number of Age 1 recruits is also similar from 1981 through 1997, but in following years the number of recruits predicted by the SEDAR 79 Base Model is generally greater and more variable (**Figure 79**).

Age-3 fishing mortality rates estimated by SEDAR 15AU are mostly higher than those estimated by the SEDAR 79 Base Model prior to 1993, but they are very similar in trend and magnitude after that time. The age-3 fishing mortality rate associated with 30%SPR ($F_{30\%SPR}$) is somewhat lower for SEDAR 79 (0.15; see section 4.3.10) compared to SEDAR 15AU (0.18), while the spawning stock biomass associated with $F_{30\%SPR}$ in SEDAR 15AU is much less (2,108.8 metric tons or 4,649,200 lbs) than that for SEDAR 79 (3,352 metric tons or 7,389,895 pounds; see section 4.3.10; **Figure 79**). This is the main reason spawning stock biomass relative to 75% of $SSB_{30\%SPR}$ differs between the two assessments (**Figure 80**). From 2010 to 2013, the SEDAR 79 Base Model estimated spawning stock biomass was at or just above 75% of $SSB_{30\%SPR}$, while SEDAR 15AU estimated spawning stock biomass to be about 1.5 times 75% of $SSB_{30\%SPR}$ (**Figure 80**).

4.7.9 SEDAR 15AU with MRIP-FES Data

For the first exploratory run (’S15AU_MRIPcatch’), all inputs from SEDAR 15AU were kept unchanged except for replacing the MRFSS landings and discards with MRIP-FES estimates provided for SEDAR 79. The spawning stock biomass using SEDAR 79 data is higher in all years except 2013 (**Figure 81**). While estimated spawning stock biomasses are very similar with the greatest difference occurring at the beginning of the time series, the spawning stock biomass at 30%SPR is much higher when using SEDAR 79 data (**Figure 81**) resulting in an overfished status throughout the entire time series while the original SEDAR 15AU status was not overfished at the beginning and end of the time series (**Figure 81**). This result was unexpected, as an increase in the scale of the landings and releases typically increases both annual spawning stock biomass estimates and reference points, so that stock status remains unchanged.

Fishing mortality rates behaved similarly to spawning stock biomass with the MRIP-FES landings and releases data, as fishing mortality rates were fairly similar to SEDAR 15AU but slightly elevated across the time series (**Figure 82**). However, the fishing mortality at 30%SPR reference point is slightly higher but relatively close to the original reference point (**Figure 82**). As a result, the overfishing statuses over time are the same or shifted slightly by a year (**Figure 82**).

For the next exploratory model, all remaining ASAP model components related to the MRFSS fleet were updated using SEDAR 79 data (model name =’S15AU_MRIPcatch_plus’). This included the MRIP-FES landings and discards, in addition to updated catch and discard proportion catch at age and updated catch and discard weight-at-age. Results are presented in **Figures 83-84**. The spawning stock biomass using SEDAR 79 data follows the same overall pattern and similar values only after 1994. Prior to 1994 the spawning stock biomass increased while the original SEDAR15AU model decreased. The spawning stock biomass at 30%SPR is higher when using SEDAR 79 data resulting in an overfished status for the entire time series. The original SEDAR 15AU status was not overfished at the beginning and end of the time series (**Figure 83**). Fishing mortality rates behaved similarly to spawning stock biomass with the SEDAR 79 data fairly similar to the SEDAR 15AU original but slightly elevated across most of the time series. However, with the fishing mortality at 30%SPR reference point, the value is slightly lower but relatively close to the original reference point. As a result, the overfishing statuses over time are less frequent (**Figure 84**).

4.7.10 Model Bridging

For this exercise, all of the models converged, and the gradients were reasonable ranging from 5.45 e-05 to 0.0003. When fleet-specific mean weight matrices by age and year are included in the model, the spawning biomass at $F_{30\%SPR}$ went up from 2,076 mt in the base model to 2,389 mt and the fishing mortality rate at 30%SPR decreased slightly but the 3-year geometric mean of the fishing mortality rates on Age-3 fish increased from 0.12 yr^{-1} to 0.16 yr^{-1} (**Table 23; Figure 85b**). The fishing mortality rate on Age-3 fish is the age when fish are fully selected on average although the actual selectivity depends upon the gear, habitat, and experience of the fisher or angler. The spawning biomass with the fleet- specific mean weights was also higher initially and then lower after 1995 (**Figure 86a**), the average fishing mortality correspondingly was lower (**Figure 86b**), and recruitment was slightly higher (**Figure 86c**).

The next model increment was to replace the landings of recreational fleets defined by fishing mode, headboat or MRFSS/MRIP, with fleets defined by combining the modes but separating them by coast with north of the Keys being the Recreational East fleet and the Florida Kest west to the Gulf of Mexico being the Recreational West fleet. The addition of the redefined recreational fleets markedly decreased the spawning biomass at F30%SPR that went down from 2,389 mt in the mean weights model to 2,148 mt and the fishing mortality rate at 30%SPR declined to 0.04 yr^{-1} while the 3-year geometric mean of the fishing mortality rates on Age-3 fish declined from 0.16 yr^{-1} to 0.08 yr^{-1} (**Table 23; Figure 86c**). The spawning biomass with the fleet- specific mean weights and redefined recreational fleets was much higher (**Figure 86a**), the average fishing mortality was correspondingly lower (**Figure 86b**), and recruitment was similar (**Figure 86c**).

The final model was to use the indices that the SEDAR 79 Data Workshop approved but to use the SEDAR 15AU versions. The effect of using only three indices was to raise the spawning biomass at $F_{30\%SPR}$ from 2,148 mt in the mean weight and landings model to 2,782 mt and the fishing mortality rate at 30%SPR went down only 0.02 $yr^{-1}$and the 3-year geometric mean of the fishing mortality rates on Age-3 fish declined from 0.08yr^{-1} to 0.06yr^{-1} (**Table 23; Figure 86c**). The spawning biomass with the three indices was lower than the configuration with the mean weights and the revised landings (**Figure 86a**), the average fishing mortality correspondingly was slightly higher (**Figure 86b**), and recruitment was similar initially then higher since 2001 (**Figure 86c**).

4.7.11 Per-recruit Analysis

The yield-per-recruit (YPR), spawner-per-recruit (SSB/R), static spawning potential ratio (SPR), and total equilibrium yield analyses were computed as a function of the instantaneous fishing mortality rate on age-3 Mutton Snapper (**Table 24** and **Figure 87**). Presented with these values is also their relation to the Maximum Fishing Mortality Threshold (MFMT) defined as $F_{30\%SPR}$ (=0.149 y^{-1}). The amount of retained yield of Mutton Snapper at equilibrium associated with $F_{30\%SPR}$ was estimated by the SEDAR 79 base model to be at 681.87 metric tons (1,503,266 pounds whole weight), while the amount of total yield of Mutton Snapper associated with F30%SPR was estimated to be 819.98 metric tons (1,807,755 pounds whole weight).

4.8 Stock Status

The equilibrium fishing mortality rates that achieve 30%SPR ($F_{MSYproxy}$, $F_{30\%SPR}$) and 40%SPR (FOY, $F_{40\%SPR}$), as well as the associated reference spawning stock biomasses ($SSB_{30\%SPR}$, $SSB_{40\%SPR}$), were determined through long-term 100-year projections, assuming that equilibrium was obtained in the final 10 years of the projection (2114-2123). These long-term projections assume that recruitment in the first year and every year thereafter follows the stock-recruit curve, as recommended by Van Beveren et al. (2021).

The resulting status determination criteria (SDCs) for Mutton Snapper specified in SAFMC Amendments 11 and 41 are summarized below

- MSY proxy = Retained yield at $F_{30\%SPR}$ = 681.87 metric tons (1,503,266 pounds whole weight) or 290,915 fish.
- MSST = 0.75*$SSB_{30\%SPR}$ = 2,514 metric tons
- MFMT = $F_{MSYproxy}$ ($F_{30\%SPR}$) = 0.149
- F_{OY} = $F4_{0\%SPR}$ = 0.11
- OY = Retained Yield at $F_{40\%SPR}$ = 276.51 metric tons (609,600 pounds)

Overfishing is defined as F > MFMT and overfished as SSB < MSST. The current condition of the stock is represented by the geometric mean of SSB ($SSB_{current}$) from the last three years (2021–2023), and the current condition of the fishery is represented by the geometric mean of F ($F_{current}$) from the last three years (2021–2023). These benchmarks are conditional on the estimated selectivity functions and the relative contributions of each fleet's fishing mortality averaged over the last three years (2021 – 2023).

According to the SEDAR 79 Base Model, the Southeastern US Mutton Snapper population is not currently undergoing overfishing ($F_{Current}$ < MFMT) and is not overfished ($SSB_{current}$ > MSST) (**Table 25**; **Figures 88-89**). The current spawning stock biomass is 5,403 metric tons (geometric mean of 2021-2023) is above $SSB_{30\%SPR}$ at 161% of the biomass level needed to support MSY (**Figure 89**). The current fishing mortality rate is 0.08 (geometric mean of 2021-2023), which is equivalent to 53% of $F_{30\%SPR}$ (**Figure 89**).

Throughout the time series, age-3 fishing mortality rates have been variable and have been above $F_{30\%SPR}$ in numerous years prior to 2018 (**Figure 88-89**; **Table 15).** The base model estimated the lowest fishing mortality rates in 2011 and then from 2018-2023. During the 1980s, spawning stock biomass was at or near the MSST before declining below the MSST through 2010; however, since 2017 spawning stock biomass has rapidly increased beyond $SSB_{30\%SPR}$ although the uncertainty is greatest in recent years (**Figure 88-89**; **Table 16).**

4.8.1 Projections

Several short-term projection scenarios explored the effects of various fishing mortality conditions. The scenarios investigated when fishing mortality rates were either held constant at $F_{30\%SPR}$ (MFMT=0.149), 75% of $F_{30\%SPR}$ (= 0.112), or $F_{current}$ (=0.08). The TORs also state to evaluate the projected spawning stock biomass when catch is held constant at the equilibrium yield at $F_{40\%SPR}$, however, $F_{40\%SPR}$ is nearly equivalent to 75% of $F_{30\%SPR}$. Short term (i.e., 10 year) projections were produced assuming predicted age 1 recruitment was equal to the geometric mean of base model estimates from 2019-2023 (3.284 million fish). While only the first 5 years of the short-term projection are recommended for use, projections were extended into the future (i.e., until 2033).

Both short- and long-term projections assumed relative fishing mortality rates in the projection period were equal to the average from 2021-2023 (Com LL = 0.016, Com Other = 0.014, Rec East =0.75, Rec West = 0.22).

Short term projections were compared to long term projections that assumed recruitment followed the stock-recruit relationship in *all* projection years (i.e., 2024 – 2033). As shown in **Figure 90**, the instantaneous age-3 fishing mortality remains the same into the future for both the long- and short-term projections; however, the predicted recruitment is much greater compared to the long-term projection that assumed recruitment followed the stock-recruit relationship due to the recent above average recruitment (**Figure 91**). The differences among predicted spawning stock biomass in these two scenarios are illustrated in **Figure 92**.

The resulting retained yield and retained number of Mutton Snapper associated with $F_{30\%SPR}$ with either predicted recruits that equal to the recent average recruitment (i.e., short-term) or that follow the stock-recruit relationship (i.e., long-term) are presented in **Figure 93** and **Table 26**. From 2024 – 2028, retained yield (in pounds) for the short-term scenario was well beyond historical yields, as projected yields ranged from 3.27 million pounds to 3.38 million pounds and historical yields averaged 1.1 million pounds with a maximum of 2.4 million pounds in 2008. Retained yield (in pounds) for the other short-term projection scenarios associated with 75% of $F_{30\%SPR}$ and $F_{current}$ averaged 2.68 million pounds and 2.05 million pounds, respectively (**Figure 94**).

5. DISCUSSION

The SEDAR 79 Benchmark Assessment incorporated a decade of new data since the previous assessment (SEDAR 15AU; terminal year = 2013) and all historical data were procured and recompiled following SEDAR Data Best Practices as closely as possible. This assessment also revised estimates of recreational landings and discards (via SRFS and SRFS-calibrated data for the Florida private mode and MRIP-FES data for charter, shore, and non-FL private modes), reanalyzed reproduction data according to recent recommendations (Lowerre-Barbieri et al. 2022), incorporated recent methods to estimate natural mortality (Hamel and Cope 2022; Lorenzen 2022), revised release mortality rates to account for delayed mortality (Ramsay et al.

2022), and added additional fishery-independent indices of abundance while simultaneously removing several fishery-dependent CPUE timeseries.

In terms of the modelling framework, the transition from ASAP version 3 to Stock Synthesis version 3.30.22.1 required less external processing of data inputs (e.g., landings and releases can be in numbers, internal growth estimation and catch-at-age calculation), allowed for additional options for model configuration (e.g., various selectivity and retention function types by length and/or age, internal bias correction of recruitment deviations), and the application of additional model diagnostics (e.g., jitter analysis, parameter profiling, model validation). The transition to Stock Synthesis addressed many of the SEDAR 15AU Review Panel concerns with the ASAP model.

There were numerous configuration changes, but a key one was the reconfiguration of the recreational fleet. The recreational fleet configuration for SEDAR 79 Base Model grouped the headboat data with data from private, shore, and charter but split the recreational fleet into an East (i.e., SE FL and north) and West (i.e., FL Keys and Gulf) fleet to account for the apparent differences in selectivity between these two regions.

Overall, the SEDAR 79 Base Model appears to perform well, and the results of the model diagnostics suggest the base model may be suitable for use in the management of Mutton Snapper. The jitter analysis, low gradient (<0.0001), and invertible hessian lend support that the base model converged to a global solution. The base model demonstrated adequate fits to the various data components, although some residual patterns were noted (e.g., fits to Rec West landings and releases). Some of the data streams revealed very large residuals in terms of magnitude, including the FIM YOY and SERFS surveys. The FIM YOY index, however, may have low power to detect changes in abundance and the SERFS survey does not have associated length or age information to inform selectivity. The base model also exhibited model consistency as the removal of successive years of data showed minimal retrospective bias in estimates of fishing mortality rates and spawning stock biomass. Profile likelihood analyses provided support for the SEDAR 79 Base Model estimates of steepness, ln(R0), and the assumed average natural mortality. Retrospective forecasting and the hindcast cross-validation techniques also suggested the base model exhibited more predictive skill than a random-walk overall.

The dominant data inputs were the length and age compositions as these produced the greatest impact on the model fit (as measured in the total likelihood), however the ASPM and ASPMdev suggested that much of the support for estimates of absolute abundance and trend originated from the catch information and the variability in recruitment.

The MRIP-FES sensitivity run illustrated the sensitivity of the absolute scale of estimated abundance to the scale of landings and releases but importantly, estimates of fishing mortality rates and spawning stock biomass relative to management reference points remained largely unaffected. This model behavior was not portrayed by the SEDAR 15AU Final Model as only the estimate of $SSB_{30\%SPR}$ was primarily impacted by increases in MRIP-FES landings and releases. This led to a change in the overfished status determination (**Figure 81**). Model explorations and model bridging exercises that revised either SEDAR 15AU data inputs or the model configuration did not fully explain these results.

Estimates of absolute abundance are always the most uncertain, as they hinge on unknown quantities (i.e., natural mortality, equilibrium conditions) and potentially imprecise catch (landings and dead releases) values. However, the rapid increase in Mutton Snapper spawning stock biomass and recruitment in recent years, which is quite remarkable, is supported by the fishery independent indices, as most are at least 1.5 times the overall mean since 2020. The robust Southeastern US Mutton Snapper population in recent years may be a reflection of successful management measures enacted in 2018, coupled with potentially favorable environmental conditions for summer spawners such as Mutton Snapper (Shertzer et al. unpublished).

6. ACKNOWLEDGEMENTS

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7. RESEARCH RECOMMENDATIONS

This assessment, as well as many others, would greatly benefit from a better understanding of movement and stock structure, as well as recent reproduction. A better understanding of these processes may shed light on the mechanisms driving the truncated length and age distributions of Mutton Snapper observed in southeast FL. The SEDAR 79 Data Workshop report includes an extensive list of research recommendations from each working group that should be prioritized (Sections 2.11, 3.8, 4.8, 5.6).

Regarding fishery sampling effort, the next assessment would benefit from additional sampling in the FL Keys, increased sampling of commercial vertical line and other gears, additional age and length samples from private and shore recreational modes, and more information on release sizes. The length and age distributions of landed Mutton Snapper in the FL Keys appear to be intermediary between generally smaller/younger fish caught in SE FL and larger/older fish caught in the Dry Tortugas, however the FL Keys are considerably under sampled in most years. For commercial vertical line and other gears, increase the number of measured Mutton Snapper to at least 320 per year. An average of approximately 20 per month from January through August and 40 per month from September through December, especially from vessels fishing in the FL Keys and Dry Tortugas. Additional age and length samples from private and shore recreational modes are also needed. Increase length sampling in all regions for the shore mode and begin aging Mutton Snapper landed by the shore mode. For both the private and shore recreational modes, increase length sampling substantially in regions west of the FL Keys and the FL Keys to at least 150 per year and continue sampling the SE FL with the goal of reaching at least 150 per year. Also, the private and shore modes account for nearly all releases but do not contribute release lengths, undoubtedly due to the logistical challenges of sampling releases from these fishing modes.

Lastly, reliable estimates of commercial discards are currently lacking. Estimates of commercial discards from at-sea observers or other sources that are demonstrated to be more reliable than discard logbooks are needed.

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9. TABLES

Table 1. Updated number of age-length pairs of Mutton Snapper by year, fishery, and region for use in the development of conditional age-at-length data. Ages sampled from tournaments or recreational longline were not included.

Year	East (SE FL and North)				West (FL Keys and Gulf)				Total
	COM LL	COM OTHER	REC	FI	COM LL	COM OTHER	REC	FI	
1981	0	0	86	0	0	0	63	0	149
1982	0	0	65	0	0	0	104	0	169
1983	0	0	4	0	0	0	0	0	4
1984	0	0	32	0	0	0	0	0	32
1985	0	0	87	0	0	0	1	0	88
1986	0	0	33	0	0	0	0	0	33
1987	0	0	14	0	0	0	0	0	14
1988	0	0	33	0	0	0	0	0	33
1989	0	0	0	0	0	0	0	0	0
1990	0	0	6	0	0	0	0	0	6
1991	0	0	7	0	0	0	4	0	11
1992	0	46	5	0	1	6	0	0	58
1993	0	36	21	0	11	0	32	0	100
1994	0	58	10	0	5	0	19	0	92
1995	2	33	104	0	1	0	22	0	162
1996	0	150	10	0	0	0	14	0	174
1997	0	205	8	0	24	0	12	0	249
1998	0	191	0	204	3	8	0	0	406
1999	0	219	0	141	5	0	0	21	386
2000	0	201	3	152	9	1	1	113	480
2001	0	252	38	67	52	6	1	147	563
2002	0	308	84	60	93	9	34	49	637
2003	0	256	324	0	144	4	10	0	738
2004	0	145	247	0	135	21	15	0	563
2005	0	160	451	0	166	18	54	0	849
2006	0	88	234	0	401	47	77	0	847
2007	0	49	599	2	230	14	77	2	973
2008	0	232	487	0	208	133	317	7	1384
2009	0	164	613	0	136	114	481	6	1514
2010	0	401	667	0	365	115	372	6	1926
2011	0	435	356	0	227	108	379	3	1508
2012	0	123	129	5	260	203	504	4	1228
2013	0	72	111	0	255	188	363	4	993

2014	0	81	306	1	287	171	314	2	1162
2015	0	38	288	1	162	135	382	2	1008
2016	0	75	331	3	121	90	668	8	1296
2017	0	49	204	0	236	81	499	6	1075
2018	0	84	161	13	337	122	559	6	1282
2019	0	219	129	17	89	126	272	3	855
2020	0	387	19	14	17	133	31	1	602
2021	14	319	103	52	35	137	77	8	745
2022	9	414	188	23	241	42	155	56	1128
Total	25	5490	6597	755	4256	2032	5913	454	25522

Table 2. Commercial landings in weight (metric tons whole weight, mt) for the Commercial Longline and Other fleets, with log-scale standard errors (log SE) and the number of releases (1000s) for the Commercial Other fleet with associated standard errors (SE).

Year	Commercial LL		Commercial Other			
	Landings (mt)	log SE	Landings (mt)	log SE	Releases (1000s)	SE
1981	28.107	0.09	105.948	0.06		
1982	43.172	0.09	105.558	0.06		
1983	36.169	0.08	98.710	0.07		
1984	23.197	0.07	86.492	0.06		
1985	20.691	0.07	78.431	0.06		
1986	54.326	0.06	132.036	0.06		
1987	85.465	0.06	166.559	0.06		
1988	53.409	0.06	153.796	0.05		
1989	77.255	0.07	172.553	0.06		
1990	59.852	0.06	147.193	0.06		
1991	66.196	0.06	153.394	0.06		
1992	33.484	0.07	148.390	0.07		
1993	34.061	0.07	168.166	0.06	5.654	0.49
1994	22.633	0.07	139.680	0.07	6.628	0.52
1995	20.717	0.06	108.485	0.06	7.58	0.59
1996	23.013	0.08	109.286	0.06	6.801	0.54
1997	26.575	0.08	106.089	0.06	6.991	0.52
1998	36.016	0.07	125.411	0.06	5.706	0.49
1999	33.641	0.07	81.168	0.05	5.815	0.53
2000	33.420	0.07	59.404	0.05	5.922	0.53
2001	41.839	0.04	63.844	0.03	4.713	0.42
2002	36.160	0.04	69.834	0.03	4.921	0.40
2003	50.441	0.03	70.634	0.03	4.322	0.38
2004	89.358	0.03	68.062	0.03	4.157	0.39
2005	54.666	0.03	52.718	0.03	3.5	0.33

2006	88.014	0.04	42.188	0.03	3.613	0.35
2007	58.609	0.04	41.749	0.03	3.505	0.30
2008	33.533	0.03	37.874	0.04	3.127	0.25
2009	14.708	0.03	40.094	0.03	4.379	0.41
2010	16.321	0.04	41.826	0.03	3.975	0.41
2011	24.792	0.04	47.329	0.02	3.31	0.26
2012	24.144	0.05	51.119	0.03	3.555	0.31
2013	38.774	0.04	43.378	0.03	4.204	0.41
2014	56.418	0.03	46.973	0.02	5.794	0.64
2015	50.626	0.03	51.400	0.02	6.731	0.80
2016	26.161	0.03	42.015	0.03	4.934	0.52
2017	43.365	0.05	43.628	0.03	3.863	0.37
2018	51.543	0.04	49.579	0.03	5.831	0.62
2019	20.874	0.04	41.203	0.02	6.339	1.06
2020	22.620	0.05	41.780	0.03	6.194	1.10
2021	21.982	0.04	34.567	0.03	5.849	1.11
2022	25.442	0.04	33.645	0.02	4.472	0.68
2023	38.213	0.04	34.367	0.02	5.505	0.96

Table 3. SRHS and MRIP landings in numbers (1000s) by mode: Headboat (HB), Charter (CH), Shore (SH), FL Private (FL PR), and Non-FL Private (non-FL PR).

Year	East (SE FL and North)						West (FL Keys and Gulf)					
	HB	CH	SH	FL PR	non-FL PR	Total	HB	CH	SH	FL PR	non-FL PR	Total
1981	24.093	9.662	293.154	78.484	0.000	405.393	21.797	6.913	34.738	540.684	0.000	604.133
1982	17.766	14.777	341.195	84.113	0.000	457.850	13.370	22.495	3.899	281.404	0.000	321.168
1983	10.778	8.152	361.239	87.083	0.000	467.252	18.006	2.893	64.275	51.106	0.000	136.280
1984	6.598	3.175	0.000	222.392	0.000	232.164	10.912	29.579	27.776	421.883	0.000	490.150
1985	10.195	1.285	0.000	63.913	0.000	75.393	11.297	9.900	40.648	0.000	0.000	61.845
1986	8.650	0.225	0.000	74.203	0.000	83.078	12.415	14.194	12.858	301.662	0.000	341.129
1987	10.224	0.000	90.134	102.767	0.000	203.125	10.358	10.653	19.405	368.432	0.000	408.848
1988	17.244	1.787	20.341	58.111	0.000	97.484	7.740	1.339	12.333	316.635	0.047	338.094
1989	18.741	2.351	45.575	74.854	2.120	143.641	7.393	1.185	20.284	229.682	0.000	258.544
1990	24.288	0.512	0.000	78.442	0.000	103.242	15.297	60.208	0.000	106.218	15.064	196.786
1991	13.375	0.245	38.623	71.046	0.000	123.288	6.202	3.024	56.591	200.661	0.000	266.478
1992	11.071	1.184	120.708	82.716	0.000	215.679	9.655	6.564	2.619	208.097	0.033	226.968
1993	15.919	0.346	60.213	228.747	0.000	305.225	9.544	12.066	34.898	239.560	0.000	296.068
1994	13.261	1.288	22.538	106.252	0.000	143.339	11.078	4.861	23.235	55.639	0.000	94.813
1995	9.139	0.927	2.731	63.422	0.000	76.220	6.788	5.507	20.732	123.455	0.000	156.481
1996	3.813	0.730	6.540	52.903	0.000	63.985	4.988	2.553	2.819	76.529	0.117	87.006
1997	4.846	4.677	4.721	45.486	0.000	59.730	4.841	3.442	8.686	37.524	0.049	54.542

1998	3.009	3.449	25.771	70.169	0.000	102.399	4.176	5.341	2.799	67.147	0.000	79.463
1999	4.473	0.447	38.179	61.555	0.000	104.654	3.020	2.429	25.507	89.929	0.029	120.914
2000	3.213	3.622	13.861	115.611	0.000	136.307	5.015	2.515	0.000	13.573	0.000	21.104
2001	4.552	4.320	15.266	90.270	0.000	114.407	5.740	2.835	4.170	3.670	0.072	16.487
2002	3.880	15.667	16.101	155.797	0.000	191.445	4.059	6.566	4.121	66.422	0.000	81.168
2003	2.553	10.656	12.956	110.024	0.000	136.190	4.727	6.300	25.655	64.806	0.000	101.488
2004	3.508	6.472	26.053	114.622	2.118	152.773	3.926	11.423	0.000	9.818	0.000	25.167
2005	9.728	13.703	14.969	145.620	0.000	184.021	6.772	3.249	4.447	0.113	0.000	14.580
2006	1.861	9.669	16.055	178.895	0.000	206.481	8.616	7.525	22.989	214.909	0.000	254.039
2007	6.132	9.033	22.198	203.607	0.000	240.970	9.468	8.502	24.932	138.103	0.036	181.041
2008	6.644	6.123	570.369	136.350	0.000	719.486	6.209	10.342	38.676	126.763	0.036	182.026
2009	8.838	16.766	29.278	152.023	0.000	206.905	9.606	6.775	0.000	39.163	0.000	55.544
2010	8.079	12.125	24.746	143.418	0.000	188.368	6.811	6.723	3.952	39.723	0.000	57.210
2011	4.697	8.809	11.414	38.768	0.000	63.688	6.949	7.784	0.000	14.956	0.000	29.689
2012	4.563	17.746	2.189	63.794	0.000	88.293	7.809	13.739	0.000	102.479	0.000	124.028
2013	4.118	8.066	20.688	133.599	0.000	166.472	5.576	10.343	13.001	99.893	0.000	128.812
2014	10.954	9.823	3.081	265.990	0.000	289.848	6.664	7.668	61.312	45.420	0.139	121.204
2015	12.555	16.875	49.872	176.941	0.000	256.242	8.452	17.651	53.158	51.533	0.000	130.795
2016	16.129	14.331	28.167	228.901	0.000	287.528	7.298	15.019	40.395	66.425	0.000	129.137
2017	5.532	6.181	38.940	117.391	0.000	168.044	8.158	3.930	0.000	43.317	0.000	55.405
2018	3.555	3.786	0.000	140.990	0.158	148.489	9.561	12.655	11.523	37.575	0.081	71.395
2019	3.371	2.742	0.000	161.708	0.000	167.821	7.986	29.984	33.010	31.191	0.000	102.172
2020	3.325	5.476	4.317	62.975	0.000	76.093	7.549	39.389	0.000	195.530	0.000	242.468
2021	5.626	6.061	1.577	124.009	0.000	137.273	16.696	18.293	14.163	108.345	0.000	157.496
2022	3.385	8.899	13.789	218.822	0.000	244.895	5.680	16.872	18.706	27.709	0.000	68.967
2023	4.008	5.565	6.047	231.611	0.000	247.231	4.527	11.352	25.761	56.317	0.000	97.956

Table 4. SRHS and MRIP CVs associated with landings by mode: Headboat (HB), Charter (CH), Shore (SH), FL Private (FL PR), and Non-FL Private (non-FL PR).

Year	East (SE FL and North)					West (FL Keys and Gulf)				
	HB	CH	SH	FL PR	non-FL PR	HB	CH	SH	FL PR	non-FL PR
1981	0.086	0.870	0.720	0.520		0.260	1.000	0.710	0.630	
1982	0.295	0.530	0.710	0.340		0.161	0.700	1.000	0.570	
1983	0.124	0.470	0.850	0.350		0.347	0.530	1.000	0.530	
1984	0.236	0.370		0.510		0.338	0.540	0.710	0.650	
1985	0.292	0.800		0.740		0.292	0.500	0.790	0.000	
1986	0.218	1.000		0.290		0.306	0.410	1.000	0.590	
1987	0.283		1.000	0.390		0.228	0.490	1.000	0.470	
1988	0.408	0.830	1.000	0.290		0.172	0.730	1.000	0.730	
1989	0.448	0.830	0.810	0.350		0.182	0.600	1.000	0.660	
1990	0.383	0.840		0.280		0.220	0.980		0.430	
1991	0.455	1.000	0.630	0.330		0.173	0.550	1.000	0.410	
1992	0.243	0.450	0.780	0.180		0.168	0.370	1.000	0.500	
1993	0.284	1.000	0.350	0.210		0.090	0.490	0.420	0.360	
1994	0.313	0.880	0.440	0.260		0.164	0.500	0.400	0.270	
1995	0.337	0.600	0.710	0.290		0.102	0.430	0.440	0.580	
1996	0.363	0.560	0.830	0.300		0.177	0.410	0.710	0.419	
1997	0.330	0.540	1.000	0.240		0.105	0.410	0.810	0.559	
1998	0.279	0.710	0.720	0.220		0.163	0.520	1.000	0.490	
1999	0.512	0.380	0.490	0.190		0.125	0.240	0.920	0.530	
2000	0.343	0.330	1.000	0.200		0.222	0.190		0.760	
2001	0.386	0.230	0.620	0.250		0.284	0.192	1.000	0.981	
2002	0.396	0.200	0.450	0.150		0.318	0.180	1.000	0.530	
2003	0.322	0.290	0.460	0.180		0.402	0.200	0.640	0.400	
2004	0.451	0.250	0.660	0.300		0.326	0.300		0.560	
2005	0.561	0.270	0.510	0.190		0.251	0.240	1.000	1.000	
2006	0.167	0.360	0.730	0.180		0.463	0.320	1.000	0.690	
2007	0.347	0.430	0.370	0.150		0.202	0.230	1.000	0.560	
2008	0.180	0.380	0.780	0.150		0.065	0.220	0.830	0.540	
2009	0.057	0.260	0.570	0.200		0.038	0.300		0.520	
2010	0.052	0.260	0.450	0.170		0.025	0.250	1.000	0.680	
2011	0.036	0.440	0.620	0.230		0.048	0.250		0.610	
2012	0.033	0.620	1.000	0.210		0.123	0.410		0.570	
2013	0.067	0.670	0.970	0.250		0.037	0.430	0.740	0.350	
2014	0.033	0.310	0.710	0.300		0.020	0.350	0.530	0.299	
2015	0.043	0.300	0.690	0.270		0.023	0.340	0.500	0.660	
2016	0.180	0.260	0.530	0.340		0.018	0.320	0.550	0.330	
2017	0.024	0.440	0.940	0.280		0.035	0.340		0.460	
2018	0.016	0.380		0.370		0.042	0.290	0.900	0.319	
2019	0.017	0.460		0.450		0.037	0.520	0.760	0.480	
2020	0.019	0.300	1.000	0.310		0.035	0.450		0.830	
2021	0.013	0.310	1.000	0.270		0.037	0.340	0.500	0.380	
2022	0.019	0.350	0.690	0.220		0.031	0.350	0.580	0.495	
2023	0.023	0.260	1.000	0.230		0.027	0.314	0.470	0.380	

Table 5. SRFS and SRFS FCAL calibrated landings and releases in numbers (1000s) and weight (metric tons, mt) for the Florida private mode (FL PR) with associated CVs.

Year	East (SE FL and North)						West (FL Keys and Gulf)					
	Landings (1000s)	CV	Landings (mt)	CV	Releases (1000s)	CV	Landings (1000s)	CV	Landings (mt)	CV	Releases (1000s)	CV
1981	41.581	0.549	39.526	0.597	0.000		197.403	0.706	105.553	0.717	0.000	
1982	44.563	0.383	27.023	0.418	0.000		102.740	0.653	253.578	0.649	0.000	
1983	46.136	0.392	32.601	0.443	11.940	1.009	18.659	0.619	64.415	0.706	0.000	
1984	117.823	0.539	139.146	0.554	2.407	1.009	154.029	0.724	280.925	0.742	113.030	0.771
1985	33.861	0.761	49.133	0.769	49.776	1.009						
1986	39.313	0.339	47.771	0.351	17.268	0.507	110.136	0.671	207.672	0.678	1.674	1.037
1987	54.446	0.428	47.824	0.459	111.295	0.830	134.514	0.568	90.186	0.562	41.476	0.762
1988	30.787	0.339	44.673	0.385	9.807	0.614	115.603	0.796	244.834	0.794	64.160	0.875
1989	39.658	0.392	56.194	0.398	14.835	0.527	83.856	0.733	84.899	0.735	4.408	1.037
1990	41.558	0.331	59.178	0.341	2.468	0.791	38.780	0.535	28.740	0.557	23.420	0.837
1991	37.640	0.374	60.381	0.391	11.928	0.402	73.261	0.519	120.149	0.540	264.149	0.642
1992	43.823	0.252	52.062	0.278	61.974	0.412	75.976	0.593	103.223	0.595	62.290	0.571
1993	121.190	0.274	110.327	0.278	90.281	0.328	87.463	0.481	81.519	0.474	307.824	0.724
1994	56.292	0.314	67.873	0.324	66.094	0.383	20.314	0.418	18.551	0.415	59.384	0.580
1995	33.601	0.339	76.301	0.357	27.945	0.527	45.073	0.662	85.556	0.659	89.120	0.678
1996	28.028	0.348	61.101	0.360	28.177	0.346	27.941	0.527	43.180	0.512	76.534	0.528
1997	24.099	0.297	47.666	0.311	60.904	0.309	13.700	0.644	30.504	0.664	171.146	0.562
1998	37.176	0.282	63.493	0.298	68.612	0.300	24.515	0.585	51.219	0.592	184.881	0.588
1999	32.612	0.259	53.510	0.274	41.516	0.248	32.833	0.618	69.977	0.607	27.108	0.580
2000	61.250	0.266	117.185	0.272	77.946	0.291	4.956	0.824	12.997	0.835	8.520	1.037
2001	47.825	0.306	79.252	0.313	40.896	0.274	1.340	1.031	4.145	1.021	6.262	0.743
2002	82.541	0.231	113.795	0.233	86.691	0.248	24.250	0.619	30.998	0.625	4.173	0.790
2003	58.291	0.252	103.168	0.269	45.438	0.265	23.661	0.512	22.744	0.526	41.462	0.606
2004	60.726	0.348	93.609	0.350	62.858	0.274	3.585	0.644	7.624	0.647	15.099	0.562
2005	77.149	0.259	102.693	0.260	90.736	0.248	0.041	1.050	0.079	1.039	216.230	1.028
2006	94.778	0.252	133.093	0.252	155.485	0.239	78.463	0.760	109.947	0.751	26.405	0.588
2007	107.871	0.231	184.771	0.235	188.476	0.231	50.421	0.644	73.442	0.634	91.410	0.580
2008	72.238	0.231	82.426	0.233	202.814	0.282	46.281	0.627	90.855	0.632	68.829	0.453
2009	80.542	0.266	91.154	0.267	118.326	0.239	14.298	0.610	31.559	0.630	45.174	0.606
2010	75.983	0.245	115.100	0.246	45.834	0.256	14.503	0.751	27.008	0.765	6.080	0.780
2011	20.539	0.289	31.297	0.294	19.888	0.346	5.460	0.688	11.019	0.673	4.309	0.818
2012	33.798	0.274	64.109	0.279	31.567	0.282	37.415	0.653	101.880	0.662	50.180	0.669
2013	70.781	0.306	108.685	0.315	111.243	0.328	36.471	0.473	86.515	0.466	141.101	0.519
2014	140.921	0.348	165.466	0.349	274.747	0.355	16.583	0.437	24.269	0.428	53.301	0.536
2015	93.743	0.322	135.188	0.332	244.526	0.248	18.815	0.733	25.718	0.724	10.724	0.528
2016	121.271	0.383	198.233	0.388	327.374	0.355	24.252	0.459	37.829	0.457	88.144	0.615
2017	62.194	0.331	118.186	0.359	249.130	0.239	15.815	0.560	43.769	0.551	54.089	0.422

2018	74.696	0.410	141.777	0.424	284.836	0.300	13.719	0.451	17.142	0.446	28.016	0.477
2019	85.673	0.483	124.968	0.495	229.718	0.231	11.388	0.576	11.689	0.563	54.250	0.379
2020	33.364	0.356	66.477	0.377	231.339	0.265	71.388	0.889	163.615	0.878	161.658	0.502
2021	106.055	0.230	224.571	0.181	549.434	0.136	42.227	0.294	66.490	0.176	86.574	0.320
2022	99.519	0.139	168.421	0.105	457.746	0.133	13.529	0.239	24.824	0.185	142.420	0.200
2023	98.765	0.179	235.698	0.153	477.399	0.124	14.478	0.345	49.460	0.257	111.997	0.305

Table 6. SRHS and MRIP releases in numbers (1000s) by mode: Headboat (HB), Charter (CH), Shore (SH), FL Private (FL PR), and Non-FL Private (non-FL PR).

Year	East (SE FL and North)						West (FL Keys and Gulf)					
	HB	CH	SH	FL PR	non-FL PR	Total	HB	CH	SH	FL PR	non-FL PR	Total
1981	0.000	0.000	0.000	0.000	0.000	0.000	21.797	6.913	34.738	0.000	0.000	63.448
1982	0.000	0.000	7.594	0.000	0.000	7.594	13.370	22.495	3.899	0.000	0.000	39.764
1983	0.000	0.000	0.000	21.758	0.000	21.758	18.006	2.893	64.275	0.000	0.000	85.174
1984	0.000	1.514	6.058	4.386	0.000	11.959	10.912	29.579	27.776	234.463	0.000	302.730
1985	0.000	0.000	29.394	90.711	0.000	120.106	11.297	9.900	40.648	0.000	0.000	61.845
1986	0.000	0.000	55.273	31.470	0.000	86.742	12.415	14.194	12.858	3.472	0.000	42.939
1987	0.000	0.000	0.000	202.822	0.000	202.822	10.358	10.653	19.405	86.035	0.000	126.451
1988	0.000	0.000	15.892	17.872	0.000	33.764	7.740	1.339	12.333	133.090	0.000	154.502
1989	0.000	0.000	0.000	27.034	0.000	27.034	7.393	1.185	20.284	9.144	0.000	38.006
1990	0.000	0.000	0.000	4.497	0.000	4.497	15.297	60.208	0.000	48.581	3.582	127.668
1991	0.000	0.053	0.000	21.738	0.000	21.791	6.202	3.024	56.591	547.933	0.000	613.750
1992	4.448	0.868	20.079	112.941	0.000	138.336	9.655	6.564	2.619	129.211	0.000	148.049
1993	0.000	0.000	16.441	164.526	0.000	180.967	9.544	12.066	34.898	638.531	0.000	695.039
1994	0.000	0.000	18.445	120.448	0.000	138.893	11.078	4.861	23.235	123.183	0.000	162.357
1995	0.975	0.180	94.084	50.927	0.000	146.166	6.788	5.507	20.732	184.866	0.000	217.893
1996	0.421	0.147	10.566	51.349	0.000	62.483	4.988	2.553	2.819	158.757	0.859	169.976
1997	0.000	0.000	4.572	110.990	0.000	115.562	4.841	3.442	8.686	355.014	1.564	373.548
1998	0.437	0.913	63.342	125.037	0.000	189.729	4.176	5.341	2.799	383.505	4.092	399.913
1999	9.150	1.667	20.976	75.657	0.000	107.451	3.020	2.429	25.507	56.231	0.000	87.187
2000	1.170	2.407	47.833	142.047	0.000	193.457	5.015	2.515	0.000	17.674	0.000	25.204
2001	0.564	0.976	14.316	74.528	0.000	90.384	5.740	2.835	4.170	12.989	0.000	25.734
2002	0.496	3.652	109.377	157.983	0.000	271.508	4.059	6.566	4.121	8.657	0.000	23.403
2003	1.014	7.721	49.358	82.806	0.000	140.899	4.727	6.300	25.655	86.007	0.000	122.689
2004	0.263	0.885	57.652	114.550	0.000	173.350	3.926	11.423	0.000	31.321	0.000	46.669
2005	2.507	6.445	55.421	165.354	0.000	229.727	6.772	3.249	4.447	448.533	0.000	463.000
2006	0.789	7.484	107.890	283.353	0.000	399.516	8.616	7.525	22.989	54.773	0.000	93.903
2007	3.488	9.376	65.555	343.474	0.000	421.893	9.468	8.502	24.932	189.615	0.000	232.518
2008	5.278	11.746	1,359.280	369.604	0.000	1,745.908	6.209	10.342	38.676	142.775	0.000	198.002
2009	4.272	12.915	102.320	215.635	0.000	335.141	9.606	6.775	0.000	93.706	0.000	110.087

2010	2.159	5.988	28.741	83.527	0.000	120.415	6.811	6.723	3.952	12.613	0.000	30.100
2011	0.369	1.229	1.554	36.243	0.000	39.395	6.949	7.784	0.000	8.938	0.000	23.670
2012	1.062	1.162	261.530	57.527	0.000	321.280	7.809	13.739	0.000	104.090	0.000	125.639
2013	3.069	7.530	103.426	202.726	0.000	316.752	5.576	10.343	13.001	292.692	0.000	321.611
2014	8.760	8.540	101.158	500.692	0.000	619.150	6.664	7.668	61.312	110.564	0.000	186.209
2015	8.787	17.573	287.839	445.618	0.000	759.817	8.452	17.651	53.158	22.245	0.000	101.506
2016	18.528	9.664	726.923	596.599	0.000	1,351.713	7.298	15.019	40.395	182.840	0.433	245.985
2017	9.583	33.943	1,202.688	454.010	0.000	1,700.224	8.158	3.930	0.000	112.198	1.695	125.981
2018	13.135	14.569	207.544	519.078	0.000	754.325	9.561	12.655	11.523	58.114	0.000	91.853
2019	8.808	13.940	176.202	418.632	0.000	617.582	7.986	29.984	33.010	112.532	0.000	183.512
2020	10.073	29.518	135.008	421.587	0.000	596.186	7.549	39.389	0.000	335.333	0.266	382.536
2021	7.568	24.278	81.163	759.708	0.000	872.717	16.696	18.293	14.163	154.769	0.000	203.921
2022	8.726	33.105	283.944	868.277	0.000	1,194.051	5.680	16.872	18.706	219.796	0.000	261.054
2023	11.766	16.767	184.390	1,077.479	0.000	1,290.402	4.527	11.352	25.761	332.765	0.000	374.405

Table 7. SRHS and MRIP CVs associated with releases by mode: Headboat (HB), Charter (CH), Shore (SH), FL Private (FL PR), and Non-FL Private (non-FL PR).

Year	East (SE FL and North)					West (FL Keys and Gulf)				
	HB	CH	SH	FL PR	non-FL PR	HB	CH	SH	FL PR	non-FL PR
1981				0.000			0.335	0.000	0.000	
1982			1.000	0.000			0.000	1.007	0.000	
1983				1.000			0.000	0.000	0.000	
1984		1.000	1.000	1.000			0.000	0.000	0.720	
1985			1.000	1.000			0.000	0.521	0.000	
1986			1.000	0.490			0.130	0.000	1.000	
1987				0.820			0.000	0.000	0.710	
1988			1.000	0.600			0.078	3.373	0.830	
1989				0.510			0.000	0.000	1.000	
1990				0.780			0.000		0.790	
1991		1.000		0.380			0.158	0.521	0.580	
1992		0.920	1.000	0.390			0.916	1.000	0.500	
1993			0.480	0.300			0.142	0.701	0.670	
1994			0.420	0.360			0.122	0.466	0.510	
1995		0.730	0.890	0.510			0.000	0.104	0.620	
1996		1.000	1.000	0.320			0.244	0.883	0.450	
1997			1.000	0.280			1.694	0.000	0.490	
1998		0.880	0.660	0.270			0.184	5.259	0.520	
1999		0.980	0.850	0.210			0.057	0.760	0.510	
2000		0.410	0.830	0.260			0.042		1.000	
2001		0.350	0.810	0.240			0.049	0.000	0.690	
2002		0.490	0.480	0.210			0.778	0.000	0.740	
2003		0.540	0.350	0.230			0.291	0.423	0.540	
2004		0.350	0.620	0.240			0.251		0.490	
2005		0.300	0.770	0.210			0.129	10.571	0.990	
2006		0.390	0.590	0.200			0.235	5.000	0.520	
2007		0.450	0.350	0.190			0.162	3.115	0.510	
2008		0.400	0.590	0.250			1.156	0.523	0.360	
2009		0.360	0.310	0.200			0.068		0.540	
2010		0.340	0.580	0.220			0.075	0.000	0.730	
2011		0.650	1.000	0.320			0.304		0.770	
2012		0.550	0.450	0.250			0.097		0.610	
2013		0.420	0.800	0.300			0.300	1.525	0.440	
2014		0.290	0.480	0.330			0.590	4.156	0.460	
2015		0.280	0.410	0.210			0.240	1.514	0.450	
2016		0.240	0.540	0.330			0.145	3.045	0.550	
2017		0.410	0.480	0.200			2.556		0.320	

2018	0.450	0.600	0.270	0.441	7.278	0.390
2019	0.450	0.610	0.190	0.365	1.666	0.260
2020	0.390	0.650	0.230	1.815		0.420
2021	0.360	0.510	0.200	0.300	3.658	0.410
2022	0.360	0.580	0.190	0.906	4.781	0.540
2023	0.310	0.460	0.170	0.433	7.454	0.270

Table 8. Recreational landings and releases in numbers (1000s) by region for all modes combined (including SRFS and SRFS calibrated estimates for Florida private mode), with log-scale standard errors (log SE).

Year	East (SE FL and North)				West (FL Keys and Gulf)			
	Landings (1000s)	log SE	Releases (1000s)	log SE	Landings (1000s)	log SE	Releases (1000s)	log SE
1981	368.490	0.536			260.851	0.509	2.318	0.833
1982	418.300	0.539	7.594	0.833	142.504	0.459	3.925	0.833
1983	426.305	0.647	11.940	0.838	103.833	0.580		
1984	127.596	0.471	9.980	0.610	222.296	0.485	113.030	0.683
1985	45.341	0.532	79.171	0.657	61.845	0.496	21.195	0.833
1986	48.188	0.274	72.541	0.683	149.603	0.475	3.976	0.583
1987	154.804	0.556	111.295	0.724	174.929	0.431	41.476	0.676
1988	70.160	0.332	25.699	0.602	137.061	0.615	126.351	0.516
1989	108.444	0.365	14.835	0.495	112.719	0.534	4.408	0.855
1990	66.359	0.246	2.468	0.697	129.349	0.459	27.002	0.650
1991	89.882	0.312	11.982	0.386	139.078	0.464	302.921	0.529
1992	176.786	0.503	87.370	0.360	94.847	0.453	79.109	0.436
1993	197.667	0.198	106.722	0.281	143.971	0.305	342.435	0.598
1994	93.379	0.219	84.539	0.306	59.488	0.215	80.936	0.426
1995	46.398	0.254	123.184	0.624	78.100	0.386	91.287	0.603
1996	39.111	0.282	39.311	0.354	38.418	0.375	82.397	0.465
1997	38.342	0.234	65.476	0.290	30.718	0.359	191.020	0.476
1998	69.405	0.302	133.304	0.340	36.832	0.389	217.035	0.477
1999	75.711	0.268	73.309	0.276	63.818	0.461	52.588	0.450
2000	81.946	0.258	129.356	0.343	12.486	0.332	14.810	0.635
2001	71.962	0.240	56.752	0.279	14.157	0.324	6.832	0.617
2002	118.189	0.174	200.216	0.278	38.996	0.387	15.212	0.385
2003	84.456	0.189	103.531	0.205	60.343	0.331	61.405	0.427
2004	98.877	0.271	121.658	0.318	18.933	0.226	22.633	0.382
2005	115.550	0.192	155.108	0.304	14.508	0.324	291.825	0.688
2006	122.364	0.216	271.649	0.267	117.593	0.510	148.529	0.690
2007	145.233	0.182	266.895	0.184	93.360	0.420	223.654	0.403
2008	655.374	0.616	1579.118	0.480	101.543	0.409	134.906	0.284

2009	135.423	0.201	237.832	0.178	30.679	0.286	142.833	0.598
2010	120.933	0.180	82.722	0.244	31.989	0.355	10.790	0.423
2011	45.459	0.218	23.040	0.301	20.193	0.208	21.096	0.561
2012	58.296	0.246	295.320	0.385	58.963	0.408	59.667	0.526
2013	103.653	0.284	225.268	0.387	65.390	0.303	186.978	0.391
2014	164.779	0.292	393.205	0.272	92.367	0.351	408.795	0.576
2015	173.045	0.262	558.725	0.234	98.076	0.304	156.976	0.485
2016	179.899	0.267	1082.488	0.366	86.963	0.285	291.249	0.439
2017	112.846	0.361	1495.345	0.375	27.903	0.313	325.491	0.439
2018	82.195	0.361	520.083	0.285	47.539	0.261	216.569	0.379
2019	91.786	0.430	428.668	0.275	82.368	0.356	181.646	0.320
2020	46.482	0.269	405.938	0.261	118.326	0.520	353.144	0.316
2021	119.319	0.204	662.443	0.129	91.379	0.169	271.643	0.215
2022	125.592	0.135	783.521	0.222	54.787	0.230	465.466	0.202
2023	114.385	0.163	690.322	0.149	56.118	0.238	726.690	0.264

Table 9. Sampling effort (N), proportion positive (Prop Pos), relative abundance (Std Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of indices deemed "Suitable and Recommended" for SEDAR 79 from west to east.

	Commercial Longline (FD)				**GOM Combined Stereo Video Survey (FI)**				**RVC Dry Tortugas (FI)**			
Year	**N**	**Prop Pos**	**Std Index**	**CV**	**N**	**Prop Pos**	**Std Index**	**CV**	**N**	**Prop Pos**	**Std Index**	**CV**
1993	134	0.51	0.45	0.3								
1994	128	0.5	0.55	0.31								
1995	137	0.51	0.96	0.24								
1996	200	0.47	0.52	0.26	42	0.214	2.959	0.652				
1997	230	0.52	0.73	0.25	54	0.167	1.295	0.34				
1998	204	0.55	0.66	0.25								
1999	144	0.52	0.69	0.29					327	0.089	0.24	0.212
2000	140	0.46	0.78	0.28					381	0.115	0.34	0.164
2001	165	0.52	0.87	0.26								
2002	114	0.52	1.49	0.29	48	0.25	1.802	0.29				
2003	192	0.47	1.3	0.26								
2004	180	0.46	1.54	0.26	26	0.423	1.316	0.349	576	0.22	0.74	0.094
2005	211	0.52	1.53	0.24	78	0.167	1.389	0.243				
2006	205	0.49	1.66	0.24	85	0.259	2.286	0.209	484	0.192	0.51	0.125
2007	177	0.5	1.17	0.26	110	0.236	1.482	0.212				
2008	170	0.45	0.81	0.28	79	0.152	1.216	0.318	653	0.277	0.87	0.081
2009	80	0.51	1.09	0.33	80	0.138	0.876	0.296				
2010	62	0.56	1.2	0.31	124	0.153	0.592	0.245	689	0.332	1.2	0.071
2011					307	0.081	1.306	0.171				
2012					320	0.088	1.324	0.176	734	0.38	1.23	0.068
2013												
2014					356	0.028	0.652	0.382	702	0.318	0.84	0.081
2015												
2016					440	0.1	0.988	0.179	535	0.402	1.63	0.069
2017					411	0.054	0.5	0.215				
2018					348	0.147	0.936	0.165	646	0.359	1.13	0.075
2019					462	0.123	1.274	0.144				
2020					464	0.099	0.372	0.157				
2021					547	0.077	0.376	0.169	292	0.623	2.24	0.082
2022												
2023									300	0.597	2.56	0.088

Table 9 (continued). Sampling effort (N), proportion positive (Prop Pos), relative abundance (Std Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of indices deemed "Suitable and Recommended" for SEDAR 79 from west to east.

	RVC FL Keys (FI)				**RVC SE FL (FI)**				**Indian River YOY index (FI)**			
Year	**N**	**Prop Pos**	**Std Index**	**CV**	**N**	**Prop Pos**	**Std Index**	**CV**	**N**	**Prop Pos**	**Std Index**	**CV**
1993												
1994												
1995												
1996												
1997	316	0.076	0.59	0.255								
1998												
1999	376	0.077	0.49	0.216					77	0.169	0.363	0.386
2000	451	0.135	0.85	0.139					78	0.192	0.501	0.326
2001	643	0.138	0.81	0.123					76	0.171	0.573	0.35
2002	499	0.17	0.74	0.118					76	0.276	0.912	0.313
2003	377	0.17	0.85	0.132					78	0.205	0.521	0.339
2004	199	0.211	0.97	0.16					77	0.247	0.721	0.334
2005	498	0.173	0.95	0.112					75	0.213	1.323	0.34
2006	482	0.156	0.83	0.126					77	0.403	0.892	0.308
2007	606	0.226	1.31	0.093					73	0.521	3.535	0.284
2008	644	0.236	1.13	0.099					75	0.293	1.571	0.305
2009	972	0.195	0.82	0.091					73	0.219	0.513	0.343
2010	530	0.177	0.63	0.127					75	0.253	0.597	0.337
2011	780	0.167	0.62	0.105					74	0.189	0.709	0.322
2012	707	0.238	0.87	0.096					76	0.303	1.2	0.303
2013					1050	0.211	0.35	0.105	75	0.293	1.27	0.315
2014	612	0.203	1.32	0.089	565	0.29	0.5	0.114	76	0.211	1.138	0.336
2015					417	0.283	0.42	0.138	75	0.28	0.854	0.332
2016	559	0.216	1.76	0.097	462	0.39	0.92	0.097	76	0.184	0.297	0.377
2017									77	0.169	1.06	0.346
2018	633	0.292	1.66	0.092	459	0.527	1.6	0.076	78	0.167	1.337	0.331
2019									75	0.16	0.23	0.389
2020									78	0.205	1.491	0.316
2021					285	0.519	1.56	0.094	77	0.26	1.06	0.318
2022	251	0.319	2.03	0.121	292	0.493	1.65	0.093	77	0.325	1.333	0.312
2023												

Table 9 (continued). Sampling effort (N), proportion positive (Prop Pos), relative abundance (Std Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of indices deemed "Suitable and Recommended" for SEDAR 79 from west to east.

	SERFS video index (FI)			
Year	**N**	**Prop Pos**	**Std Index**	**CV**
1993				
1994				
1995				
1996				
1997				
1998				
1999				
2000				
2001				
2002				
2003				
2004				
2005				
2006				
2007				
2008				
2009				
2010				
2011	543	0.009	0.083	0.46
2012	1017	0.005	0.235	0.58
2013	1114	0.009	0.263	0.5
2014	1364	0.026	0.769	0.26
2015	1374	0.057	1.188	0.19
2016	1409	0.026	0.581	0.26
2017	1409	0.044	1.007	0.24
2018	1647	0.06	1.501	0.16
2019	1538	0.07	2.248	0.15
2020				
2021	1373	0.075	1.394	0.16
2022	1016	0.069	1.731	0.2
2023				

Table 10. Life history inputs for the SEDAR 79 Base Model.

	Parameterization in SS	SS Parameters		Estimated?
Length (MaxTL, cm) to whole weight (ww, kg)	$ww = aMaxTL^b$	$a = 6.63\text{E} - 06$	$b = 3.1601$	No
Length (MaxTL, cm) to age (a, yr)	$MaxTL_a = L_\infty + (L_{min} - L_\infty)e^{-k(a-Amin)}$	$L_{min} = 27.65$ $A_{min} = 0$	$L_\infty = 82.26$ $k = 0.195$	Yes, except A_{min}
Proportion Mature-at-age ($prop_{mat}$)	$prop_{mat} = \frac{1}{1 + e^{\alpha(age-\beta)}}$ $A_{50} = \frac{\alpha}{\beta}$	$\alpha = -2.535$ $\beta = -13.021$	$A_{50} = 3.48$	No
Fraction Female ($fracfem$)		$fracfem = 0.5$		No
Instantaneous Natural Mortality (M, yr^{-1})	$M = 5.4/t_{max}$	$M = 0.129$		No
Fecundity ($eggs$)	$eggs = mWW + b$	$m = 1$	$b = 0$	No

Table 11. Model-estimated length-at-age and model-calculated maturity-at-age and natural mortality-at-age versus those approved at the SEDAR 79 Data Workshop.

Calendar Age	Model Output			Data Workshop Approved			
	Max TL (cm)	M_a	Proportion Mature	Max TL (cm)	M_a	M_a (using SS estimated growth)	Proportion Mature
1	27.65	0.300	0.000	24.70	0.394	0.357	0.000
2	32.72	0.262	0.022	33.72	0.288	0.262	0.004
3	41.48	0.215	0.220	41.39	0.235	0.215	0.143
4	48.69	0.188	0.780	47.90	0.203	0.188	0.875
5	54.63	0.170	0.978	53.44	0.182	0.170	0.997
6	59.52	0.158	0.998	58.14	0.167	0.158	1.000
7	63.54	0.149	1.000	62.14	0.157	0.149	1.000
8	66.85	0.142	1.000	65.53	0.148	0.142	1.000
9	69.58	0.137	1.000	68.41	0.142	0.137	1.000
10	71.82	0.133	1.000	70.86	0.137	0.133	1.000
11	73.67	0.130	1.000	72.94	0.133	0.130	1.000
12	75.19	0.128	1.000	74.71	0.130	0.128	1.000
13	76.44	0.126	1.000	76.21	0.128	0.126	1.000
14	77.47	0.125	1.000	77.49	0.126	0.125	1.000
15	78.32	0.123	1.000	78.58	0.124	0.123	1.000
16	79.02	0.122	1.000	79.50	0.122	0.122	1.000
17	79.59	0.122	1.000	80.28	0.121	0.122	1.000
18	80.06	0.121	1.000	80.94	0.120	0.121	1.000
19	80.45	0.120	1.000	81.51	0.119	0.120	1.000
20	80.77	0.120	1.000	81.99	0.119	0.120	1.000
21	81.04	0.120	1.000	82.40	0.118	0.120	1.000
22	81.25	0.119	1.000	82.74	0.118	0.119	1.000
23	81.43	0.119	1.000	83.04	0.117	0.119	1.000
24	81.58	0.119	1.000	83.29	0.117	0.119	1.000
25	81.70	0.119	1.000	83.50	0.116	0.119	1.000
26	81.80	0.119	1.000	83.68	0.116	0.119	1.000
27	81.88	0.119	1.000	83.83	0.116	0.118	1.000
28	81.95	0.118	1.000	83.96	0.116	0.118	1.000
29	82.01	0.118	1.000	84.07	0.116	0.118	1.000
30	82.05	0.118	1.000	84.17	0.116	0.118	1.000
31	82.09	0.118	1.000	84.25	0.115	0.118	1.000
32	82.12	0.118	1.000	84.32	0.115	0.118	1.000
33	82.15	0.118	1.000	84.37	0.115	0.118	1.000
34	82.17	0.118	1.000	84.42	0.115	0.118	1.000
35	82.18	0.118	1.000	84.46	0.115	0.118	1.000
36	82.20	0.118	1.000	84.50	0.115	0.118	1.000

37	82.21	0.118	1.000	84.53	0.115	0.118	1.000
38	82.22	0.118	1.000	84.56	0.115	0.118	1.000
39	82.23	0.118	1.000	84.58	0.115	0.118	1.000
40	82.23	0.118	1.000	84.60	0.115	0.118	1.000

Table 12. List of Stock Synthesis parameters for the SEDAR 79 Base Model. The list includes expected parameter values, lower and upper bounds of the parameters, associated standard error (SE) and coefficients of variation (CV), prior type and densities (value, SD) if applicable, and the phase of estimation. Parameters designated as fixed were held at their initial values and have no associated range or SE.

	Parameter Label	Value	Range	SE	CV	Prior	Phase
1	NatM_Lorenzen_averageFem_GP_1	0.129					Fixed
2	L_at_Amin_Fem_GP_1	27.653	(2,40)	0.436	0.02		1
3	L_at_Amax_Fem_GP_1	82.265	(50,105)	0.642	0.01		2
4	VonBert_K_Fem_GP_1	0.195	(0.05,0.5)	0.005	0.03		2
5	CV_young_Fem_GP_1	0.167	(0.1,0.5)	0.007	0.04		3
6	CV_old_Fem_GP_1	0.091	(0.005,0.4)	0.004	0.04		3
7	Wtlen_1_Fem_GP_1	0.000					Fixed
8	Wtlen_2_Fem_GP_1	3.160					Fixed
9	Mat50%_Fem_GP_1	3.500					Fixed
10	Mat_slope_Fem_GP_1	-2.535					Fixed
11	Eggs_intercept_Fem_GP_1	0.000					Fixed
12	Eggs_slope_Wt_Fem_GP_1	1.000					Fixed
13	CohortGrowDev	1.000					Fixed
14	FracFemale_GP_1	0.500					Fixed
15	SR_LN(R0)	7.829	(6.5,11)	0.254	0.03		3
16	SR_BH_steep	0.644	(0.41,0.99)	0.064	0.10		3
17	SR_sigmaR	0.553	(0.1,0.8)	0.069	0.13		6
18	SR_regime	0.000					Fixed
19	SR_autocorr	0.000					Fixed
20	Early_InitAge_11	0.001	(-4,4)	0.525	730.72		6
21	Early_InitAge_10	-0.097	(-4,4)	0.518	-5.37		6
22	Early_InitAge_9	-0.008	(-4,4)	0.497	-60.29		6
23	Early_InitAge_8	0.054	(-4,4)	0.470	8.66		6
24	Early_InitAge_7	-0.077	(-4,4)	0.457	-5.96		6
25	Early_InitAge_6	0.023	(-4,4)	0.417	18.04		6
26	Early_InitAge_5	-0.443	(-4,4)	0.423	-0.95		6
27	Early_InitAge_4	-0.219	(-4,4)	0.355	-1.62		6
28	Early_InitAge_3	0.228	(-4,4)	0.284	1.25		6
29	Early_InitAge_2	-0.675	(-4,4)	0.333	-0.49		6
30	Early_InitAge_1	-0.925	(-4,4)	0.342	-0.37		6
31	Early_RecrDev_1981	-0.577	(-4,4)	0.305	-0.53		6
32	Early_RecrDev_1982	-0.109	(-4,4)	0.237	-2.17		6
33	Early_RecrDev_1983	-0.777	(-4,4)	0.315	-0.41		6
34	Early_RecrDev_1984	-0.493	(-4,4)	0.284	-0.57		6
35	Early_RecrDev_1985	-0.078	(-4,4)	0.251	-3.23		6
36	Main_RecrDev_1986	-0.065	(-4,4)	0.245	-3.78		4

37	Main_RecrDev_1987	-0.324	(-4,4)	0.253	-0.78		4
38	Main_RecrDev_1988	-0.372	(-4,4)	0.244	-0.66		4
39	Main_RecrDev_1989	-0.290	(-4,4)	0.230	-0.79		4
40	Main_RecrDev_1990	-0.107	(-4,4)	0.199	-1.86		4
41	Main_RecrDev_1991	-0.171	(-4,4)	0.185	-1.08		4
42	Main_RecrDev_1992	-0.312	(-4,4)	0.184	-0.59		4
43	Main_RecrDev_1993	-0.626	(-4,4)	0.205	-0.33		4
44	Main_RecrDev_1994	-0.551	(-4,4)	0.192	-0.35		4
45	Main_RecrDev_1995	-0.458	(-4,4)	0.180	-0.39		4
46	Main_RecrDev_1996	-0.288	(-4,4)	0.166	-0.58		4
47	Main_RecrDev_1997	-0.155	(-4,4)	0.158	-1.02		4
48	Main_RecrDev_1998	0.033	(-4,4)	0.150	4.51		4
49	Main_RecrDev_1999	0.079	(-4,4)	0.146	1.85		4
50	Main_RecrDev_2000	-0.057	(-4,4)	0.147	-2.58		4
51	Main_RecrDev_2001	-0.103	(-4,4)	0.146	-1.41		4
52	Main_RecrDev_2002	0.143	(-4,4)	0.134	0.94		4
53	Main_RecrDev_2003	0.470	(-4,4)	0.125	0.27		4
54	Main_RecrDev_2004	0.043	(-4,4)	0.136	3.18		4
55	Main_RecrDev_2005	0.935	(-4,4)	0.122	0.13		4
56	Main_RecrDev_2006	0.441	(-4,4)	0.118	0.27		4
57	Main_RecrDev_2007	0.236	(-4,4)	0.118	0.50		4
58	Main_RecrDev_2008	-0.369	(-4,4)	0.134	-0.36		4
59	Main_RecrDev_2009	-1.173	(-4,4)	0.174	-0.15		4
60	Main_RecrDev_2010	-0.415	(-4,4)	0.140	-0.34		4
61	Main_RecrDev_2011	0.412	(-4,4)	0.112	0.27		4
62	Main_RecrDev_2012	0.336	(-4,4)	0.116	0.35		4
63	Main_RecrDev_2013	0.371	(-4,4)	0.122	0.33		4
64	Main_RecrDev_2014	0.654	(-4,4)	0.120	0.18		4
65	Main_RecrDev_2015	0.939	(-4,4)	0.123	0.13		4
66	Main_RecrDev_2016	0.615	(-4,4)	0.145	0.24		4
67	Main_RecrDev_2017	0.487	(-4,4)	0.165	0.34		4
68	Main_RecrDev_2018	0.688	(-4,4)	0.181	0.26		4
69	Main_RecrDev_2019	0.442	(-4,4)	0.229	0.52		4
70	Main_RecrDev_2020	0.996	(-4,4)	0.174	0.17		4
71	Main_RecrDev_2021	0.969	(-4,4)	0.334	0.34		4
72	Main_RecrDev_2022	0.591	(-4,4)	0.325	0.55		4
73	Late_RecrDev_2023	0.000					Fixed
74	InitF_seas_1_flt_1COM_LL	0.035	(0.0001,0.3)	0.046	1.29	Sym_Beta (0.01, 0.5)	1
75	InitF_seas_1_flt_2COM_OTHER	0.033	(0.001,0.3)	0.040	1.22	Sym_Beta (0.05, 0.5)	1
76	InitF_seas_1_flt_3REC_E	0.341	(0.05,0.6)	0.188	0.55	Sym_Beta (0.10, 0.5)	1
77	InitF_seas_1_flt_4REC_W	0.118	(0.05,0.4)	0.080	0.67	Sym_Beta (0.10, 0.5)	1
78	F_fleet_3_YR_1981_s_1	0.350	(0,3)	0.208	0.59		3
79	F_fleet_3_YR_1982_s_1	0.117	(0,3)	0.072	0.61		3
80	F_fleet_3_YR_1983_s_1	0.104	(0,3)	0.073	0.70		3
81	F_fleet_3_YR_1984_s_1	0.072	(0,3)	0.032	0.45		3
82	F_fleet_3_YR_1985_s_1	0.103	(0,3)	0.044	0.43		3

83	F_fleet_3_YR_1986_s_1	0.075	(0,3)	0.022	0.30	3
84	F_fleet_3_YR_1987_s_1	0.197	(0,3)	0.090	0.45	3
85	F_fleet_3_YR_1988_s_1	0.077	(0,3)	0.025	0.33	3
86	F_fleet_3_YR_1989_s_1	0.076	(0,3)	0.026	0.35	3
87	F_fleet_3_YR_1990_s_1	0.058	(0,3)	0.017	0.29	3
88	F_fleet_3_YR_1991_s_1	0.062	(0,3)	0.018	0.30	3
89	F_fleet_3_YR_1992_s_1	0.233	(0,3)	0.076	0.32	3
90	F_fleet_3_YR_1993_s_1	0.298	(0,3)	0.058	0.20	3
91	F_fleet_3_YR_1994_s_1	0.195	(0,3)	0.041	0.21	3
92	F_fleet_3_YR_1995_s_1	0.143	(0,3)	0.038	0.27	3
93	F_fleet_3_YR_1996_s_1	0.102	(0,3)	0.026	0.26	3
94	F_fleet_3_YR_1997_s_1	0.123	(0,3)	0.027	0.22	3
95	F_fleet_3_YR_1998_s_1	0.235	(0,3)	0.061	0.26	3
96	F_fleet_3_YR_1999_s_1	0.154	(0,3)	0.036	0.23	3
97	F_fleet_3_YR_2000_s_1	0.195	(0,3)	0.047	0.24	3
98	F_fleet_3_YR_2001_s_1	0.113	(0,3)	0.025	0.22	3
99	F_fleet_3_YR_2002_s_1	0.259	(0,3)	0.048	0.19	3
100	F_fleet_3_YR_2003_s_1	0.156	(0,3)	0.029	0.19	3
101	F_fleet_3_YR_2004_s_1	0.168	(0,3)	0.042	0.25	3
102	F_fleet_3_YR_2005_s_1	0.197	(0,3)	0.042	0.21	3
103	F_fleet_3_YR_2006_s_1	0.192	(0,3)	0.041	0.21	3
104	F_fleet_3_YR_2007_s_1	0.189	(0,3)	0.034	0.18	3
105	F_fleet_3_YR_2008_s_1	0.700	(0,3)	0.163	0.23	3
106	F_fleet_3_YR_2009_s_1	0.212	(0,3)	0.036	0.17	3
107	F_fleet_3_YR_2010_s_1	0.147	(0,3)	0.027	0.18	3
108	F_fleet_3_YR_2011_s_1	0.057	(0,3)	0.013	0.22	3
109	F_fleet_3_YR_2012_s_1	0.169	(0,3)	0.042	0.25	3
110	F_fleet_3_YR_2013_s_1	0.212	(0,3)	0.058	0.28	3
111	F_fleet_3_YR_2014_s_1	0.231	(0,3)	0.050	0.21	3
112	F_fleet_3_YR_2015_s_1	0.242	(0,3)	0.046	0.19	3
113	F_fleet_3_YR_2016_s_1	0.258	(0,3)	0.061	0.24	3
114	F_fleet_3_YR_2017_s_1	0.328	(0,3)	0.093	0.28	3
115	F_fleet_3_YR_2018_s_1	0.170	(0,3)	0.043	0.25	3
116	F_fleet_3_YR_2019_s_1	0.146	(0,3)	0.038	0.26	3
117	F_fleet_3_YR_2020_s_1	0.105	(0,3)	0.024	0.23	3
118	F_fleet_3_YR_2021_s_1	0.188	(0,3)	0.032	0.17	3
119	F_fleet_3_YR_2022_s_1	0.183	(0,3)	0.036	0.20	3
120	F_fleet_3_YR_2023_s_1	0.153	(0,3)	0.029	0.19	3
121	F_fleet_4_YR_1981_s_1	0.025	(0,3)	0.020	0.80	3
122	F_fleet_4_YR_1982_s_1	0.038	(0,3)	0.019	0.51	3
123	F_fleet_4_YR_1983_s_1	0.073	(0,3)	0.047	0.65	3
124	F_fleet_4_YR_1984_s_1	0.178	(0,3)	0.076	0.43	3
125	F_fleet_4_YR_1985_s_1	0.044	(0,3)	0.021	0.47	3
126	F_fleet_4_YR_1986_s_1	0.019	(0,3)	0.011	0.59	3
127	F_fleet_4_YR_1987_s_1	0.099	(0,3)	0.041	0.42	3
128	F_fleet_4_YR_1988_s_1	0.141	(0,3)	0.059	0.42	3
129	F_fleet_4_YR_1989_s_1	0.033	(0,3)	0.019	0.58	3
130	F_fleet_4_YR_1990_s_1	0.071	(0,3)	0.030	0.43	3
131	F_fleet_4_YR_1991_s_1	0.223	(0,3)	0.082	0.37	3
132	F_fleet_4_YR_1992_s_1	0.095	(0,3)	0.032	0.34	3

133	F_fleet_4_YR_1993_s_1	0.186	(0,3)	0.053	0.29	3
134	F_fleet_4_YR_1994_s_1	0.074	(0,3)	0.016	0.22	3
135	F_fleet_4_YR_1995_s_1	0.109	(0,3)	0.037	0.34	3
136	F_fleet_4_YR_1996_s_1	0.075	(0,3)	0.023	0.30	3
137	F_fleet_4_YR_1997_s_1	0.086	(0,3)	0.026	0.30	3
138	F_fleet_4_YR_1998_s_1	0.104	(0,3)	0.032	0.31	3
139	F_fleet_4_YR_1999_s_1	0.066	(0,3)	0.023	0.34	3
140	F_fleet_4_YR_2000_s_1	0.016	(0,3)	0.005	0.33	3
141	F_fleet_4_YR_2001_s_1	0.013	(0,3)	0.004	0.33	3
142	F_fleet_4_YR_2002_s_1	0.023	(0,3)	0.007	0.31	3
143	F_fleet_4_YR_2003_s_1	0.064	(0,3)	0.019	0.30	3
144	F_fleet_4_YR_2004_s_1	0.019	(0,3)	0.004	0.24	3
145	F_fleet_4_YR_2005_s_1	0.025	(0,3)	0.008	0.33	3
146	F_fleet_4_YR_2006_s_1	0.141	(0,3)	0.068	0.48	3
147	F_fleet_4_YR_2007_s_1	0.095	(0,3)	0.030	0.31	3
148	F_fleet_4_YR_2008_s_1	0.074	(0,3)	0.019	0.25	3
149	F_fleet_4_YR_2009_s_1	0.031	(0,3)	0.009	0.28	3
150	F_fleet_4_YR_2010_s_1	0.016	(0,3)	0.005	0.30	3
151	F_fleet_4_YR_2011_s_1	0.016	(0,3)	0.004	0.23	3
152	F_fleet_4_YR_2012_s_1	0.046	(0,3)	0.016	0.36	3
153	F_fleet_4_YR_2013_s_1	0.077	(0,3)	0.021	0.28	3
154	F_fleet_4_YR_2014_s_1	0.088	(0,3)	0.027	0.31	3
155	F_fleet_4_YR_2015_s_1	0.059	(0,3)	0.016	0.27	3
156	F_fleet_4_YR_2016_s_1	0.063	(0,3)	0.017	0.26	3
157	F_fleet_4_YR_2017_s_1	0.032	(0,3)	0.009	0.29	3
158	F_fleet_4_YR_2018_s_1	0.038	(0,3)	0.010	0.25	3
159	F_fleet_4_YR_2019_s_1	0.047	(0,3)	0.013	0.27	3
160	F_fleet_4_YR_2020_s_1	0.087	(0,3)	0.025	0.29	3
161	F_fleet_4_YR_2021_s_1	0.049	(0,3)	0.009	0.18	3
162	F_fleet_4_YR_2022_s_1	0.051	(0,3)	0.011	0.21	3
163	F_fleet_4_YR_2023_s_1	0.052	(0,3)	0.012	0.23	3
164	LnQ_base_COM_LL(1)	-7.882	(-18,5)			Float
165	LnQ_base_RVC_DT(5)	-7.335	(-18,5)			Float
166	LnQ_base_RVC_KEYS(6)	-7.548	(-18,5)			Float
167	LnQ_base_RVC_SEFL(7)	-8.049	(-18,5)			Float
168	LnQ_base_FIM_YOY(8)	-7.455	(-18,5)			Float
169	LnQ_base_GOM_VID(9)	-7.068	(-15,5)	0.206	-0.03	3
170	LnQ_base_SERFS_VID(10)	-7.883	(-18,5)			Float
171	LnQ_base_GOM_VID(9)_BLK3mult_2016	0.110	(-2,2)	0.017	0.16	4
172	LnQ_base_GOM_VID(9)_BLK3mult_2020	0.257	(-2,2)	0.018	0.07	4
173	Size_inflection_COM_LL(1)	61.289	(50,90)	1.521	0.02	1
174	Size_95%width_COM_LL(1)	16.007	(1,40)	1.379	0.09	2
175	Size_inflection_COM_OTHER(2)	35.923	(8,70)	0.981	0.03	1
176	Size_95%width_COM_OTHER(2)	10.484	(-2,66)	2.060	0.20	2
177	Retain_L_infl_COM_OTHER(2)	10.000				Fixed
178	Retain_L_width_COM_OTHER(2)	1.000				Fixed
179	Retain_L_asymptote_logit_COM_OTHER(2)	9.000				Fixed
180	Retain_L_maleoffset_COM_OTHER(2)	0.000				Fixed
181	DiscMort_L_infl_COM_OTHER(2)	1.000				Fixed

182	DiscMort_L_width_COM_OTHER(2)	1.0E+06				Fixed
183	DiscMort_L_level_old_COM_OTHER(2)	-0.400				Fixed
184	DiscMort_L_male_offset_COM_OTHER(2)	0.000				Fixed
185	Size_DblN_peak_REC_E(3)	34.041	(28,45)	0.029	0.00	3
186	Size_DblN_top_logit_REC_E(3)	-5.682	(-18,3)	8.201	-1.44	3
187	Size_DblN_ascend_se_REC_E(3)	-10.018	(-40,20)	670.817	-66.96	3
188	Size_DblN_descend_se_REC_E(3)	5.358	(-2,10)	0.195	0.04	3
189	Size_DblN_start_logit_REC_E(3)	-0.720	(-20,15)	0.252	-0.35	3
190	Size_DblN_end_logit_REC_E(3)	-3.057	(-15,5)	0.244	-0.08	3
191	Retain_L_infl_REC_E(3)	33.232	(10,50)	1.617	0.05	2
192	Retain_L_width_REC_E(3)	5.748	(0,30)	1.346	0.23	2
193	Retain_L_asymptote_logit_REC_E(3)	7.000				Fixed
194	Retain_L_maleoffset_REC_E(3)	0.000				Fixed
195	DiscMort_L_infl_REC_E(3)	1.000				Fixed
196	DiscMort_L_width_REC_E(3)	1.0E+06				Fixed
197	DiscMort_L_level_old_REC_E(3)	-0.400				Fixed
198	DiscMort_L_male_offset_REC_E(3)	0.000				Fixed
199	Size_DblN_peak_REC_W(4)	30.012	(20,42)	0.041	0.00	3
200	Size_DblN_top_logit_REC_W(4)	-16.361	(-35,3)	368.832	-22.54	3
201	Size_DblN_ascend_se_REC_W(4)	-10.975	(-18,5)	42.376	-3.86	3
202	Size_DblN_descend_se_REC_W(4)	8.058	(-20,20)	0.569	0.07	3
203	Size_DblN_start_logit_REC_W(4)	-0.508	(-15,5)	0.473	-0.93	3
204	Size_DblN_end_logit_REC_W(4)	-5.355	(-15,10)	18.758	-3.50	3
205	Retain_L_infl_REC_W(4)	37.342	(15,60)	1.135	0.03	2
206	Retain_L_width_REC_W(4)	4.285	(0.1,20)	0.807	0.19	2
207	Retain_L_asymptote_logit_REC_W(4)	9.000				Fixed
208	Retain_L_maleoffset_REC_W(4)	0.000				Fixed
209	DiscMort_L_infl_REC_W(4)	1.000				Fixed
210	DiscMort_L_width_REC_W(4)	1.0E+06				Fixed
211	DiscMort_L_level_old_REC_W(4)	-0.400				Fixed
212	DiscMort_L_male_offset_REC_W(4)	0.000				Fixed
213	Size_DblN_peak_RVC_DT(5)	56.074	(5,94)	4.081	0.07	2
214	Size_DblN_top_logit_RVC_DT(5)	-2.252	(-12,25)	3.104	-1.38	3
215	Size_DblN_ascend_se_RVC_DT(5)	5.114	(-10,10)	0.565	0.11	3
216	Size_DblN_descend_se_RVC_DT(5)	4.755	(-20,35)	2.152	0.45	3
217	Size_DblN_start_logit_RVC_DT(5)	-2.818	(-15,5)	0.813	-0.29	3
218	Size_DblN_end_logit_RVC_DT(5)	-1.372	(-35,20)	1.372	-1.00	4
219	Size_DblN_peak_RVC_KEYS(6)	34.122	(17,55)	0.469	0.01	2
220	Size_DblN_top_logit_RVC_KEYS(6)	-15.047	(-30,0)	327.702	-21.78	2
221	Size_DblN_ascend_se_RVC_KEYS(6)	-6.273	(-20,30)	58.214	-9.28	3
222	Size_DblN_descend_se_RVC_KEYS(6)	6.743	(-10,30)	0.808	0.12	3
223	Size_DblN_start_logit_RVC_KEYS(6)	0.168	(-15,20)	0.719	4.27	3
224	Size_DblN_end_logit_RVC_KEYS(6)	-2.144	(-15,10)	2.544	-1.19	4
225	Size_inflection_RVC_SEFL(7)	54.284	(15,70)	2.334	0.04	1
226	Size_95%width_RVC_SEFL(7)	-9.323	(-25,5)	2.966	-0.32	2

227	Size_inflection_GOM_VID(9)	44.499	(0,95)	3.980	0.09	4
228	Size_95%width_GOM_VID(9)	18.494	(-2,60)	5.945	0.32	4
229	minage@sel=1_SERFS_VID(10)	3.000				Fixed
230	maxage@sel=1_SERFS_VID(10)	40.000				Fixed
231	Retain_L_infl_COM_OTHER(2)_BLK1add_1992	28.077	(10,45)	0.675	0.02	3
232	Retain_L_infl_COM_OTHER(2)_BLK1add_2018	39.178	(25,50)	1.651	0.04	3
233	Retain_L_width_COM_OTHER(2)_BLK1add_1992	1.584	(-5,15)	0.459	0.29	3
234	Retain_L_width_COM_OTHER(2)_BLK1add_2018	1.935	(-5,6)	0.880	0.45	3
235	Retain_L_infl_REC_E(3)_BLK2mult_1995	0.201	(-1,4)	0.049	0.24	3
236	Retain_L_infl_REC_E(3)_BLK2mult_2018	0.384	(-2,5)	0.056	0.14	3
237	Retain_L_width_REC_E(3)_BLK2mult_1995	-1.418	(-4,3)	0.254	-0.18	3
238	Retain_L_width_REC_E(3)_BLK2mult_2018	-0.645	(-3,2)	0.301	-0.47	3
239	Retain_L_infl_REC_W(4)_BLK2mult_1995	0.118	(-1,1)	0.031	0.26	3
240	Retain_L_infl_REC_W(4)_BLK2mult_2018	0.207	(-1,1)	0.033	0.16	3
241	Retain_L_width_REC_W(4)_BLK2mult_1995	-0.750	(-2.5,2)	0.217	-0.29	3
242	Retain_L_width_REC_W(4)_BLK2mult_2018	-0.699	(-3,2)	0.277	-0.40	3

Table 13. An overview of configuration settings for SEDAR 15AU Final Model (S15AU) and each model bridging exercise

	SEDAR 15AU base	**Model Bridging Exercises**		
		Mean weights	Mean weights plus landings	Mean weights, landings, plus indices
Years	1981 - 2013			
Fleets	Com H&L, Com LL, MRFSS, Headboat	Com H&L, Com LL, MRFSS, Headboat	Com H&L, Com LL, Rec East, Rec West	Com H&L, Com LL, Rec East, Rec West
Indices	Logbook HL, Logbook LL, Headboat, MRFSS, FIM YOY, NMFS-UM RVC, Riley Hump	Logbook HL, Logbook LL, Headboat, MRFSS, FIM YOY, NMFS-UM RVC, Riley Hump	Logbook HL, Logbook LL, Headboat, MRFSS, FIM YOY, NMFS-UM RVC, Riley Hump	Logbook LL, FIM YOY, NMFS-UM RVC
# of Mean Weight-at-age Matrices	1 for fleets, 1 for SSB, 1 for Jan 1	10 for fleets (based on SEDAR 79 Data), 1 for SSB, 1 for Jan 1	10 for fleets (based on SEDAR 79 Data), 1 for SSB, 1 for Jan 1	10 for fleets (based on SEDAR 79 Data), 1 for SSB, 1 for Jan 1
Time-varying Mean Weight-at-age?	No	Yes, for fleets. Constant WAA for SSB and Jan 1	Yes, for fleets. Constant WAA for SSB and Jan 1	Yes, for fleets. Constant WAA for SSB and Jan 1

Table 14. Settings used for Southeastern U.S. Mutton Snapper projections based on the SEDAR 79 Base Model.

Parameter	Value	Comment
Relative F Average	Average from 2021-2023	Average relative fishing mortality (apical F) over terminal three years of model
Selectivity	Average from 2021-2023	Fleet specific selectivity over terminal three years of model estimated
Recruitment		
Long Term Projections	Beverton-Holt stock-recruit relationship	Derived from the model estimated Beverton-Holt stock-recruit relationship
Short Term Projections	2024 to 2033: Average from 2019 - 2023	Recent Average
Allocation Ratio	None	

Table 15. Annual estimates of instantaneous apical fishing mortality rates by fleet, as well as estimates of annual instantaneous fishing mortality rates on age-3 Southeastern U.S. Mutton Snapper combined across all fleets for the SEDAR 79 Base Model. Apical fishing mortality rates represent the instantaneous fishing mortality level on the most vulnerable age class for each fleet.

Year	Commercial Longline	Commercial Other	Rec West	Rec East	Age 3 Total F
Equil Catch	0.04	0.03	0.12	0.34	
1981	0.01	0.02	0.02	0.35	0.26
1982	0.01	0.02	0.04	0.12	0.12
1983	0.01	0.02	0.07	0.10	0.13
1984	0.01	0.02	0.18	0.07	0.19
1985	0.01	0.01	0.04	0.10	0.11
1986	0.01	0.02	0.02	0.07	0.08
1987	0.02	0.03	0.10	0.20	0.22
1988	0.02	0.03	0.14	0.08	0.17
1989	0.02	0.03	0.03	0.08	0.10
1990	0.02	0.03	0.07	0.06	0.11
1991	0.02	0.03	0.22	0.06	0.22
1992	0.01	0.03	0.10	0.23	0.24
1993	0.01	0.04	0.19	0.30	0.35
1994	0.01	0.04	0.07	0.20	0.20

1995	0.01	0.03	0.11	0.14	0.16
1996	0.01	0.03	0.08	0.10	0.12
1997	0.01	0.03	0.09	0.12	0.13
1998	0.02	0.04	0.10	0.24	0.21
1999	0.01	0.02	0.07	0.15	0.14
2000	0.01	0.02	0.02	0.19	0.12
2001	0.02	0.02	0.01	0.11	0.08
2002	0.01	0.02	0.02	0.26	0.16
2003	0.02	0.02	0.06	0.16	0.13
2004	0.03	0.02	0.02	0.17	0.11
2005	0.02	0.01	0.03	0.20	0.13
2006	0.03	0.01	0.14	0.19	0.19
2007	0.02	0.01	0.10	0.19	0.16
2008	0.01	0.01	0.07	0.70	0.41
2009	0.00	0.01	0.03	0.21	0.13
2010	0.00	0.01	0.02	0.15	0.09
2011	0.01	0.01	0.02	0.06	0.04
2012	0.01	0.01	0.05	0.17	0.12
2013	0.01	0.01	0.08	0.21	0.16
2014	0.01	0.01	0.09	0.23	0.18
2015	0.01	0.01	0.06	0.24	0.17
2016	0.01	0.01	0.06	0.26	0.18
2017	0.01	0.01	0.03	0.33	0.19
2018	0.01	0.01	0.04	0.17	0.07
2019	0.00	0.01	0.05	0.15	0.07
2020	0.00	0.00	0.09	0.11	0.07
2021	0.00	0.00	0.05	0.19	0.08
2022	0.00	0.00	0.05	0.18	0.08
2023	0.00	0.00	0.05	0.15	0.07

Table 16. Predicted total biomass (metric tons, pounds), spawning stock biomass (SSB; metric tons, pounds), abundance (1000s of fish), age-1 recruits (1000s of fish), and depletion (SSB/SSB0) for Southeastern U.S. Mutton Snapper from the SEDAR 79 Base Model. Virgin is the estimated unfished condition while Initial is the estimated initial conditions of the stock before the model start year.

Year	Total Biomass (mt)	Total Biomass (lbs.)	SSB (mt)	SSB (lbs.)	Abundance (000s)	Age-1 Recruits (000s)	SSB/ SSB0
Virgin	38,589	85,074,081	17,778	39,194,175	14,371	2,513	1.00
Initial	6,942	15,303,656	2,377	5,241,330	7,160	2,513	0.13
1981	5,794	12,773,370	2,199	4,848,643	4,486	908	0.12
1982	5,786	12,755,821	2,423	5,342,676	3,714	646	0.14
1983	6,092	13,430,038	2,579	5,686,156	3,860	1,080	0.15
1984	6,038	13,310,988	2,558	5,639,683	3,427	568	0.14
1985	5,771	12,722,708	2,489	5,486,814	3,188	746	0.14
1986	5,930	13,072,934	2,543	5,606,922	3,529	1,107	0.14
1987	6,068	13,377,237	2,485	5,478,833	3,825	1,126	0.14
1988	5,729	12,630,334	2,323	5,122,192	3,548	855	0.13
1989	5,477	12,074,549	2,269	5,001,247	3,321	786	0.13
1990	5,518	12,164,652	2,301	5,071,794	3,338	842	0.13
1991	5,541	12,215,601	2,219	4,891,633	3,505	1,018	0.12
1992	5,085	11,209,457	2,054	4,527,364	3,345	937	0.12
1993	4,846	10,683,236	1,900	4,188,844	3,109	778	0.11
1994	4,278	9,431,563	1,757	3,874,201	2,560	543	0.10
1995	4,125	9,093,264	1,710	3,770,782	2,380	558	0.10
1996	3,979	8,771,389	1,672	3,685,662	2,331	602	0.09
1997	3,947	8,702,583	1,634	3,602,503	2,440	704	0.09
1998	3,906	8,611,290	1,565	3,449,172	2,589	792	0.09
1999	3,784	8,341,951	1,502	3,312,177	2,763	930	0.08
2000	3,859	8,507,210	1,524	3,359,202	2,980	948	0.09
2001	4,036	8,896,810	1,607	3,541,722	3,051	836	0.09
2002	4,313	9,509,496	1,719	3,790,822	3,144	825	0.10
2003	4,511	9,945,173	1,796	3,959,013	3,396	1,102	0.10
2004	4,779	10,536,518	1,860	4,100,152	4,066	1,570	0.10
2005	4,980	10,978,611	1,947	4,293,211	4,069	1,046	0.11
2006	5,733	12,639,946	2,028	4,470,595	5,641	2,625	0.11
2007	5,731	12,635,515	2,101	4,631,973	5,614	1,640	0.12
2008	6,092	13,429,884	2,149	4,737,993	5,405	1,364	0.12
2009	5,651	12,459,300	2,260	4,982,265	4,164	754	0.13
2010	5,863	12,925,246	2,522	5,559,743	3,432	347	0.14

2011	6,241	13,758,570	2,774	6,116,586	3,430	787	0.16
2012	6,839	15,076,492	2,907	6,409,756	4,602	1,891	0.16
2013	7,034	15,507,716	2,846	6,274,966	5,248	1,793	0.16
2014	7,236	15,951,572	2,780	6,127,962	5,685	1,839	0.16
2015	7,570	16,689,877	2,855	6,293,683	6,507	2,410	0.16
2016	8,199	18,076,054	2,998	6,609,517	7,956	3,249	0.17
2017	8,624	19,012,356	3,169	6,987,455	8,126	2,406	0.18
2018	9,199	20,281,291	3,480	7,671,284	7,981	2,176	0.20
2019	10,325	22,762,481	4,028	8,879,790	8,792	2,777	0.23
2020	11,294	24,898,317	4,527	9,979,962	8,977	2,330	0.25
2021	12,688	27,972,659	4,944	10,898,539	11,057	4,300	0.28
2022	13,965	30,786,857	5,410	11,925,958	12,659	4,382	0.30
2023	15,132	33,359,869	5,898	13,002,562	12,611	3,138	0.33

Table 17. Geweke's diagnostic used to determine convergence of a single MCMC chain of selected parameters and derived quantities for the SEDAR 79 Base Model.

Parameter/Derived Quantity	Z-Score	p-value
Recr_Virgin	-0.7905	0.42926
SSB_Virgin	-0.9202	0.35746
SR_BH_steep	-0.1614	0.87176
SR_sigmaR	0.98357	0.32533
F_2021	1.27813	0.2012
F_2022	1.63342	0.10238
F_2023	0.82382	0.41004
SSB_2021	-0.3299	0.74145
SSB_2022	-0.3605	0.7185
SSB_2023	-0.5318	0.59488
F30%SPR	0.68777	0.4916
SSB_30%SPR	-0.9318	0.35145
Ret_Catch_F30%SPR	-0.6592	0.50977
SPRratio_2023	0.8731	0.38261

Table 18. Summary of correlated parameters with correlation coefficients exceeding 0.7 for the SEDAR 79 Base Model.

Parameter 1	**Parameter 2**	**Correlation**
Retain_L_infl_REC_E(3)_BLK2mult_1995	Retain_L_infl_REC_E(3)	-0.99
Retain_L_infl_REC_W(4)_BLK2mult_1995	Retain_L_infl_REC_W(4)	-0.95
Retain_L_width_REC_E(3)_BLK2mult_1995	Retain_L_width_REC_E(3)	-0.92
Size_DblN_ascend_se_RVC_DT(5)	Size_DblN_peak_RVC_DT(5)	0.91
Size_DblN_end_logit_RVC_KEYS(6)	Size_DblN_descend_se_RVC_KEYS(6)	-0.90
Size_DblN_descend_se_REC_E(3)	Size_DblN_top_logit_REC_E(3)	-0.89
Retain_L_infl_REC_W(4)_BLK2mult_2018	Retain_L_infl_REC_W(4)	-0.89
Retain_L_infl_REC_E(3)_BLK2mult_2018	Retain_L_infl_REC_E(3)	-0.89
Retain_L_infl_REC_E(3)_BLK2mult_2018	Retain_L_infl_REC_E(3)_BLK2mult_1995	0.88
Retain_L_width_REC_W(4)_BLK2mult_1995	Retain_L_width_REC_W(4)	-0.87
Retain_L_infl_REC_W(4)_BLK2mult_2018	Retain_L_infl_REC_W(4)_BLK2mult_1995	0.86
Size_95%width_COM_LL(1)	Size_inflection_COM_LL(1)	0.83
Size_DblN_end_logit_REC_W(4)	Size_DblN_descend_se_REC_W(4)	-0.82
VonBert_K_Fem_GP_1	L_at_Amax_Fem_GP_1	-0.82
Size_DblN_descend_se_RVC_DT(5)	Size_DblN_top_logit_RVC_DT(5)	-0.82
Retain_L_width_COM_OTHER(2)_BLK1add_2018	Retain_L_infl_COM_OTHER(2)_BLK1add_2018	0.81
Size_DblN_end_logit_RVC_DT(5)	Size_DblN_descend_se_RVC_DT(5)	-0.80
Size_95%width_GOM_VID(9)	Size_inflection_GOM_VID(9)	0.77
Retain_L_width_REC_E(3)_BLK2mult_2018	Retain_L_width_REC_E(3)	-0.76
Size_inflection_GOM_VID(9)	LnQ_base_GOM_VID(9)	0.76
SR_BH_steep	SR_LN(R0)	-0.72
Retain_L_width_REC_E(3)_BLK2mult_2018	Retain_L_width_REC_E(3)_BLK2mult_1995	0.71
CV_young_Fem_GP_1	L_at_Amin_Fem_GP_1	-0.70

Table 19. Joint residual summary statistics for the SEDAR 79 Base Model. N = number of observations to compute each statistic. RMSE = root mean squared error (as a percentage) associated with each data source and for each model component.

Model Component	Data Source	RMSE (%)	N
Indices of Abundance	COM_LL	38.3	18
	FIM_YOY	74	24
	GOM_VID	34.5	20
	RVC_DT	30.4	12
	RVC_KEYS	20.8	18
	RVC_SEFL	35	7
	SERFS_VID	84.9	11
	Combined	51.2	110
Mean Length (4 cm bins)	COM_LL	3.2	31
	COM_OTHER	5.2	34
	GOM_VID	1.9	1
	REC_E	3.5	42
	REC_W	3.7	42
	Combined	4	150
Mean Length (5 cm bins)	RVC_DT	6.8	12
	RVC_KEYS	11.2	19
	RVC_SEFL	7	7
	Combined	9.3	38
Mean Conditional Age-at-Length	COM_LL	6.3	21
	COM_OTHER	7.6	31
	FI_AGE	11.3	7
	REC_E	9	28
	REC_W	8.3	22
	Combined	8.2	109

Table 20. Retrospective analysis and retrospective forecast spawning stock biomass (SSB) and age-3 fishing mortality (F) for the last seven terminal years and combined (grey rows) for the SEDAR 79 Base Model. The rule of thumb of the acceptable range of Mohn's Rho values is -0.15 to 0.20 for longer-lived species (Hurtado-Ferro et al. 2015).

Type	Peel	Mohn's Rho	Forcast Mohn's Rho
SSB	2022	0.03	0.04
SSB	2021	0.13	0.17
SSB	2020	0.13	0.11
SSB	2019	0.07	0.12
SSB	2018	0.11	0.06
SSB	2017	0.22	0.21
SSB	2016	0.14	0.20
SSB	Combined	0.12	0.13
F	2022	0.05	-0.26
F	2021	-0.05	-0.30
F	2020	0.20	-0.06
F	2019	0.01	-0.45
F	2018	0.06	-0.20
F	2017	-0.03	0.82
F	2016	-0.09	-0.75
F	Combined	0.02	-0.17

Table 21. Index root mean square error (RMSE %) values from the SEDAR 79 Base Model, the age-structured production model (ASPM), and the ASPM with estimated recruitment deviations (ASPMdev).

Index	Base Model	ASPM	ASPMdev
Commercial LL CPUE	38.3	52.7	33.3
FIM YOY	74	58.4	70.6
Gulf Video	34.5	33.4	34.7
RVC Dry Tortugas	30.4	46.2	33.0
RVC FL Keys	20.8	30.6	19.2
RVC SE FL	35	60.3	36.5
SERFS Video	84.9	103	85.8
Combined	51.2	55.6	49.9

Table 22. Hindcast cross-validation summary statistics for the SEDAR 79 Base Model. N = number of observations to compute each statistic. MASE = mean absolute scaled error, with values < 1 (in green) indicative of superior prediction skill over a naïve baseline forecast (random walk) and values > 1 (in red) indicative of poor prediction skill. Model MAE = mean absolute error of model prediction residuals. Naïve MAE = mean absolute error of naïve predictions.

Model Component	Data Source	MASE	Model MAE	Naive MAE	N
Index of Abundance	RVC_DT	0.47	0.22	0.48	4
	RVC_KEYS	1.16	0.21	0.18	3
	RVC_SEFL	1.88	0.60	0.32	5
	FIM_YOY	0.54	0.48	0.88	8
	GOM_VID	1.17	0.46	0.39	7
	SERFS_VID	0.74	0.34	0.46	7
	Joint	0.81	0.41	0.50	34
Length Composition	COM_LL	0.66	0.03	0.04	7
	COM_OTHER	2.68	0.05	0.02	8
	REC_E	2.00	0.04	0.02	8
	REC_W	1.52	0.03	0.02	8
	Joint	1.50	0.04	0.02	31
Conditional Age-at-Length	COM_LL	0.64	0.06	0.09	7
	COM_OTHER	0.41	0.04	0.09	8
	REC_E	0.55	0.04	0.07	7
	REC_W	0.68	0.10	0.15	8
	FI_AGE	0.39	0.02	0.06	1
	Joint	0.58	0.06	0.10	31

Table 23. Comparison of the reference points (75% of spawning biomass at $F_{30\%SPR}$ – $75\%SSB_{F30\%SPR}$, fishing mortality rate corresponding to spawning potential ratio of 30% - $F_{30\%SPR}$), the geometric mean of spawning stock biomass from 2011-2013 (SSB-Geo), and the geometric mean of fishing mortality rate on age-3 fish from 2011-2013 (F-Geo) between SEDAR 15AU Final Model and the three model bridging exercises.

Configuration	75% $SSB_{F30\%SPR}$	SSB-Geo	$F_{30\%SPR}$	F-Geo
SEDAR 15AU base	1557	2223	0.18	0.12
Mean weights	1791	1849	0.17	0.16
Mean weights and landings	1611	3655	0.15	0.08
Mean weights, landings, and indices	2087	3597	0.11	0.05

Table 24. The yield-per-recruit (YPR), spawner-per-recruit (SSB/R), static spawning potential ratio (SPR), and total equilibrium yield in metric tons computed over a range of instantaneous fishing mortality rates (F) on age-3 Mutton Snapper.

Age-3 F	YPR	SSB/R	SPR	Total Yield (mt)
0.000	0.000	7.073	1.000	0.72
0.008	0.068	6.550	0.926	167.75
0.017	0.127	6.073	0.858	311.52
0.025	0.180	5.637	0.797	434.56
0.034	0.227	5.239	0.741	539.08
0.042	0.269	4.875	0.689	627.00
0.051	0.306	4.540	0.642	700.01
0.059	0.339	4.233	0.598	759.60
0.067	0.368	3.951	0.558	807.07
0.076	0.393	3.691	0.522	843.57
0.084	0.416	3.452	0.488	870.10
0.093	0.436	3.231	0.457	887.54
0.101	0.454	3.027	0.428	896.70
0.109	0.470	2.838	0.401	898.25
0.118	0.483	2.664	0.377	892.79
0.126	0.495	2.503	0.354	880.88
0.135	0.506	2.353	0.333	862.98
0.143	0.515	2.214	0.313	839.51
0.152	0.523	2.085	0.295	810.84
0.160	0.530	1.965	0.278	777.29
0.168	0.536	1.853	0.262	739.14
0.177	0.541	1.749	0.247	696.66
0.185	0.545	1.652	0.233	650.04
0.194	0.549	1.561	0.221	599.50
0.202	0.552	1.477	0.209	545.19
0.210	0.554	1.398	0.198	487.27
0.219	0.556	1.324	0.187	425.85
0.227	0.557	1.255	0.177	361.04
0.236	0.558	1.191	0.168	292.95
0.244	0.559	1.130	0.160	221.65
0.253	0.559	1.073	0.152	147.20
0.261	0.559	1.020	0.144	69.67
0.269	0.559		0.137	
0.278	0.558		0.130	
0.286	0.557		0.124	
0.295	0.556		0.118	
0.303	0.555		0.113	
0.311	0.554		0.107	
0.320	0.553		0.103	
0.328	0.551		0.098	

Table 25. The stock status determination criterion for Southeastern U.S. Mutton Snapper according to the South Atlantic Fishery Management Council (SAFMC) and the Gulf of Mexico Fishery Management Council (GMFMC). Note: values of MSST and OY are currently undefined for the GMFMC and they default to the definition provided below by the SAFMC.

South Atlantic and Gulf of Mexico Fishery Management Councils

Criteria	Definition	Base Model Value
$F_{30\%SPR}$	The fishing mortality rate associated with 30% SPR and the proxy used for F_{MSY}	0.149 yr^{-1}
$F_{40\%SPR}$	The fishing mortality rate associated with 40% SPR and the proxy used for F_{OY}	0.11 yr^{-1}
MFMT (Maximum Fishing Mortality Threshold)	$F_{30\%\ SPR}$	0.149 yr^{-1}
F_{OY}	$F_{40\%SPR}$	0.11 yr^{-1}
$F_{current}$ (recent average fishing mortality rate on age-3 fish)	The geometric mean of F on age-3 fish for 2021 - 2023	0.08 yr^{-1}
$SSB_{F30\%SPR}$	The estimated spawning stock biomass associated with F at 30% SPR	3,352 mt (7,389,895 lbs.)
MSST (Minimum Stock Size Threshold)	0.75*$SSB_{F30\%SPR}$	2,514 mt (5,542,421 lbs.)
$SSB_{current}$ (recent average of SSB)	The geometric mean of SSB for 2021 - 2023	5,403 mt (11,911,576 lbs.)
MSY proxy (Maximum Sustainable Yield Proxy)	Yield at $F_{30\%SPR}$	681.87 mt (1,503,266 lbs.)

Table 26. Results of the short- and long-term projections when age-3 fishing mortality rates = $F_{30\%SPR}$ (0.149) for Southeastern US Mutton Snapper. Long-term projections assume predicted recruitment follows the spawner-recruit curve. Short-term projections assume predicted age 1 recruitment is equal to the geometric mean from 2019 to 2023 (3.284 million). Recruitment (Recruits) is in millions of age-1 fish, F is age-3 instantaneous fishing mortality rate, SSB is in metric tons (female SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	Long-Term Projections					**Short-Term Projections**				
Year	**Age 1 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age 1 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2024	1.966	0.149	6,488	3,278,980	627,789	3,284	0.149	6,488	3,280,143	628,742
2025	2.026	0.149	6,864	3,372,143	623,832	3,284	0.149	6,867	3,384,760	630,618
2026	2.061	0.149	6,974	3,249,912	564,280	3,284	0.149	7,029	3,363,706	605,530
2027	2.070	0.149	6,821	3,023,751	495,817	3,284	0.149	7,089	3,313,030	583,152
2028	2.057	0.149	6,584	2,814,305	446,663	3,284	0.149	7,118	3,270,355	568,844
2029	2.035	0.149	6,342	2,650,664	415,719	3,284	0.149	7,130	3,239,178	560,244
2030	2.012	0.149	6,109	2,523,697	395,653	3,284	0.149	7,130	3,216,409	554,984
2031	1.989	0.149	5,889	2,421,114	381,362	3,284	0.149	7,123	3,199,290	551,639
2032	1.965	0.149	5,682	2,335,047	370,254	3,284	0.149	7,112	3,186,071	549,426
2033	1.942	0.149	5,490	2,261,068	361,084	3,284	0.149	7,098	3,175,662	547,907

Table 27. Results of the short-term projections when age-3 fishing mortality rates equal 75% $F_{30\%SPR}$ (0.112) and $F_{current}$ (0.08) for Southeastern US Mutton Snapper assuming predicted age 1 recruitment is equal to the geometric mean from 2019 to 2023 (3.284 million). Recruitment (Recruits) is in millions of age-1 fish, F is age-3 instantaneous fishing mortality rate, SSB is in metric tons (female SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	Short-Term Projections - 75% $F_{30\%SPR}$					**Short-Term Projections - $F_{current}$**				
Year	**Age 1 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age 1 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2024	3.284	0.112	6,565	2,498,073	479,551	3.284	0.080	6,631	1,811,994	348,293
2025	3.284	0.112	7,160	2,662,320	497,423	3.284	0.080	7,419	1,985,255	371,812
2026	3.284	0.112	7,547	2,725,359	491,431	3.284	0.080	8,022	2,084,741	376,453
2027	3.284	0.112	7,822	2,752,377	483,445	3.284	0.080	8,512	2,151,561	377,279
2028	3.284	0.112	8,047	2,772,615	478,662	3.284	0.080	8,942	2,206,166	378,545
2029	3.284	0.112	8,233	2,791,436	476,385	3.284	0.080	9,319	2,253,469	380,361
2030	3.284	0.112	8,386	2,808,849	475,505	3.284	0.080	9,646	2,294,626	382,360
2031	3.284	0.112	8,513	2,824,461	475,332	3.284	0.080	9,930	2,330,278	384,303
2032	3.284	0.112	8,618	2,838,173	475,501	3.284	0.080	10,177	2,361,052	386,090
2033	3.284	0.112	8,705	2,850,076	475,824	3.284	0.080	10,389	2,387,571	387,685

10. FIGURES

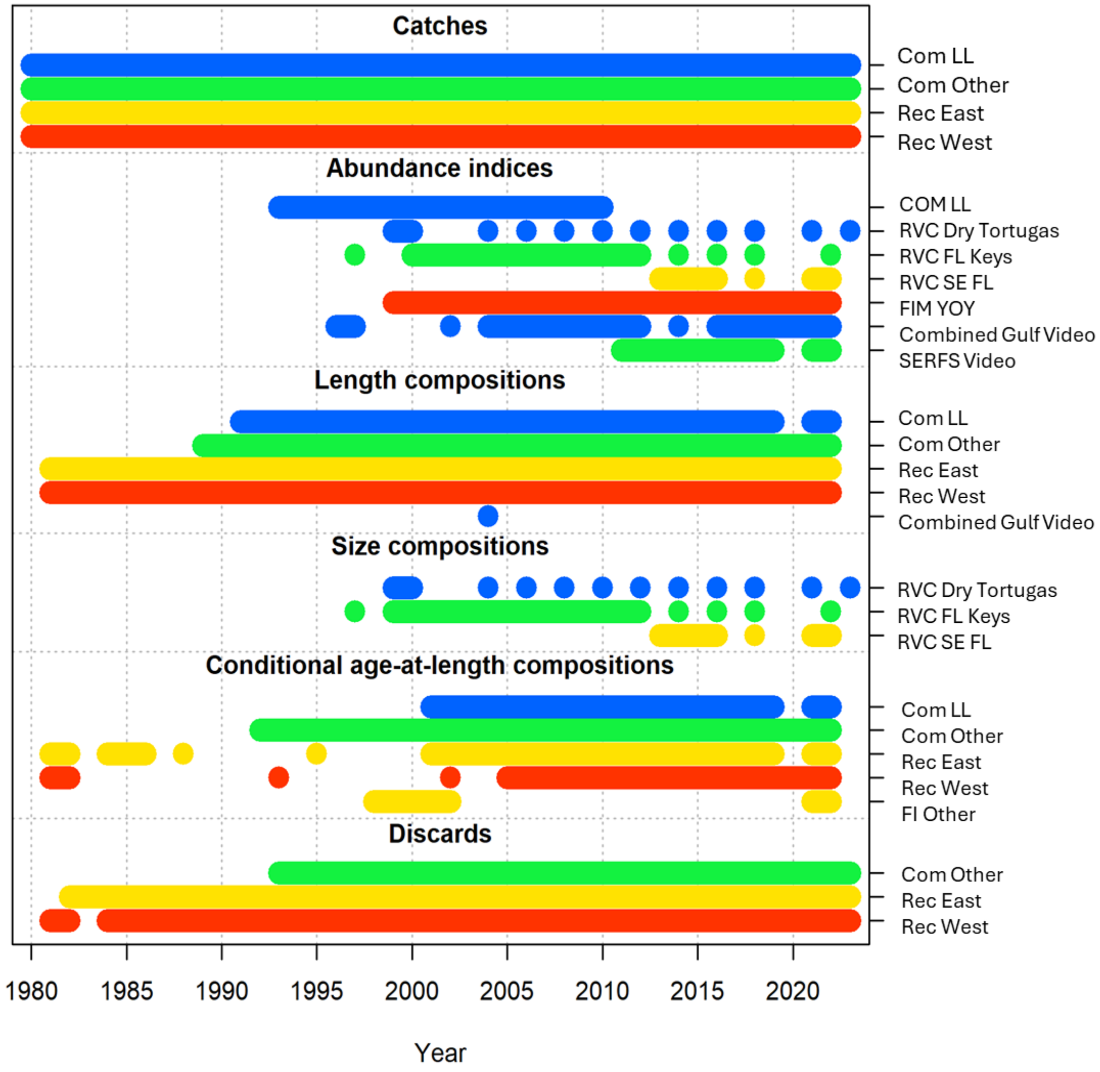


Figure 1. Data sources used in the Southeastern US Mutton Snapper Stock Synthesis assessment model.

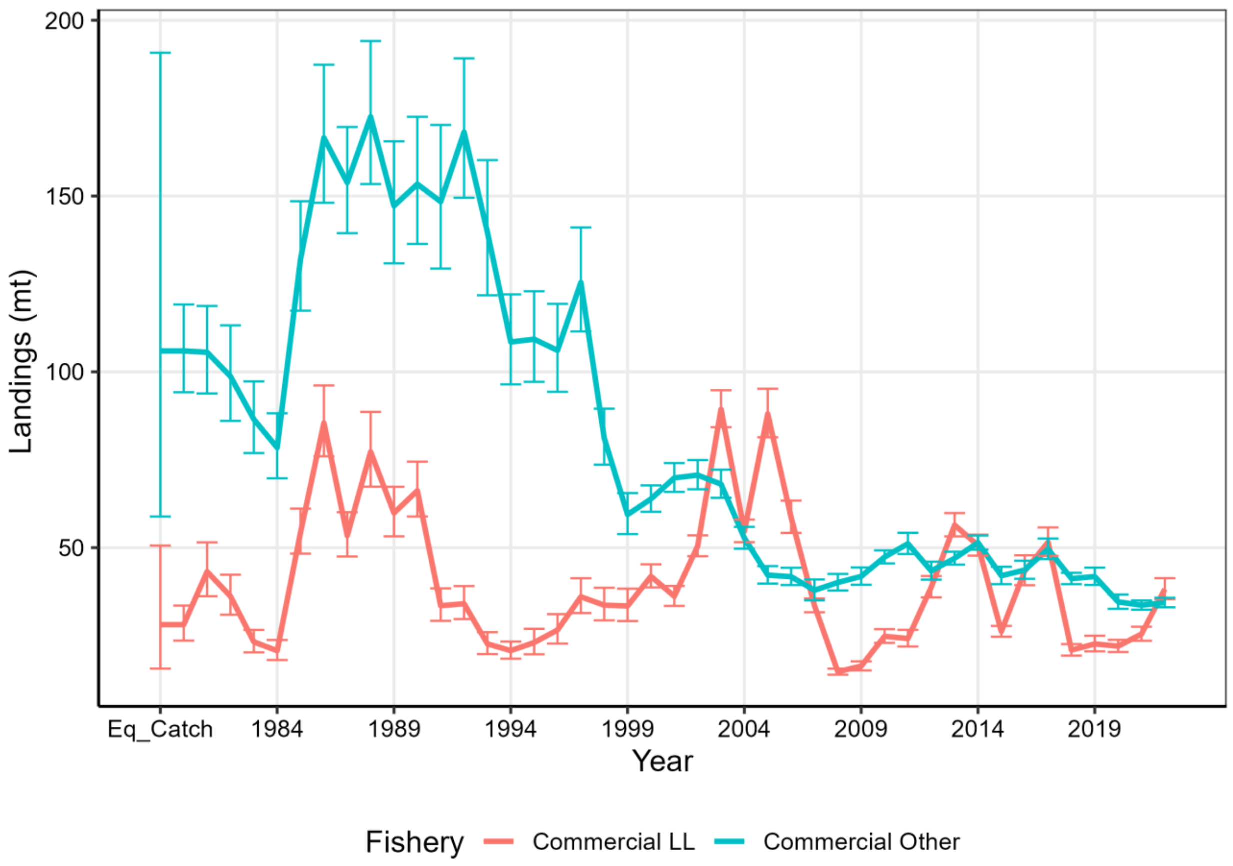


Figure 2. Observed commercial landings in weight (metric tons, mt) for Southeastern US Mutton Snapper and associated uncertainty, 1981-2023.

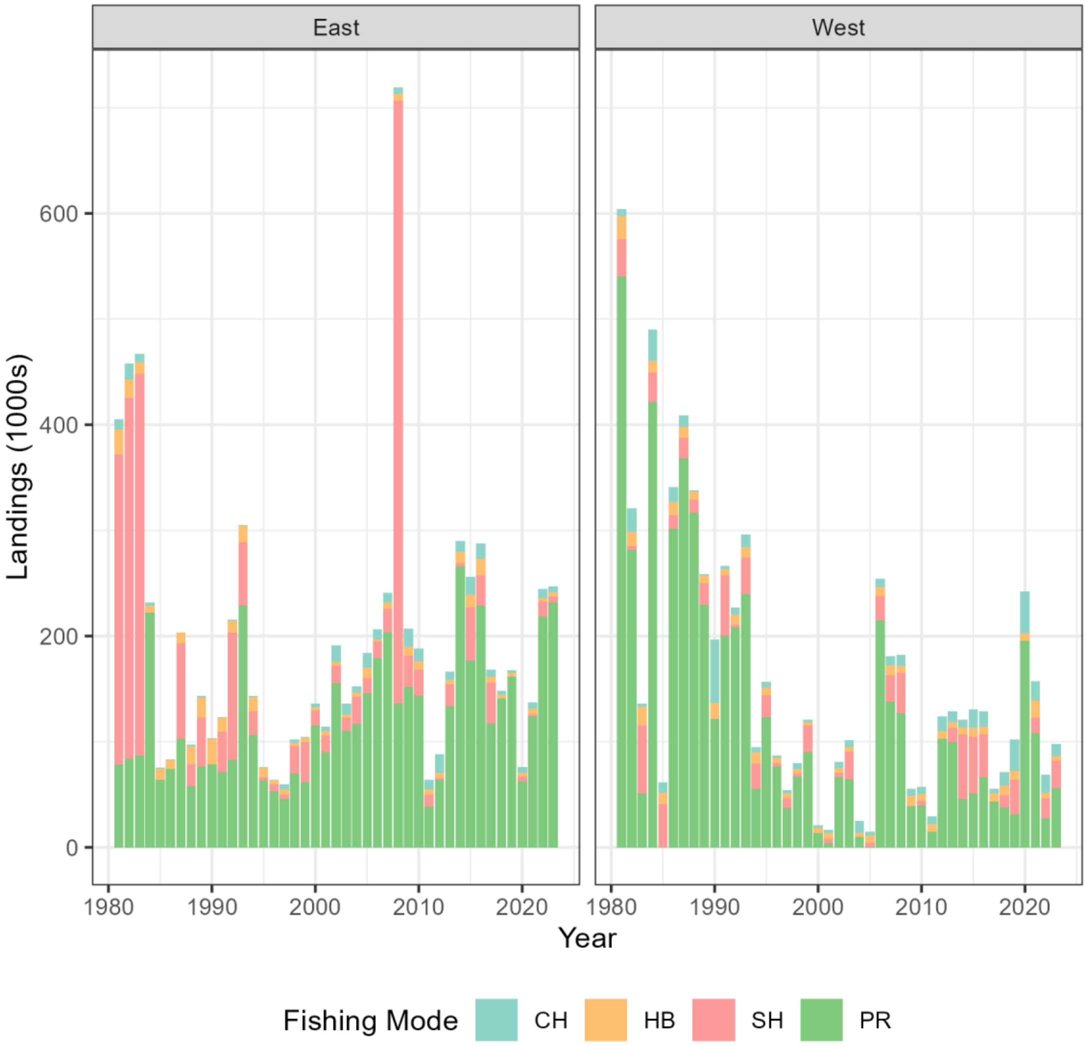


Figure 3. Observed recreational landings in numbers (1000s) for Southeastern US Mutton Snapper using data from SRHS (HB) and MRIP (CH, SH, PR), 1981-2023.

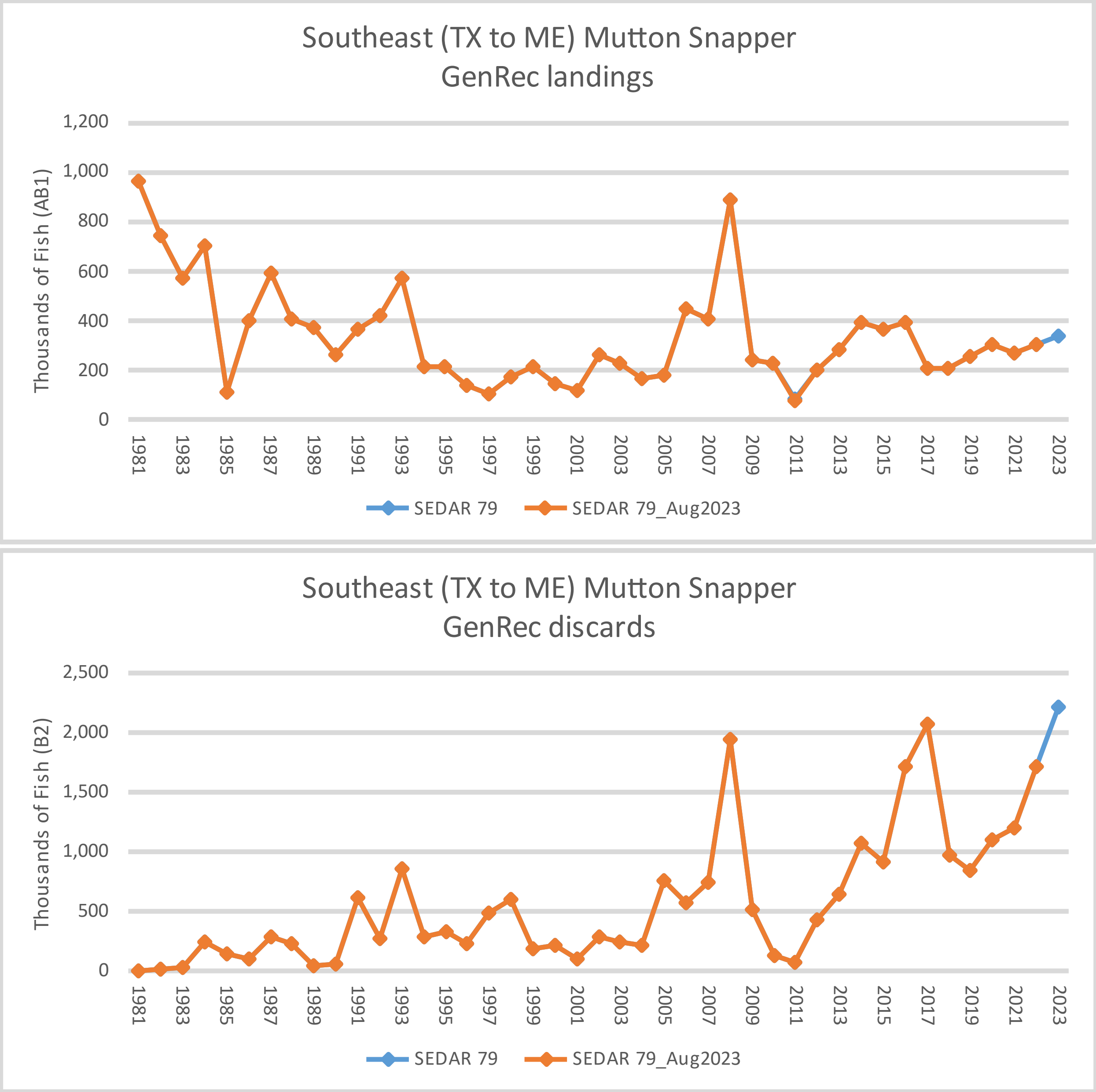


Figure 4. A comparison of observed recreational landings and releases in numbers (1000s) for Southeastern US Mutton Snapper using only MRIP data from 1981-2022 (orange) and 1981-2023 (blue).

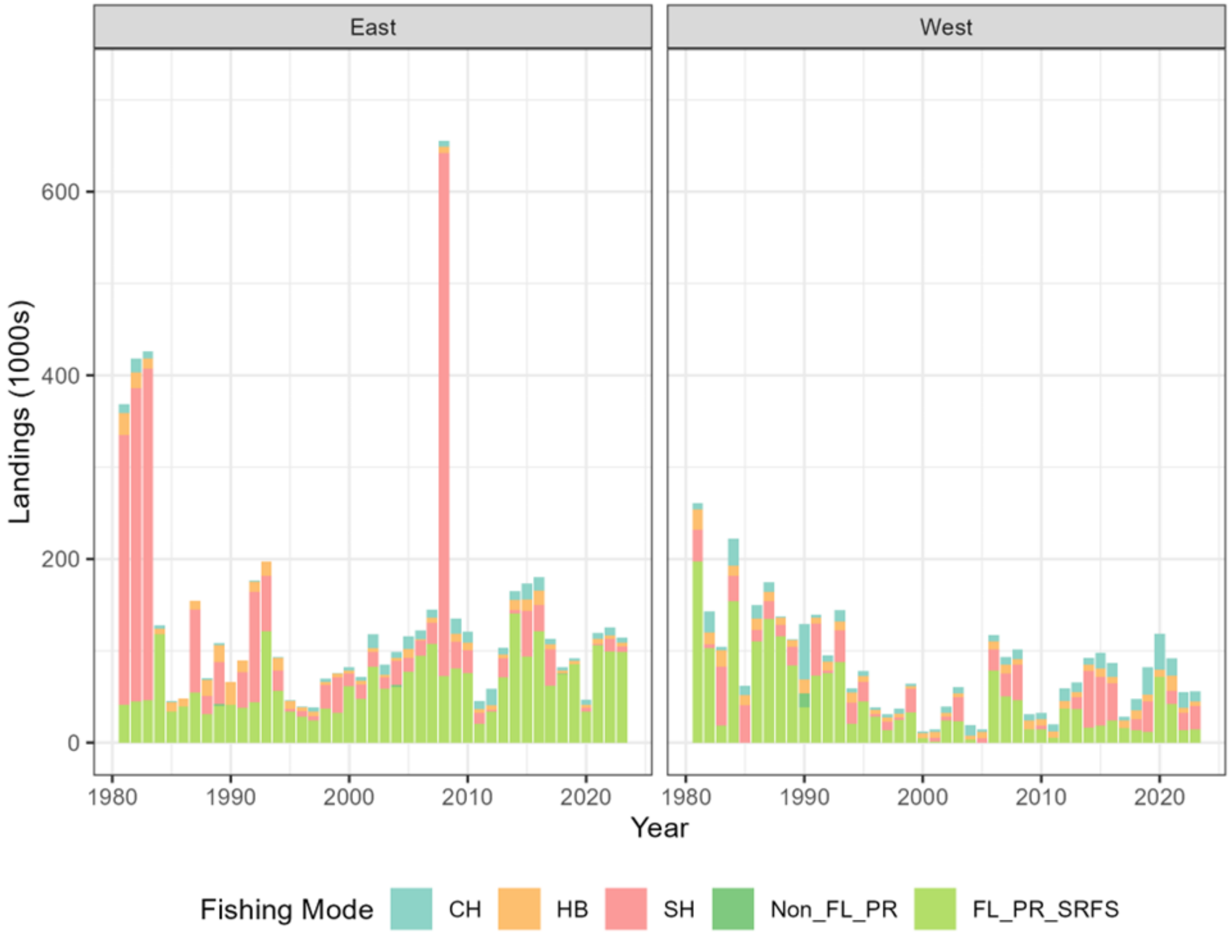


Figure 5. Observed recreational landings in numbers (1000s) for Southeastern US Mutton Snapper using data from SRHS (HB), MRIP (CH, SH, Non-FL PR), and SRFS (FL PR), 1981-2023.

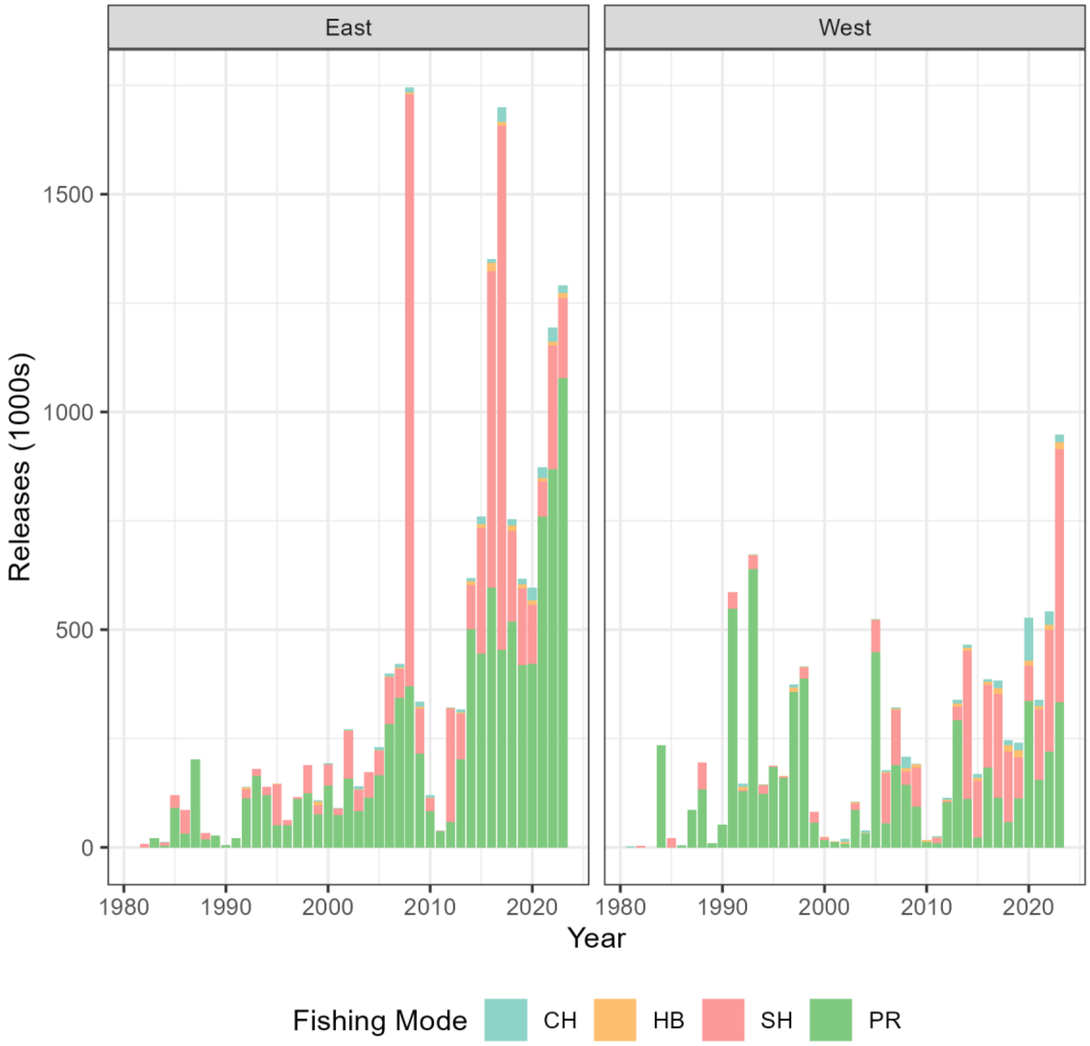


Figure 6. Observed recreational releases in numbers (1000s) for Southeastern US Mutton Snapper using data from SRHS (HB) and MRIP (CH, SH, PR), 1981-2023.

Figure 7. Observed recreational releases in numbers (1000s) for Southeastern US Mutton Snapper using data from SRHS (HB), MRIP (CH, SH, Non-FL PR), and SRFS (FL PR), 1981-2023.

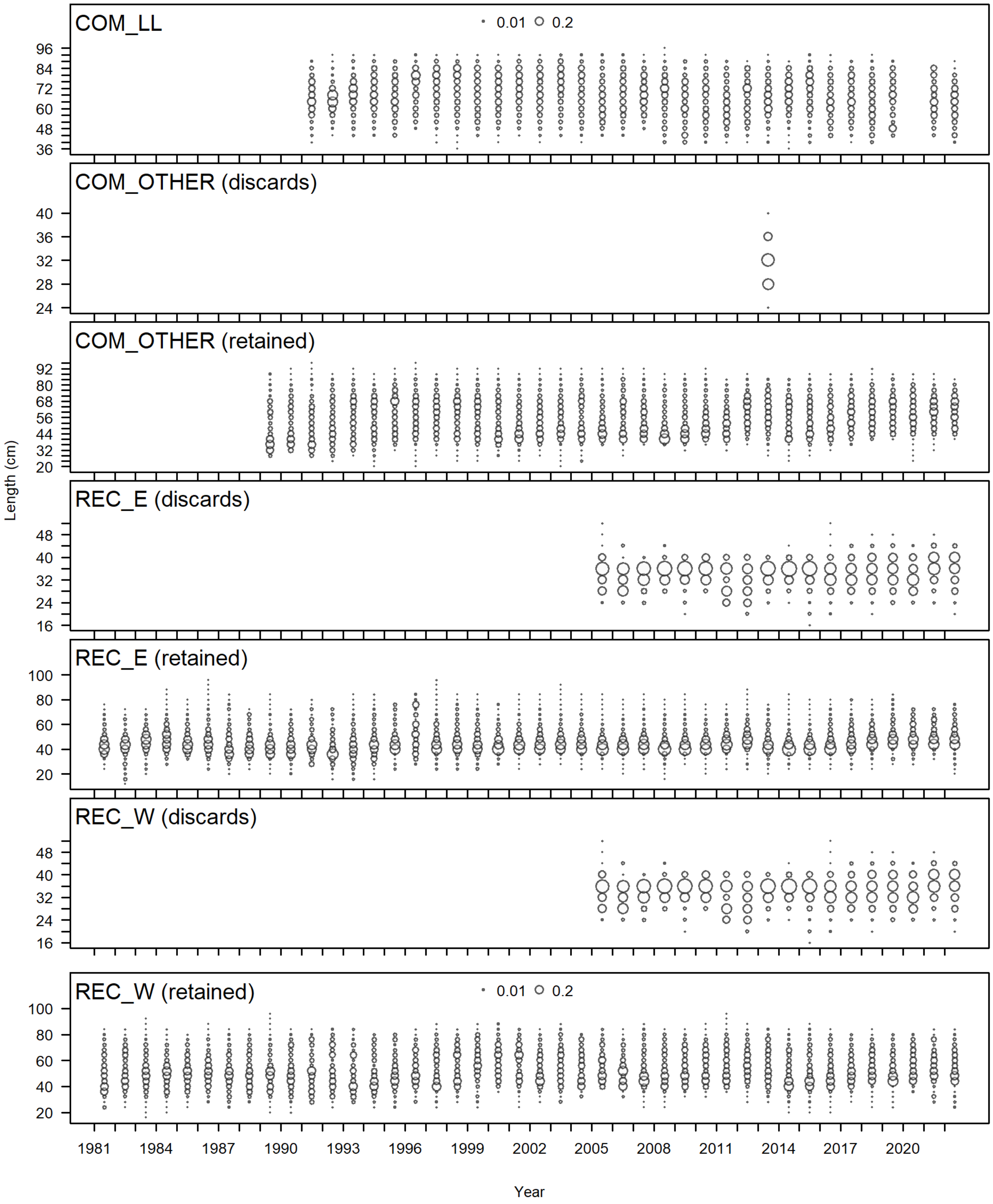


Figure 8. Catch-weighted length compositions (4 cm Max TL bins) of Southeastern US Mutton Snapper landings and releases by fleet, 1981-2022.

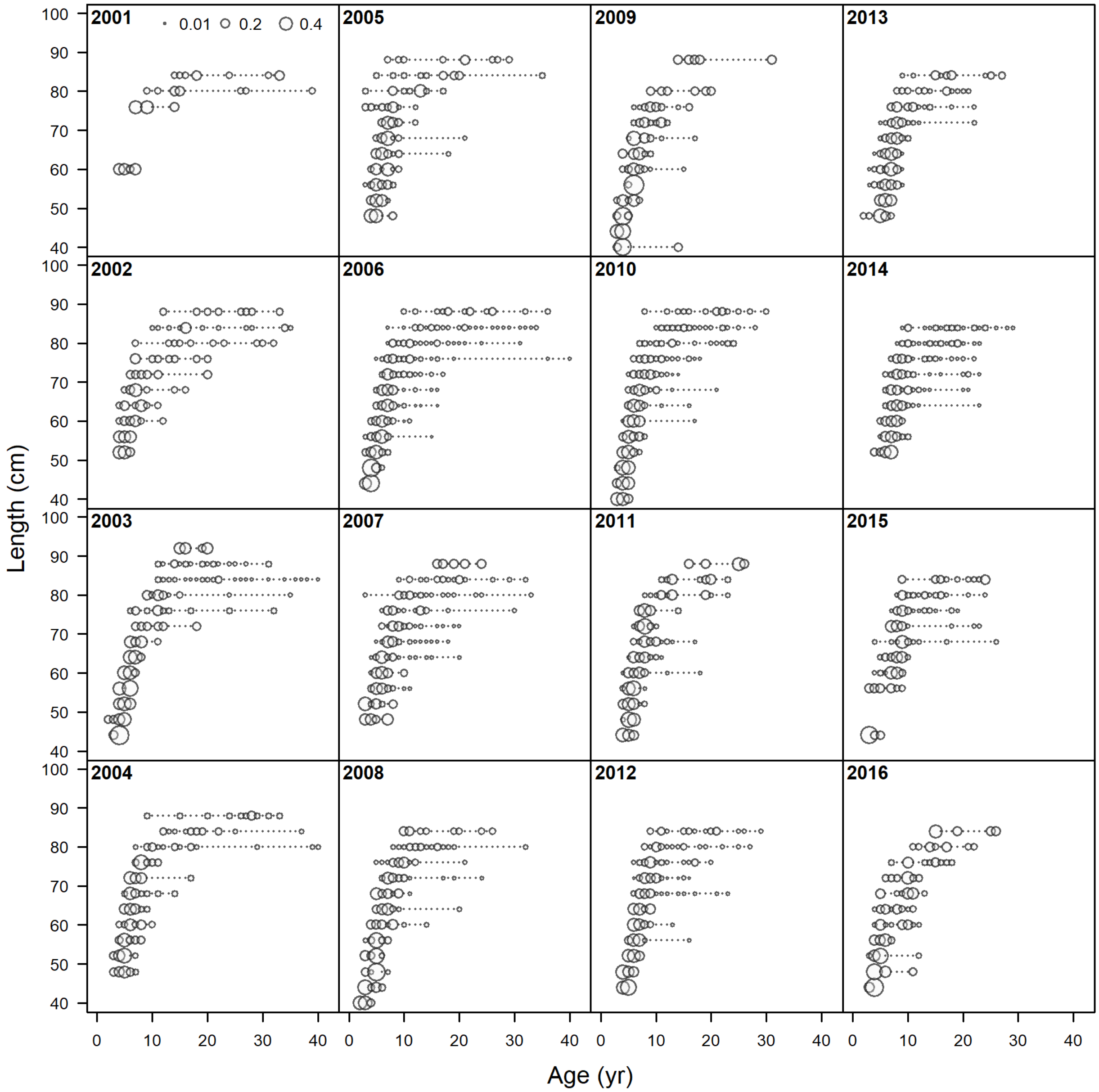


Figure 9. Observed conditional age-at-length in 4 cm Max TL bins of Southeastern US Mutton Snapper for the commercial Longline fleet, 2001-2022.

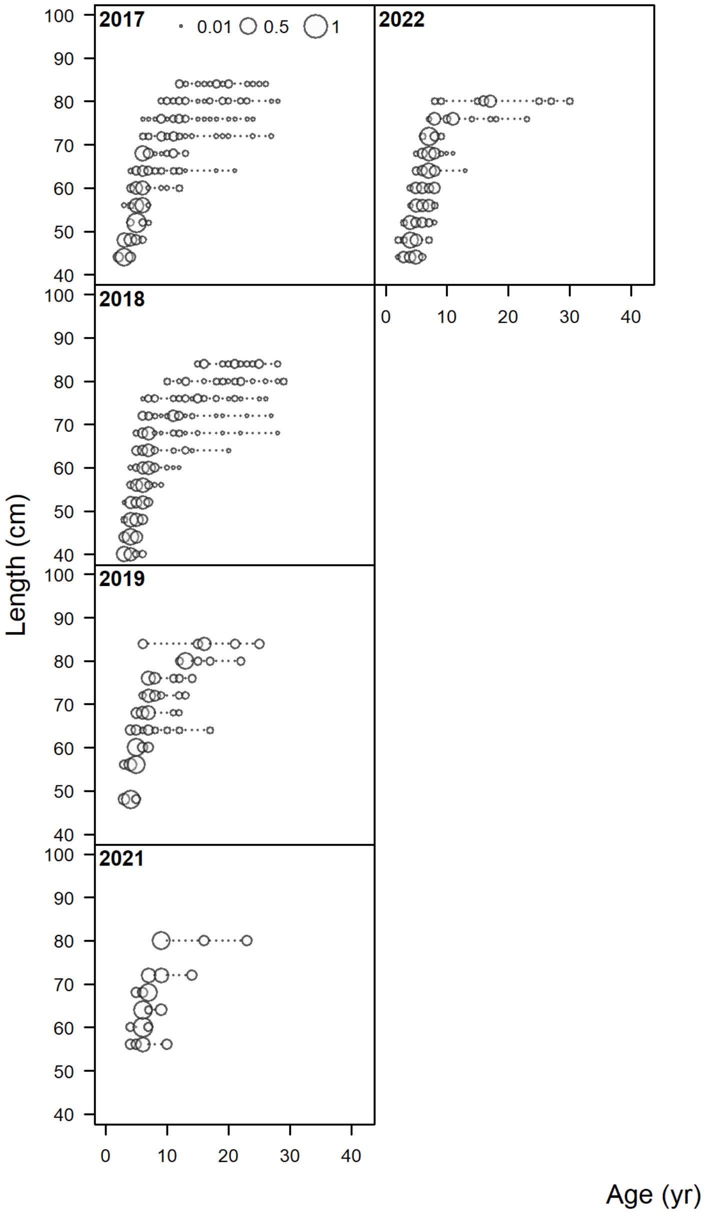


Figure 9 (continued). Observed conditional age-at-length in 4 cm Max TL bins of Southeastern US Mutton Snapper for the Commercial Longline fleet, 2001-2022.

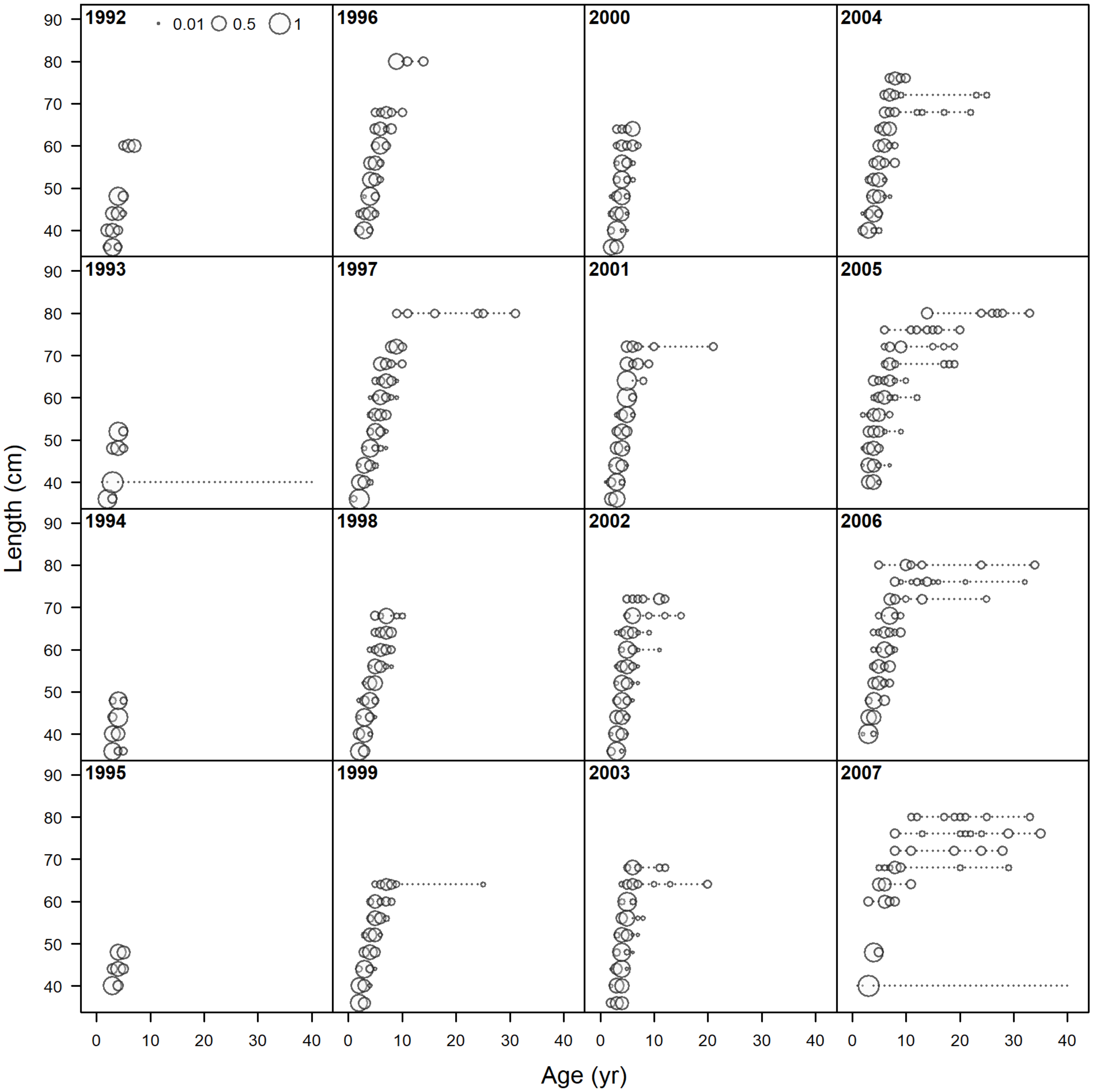


Figure 10. Observed conditional age-at-length in 4 cm Max TL bins of Southeastern US Mutton Snapper for the Commercial Other fleet, 1992-2022.

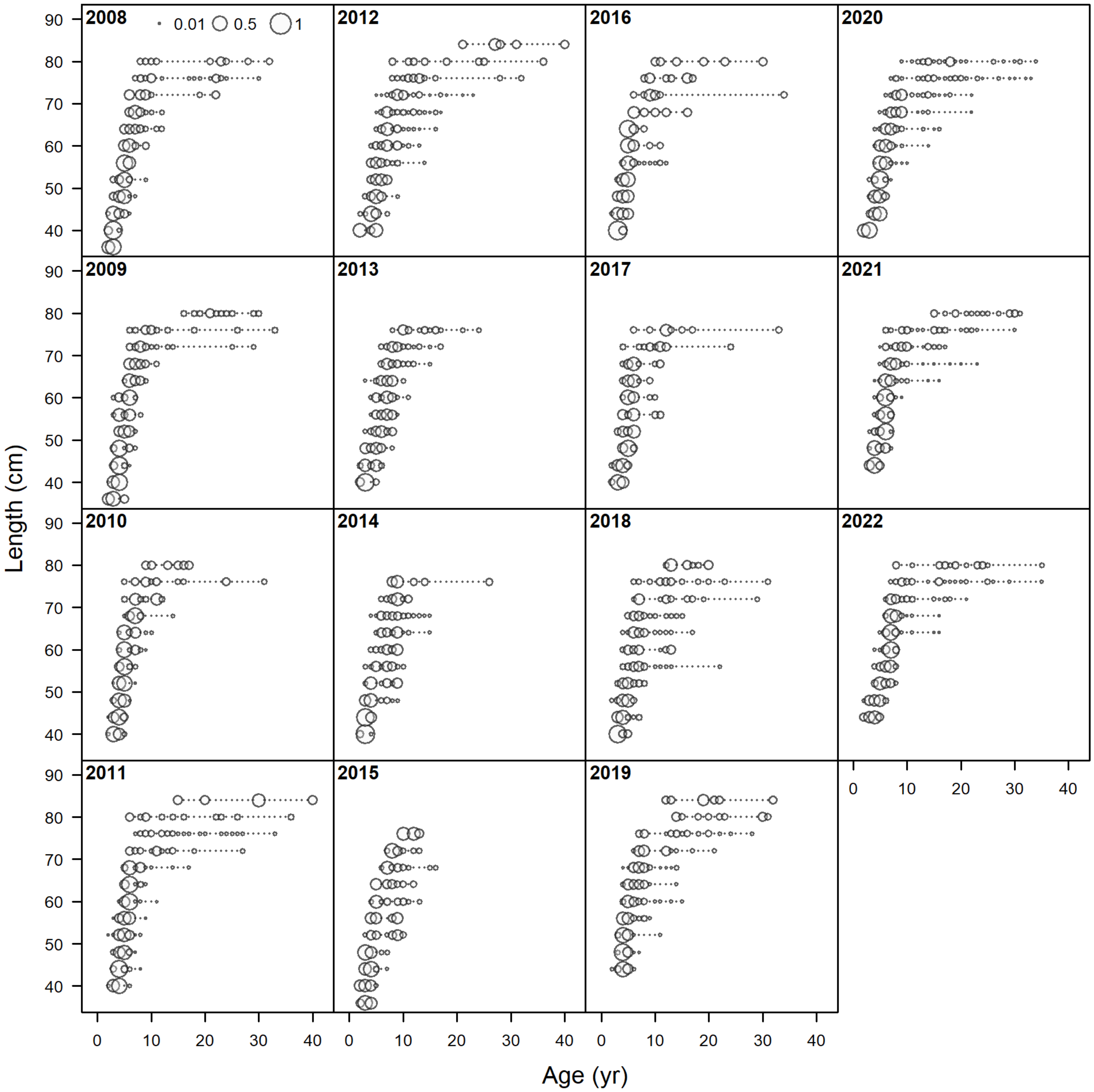


Figure 10 (continued). Observed conditional age-at-length in 4 cm Max TL bins of Southeastern US Mutton Snapper for the Commercial Other fleet, 1992-2022.

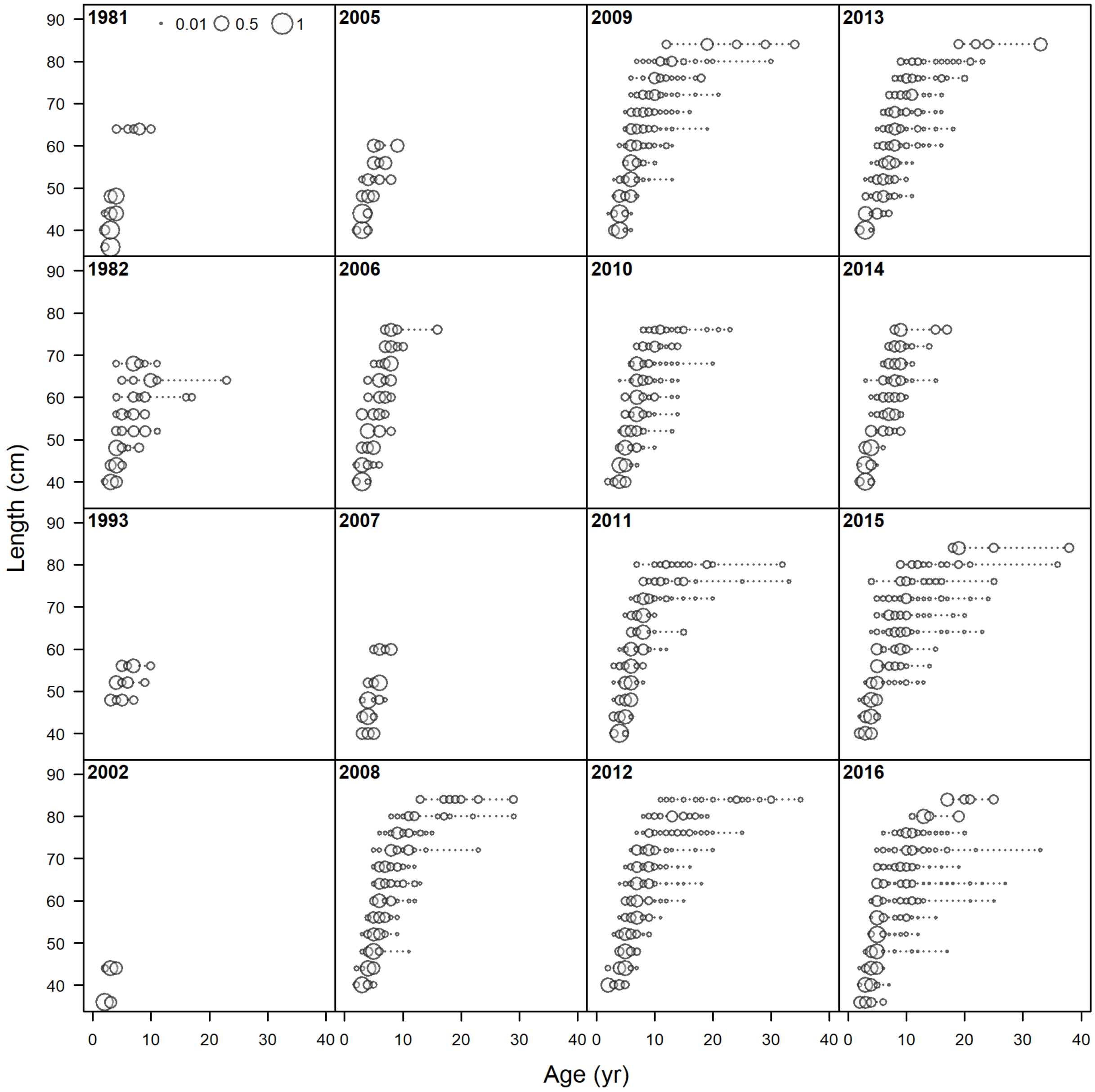


Figure 11. Observed conditional age-at-length in 4 cm Max TL bins of Southeastern US Mutton Snapper for the Recreational West fleet, 1981-2022.

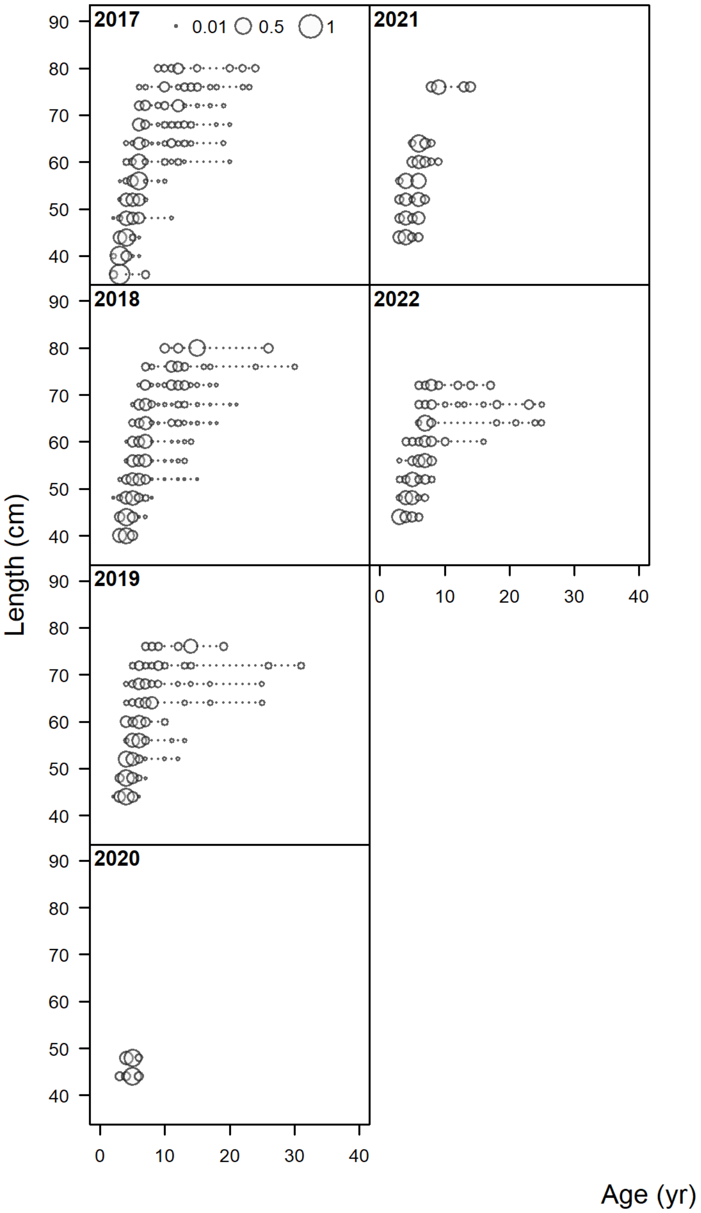


Figure 11 (continued). Observed conditional age-at-length in 4 cm Max TL bins of Southeastern US Mutton Snapper for the Recreational West fleet, 1981-2022.

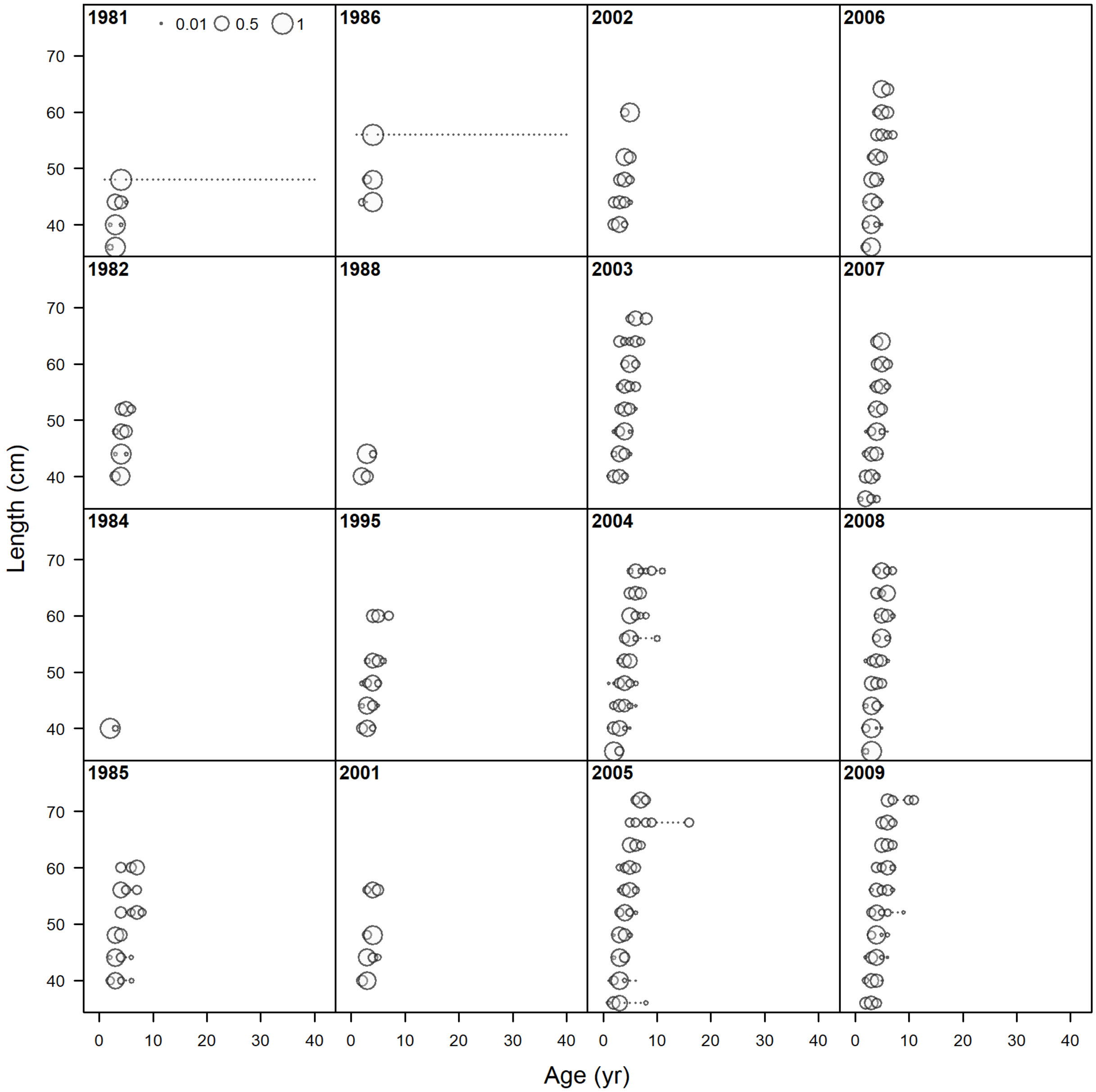


Figure 12. Observed conditional age-at-length in 4 cm Max TL bins of Southeastern US Mutton Snapper for the Recreational East fleet, 1981-2022.

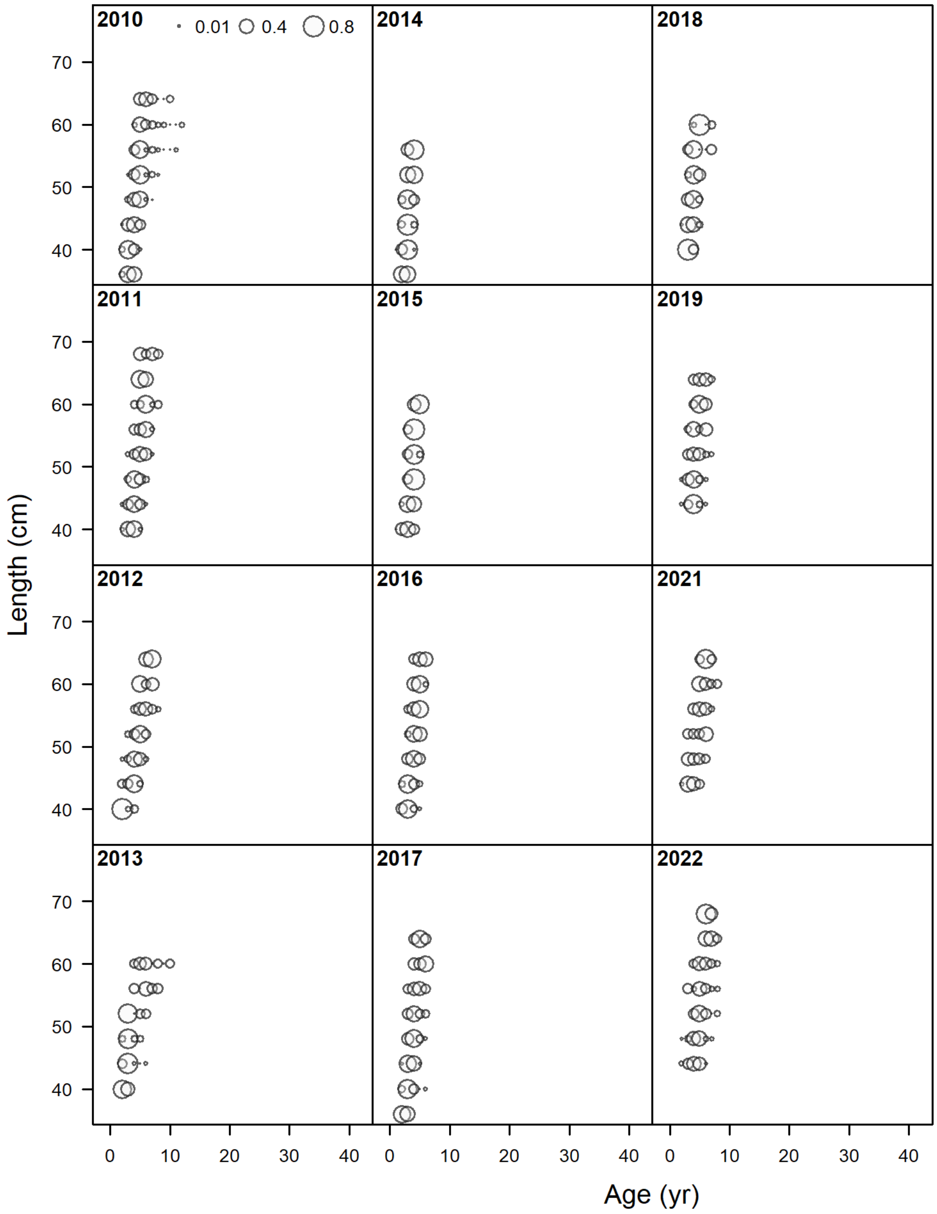


Figure 12 (continued). Observed conditional age-at-length in 4 cm Max TL bins of Southeastern US Mutton Snapper for the Recreational East fleet, 1981-2022.

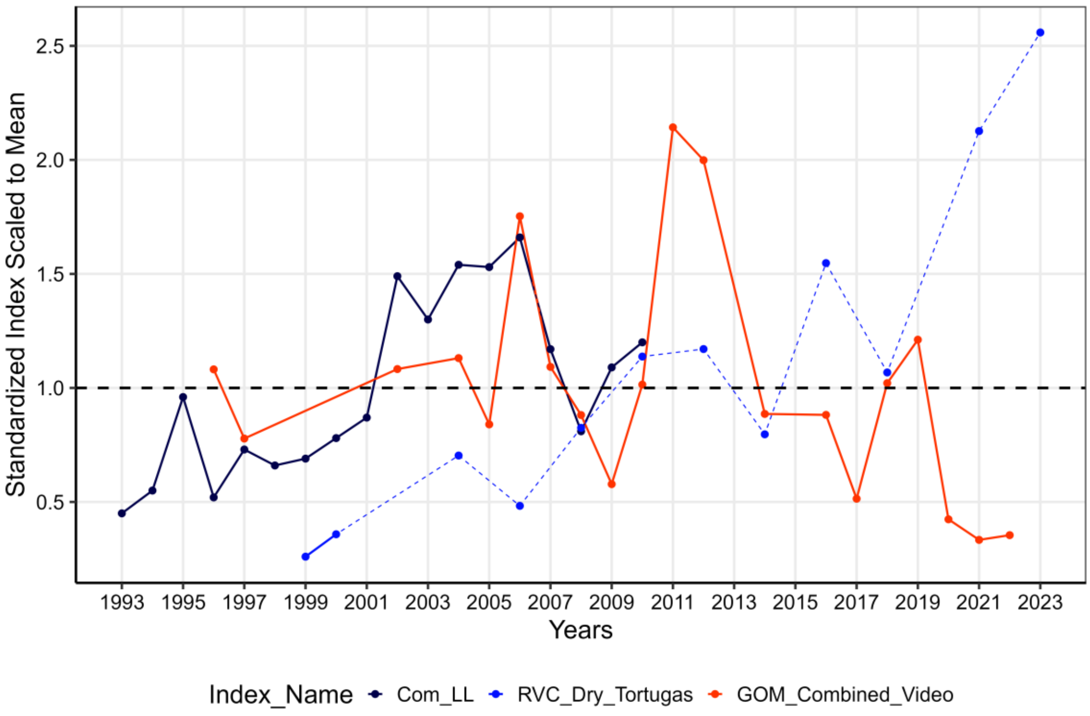


Figure 13. Indices of Southeastern US Mutton Snapper occurring in the Gulf of Mexico, 1993-2023. Non-consecutive years are joined by the dashed line.

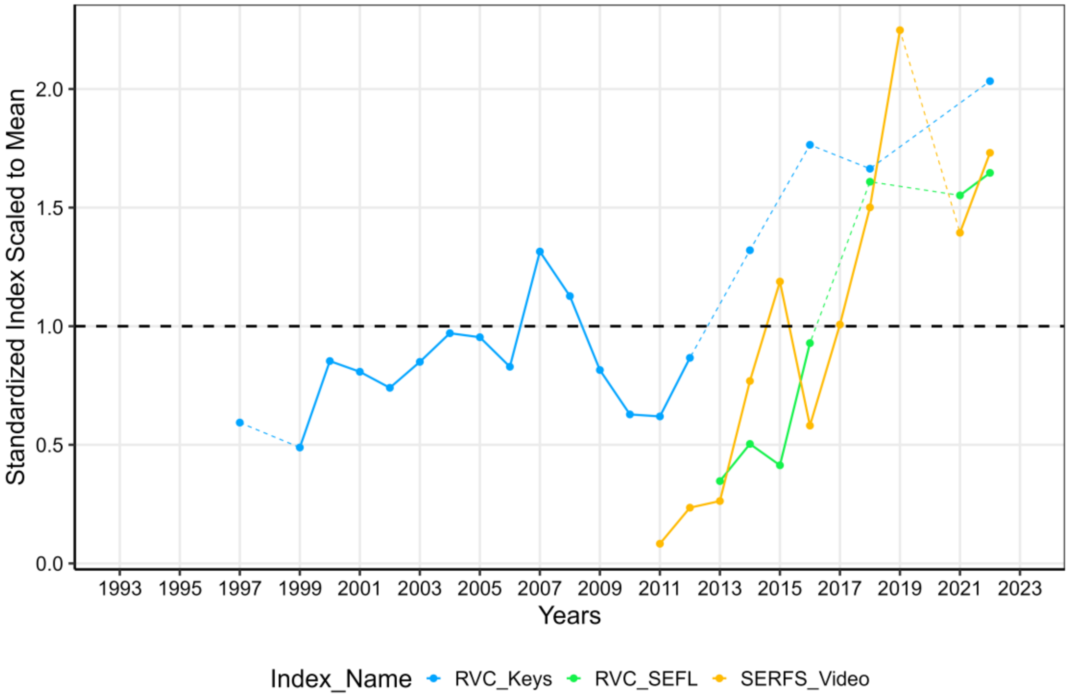


Figure 14. Indices of Southeastern US Mutton Snapper occurring in the South Atlantic, 1997-2022. Non-consecutive years are joined by the dashed line.

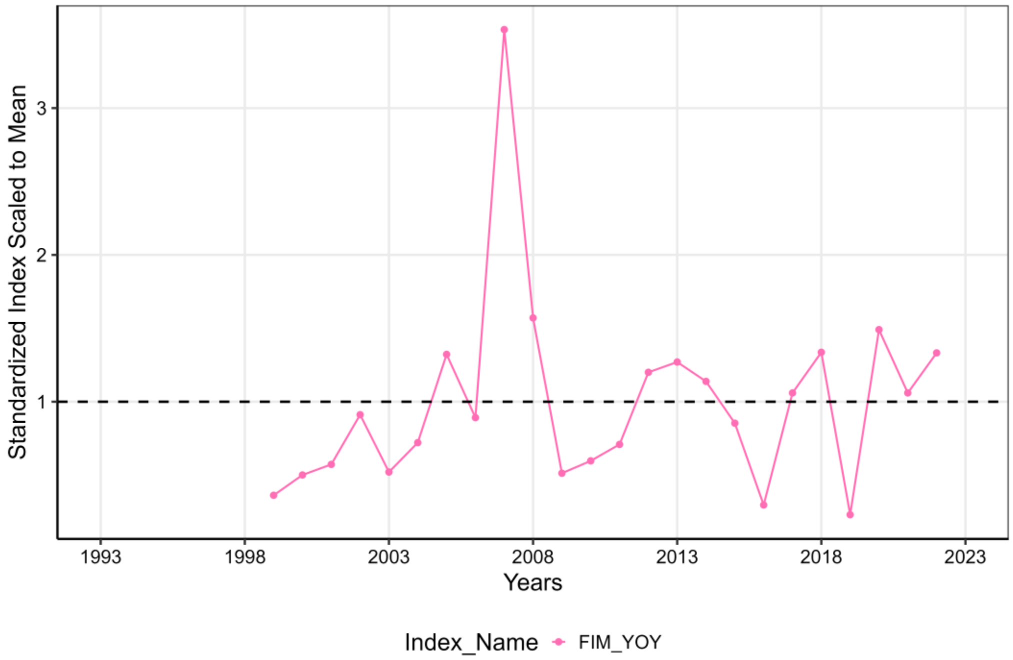


Figure 15. Fishery-independent young-of-year index of Southeastern US Mutton Snapper occurring in the Indian River Lagoon, FL, 1999-2022.

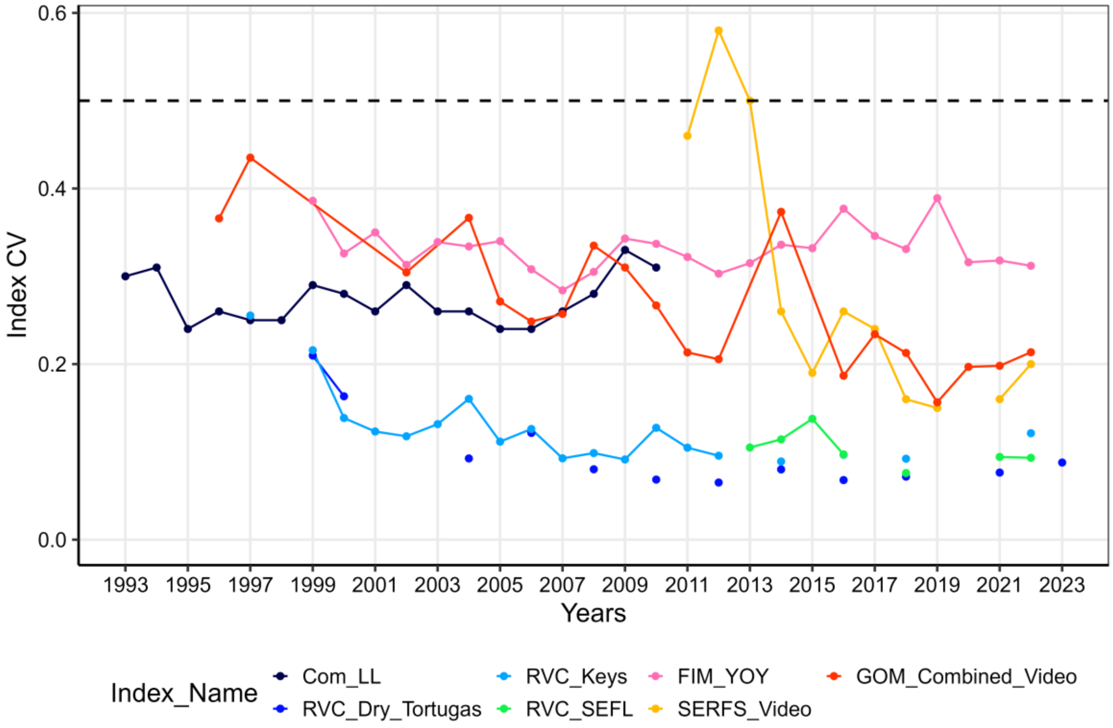


Figure 16. Annual CVs of indices of Southeastern US Mutton Snapper, 1993-2023.

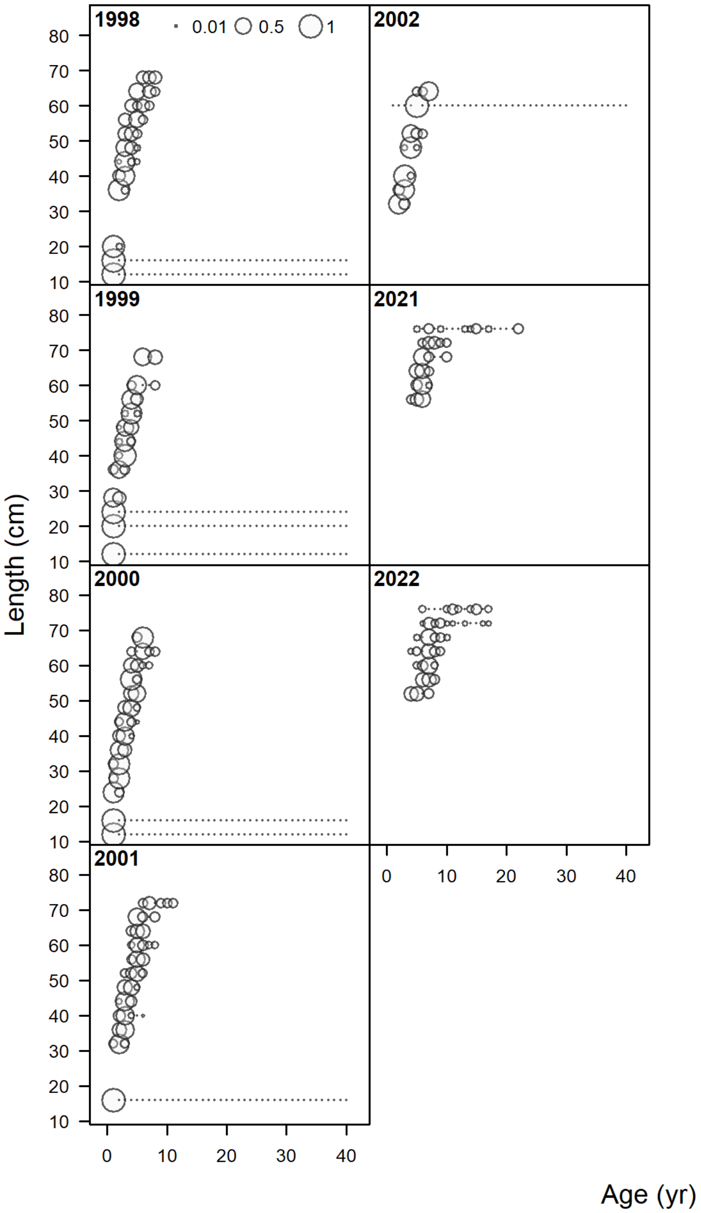


Figure 17. Observed conditional age-at-length in 4 cm Max TL bins of Southeastern US Mutton Snapper from fishery independent sources, 1998-2022.

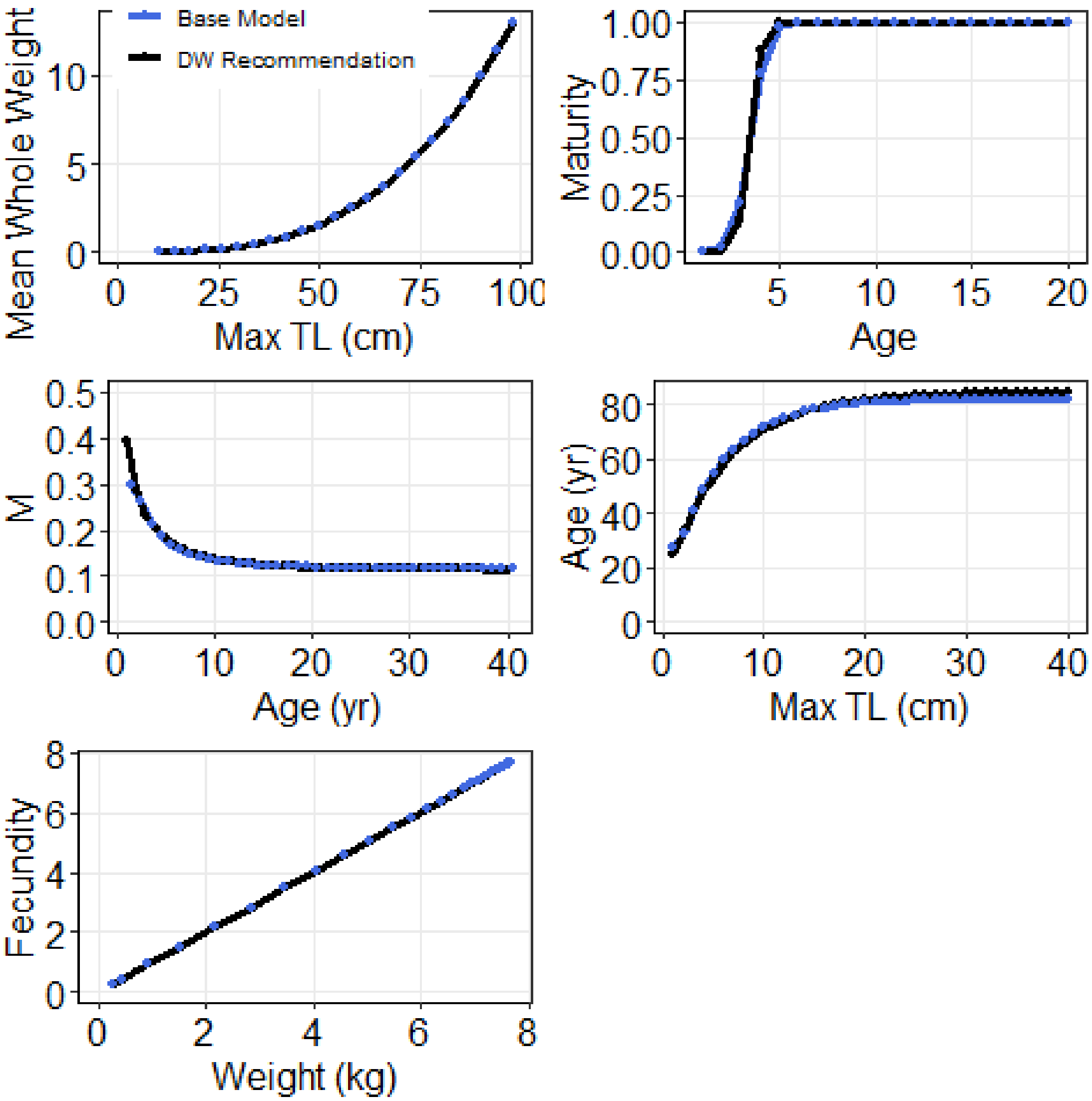


Figure 18. Life history relationships for Southeastern US Mutton Snapper including mean weight-at length and fecundity (proportion female = 0.5 is not shown but required by Stock Synthesis as an input), as well as recommended (black) and estimated (blue) maturity-at-age, natural mortality-at-age, and growth curves.

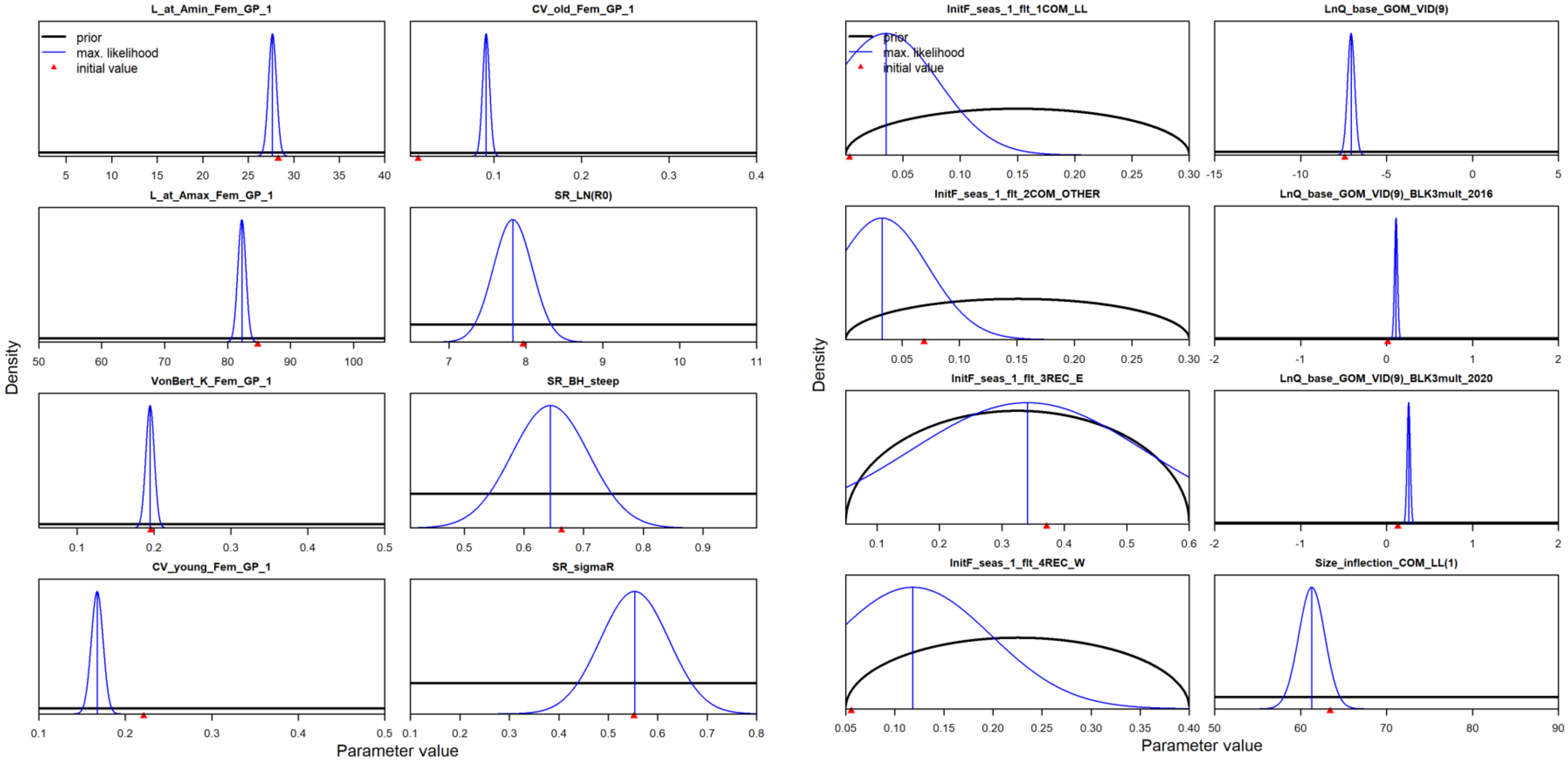


Figure 19. Parameter distribution (blue line) plots along with starting values (red arrow), parameter bounds (min and max values on the x-axis), and priors (black lines). Recruitment deviation parameters and estimated fishing mortality rate parameters are not included. Note: parameter point estimates from a jitter analysis were used as the starting values for this final model run.

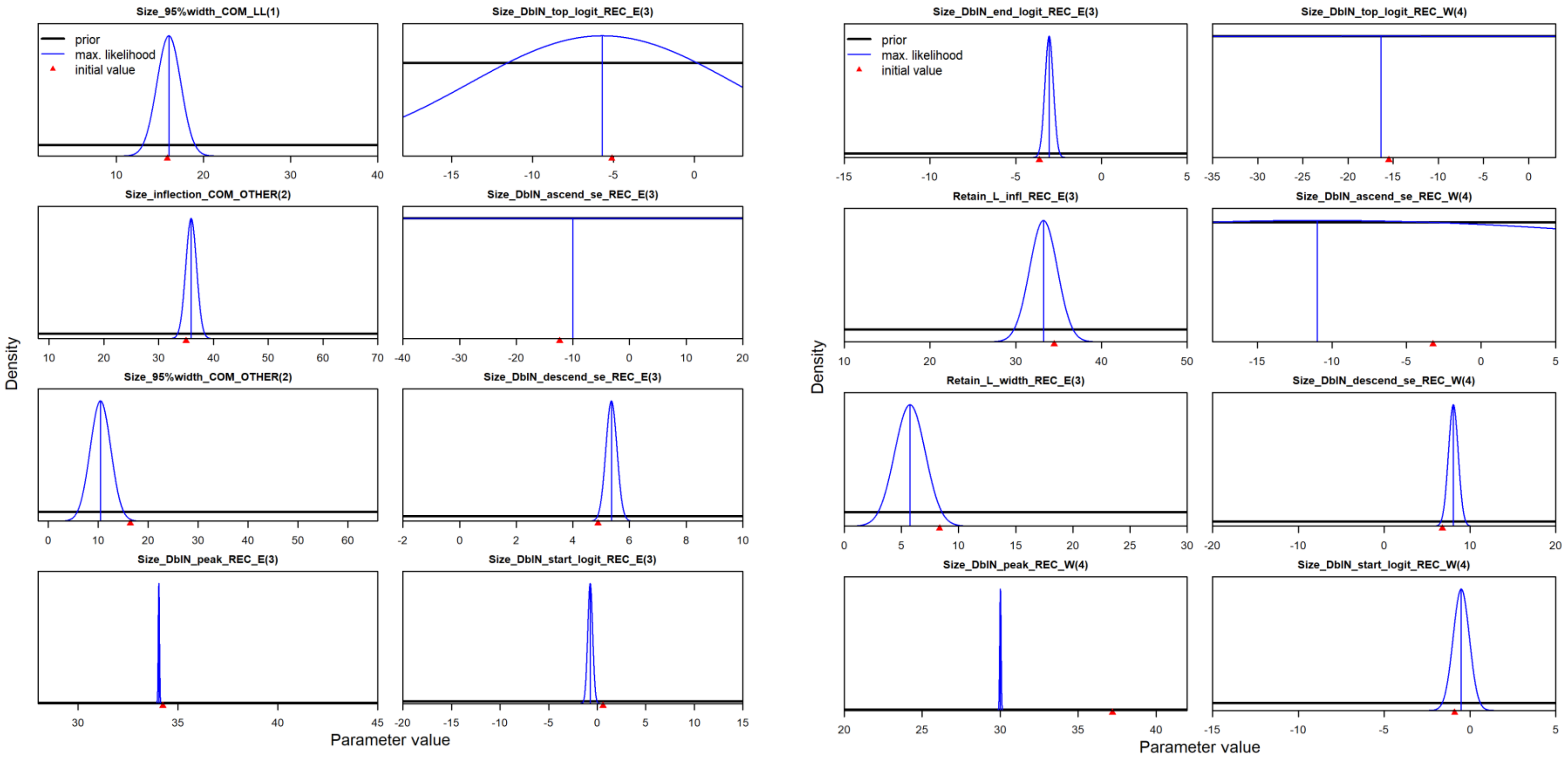
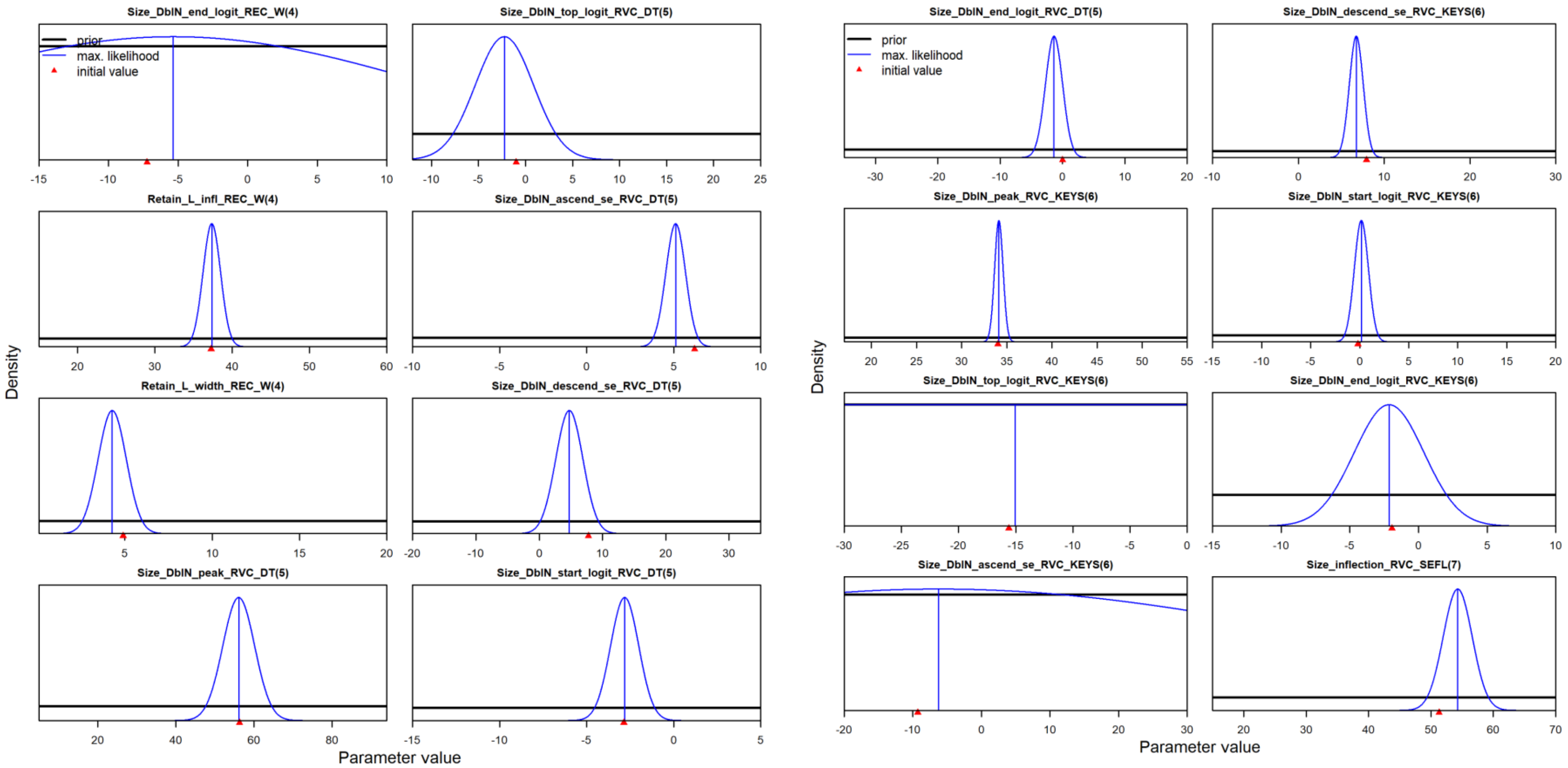


Figure 19 (continued). Parameter distribution (blue line) plots along with starting values (red arrow), parameter bounds (min and max values on the x-axis), and priors (black lines). Recruitment deviation parameters and estimated fishing mortality rate parameters are not included. Note: parameter point estimates from a jitter analysis were used as the starting values for this final model run.



Size_DblN_end_logit_REC_W(4)

Size_DblN_top_logit_RVC_DT(5)

Retain_L_infl_REC_W(4)

Size_DblN_ascend_se_RVC_DT(5)

Retain_L_width_REC_W(4)

Size_DblN_descend_se_RVC_DT(5)

Size_DblN_peak_RVC_DT(5)

Size_DblN_start_logit_RVC_DT(5)

Size_DblN_end_logit_RVC_DT(5)

Size_DblN_descend_se_RVC_KEYS(6)

Size_DblN_peak_RVC_KEYS(6)

Size_DblN_start_logit_RVC_KEYS(6)

Size_DblN_top_logit_RVC_KEYS(6)

Size_DblN_end_logit_RVC_KEYS(6)

Size_DblN_ascend_se_RVC_KEYS(6)

Size_inflection_RVC_SEFL(7)

Figure 19 (continued). Parameter distribution (blue line) plots along with starting values (red arrow), parameter bounds (min and max values on the x-axis), and priors (black lines). Recruitment deviation parameters and estimated fishing mortality rate parameters are not included. Note: parameter point estimates from a jitter analysis were used as the starting values for this final model run.

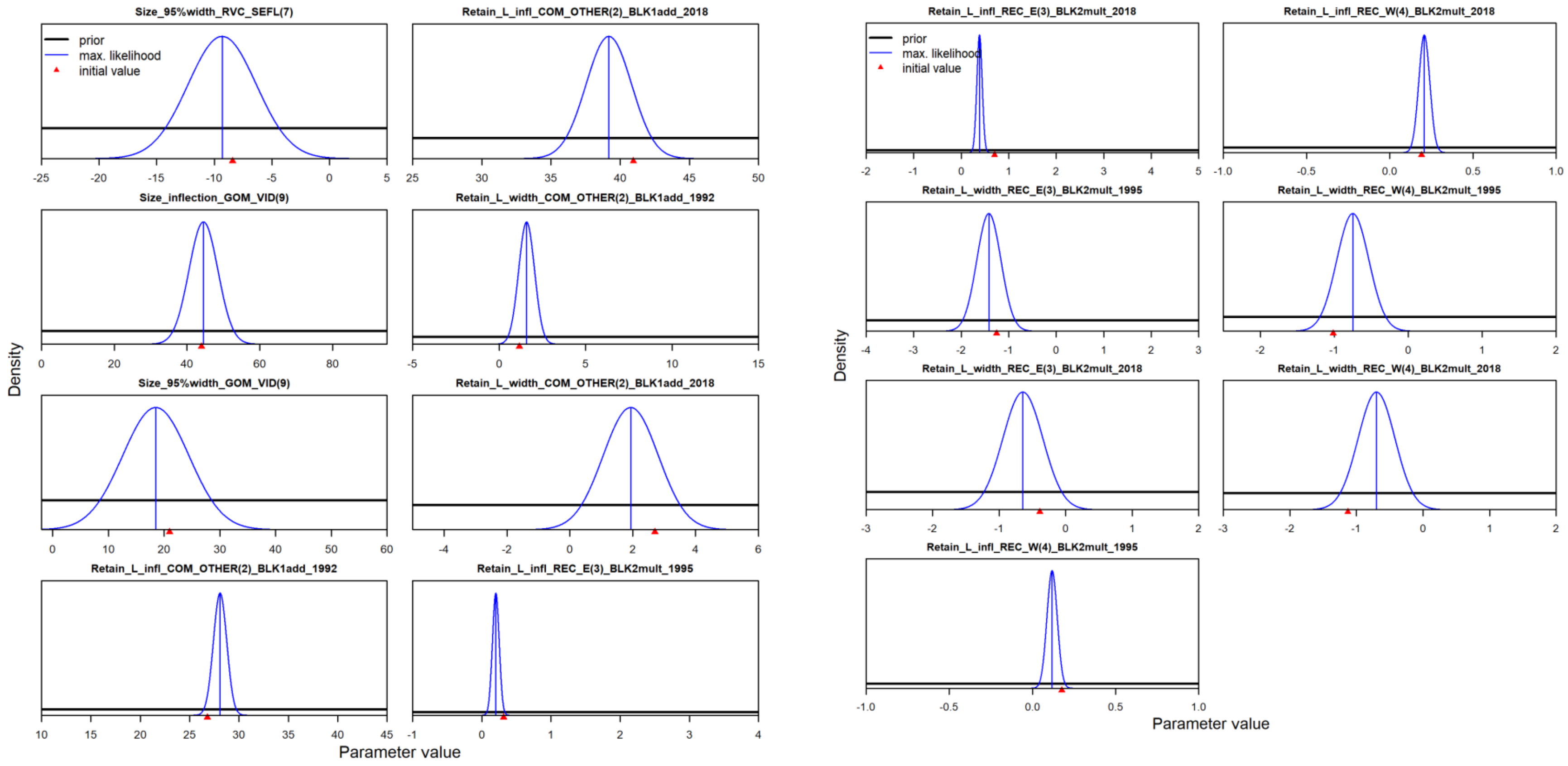
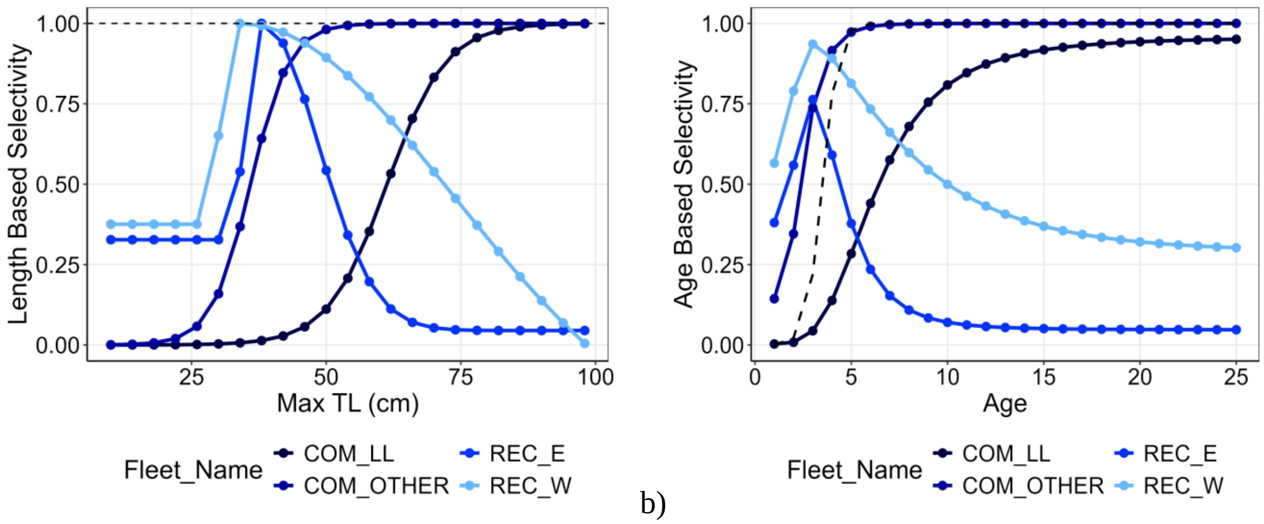
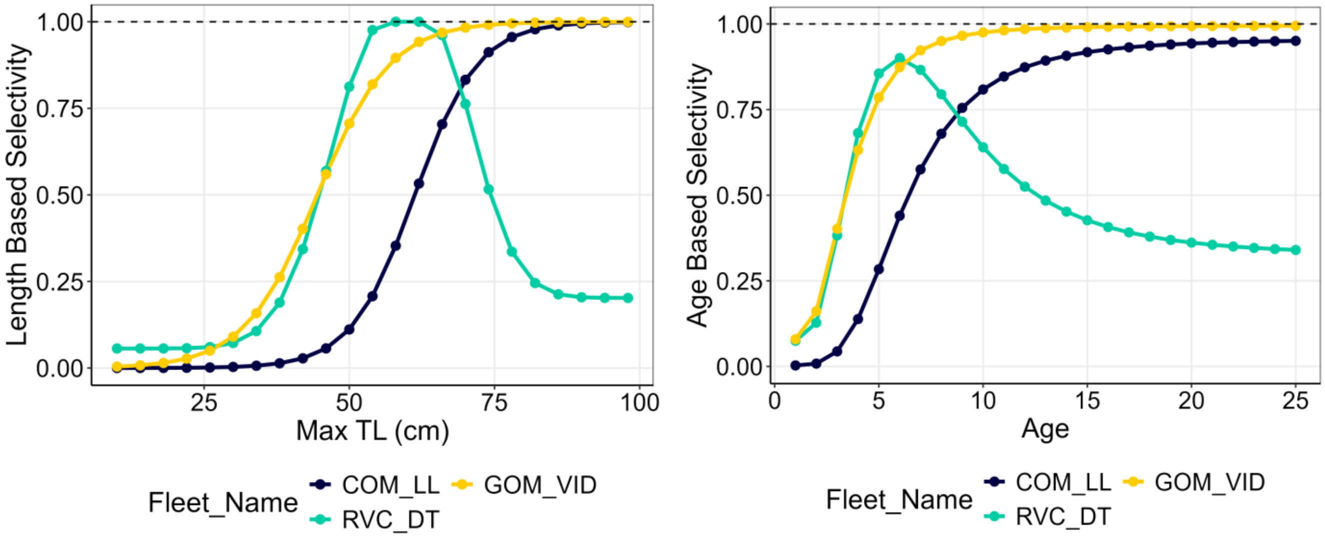


Figure 19 (continued). Parameter distribution (blue line) plots along with starting values (red arrow), parameter bounds (min and max values on the x-axis), and priors (black lines). Recruitment deviation parameters and estimated fishing mortality rate parameters are not included. Note: parameter point estimates from a jitter analysis were used as the starting values for this final model run.



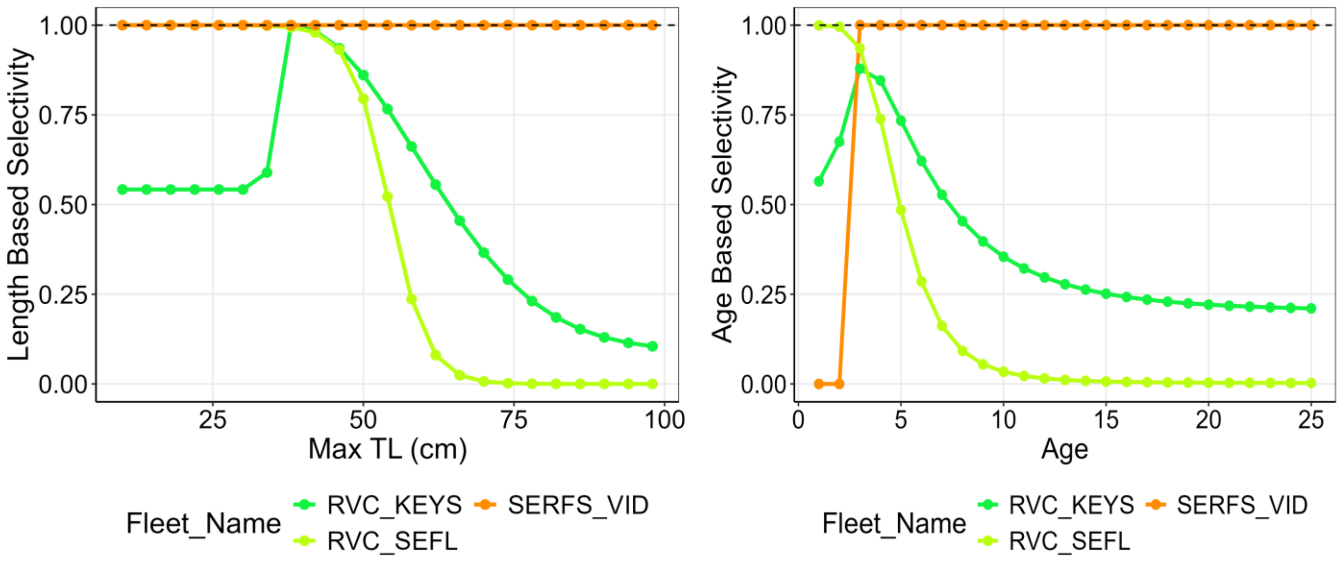
a) b)

Figure 20. Length-based selectivity (a) for each fleet in the SEDAR 79 Base Model and related age-derived selectivity (b).



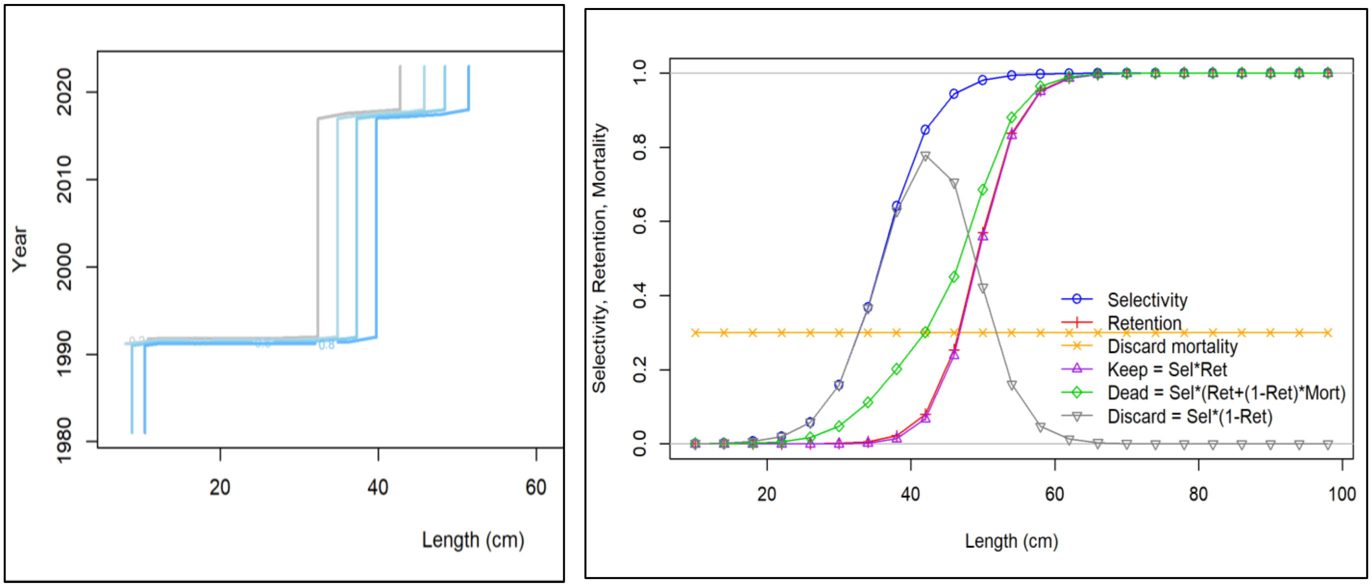
a) b)

Figure 21. Length-based selectivity (a) for indices in the SEDAR 79 Base Model occurring in the Gulf and related age-derived selectivity (b).



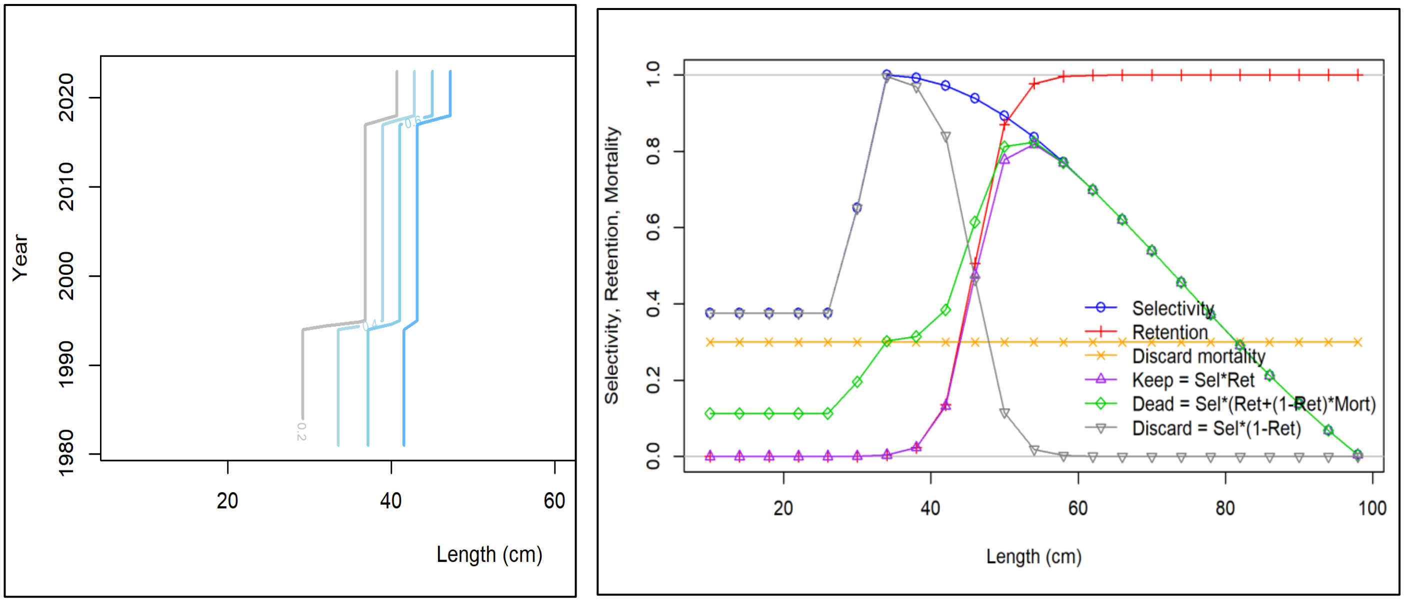
a) b)

Figure 22. Length-based selectivity (a) for indices in the SEDAR 79 Base Model occurring in the South Atlantic and related age-based selectivity (b). Age-based selectivity is derived from length-based selectivity for the RVC indices but was specified for the SERFS index.



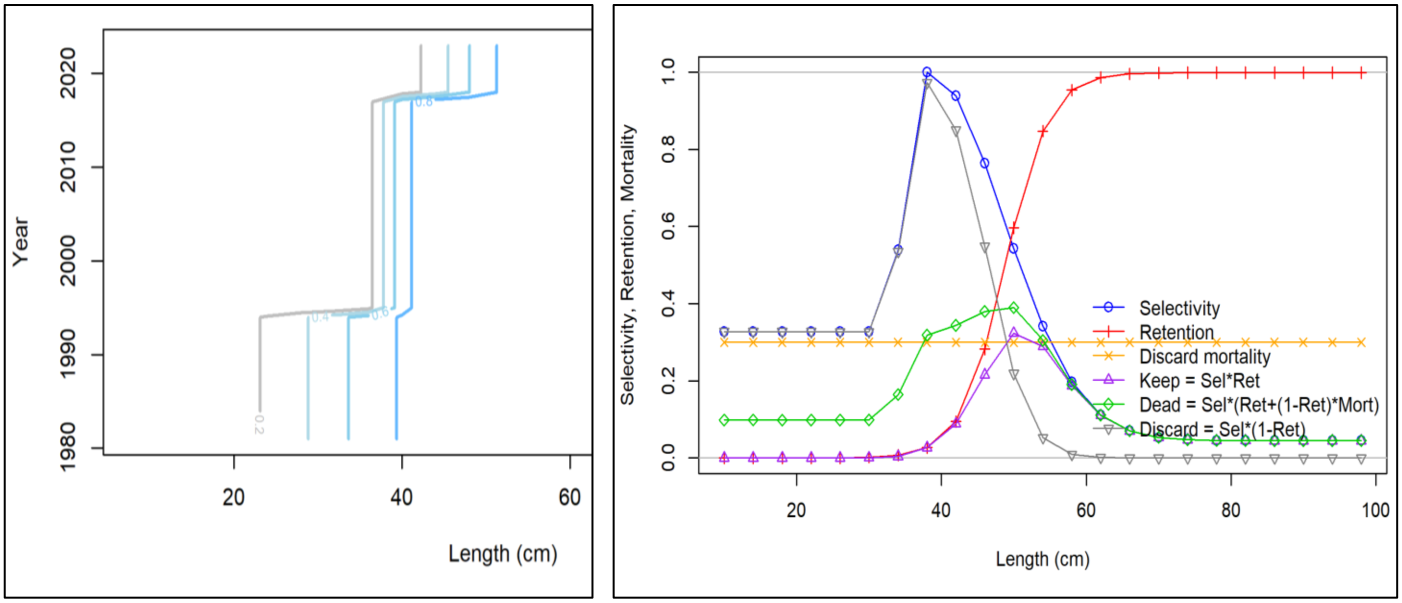
a) b)

Figure 23. Time-varying retention (a) for the Commercial Other fleet in the SEDAR 79 Base Model and the related interplay between terminal year (2023) selectivity, retention, discard mortality (constant at 0.30), along with the fraction of fish kept, dead and discarded (2024, b).



a) b)

Figure 24. Time-varying retention (a) for the Rec West fleet in the SEDAR 79 Base Model and the related interplay between terminal year (2023) selectivity, retention, discard mortality (constant at 0.30), along with the fraction of fish kept, dead and discarded (2024, b).



a) b)

Figure 25. Time-varying retention (a) for the Rec East fleet in the SEDAR 79 Base Model and the related interplay between terminal year (2023) selectivity, retention, discard mortality (constant at 0.30), along with the fraction of fish kept, dead and discarded (2024, b).

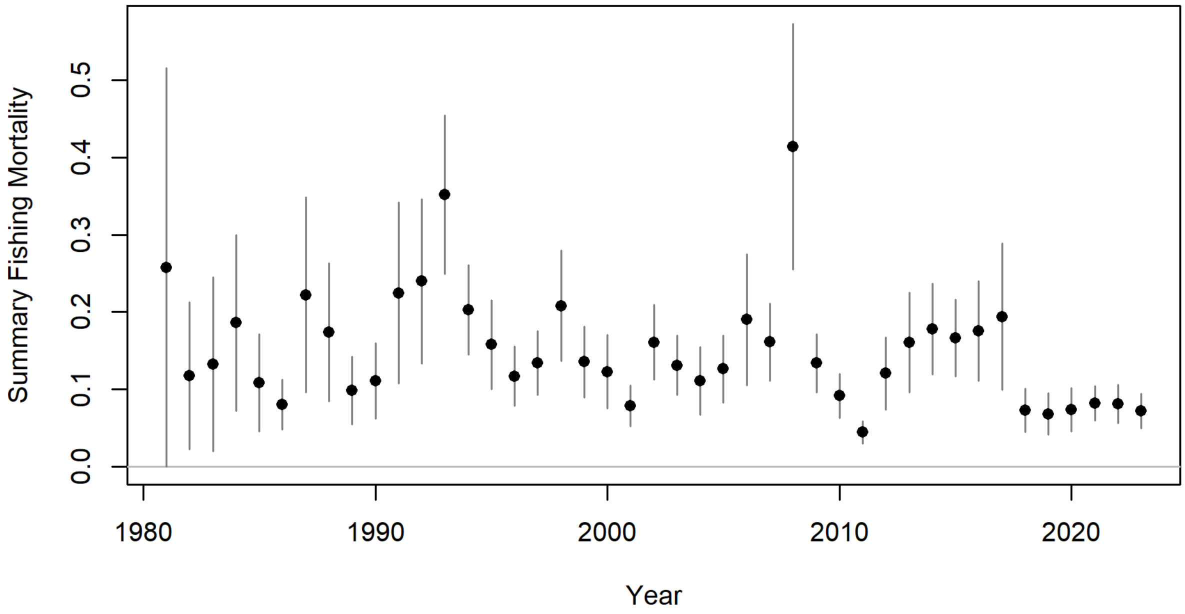


Figure 26. Annual instantaneous fishing mortality rates for age-3 Southeastern U.S. Mutton Snapper with approximate 95% confidence intervals.

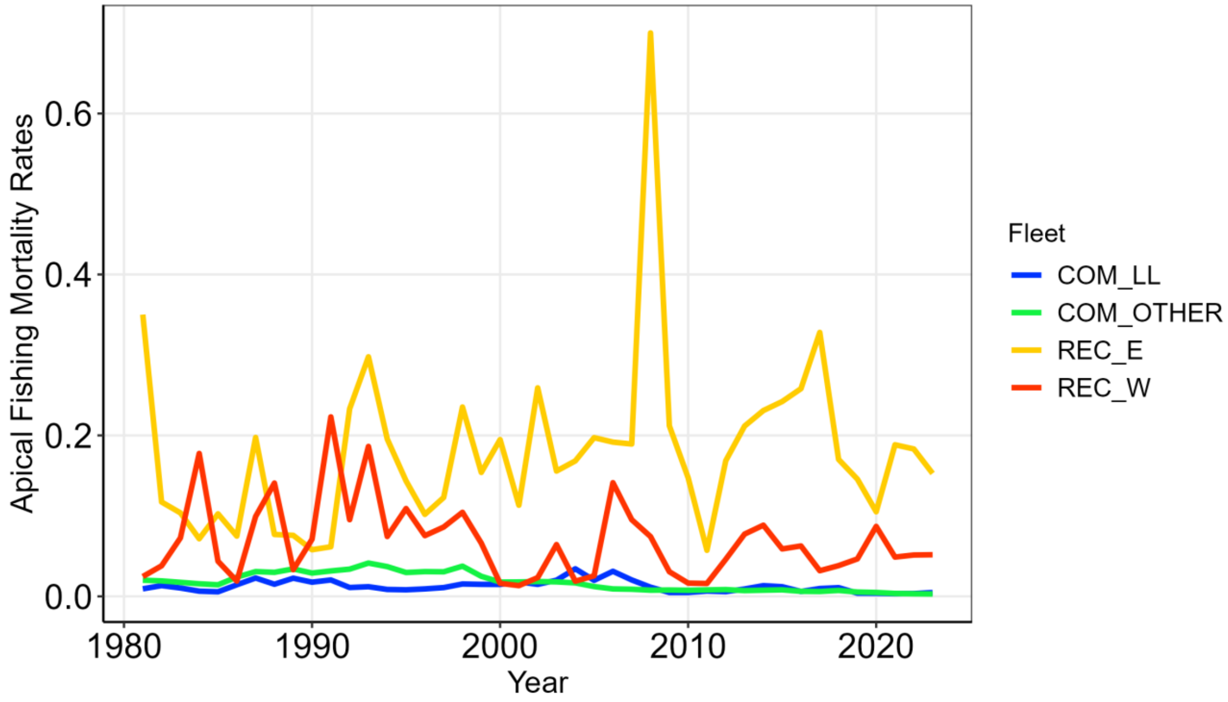


Figure 27. Annual fleet-specific instantaneous apical fishing mortality rates for Southeastern U.S. Mutton Snapper. Apical Fs represents the instantaneous fishing mortality level on the most vulnerable age class for each fleet (i.e., the age corresponding to a selectivity equal to 1).

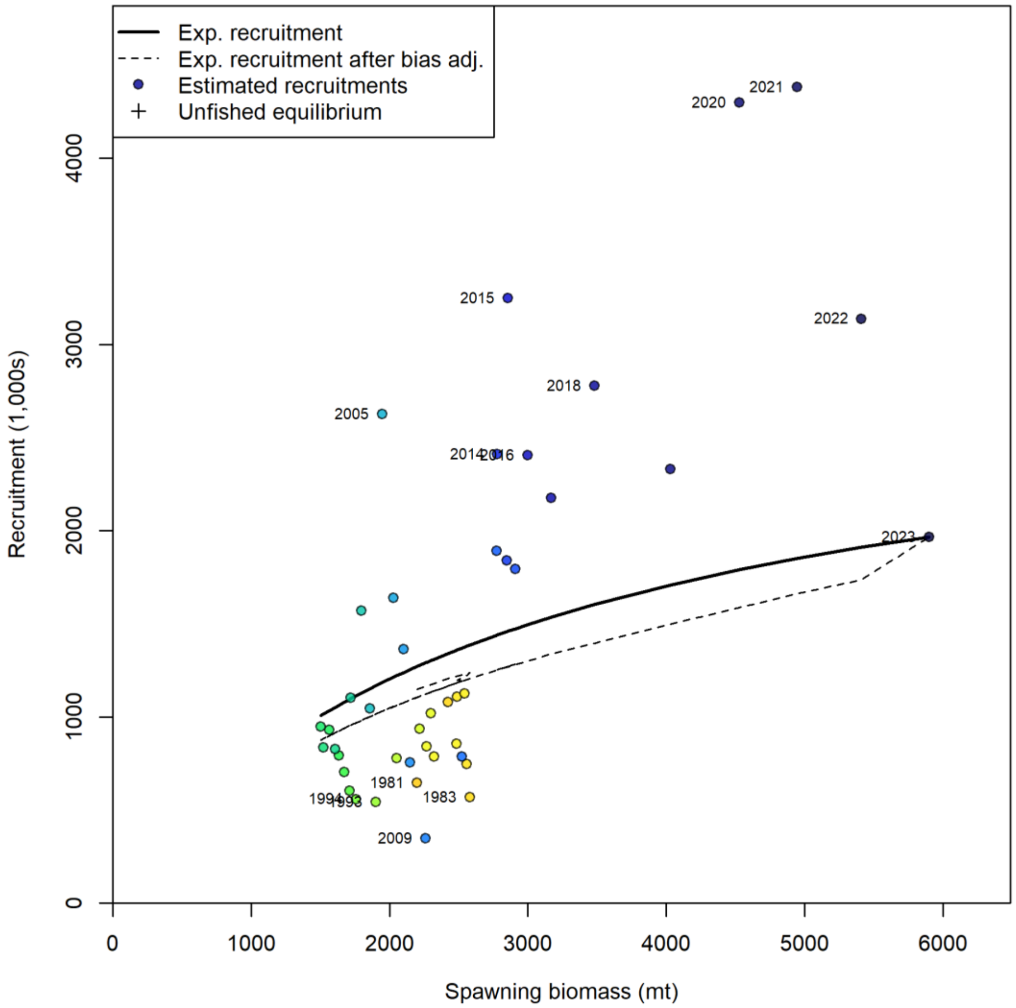


Figure 28. Expected stock-recruitment relationship for Southeastern U.S. Mutton Snapper. Steepness was estimated at 0.644 and sigmaR was estimated at 0.55. Plotted are expected annual recruitments from the SEDAR 79 Base Model (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line). Point colors indicate year, with warmer colors indicating earlier years and cooler colors showing later years.

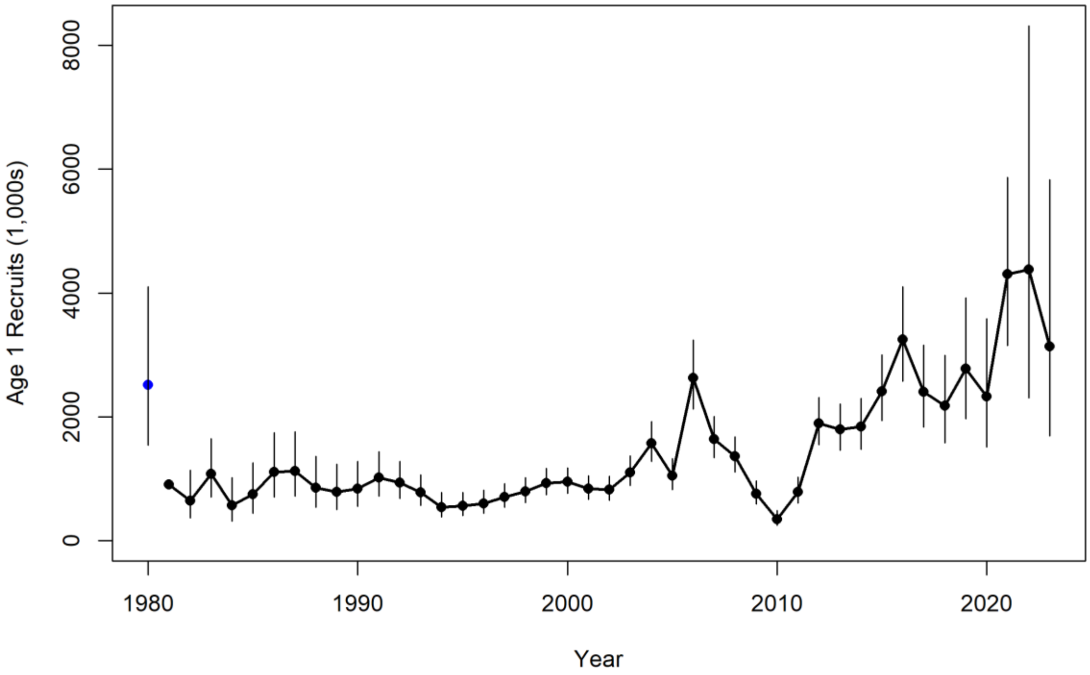


Figure 29. Estimated Age-1 recruitment (in 1,000s) with approximate 95% confidence intervals for Southeastern U.S. Mutton Snapper. Virgin recruitment is shown in blue.

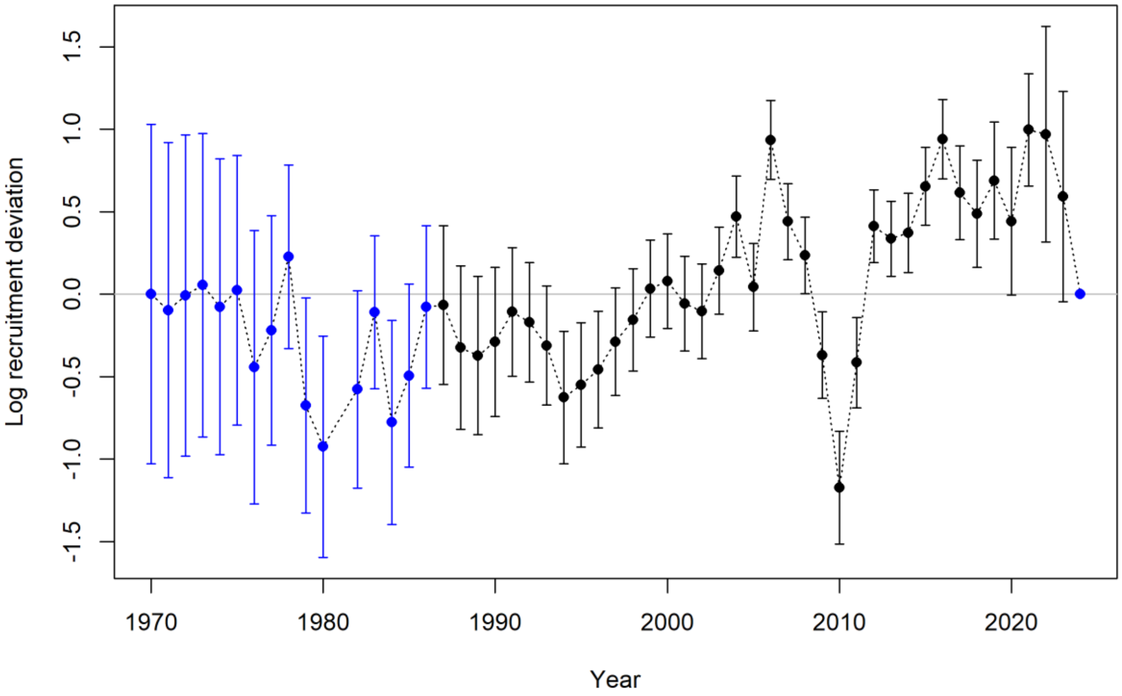


Figure 30. Estimated log-scale Age-1 recruitment deviations with 95% confidence intervals for Southeastern U.S. Mutton Snapper (steepness and SigmaR were estimated at 0.644 and 0.55, respectively). Blue dots identify early and late recruitment deviations.

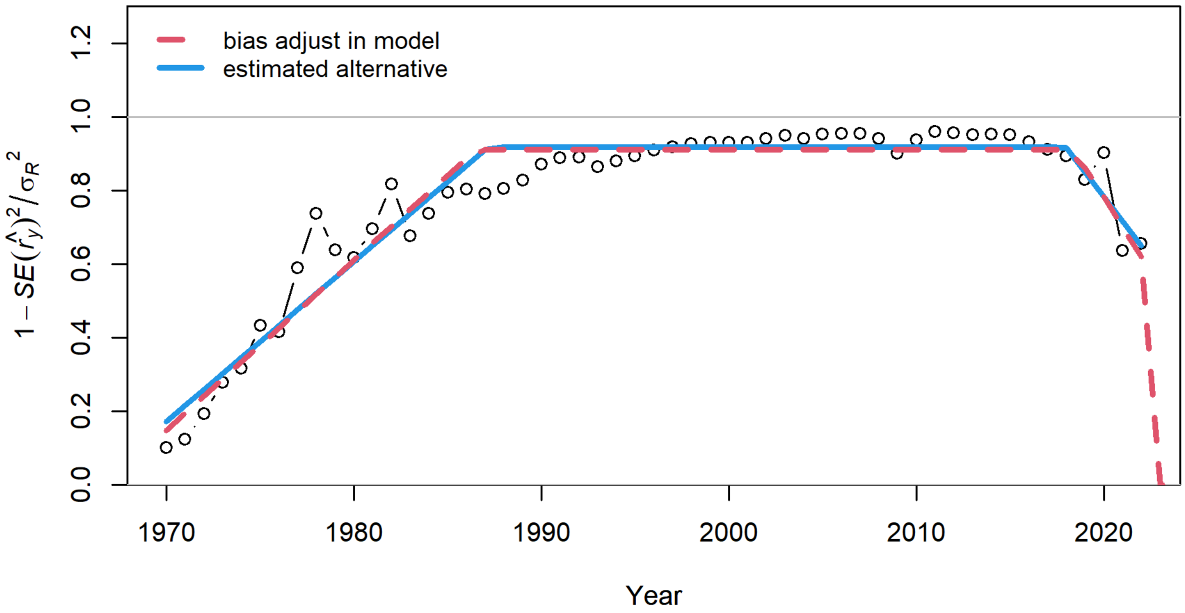


Figure 31. Points are transformed variances. Red line shows current settings for bias adjustment specified for the SEDAR 79 Base Run, which coincides with the least squares estimate of alternative bias adjustment relationship for recruitment deviations (dashed red line). For more information, see Methot and Taylor (2011).

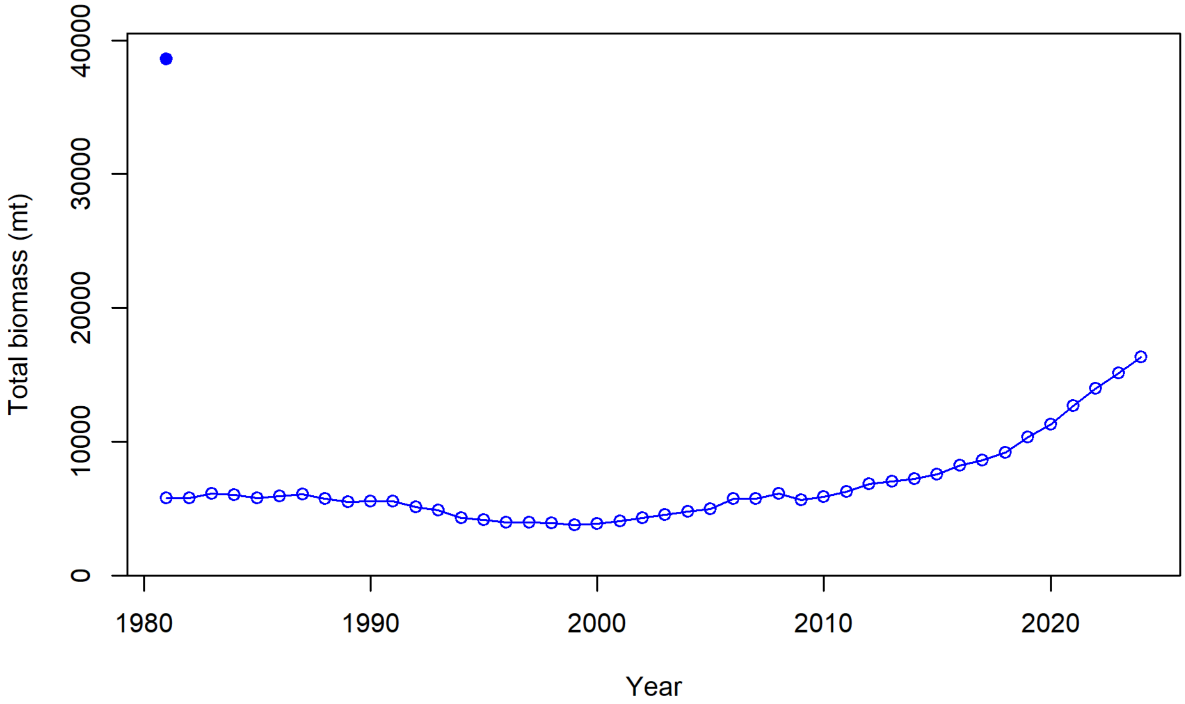


Figure 32. Estimate of total biomass (metric tons) for Southeastern U.S. Mutton Snapper. Unfished total biomass is shown by the solid blue point in 1980.

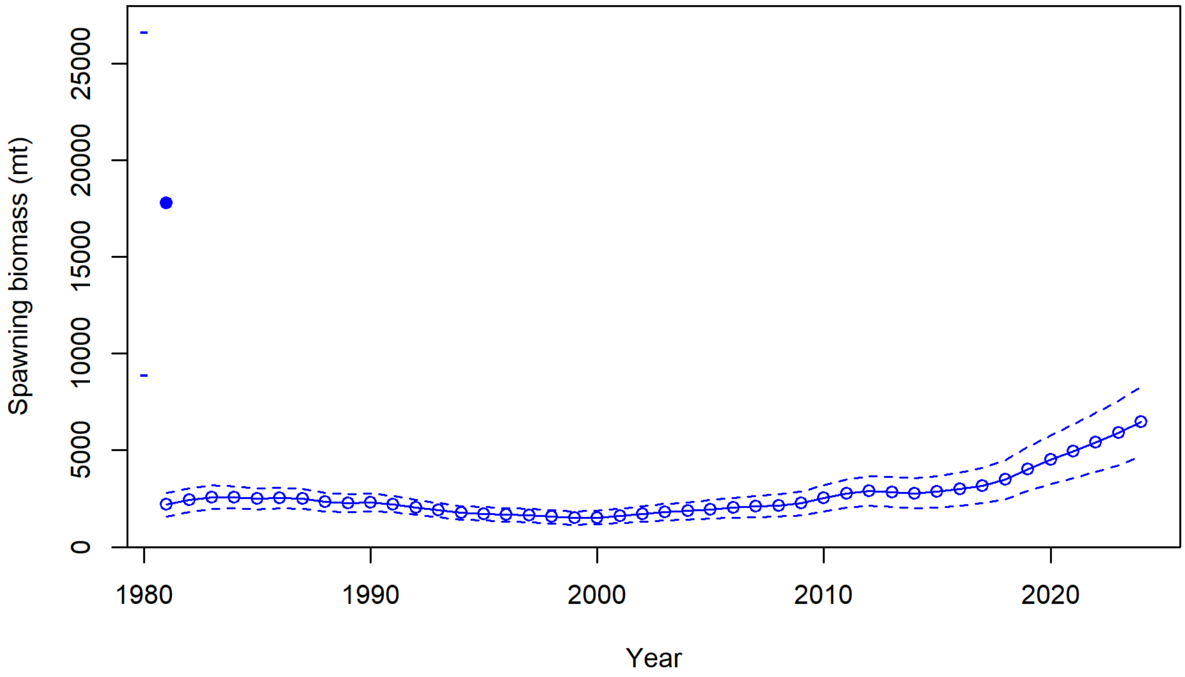


Figure 33. Estimate of female spawning stock biomass (metric tons) with approximate 95% confidence intervals for Southeastern U.S. Mutton Snapper. Unfished spawning stock biomass is shown by the solid blue point in 1980.

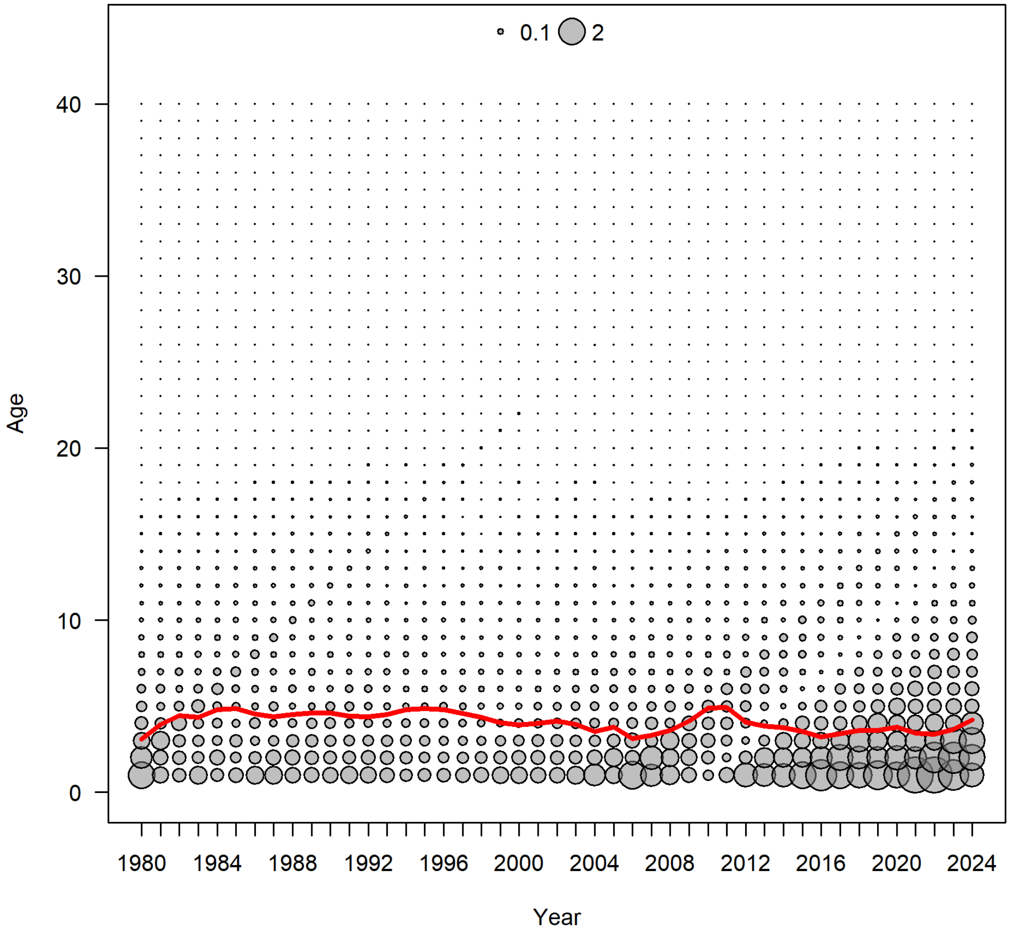


Figure 34. Expected numbers-at-age (bubbles) and mean age (red line) at the middle of the year (max ~ 3.7 million) for Southeastern U.S. Mutton Snapper.

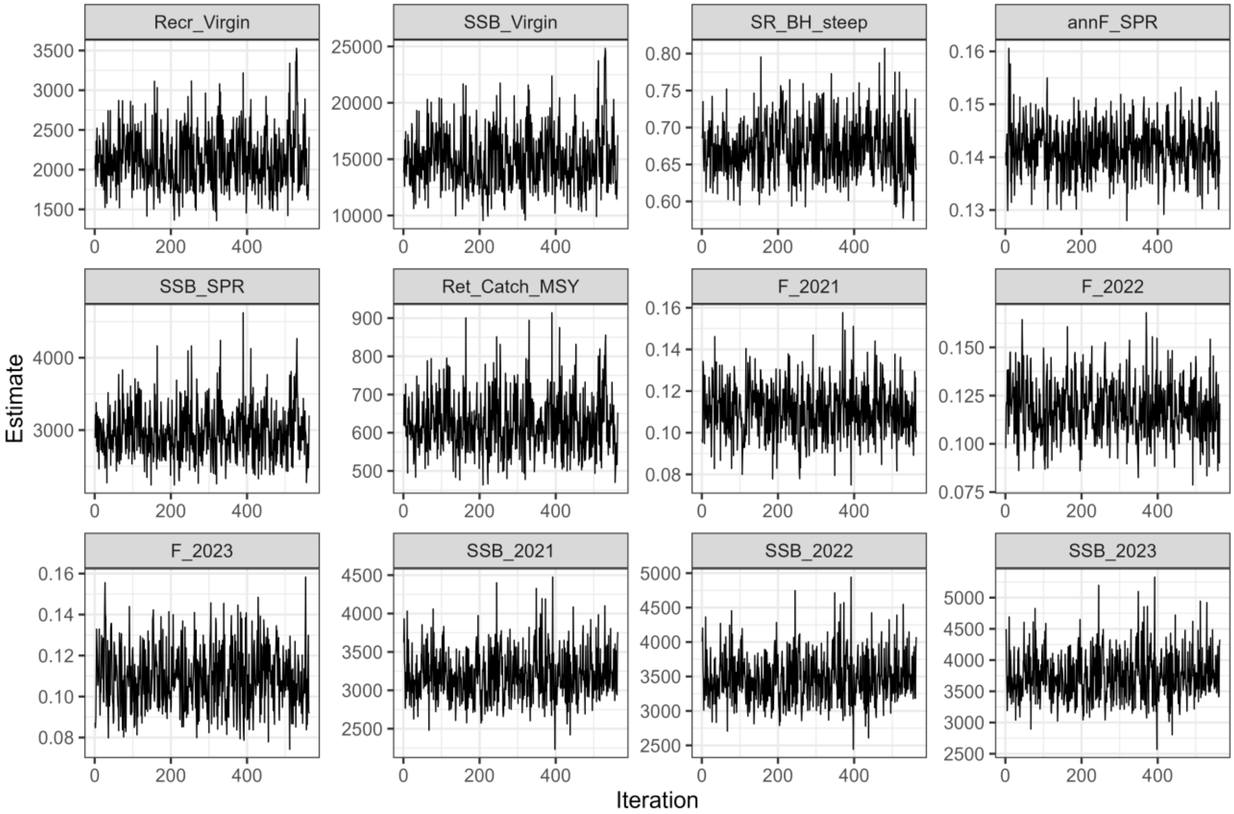


Figure 35. Traceplot of a single MCMC chain for selected parameters and derived quantities.

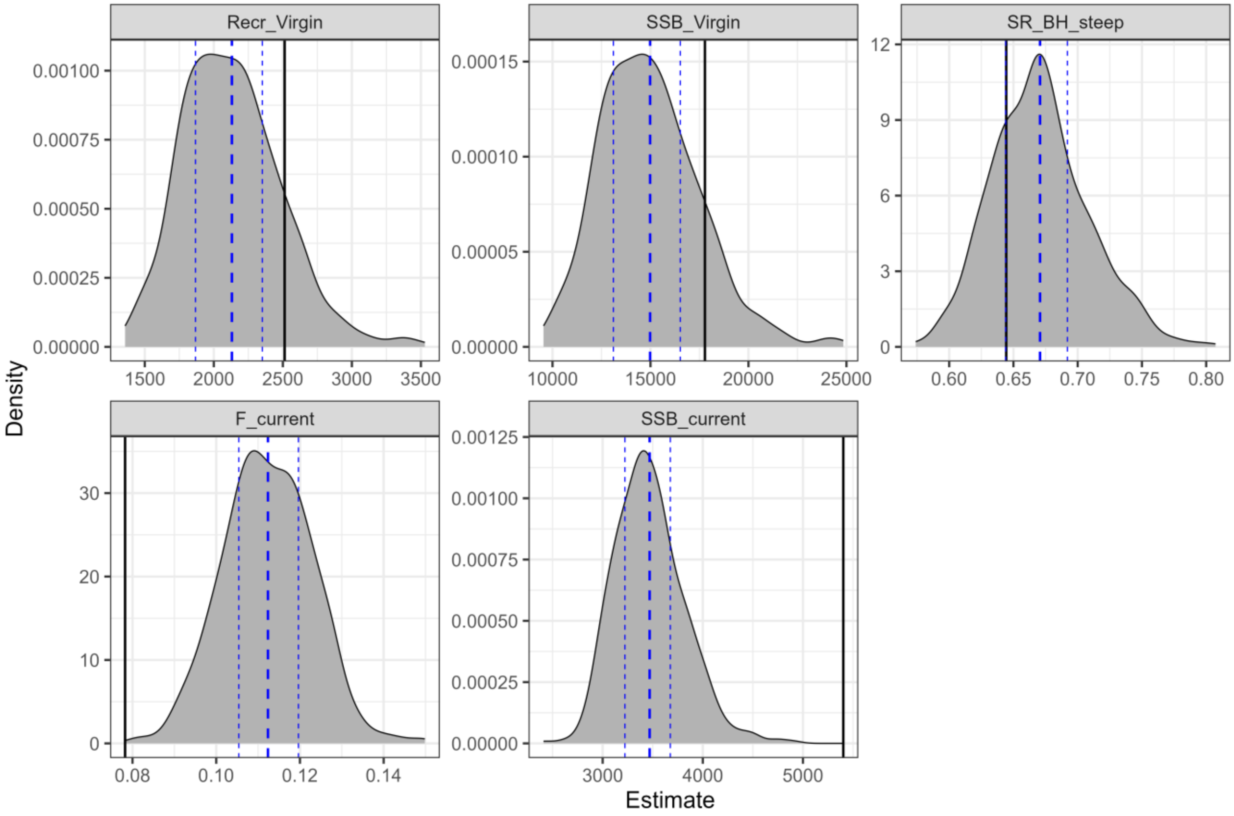


Figure 36. Posterior distribution of selected parameters and derived quantities. Blue dotted lines indicate the mean and interquartile range. SEDAR 79 Base Model run estimates are shown in black

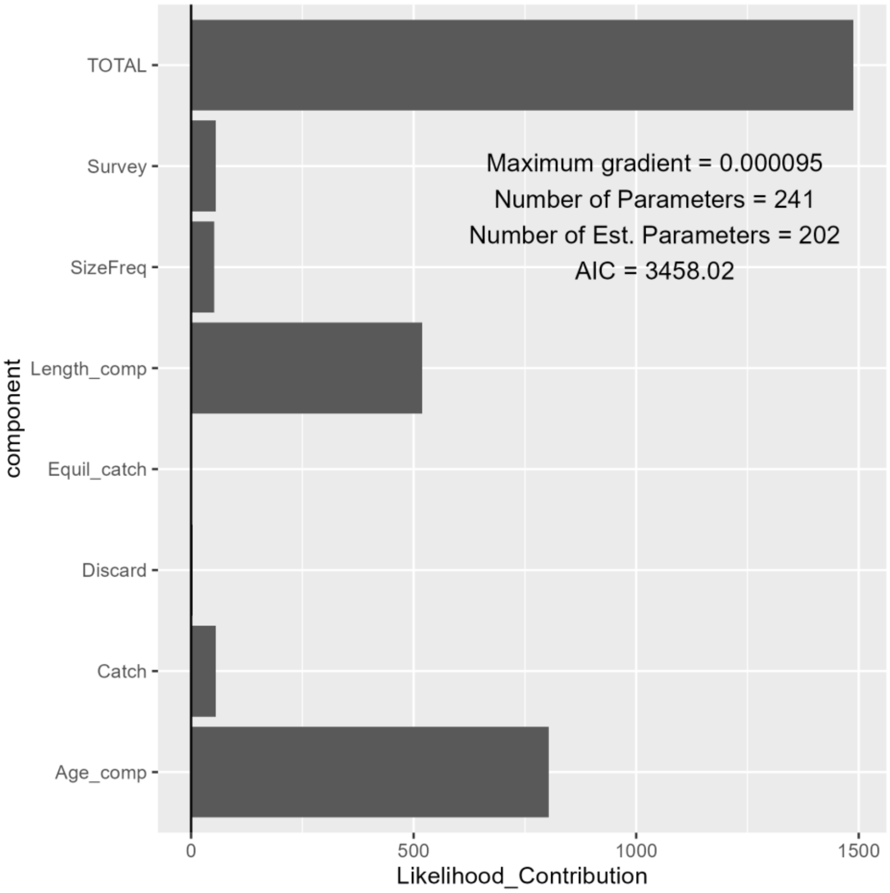


Figure 37. Magnitude of the components of the likelihood function for the SEDAR 79 Base Model.

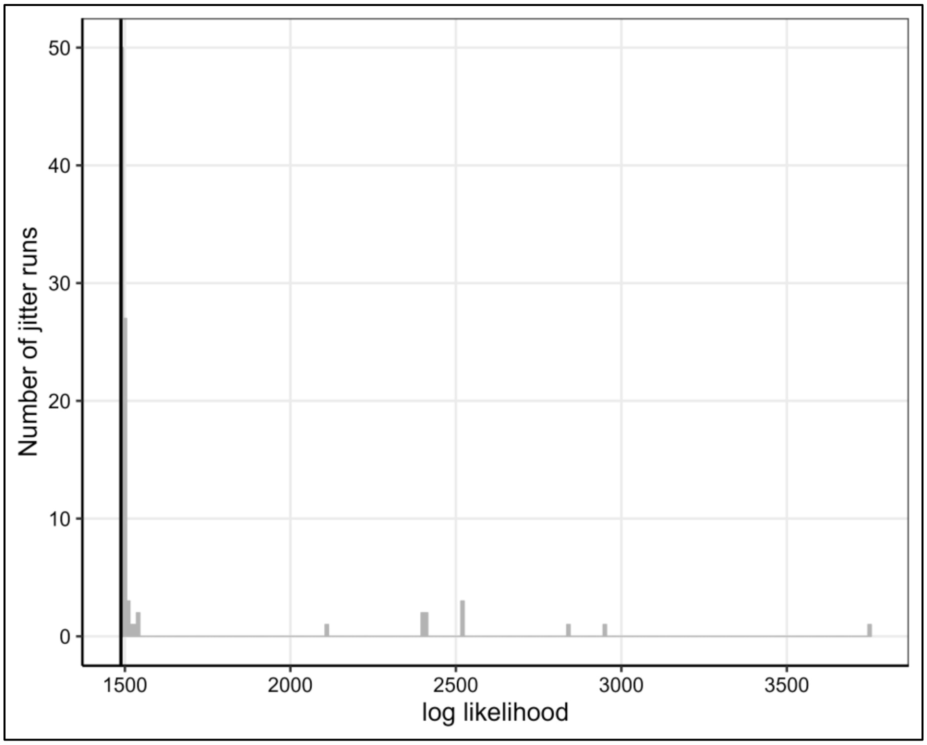


Figure 38. Histogram of log-likelihood values associated with jittered runs that had a maximum gradient < 0.05. The log-likelihood value associated with the base model is shown by the black line. No jitter run (regardless of maximum gradient) found a lower log-likelihood value than the base model.

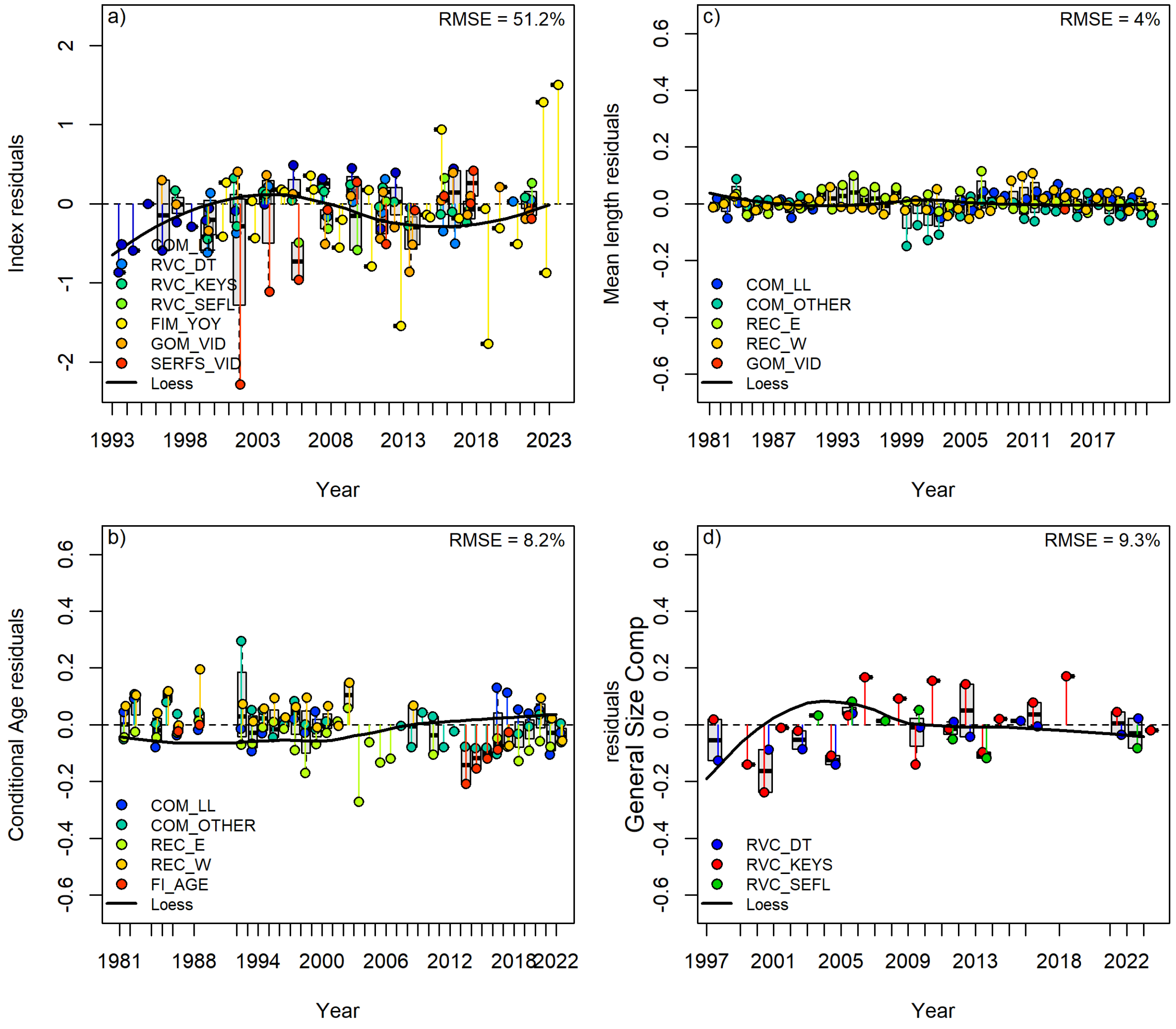


Figure 39. Joint residual plots for a) the indices of abundance, b) the annual mean length, c) annual mean conditional age, and d) annual mean general size composition (i.e., RVC lengths) estimates from the SEDAR 79 Base Model. Vertical lines with points show the residuals, boxplots show residual medians and quantiles, and solid black lines are a loess smoother. Root-mean squared errors (RMSE, as a percentage) are included in the upper right-hand corner of each plot.

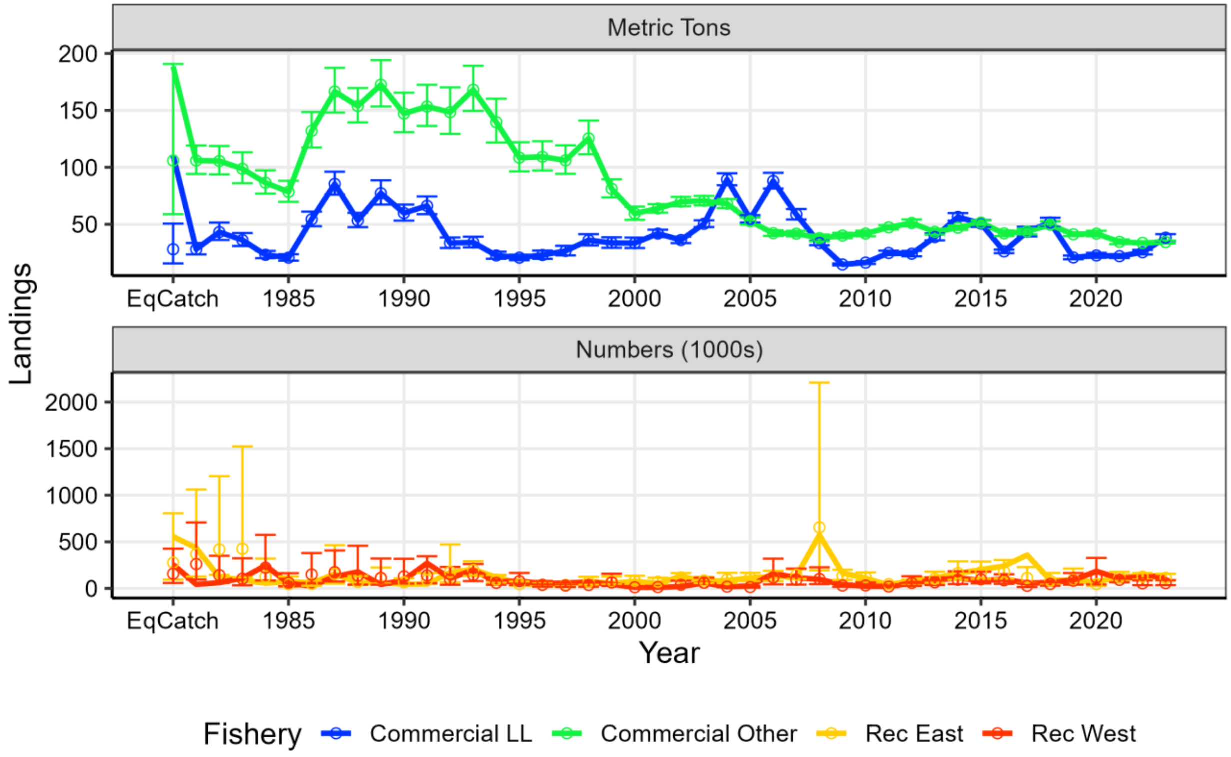


Figure 40. Observed (open circles and error bars) and predicted (solid lines) landings for the commercial fleets (in metric tons) and the recreational fleets (in 1000s) for the SEDAR 79 Base Model. Input and predicted equilibrium catch values are shown in the first year.

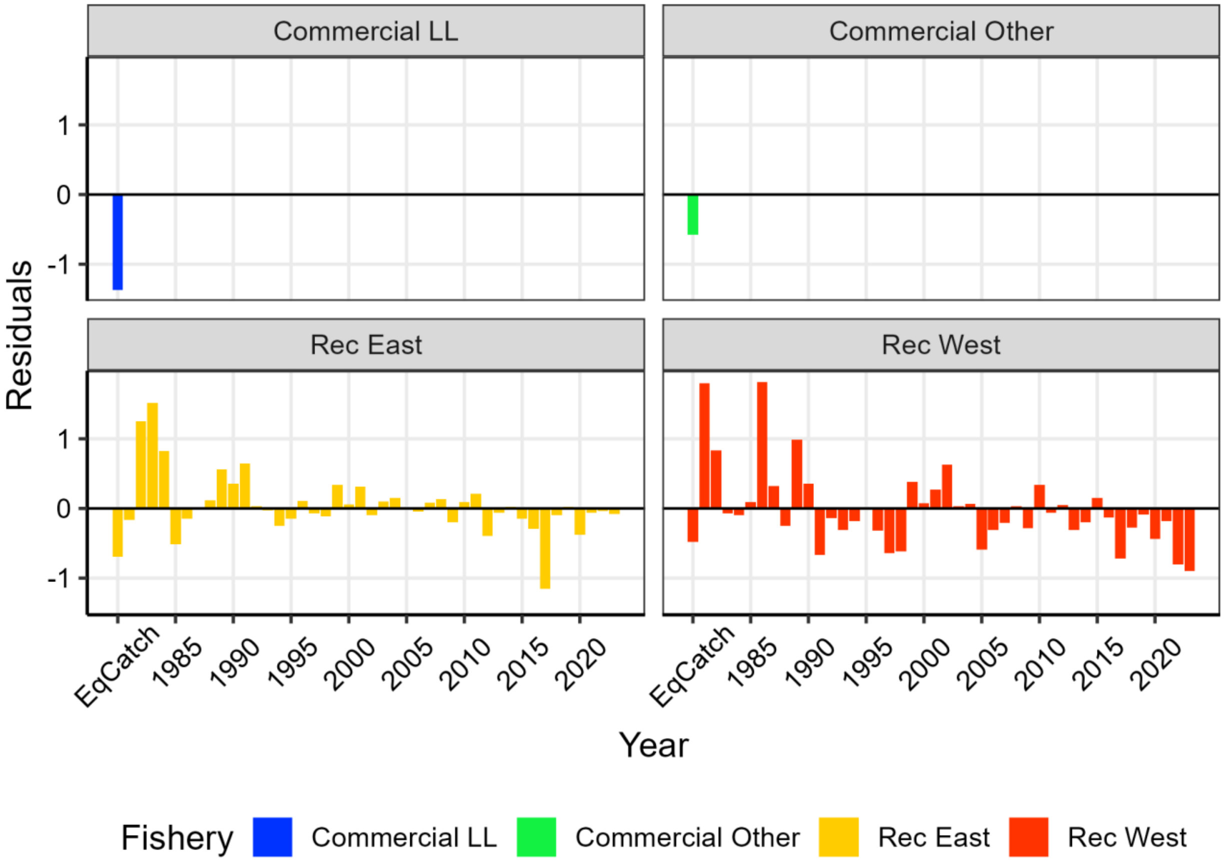


Figure 41. Residuals [log(observed) – log(predicted)] of the fit to the landings for the Commercial Longline, Commercial Other, Rec East, and Rec West fleets for the SEDAR 79 Base Model. Residuals for the equilibrium catch values are shown in the first year.

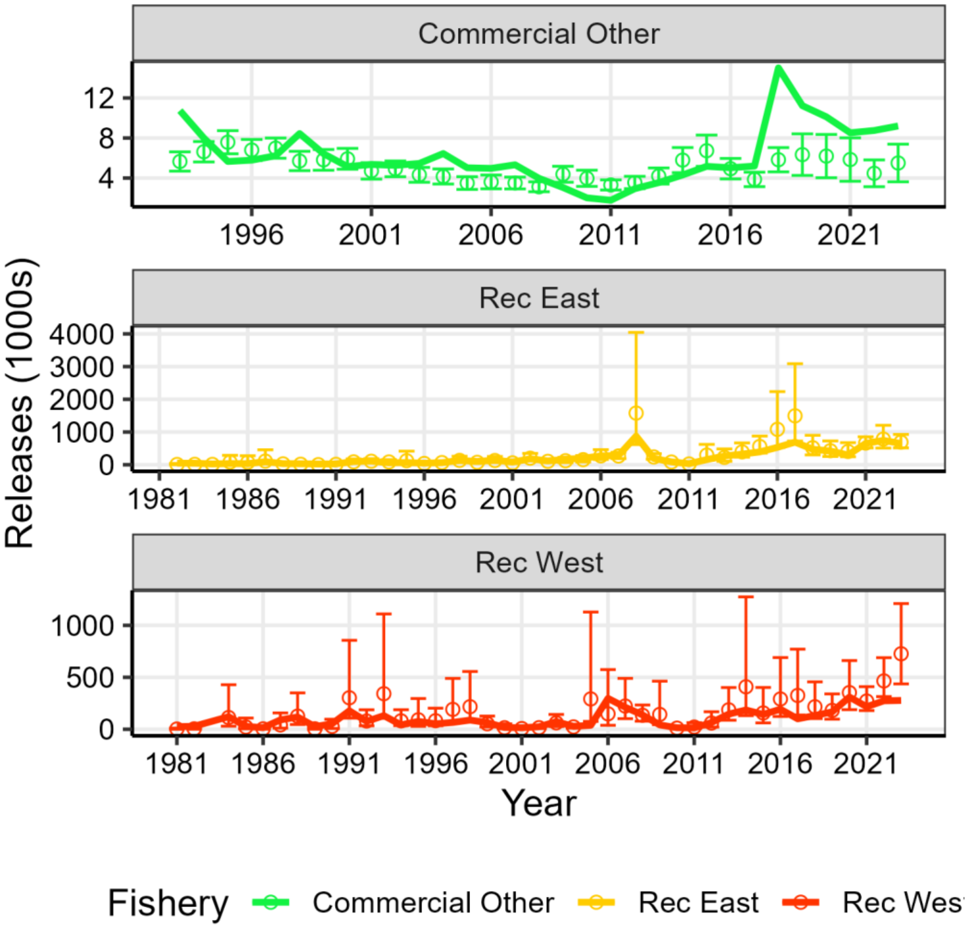


Figure 42. Observed (open circles and error bars) and predicted (solid lines) releases (in 1000s) for the Commercial Other fleet and the recreational fleets for the SEDAR 79 Base Model.

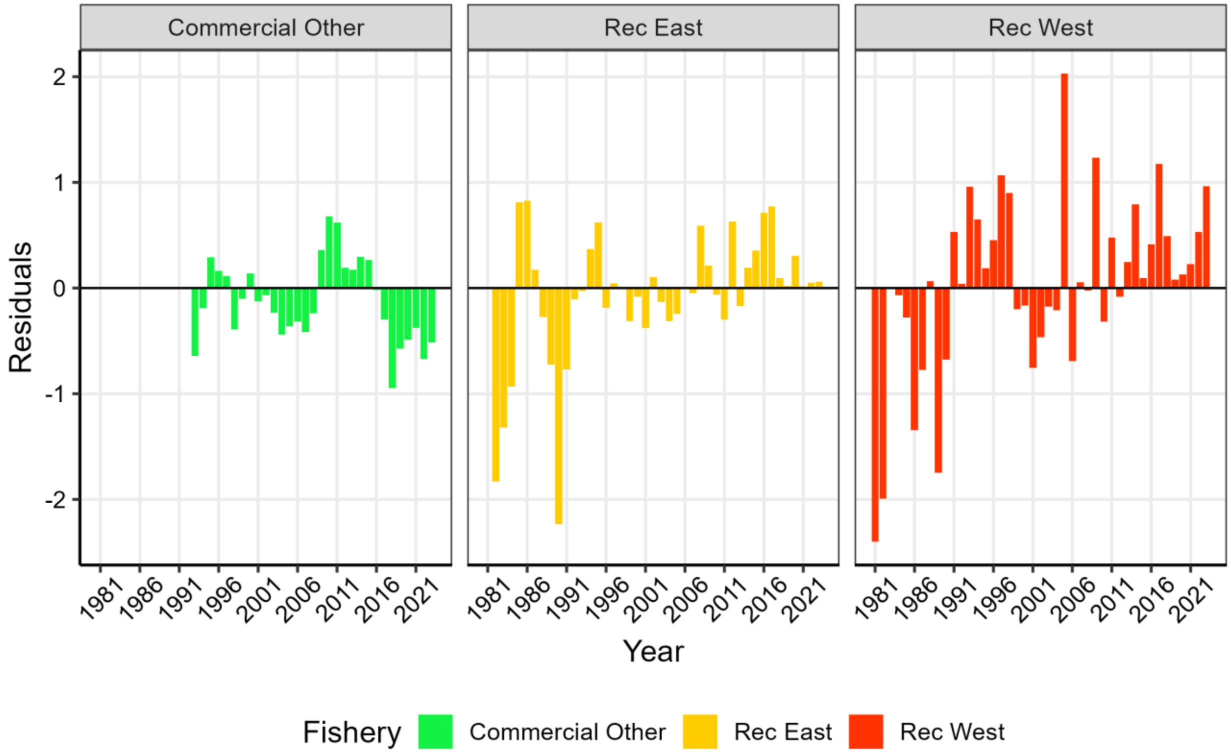


Figure 43. Residuals [log(observed) – log(predicted)] of the fit to the releases for the Commercial Other, Rec East, and Rec West fleets for the SEDAR 79 Base Model.

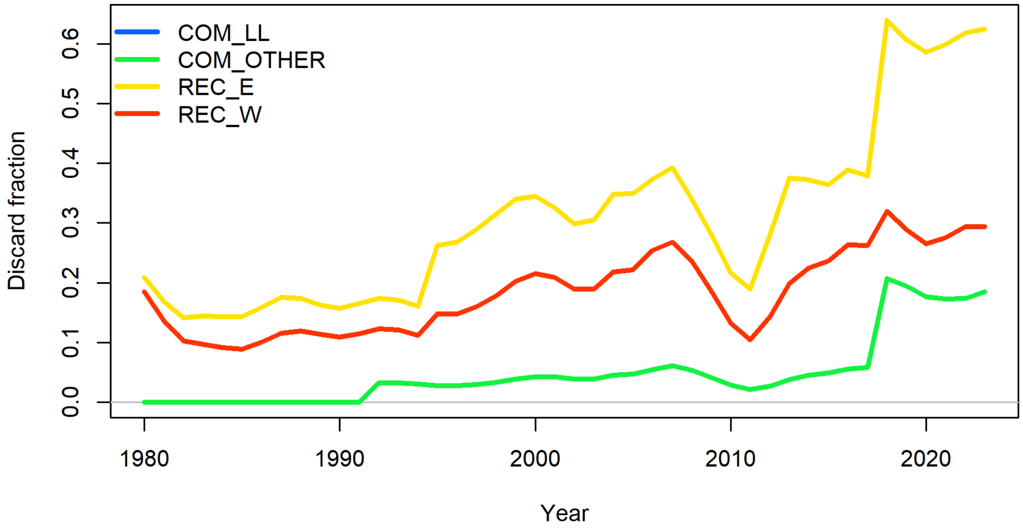
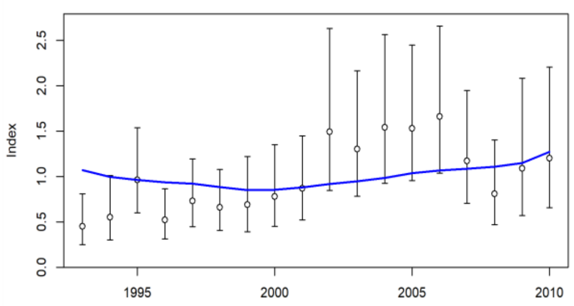
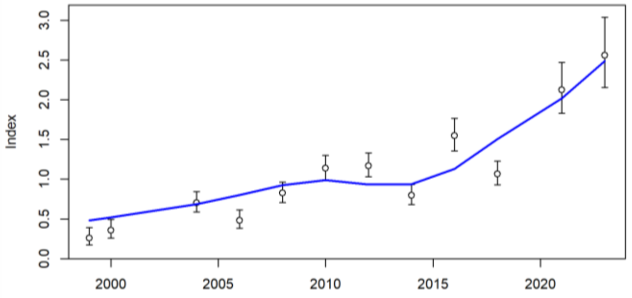


Figure 44. Estimated discard fractions for the Commercial Other, Rec East, and Rec West fleets by the SEDAR 79 Base Model.

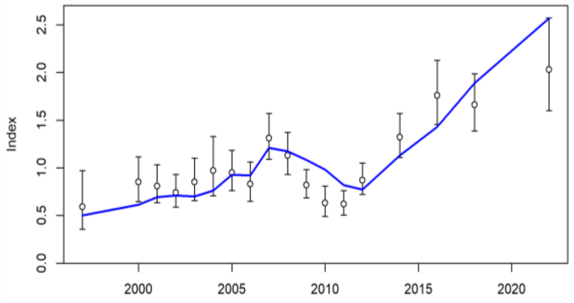
a) Commercial Longline



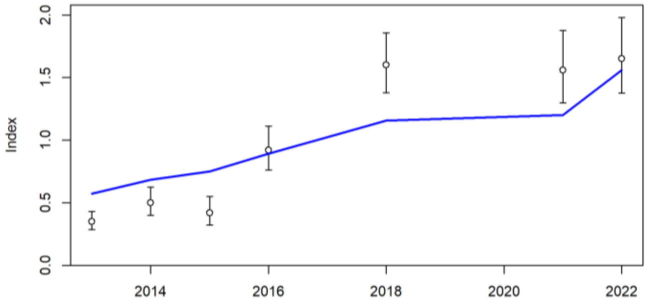
b) RVC Dry Tortugas



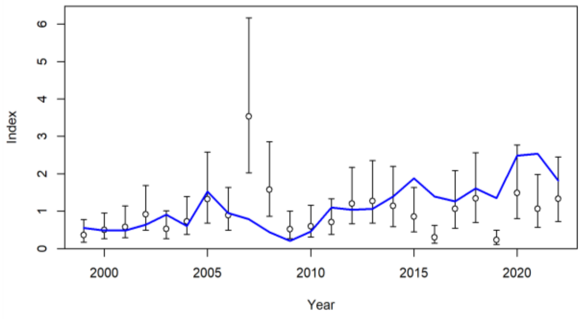
c) RVC FL Keys



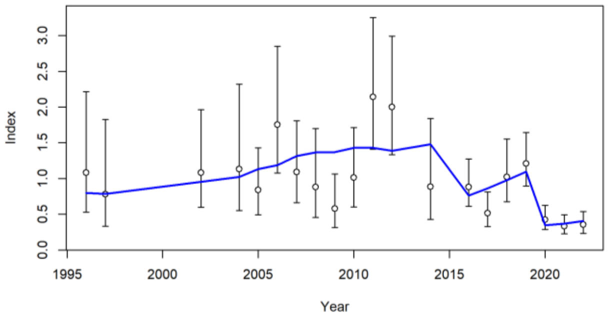
d) RVC SE FL



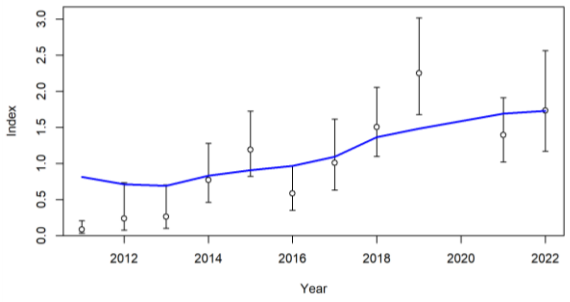
e) FIM YOY



f) Gulf Combined Video



g) SERFS Video



h) Gulf Combined Video Catchability

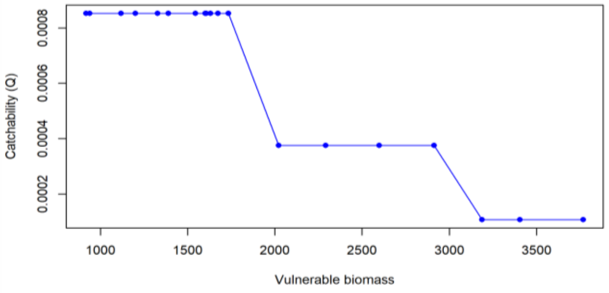


Figure 45. Observed (open circles and error bars) and predicted (solid lines) indices of abundance for the SEDAR 79 Base Model. Lines indicate 95% uncertainty interval around index values based on the model assumption of lognormal error. Also shown are estimated catchability coefficients for the Gulf Combined Vido Index (**h**).

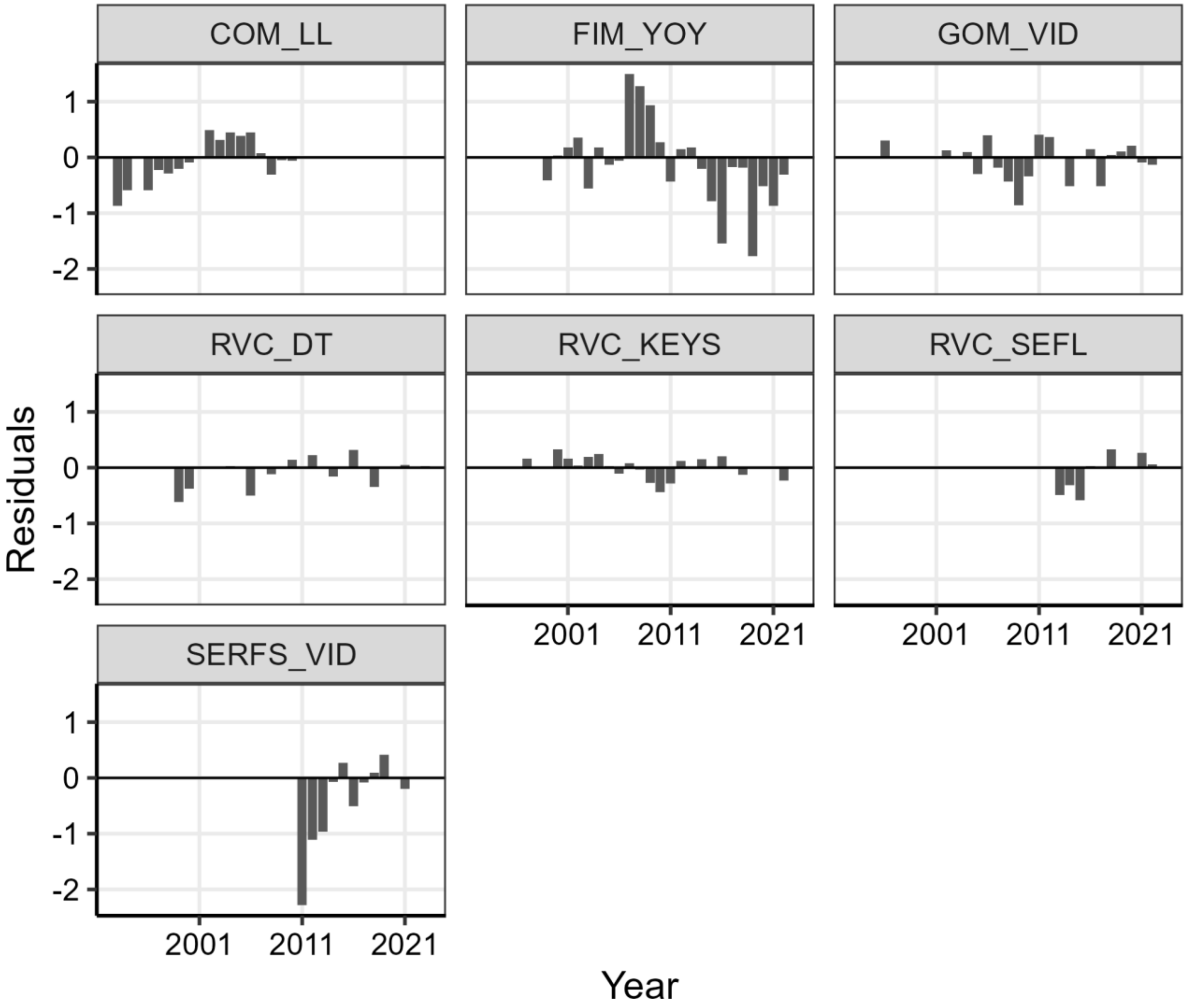


Figure 46. Residuals [log(observed) – log(predicted)] of the fit to the indices of abundance for the SEDAR 79 Base Model.

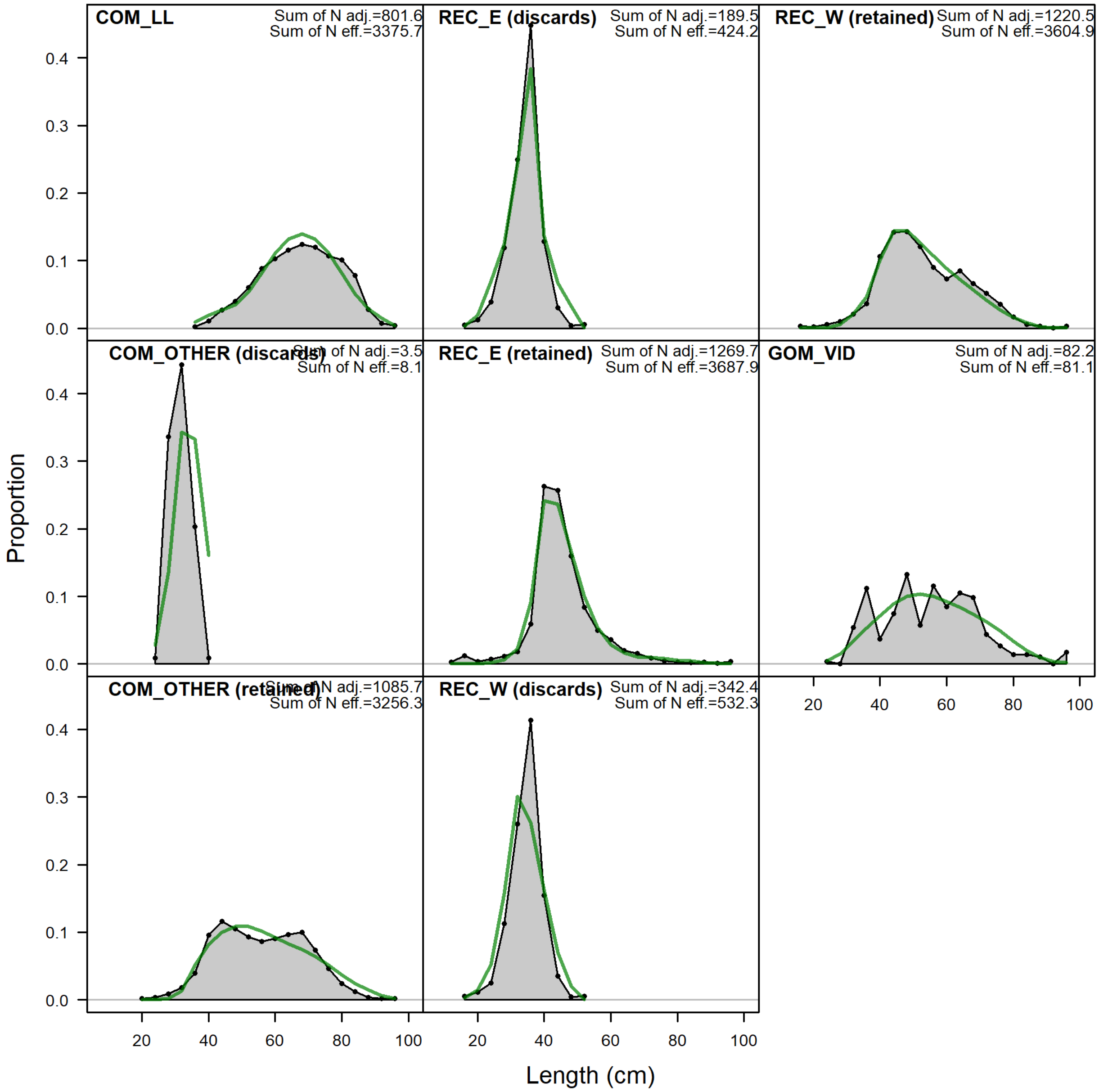


Figure 47. Model fits to the length composition (4 cm Max TL binwidth) of discarded (i.e., released) or retained catch aggregated across years within a given fleet or survey for Southeastern U.S. Mutton Snapper. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. 'N adj.' is the input sample size after data-weighting adjustment. ‘N eff.’ is the calculated effective sample size used in the McAllister-Ianelli tuning method. Abbreviations include: Commercial Longline (COM_LL), Commercial Other (COM_OTH), Recreational East (REC_E), Recreational West (REC_W), and Gulf Combined Video (GOM_VID).

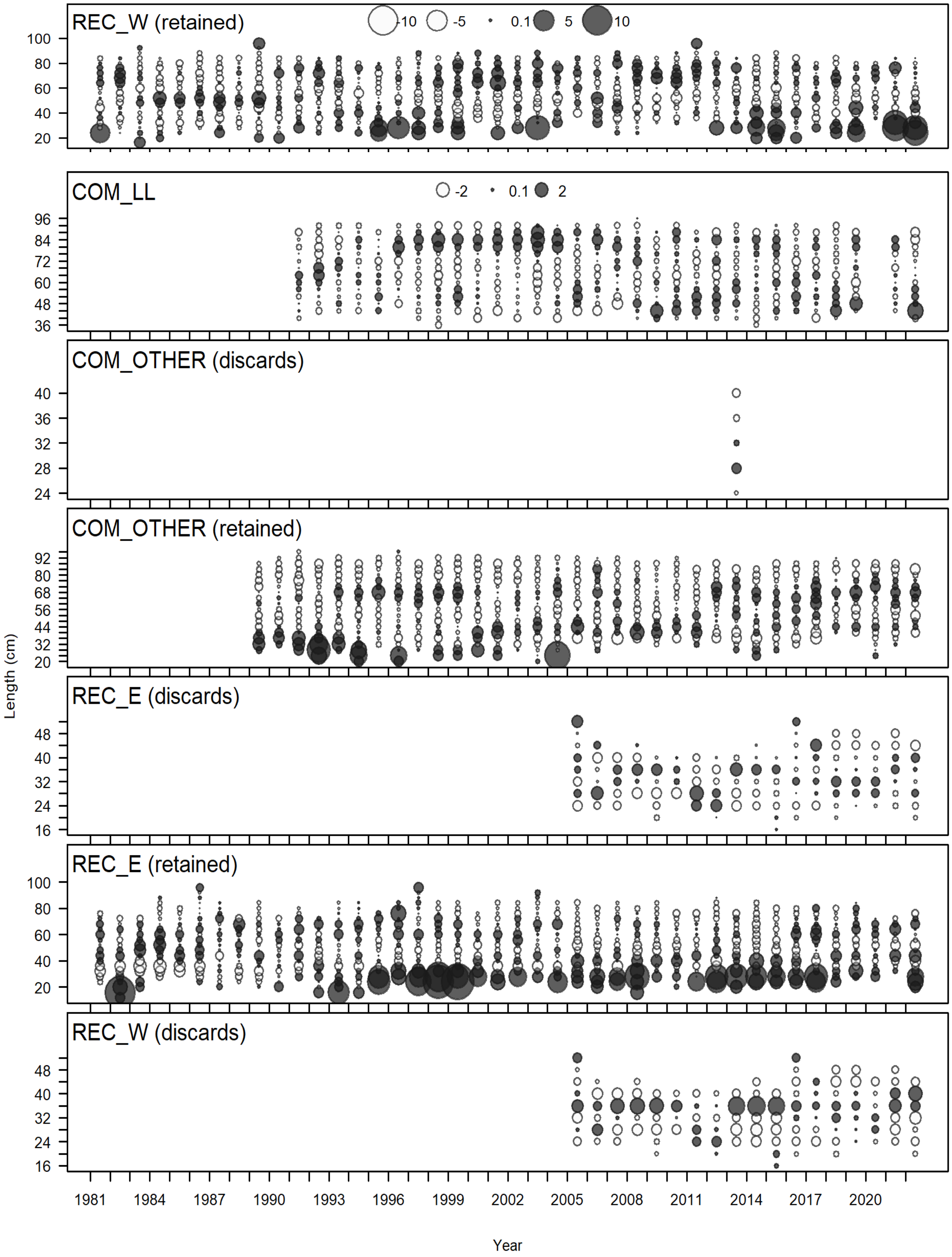


Figure 48. Pearson residuals for retained and discarded length compositions of Southeastern US Mutton Snapper by fleet for SEDAR 79. Closed bubbles are positive residuals (observed > expected), and open bubbles are negative residuals (observed < expected).

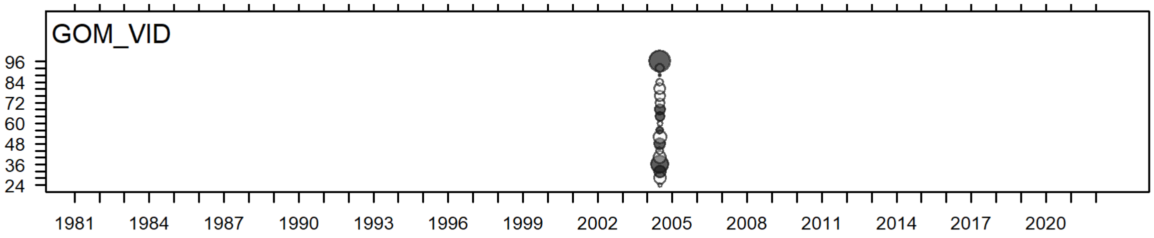


Figure 49. Pearson residuals for Gulf Combined Video length compositions of Southeastern US Mutton Snapper for SEDAR 79. Closed bubbles are positive residuals (observed > expected), and open bubbles are negative residuals (observed < expected).

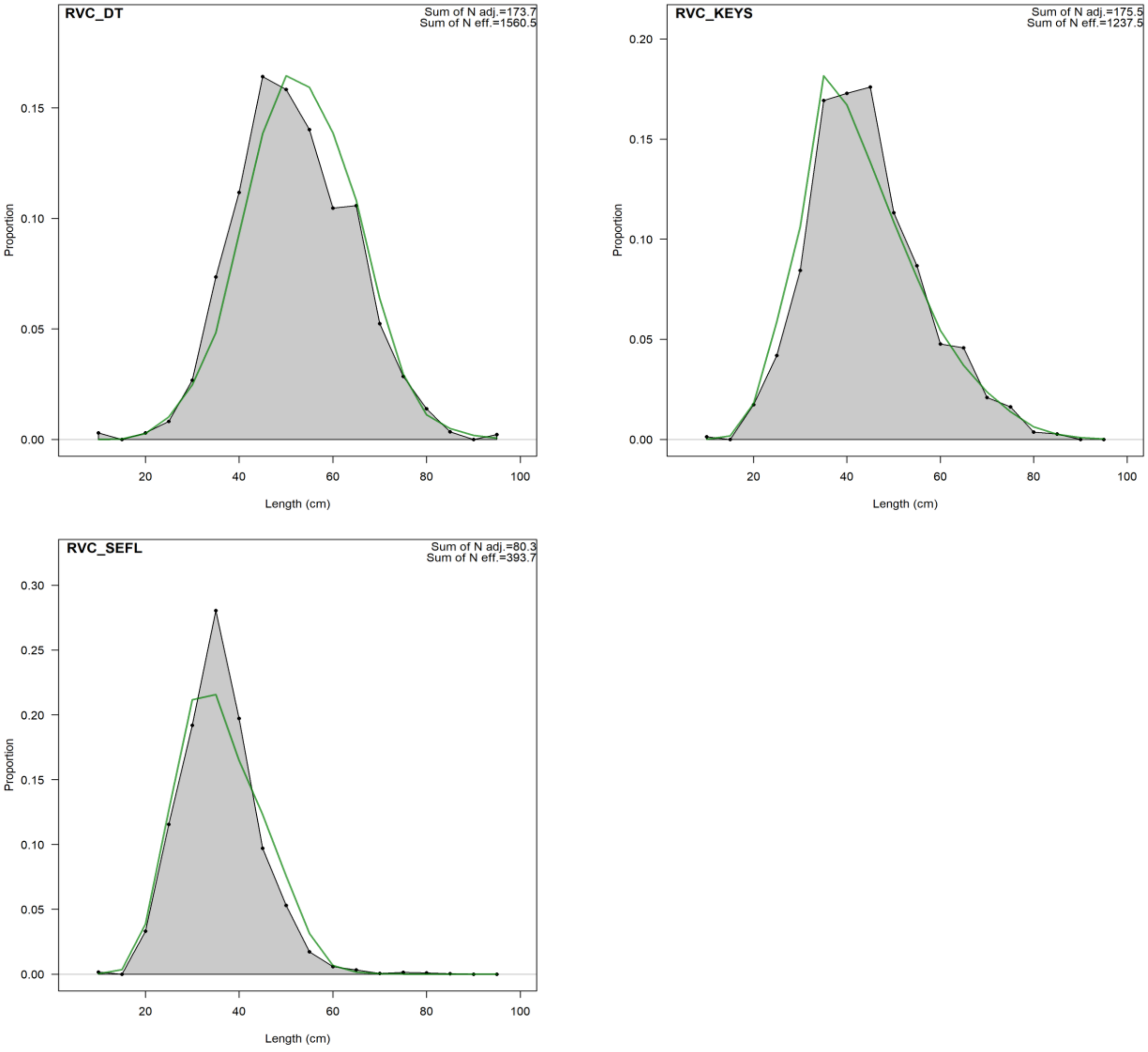
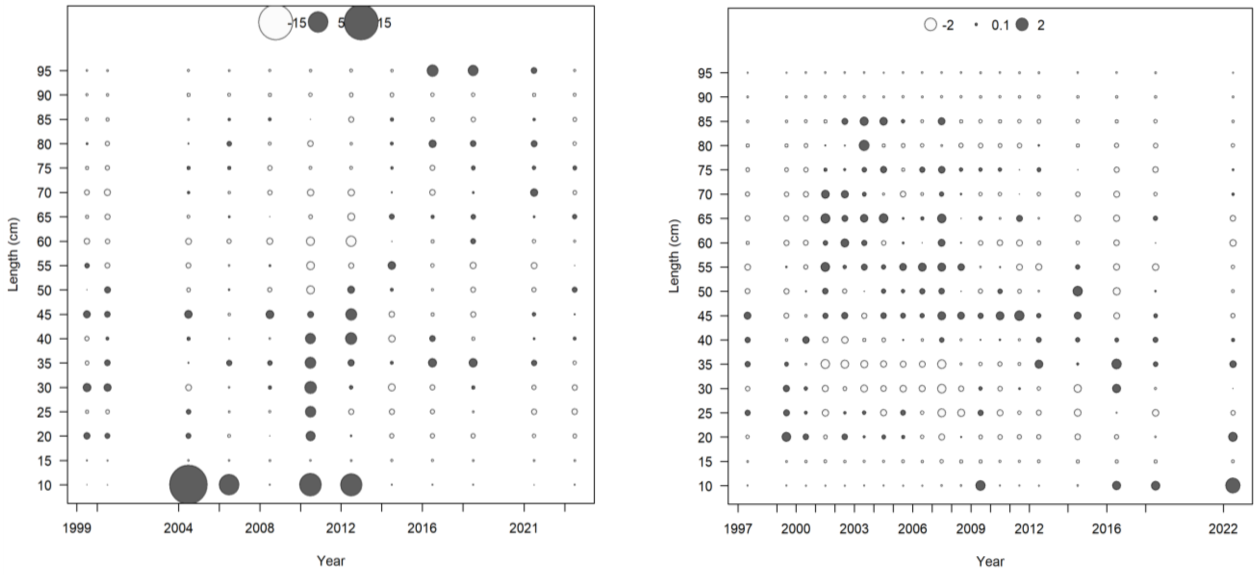


Figure 50. Model fits to the length composition (5 cm Max TL bin width) aggregated across years within RVC surveys for Southeastern U.S. Mutton Snapper. Green lines represent expected length compositions, while grey shaded regions represent observed length compositions. 'N adj.' is the input sample size after data-weighting adjustment.



a) RVC Dry Tortugas

b) RVC FL Keys

c) RVC SE FL

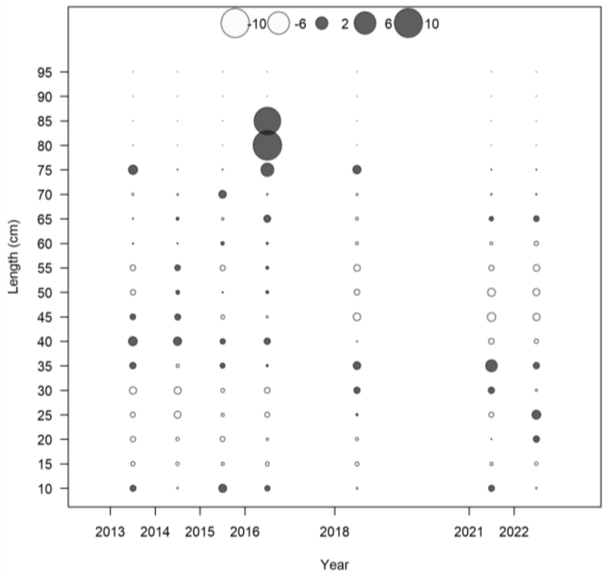
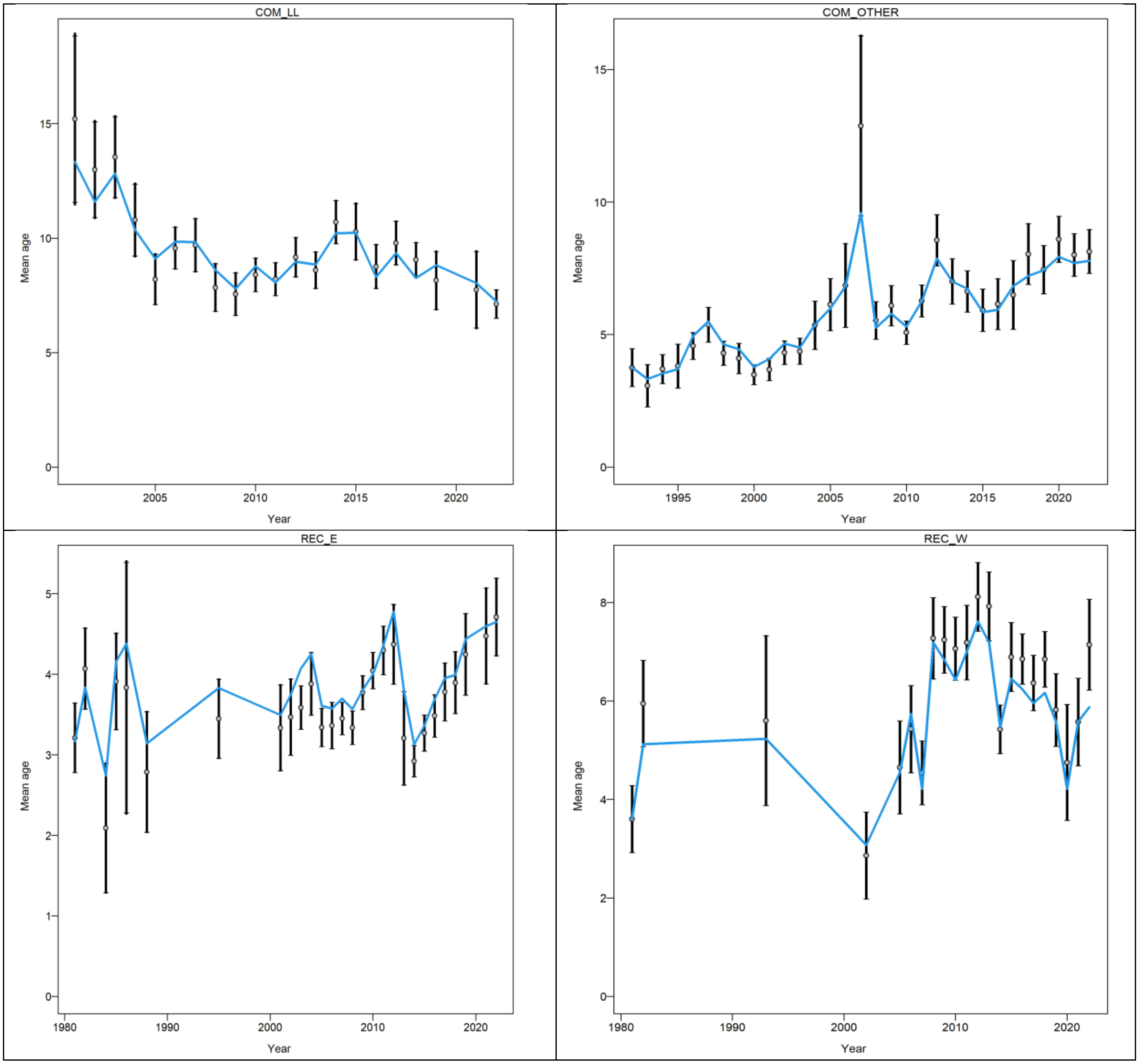


Figure 51. Pearson residuals for RVC length compositions (5 cm MaxTL bin width) of Southeastern US Mutton Snapper by fleet for SEDAR 79. Closed bubbles are positive residuals (observed > expected), and open bubbles are negative residuals (observed < expected).


COM_LL
Mean age
0
5
10
15
2005
2010
2015
2020
Year
COM_OTHER
Mean age
0
5
10
15
1995
2000
2005
2010
2015
2020
Year
REC_E
Mean age
0
1
2
3
4
5
1980
1990
2000
2010
2020
Year
REC_W
Mean age
0
2
4
6
8
1980
1990
2000
2010
2020
Year

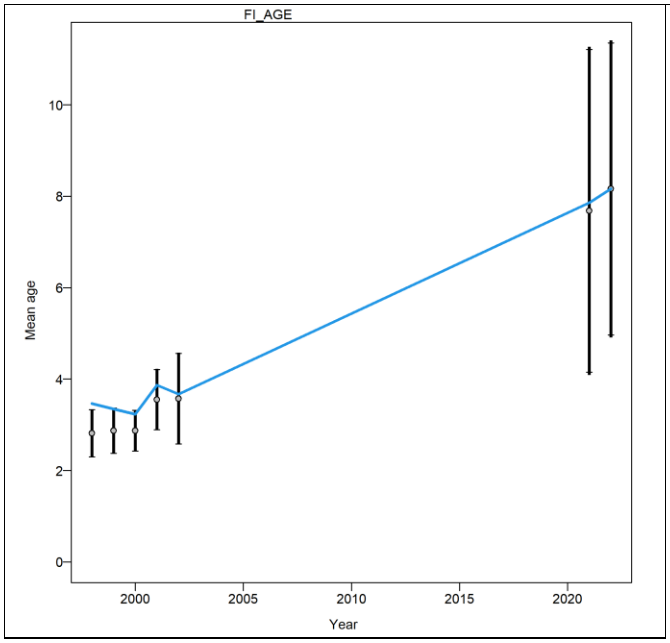


Figure 52. Mean ages of Southeastern U.S. Mutton Snapper from conditional age-at-length data aggregated across length bins for each fleet and the fishery-independent data source (observed --dots with 95% confidence intervals and predicted --black line).

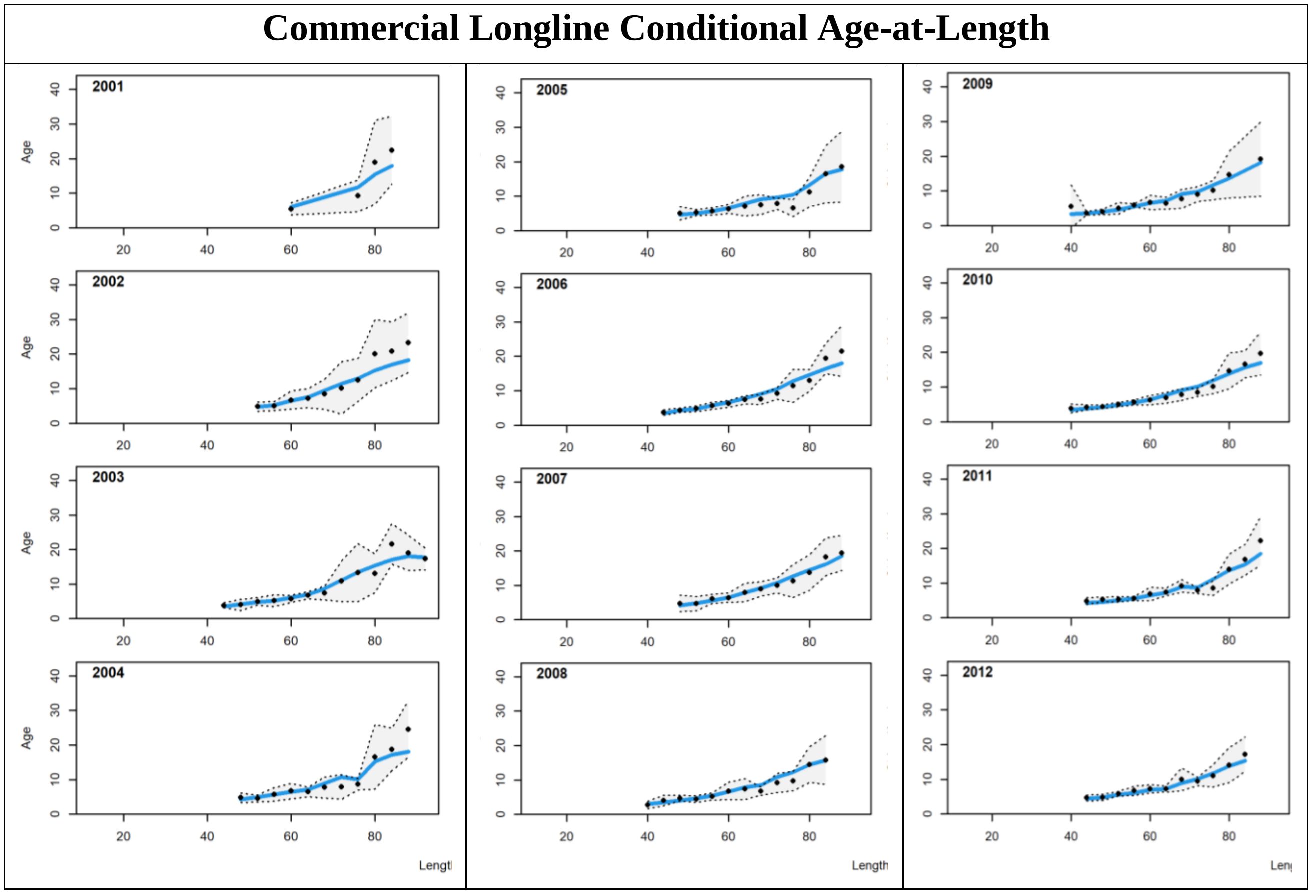


Figure 53. SEDAR 79 Base Model fits to the annual conditional age-at-length data from retained catch by the Commercial Longline fleet for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

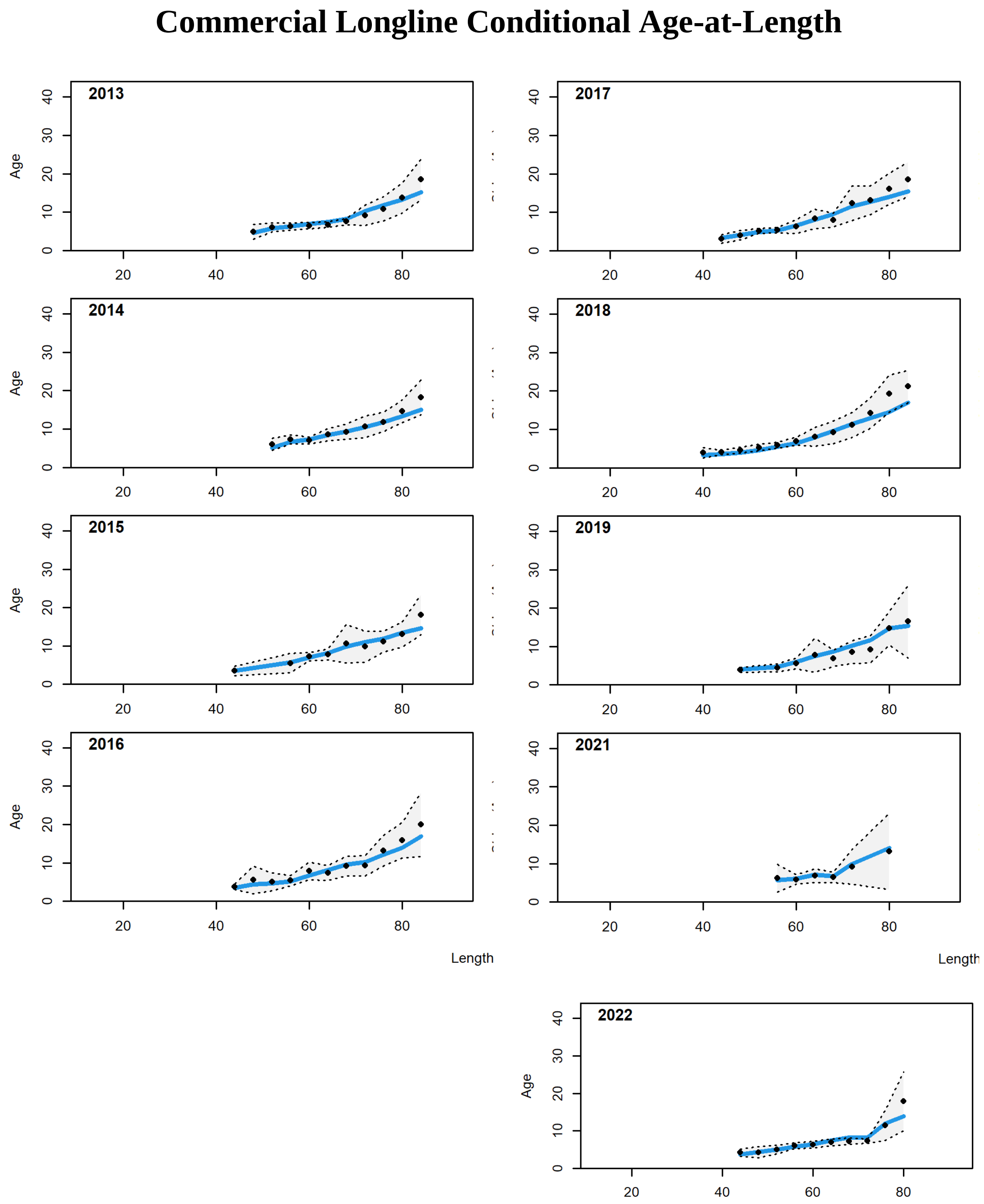


Figure 53 continued. SEDAR 79 Base Model fits to the annual conditional age-at-length data from retained catch by the Commercial Longline fleet for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

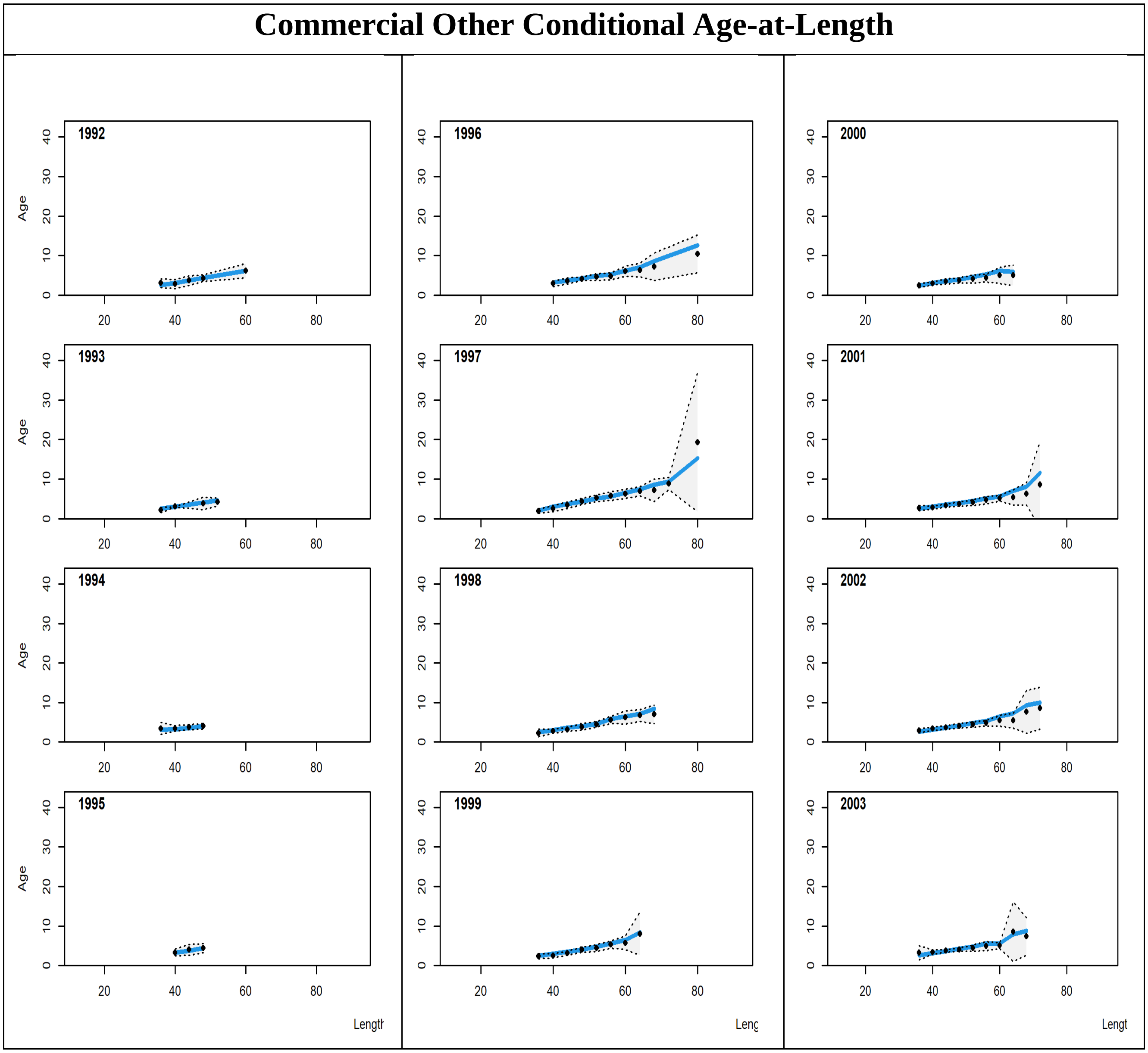


Figure 54. SEDAR 79 Base Model fits to the annual conditional age-at-length data from retained catch by the Commercial Other fleet for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

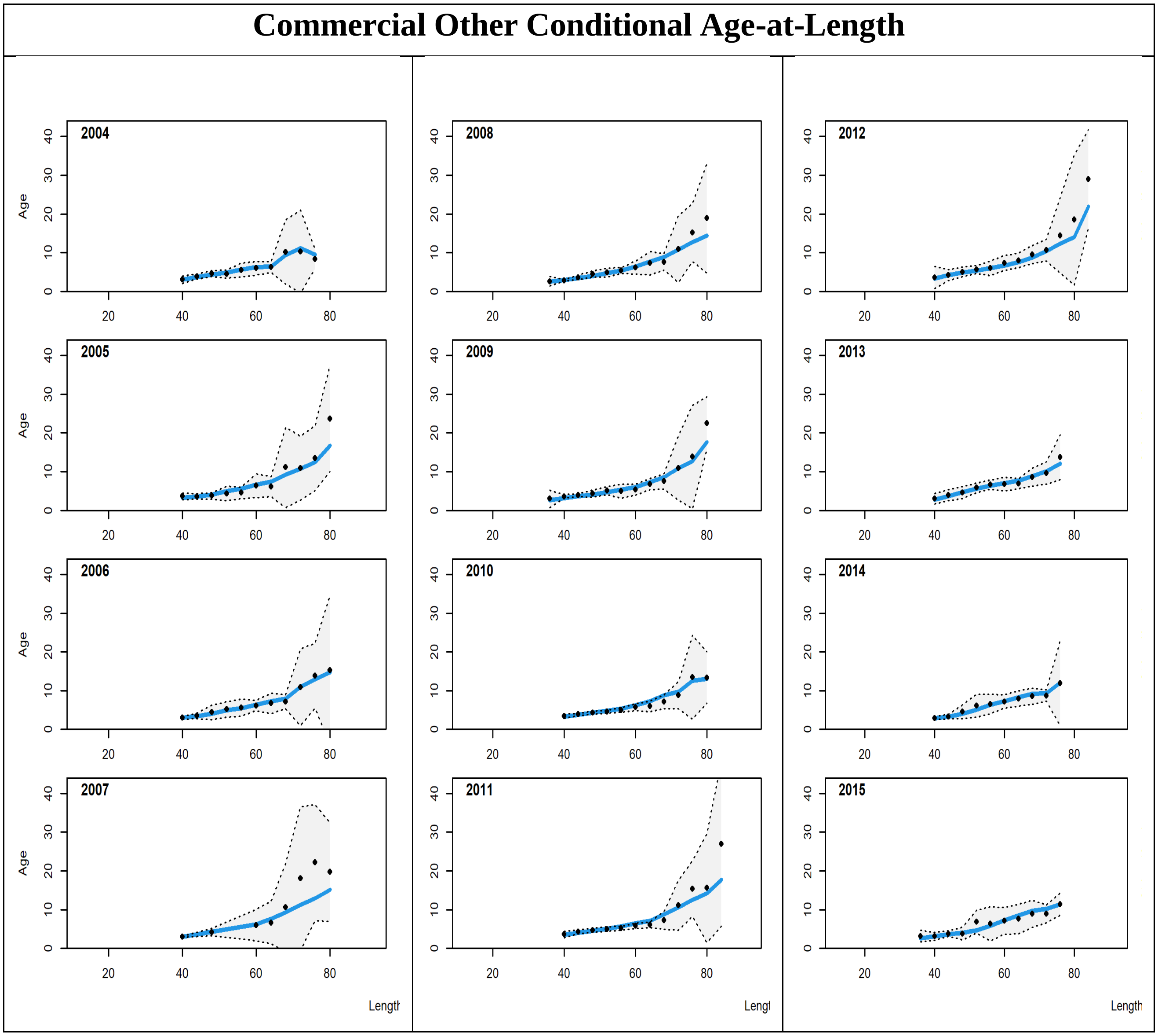


Figure 54 continued. SEDAR 79 Base Model fits to the annual conditional age-at-length data from retained catch by the Commercial Other fleet for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

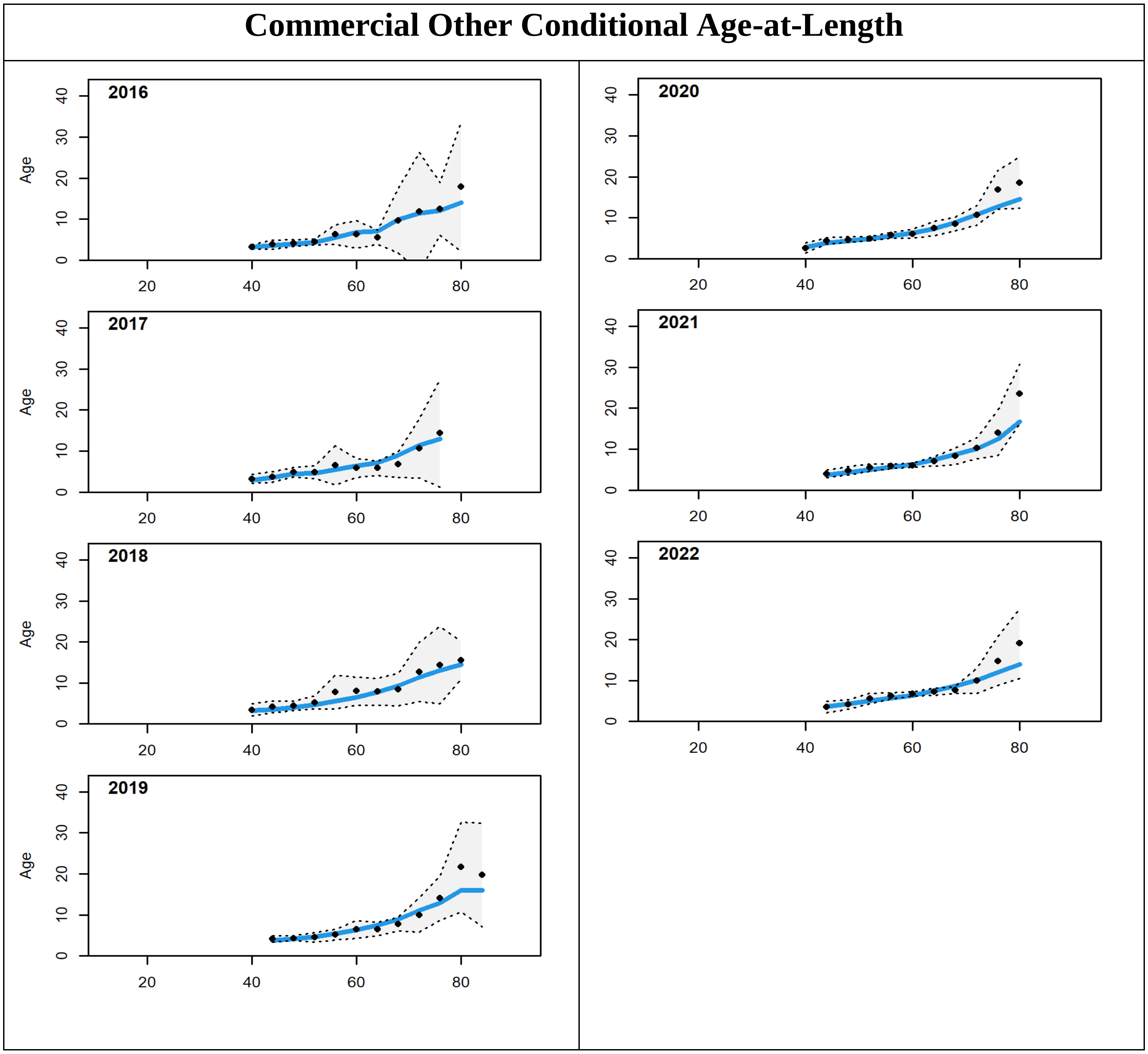


Figure 54 continued. SEDAR 79 Base Model fits to the annual conditional age-at-length data from retained catch by the Commercial Other fleet for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

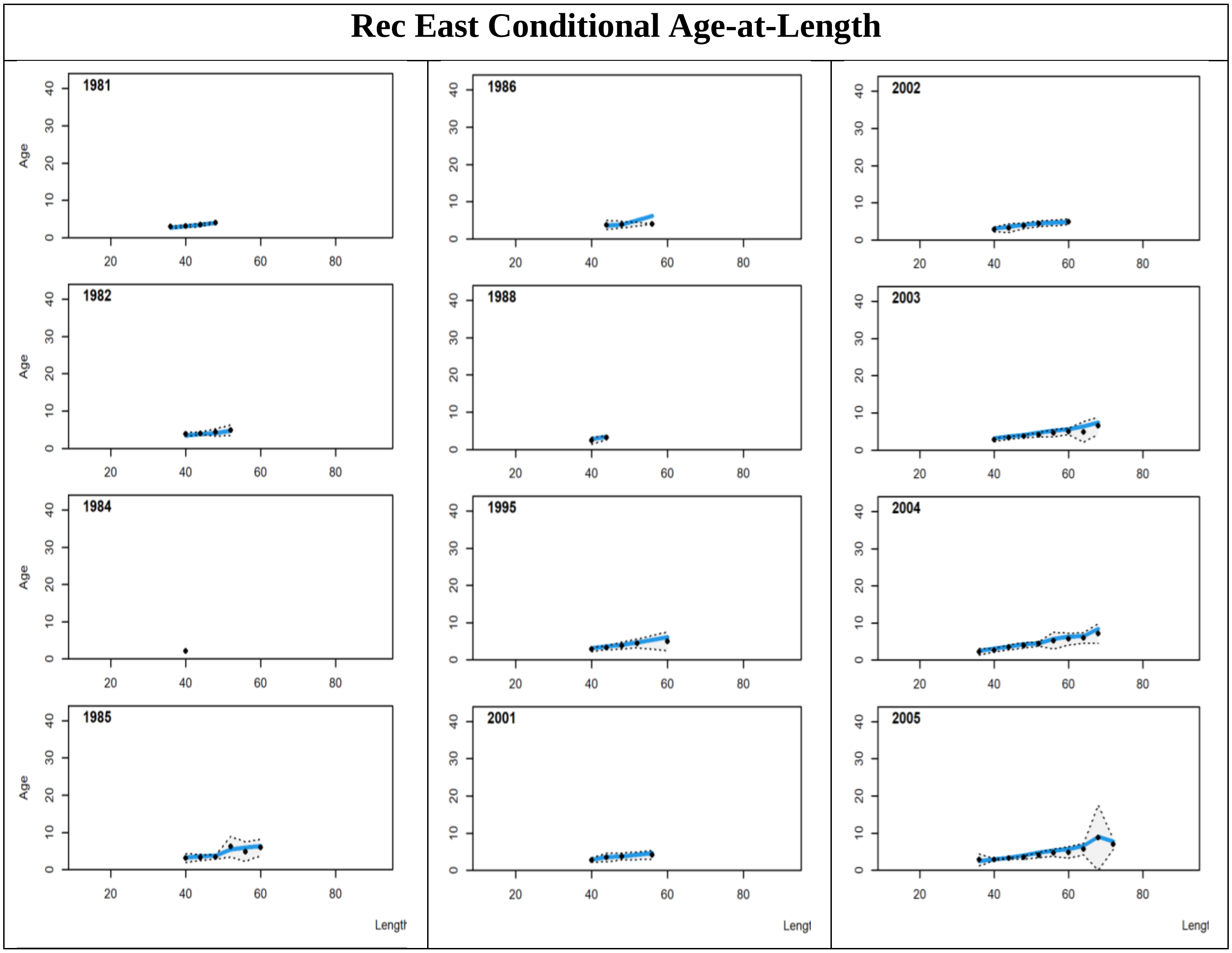


Figure 55. SEDAR 79 Base Model fits to the annual conditional age-at-length data from retained catch by the Recreational East fleet for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

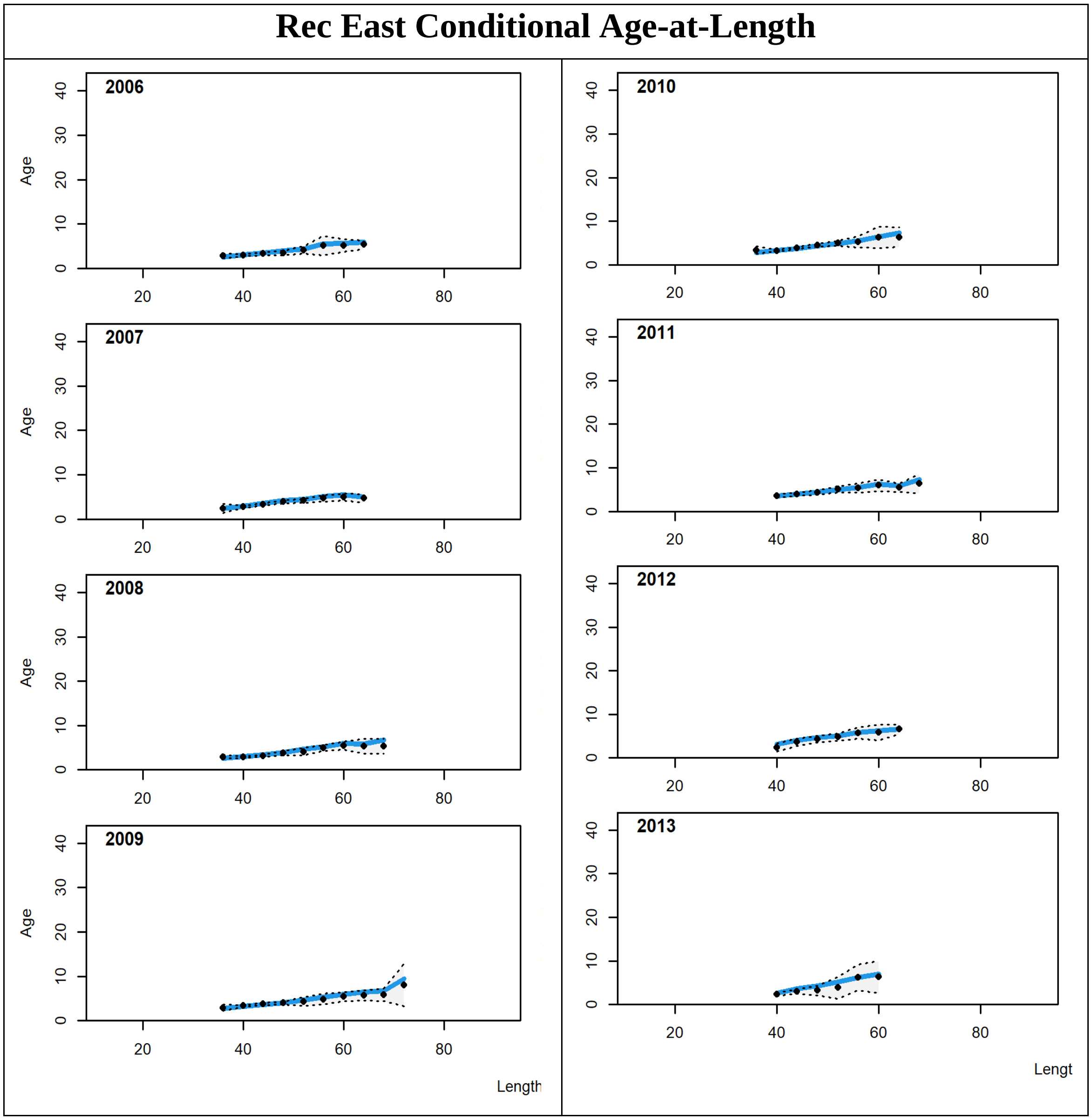


Figure 55 continued. SEDAR 79 Base Model fits to the annual conditional age-at-length data from retained catch by the Recreational East fleet for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

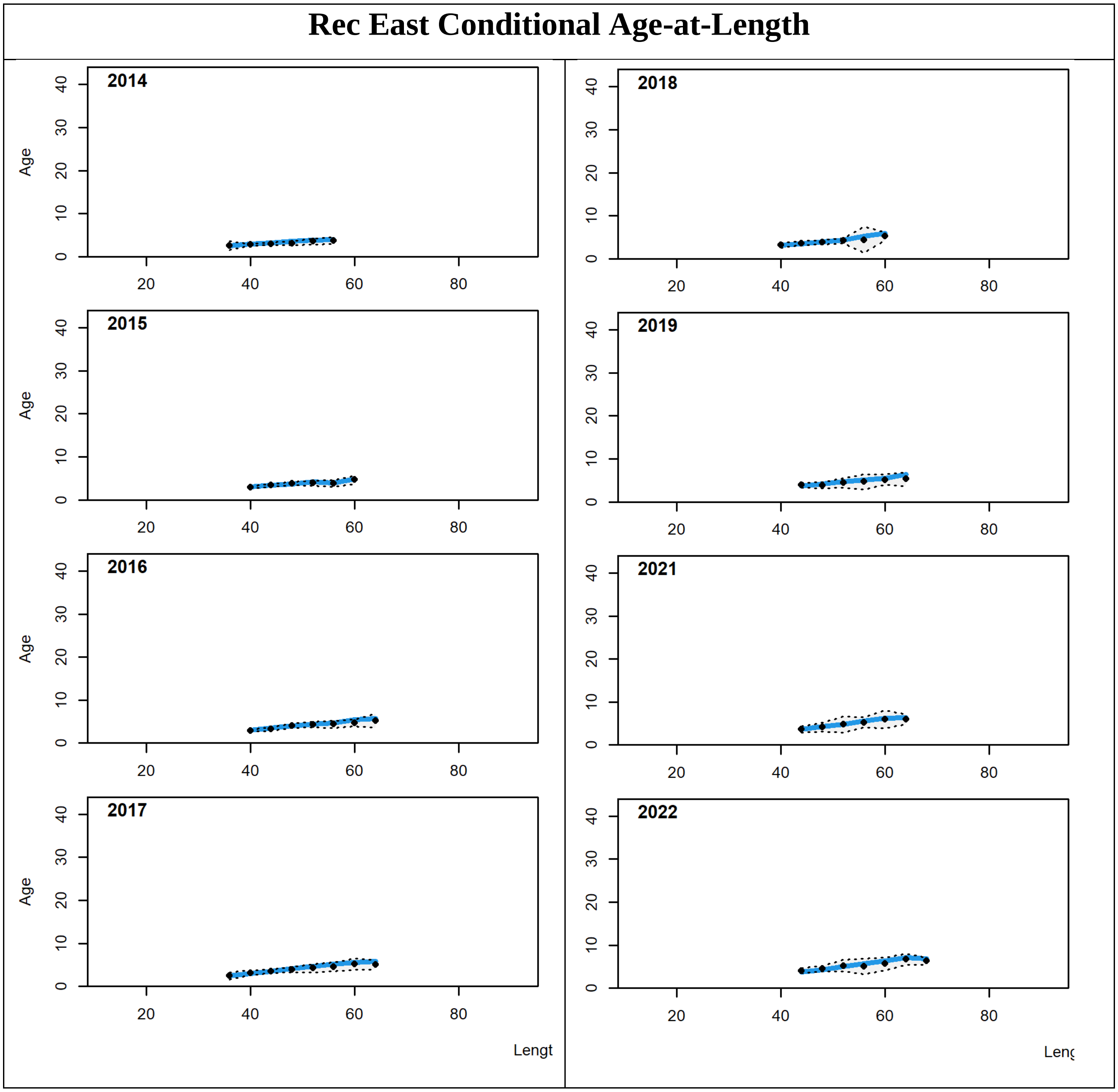


Figure 55 continued. SEDAR 79 Base Model fits to the annual conditional age-at-length data from retained catch by the Recreation East fleet for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

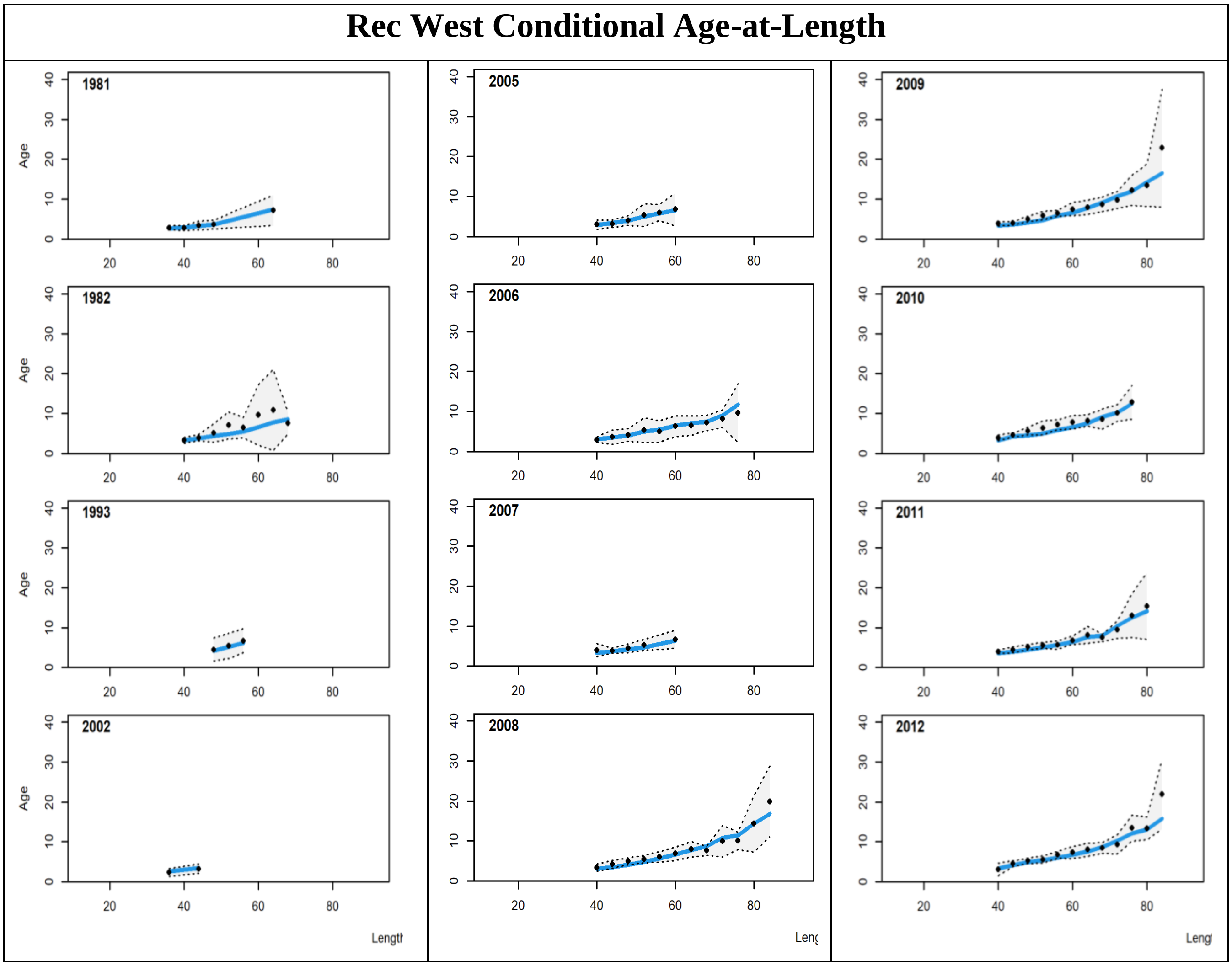


Figure 56. SEDAR 79 Base Model fits to the annual conditional age-at-length data from retained catch by the Recreation West fleet for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

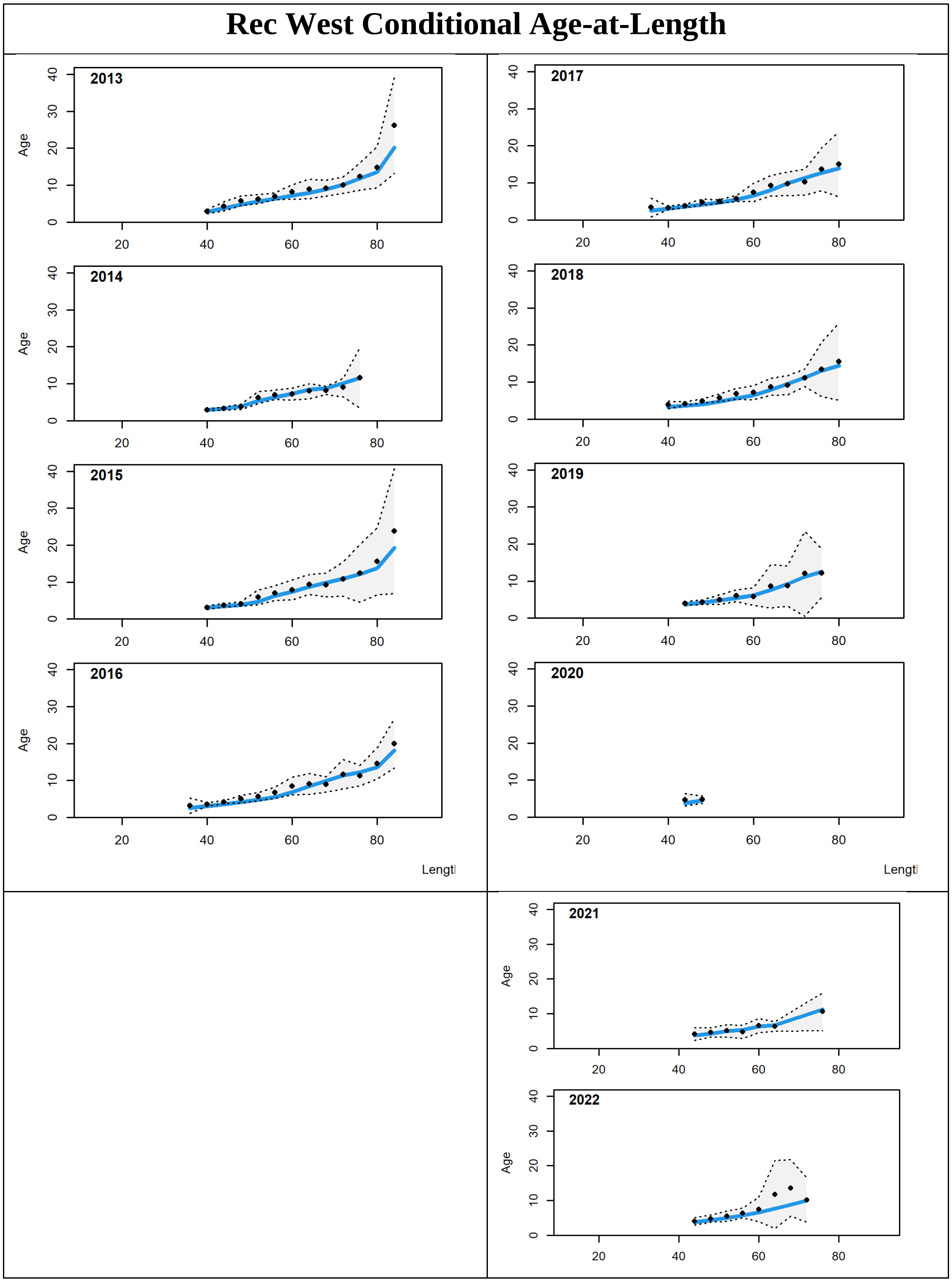


Figure 56 continued. SEDAR 79 Base Model fits to the annual conditional age-at-length data from retained catch by the Recreation West fleet for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

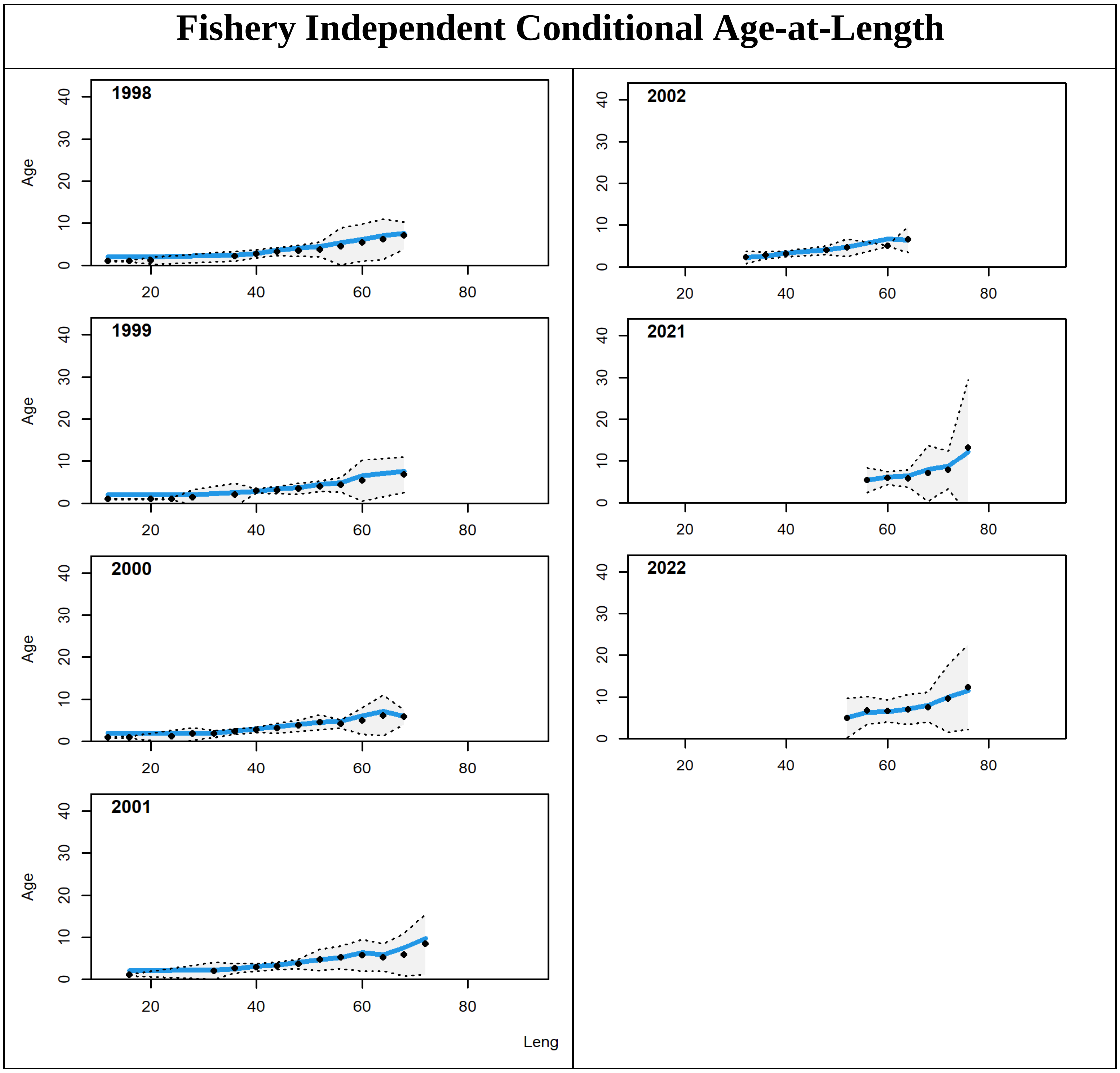

Fishery Independent Conditional Age-at-Length

Figure 57. SEDAR 79 Base Model fits to the annual conditional age-at-length data from fishery independent data sources for Southeastern U.S. Mutton Snapper. Blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals.

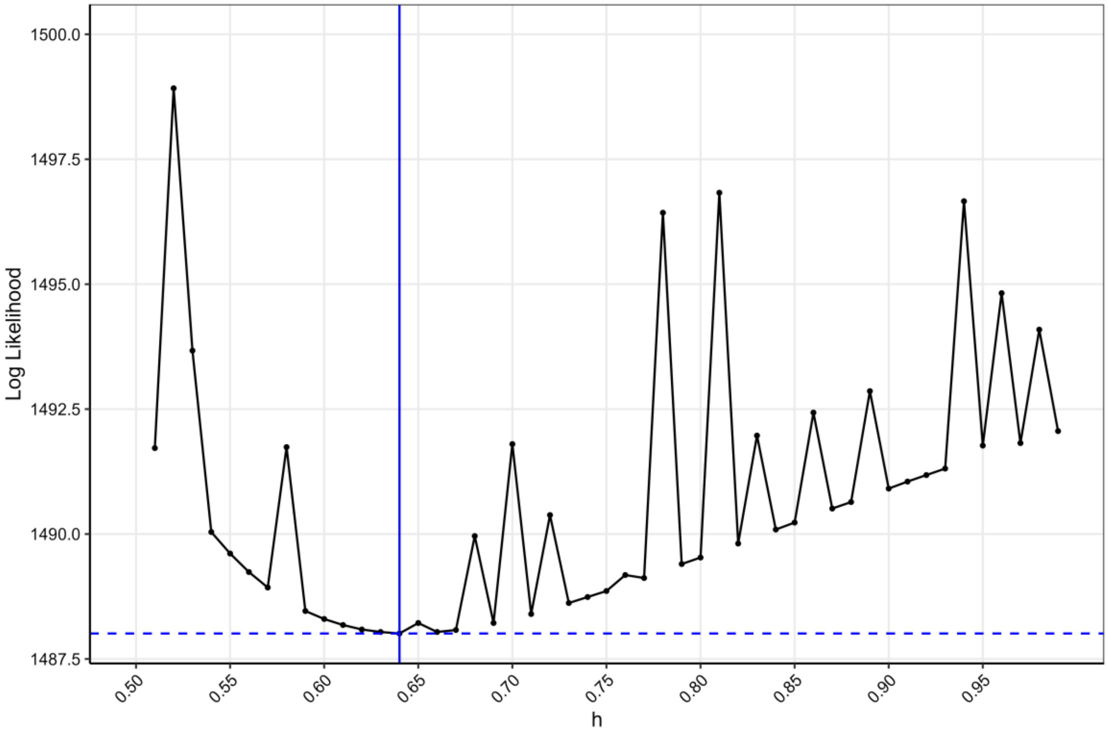


Figure 58. The likelihood profile for steepness (*h*) of the Beverton – Holt stock-recruit function for Southeastern U.S. Mutton Snapper. The black line indicates the negative log-likelihood value across the range of fixed values tested. The estimate of steepness from the SEDAR 79 Base Model was 0.644. The dashed horizontal line is the SEDAR 79 Base Model log-likelihood value of 1488.01. The approximate 95% confidence interval of the SEDAR 79 Base Model log-likelihood value is 1489.97 (1488.01 + 1.97).

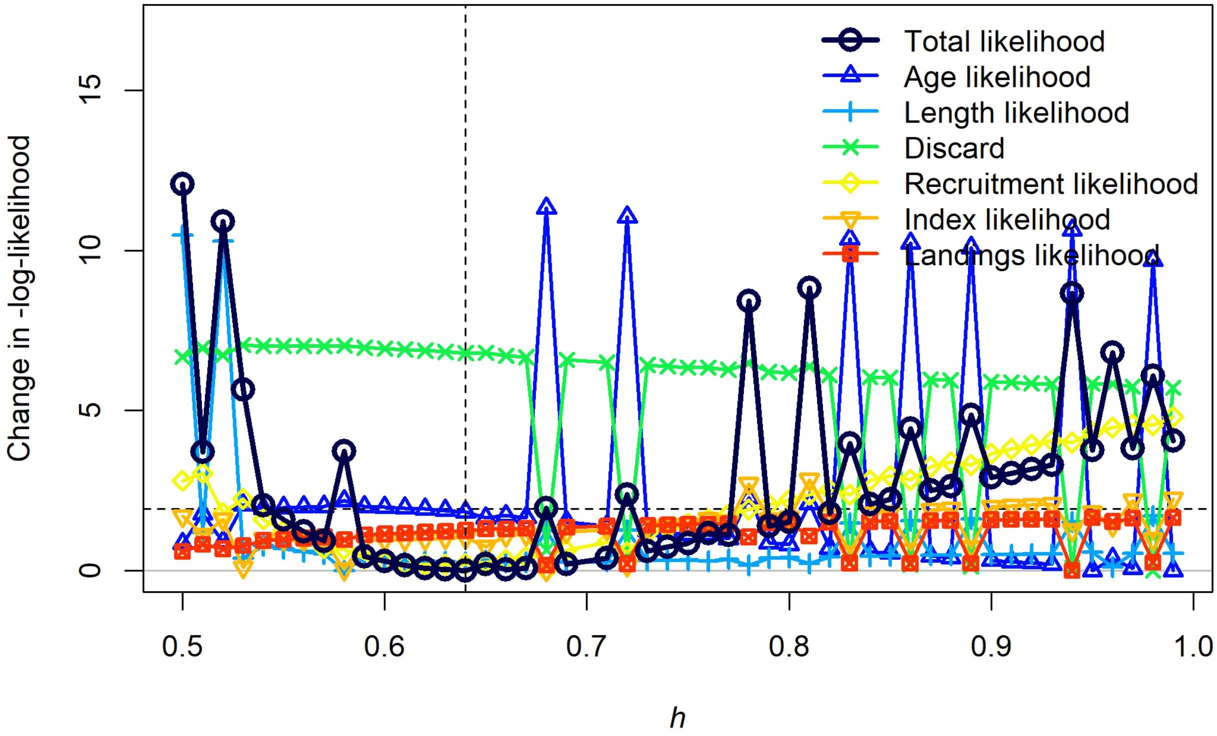
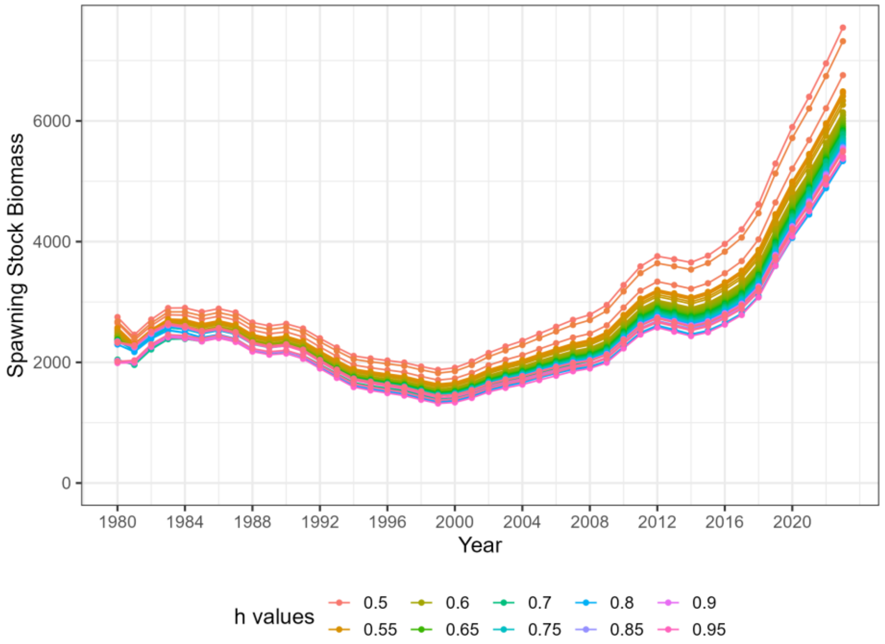


Figure 59. The likelihood profile for steepness (*h*) of the Beverton – Holt stock-recruit function for Southeastern U.S. Mutton Snapper by model component. Colored lines indicate the negative log-likelihood value associated with each model component across the range of fixed values tested. The estimate of steepness from the SEDAR 79 Base Model was 0.644. The dashed horizontal line the approximate 95% confidence interval of the SEDAR 79 Base Model log-likelihood value (1.97).



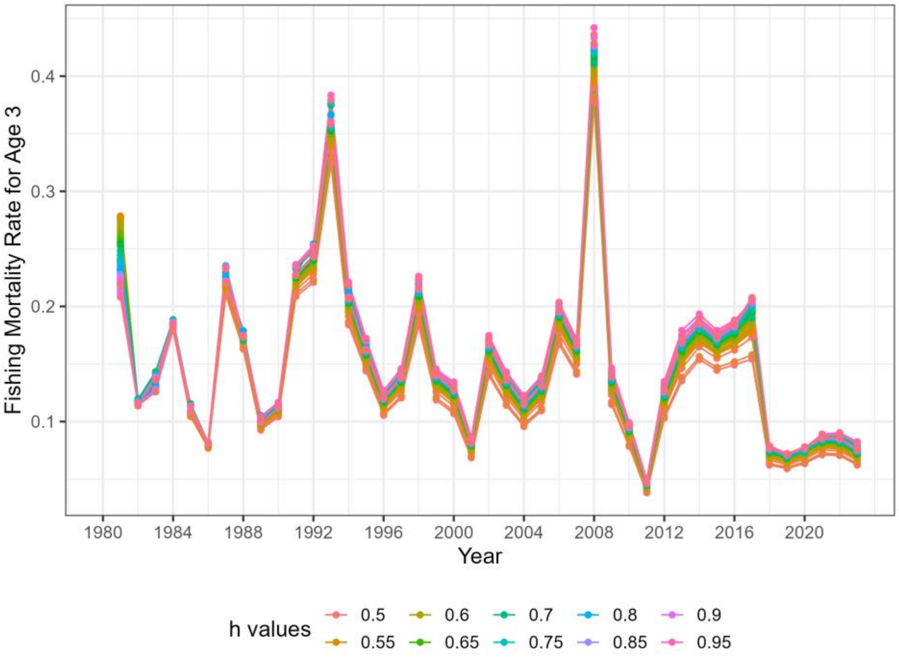


Figure 60. Trends in spawning stock biomass (SSB; top) and age 3 fishing mortality rates (F; bottom) for Southeastern U.S. Mutton Snapper when profiling across a range of fixed steepness (*h*) values in the SEDAR 79 Base Model.

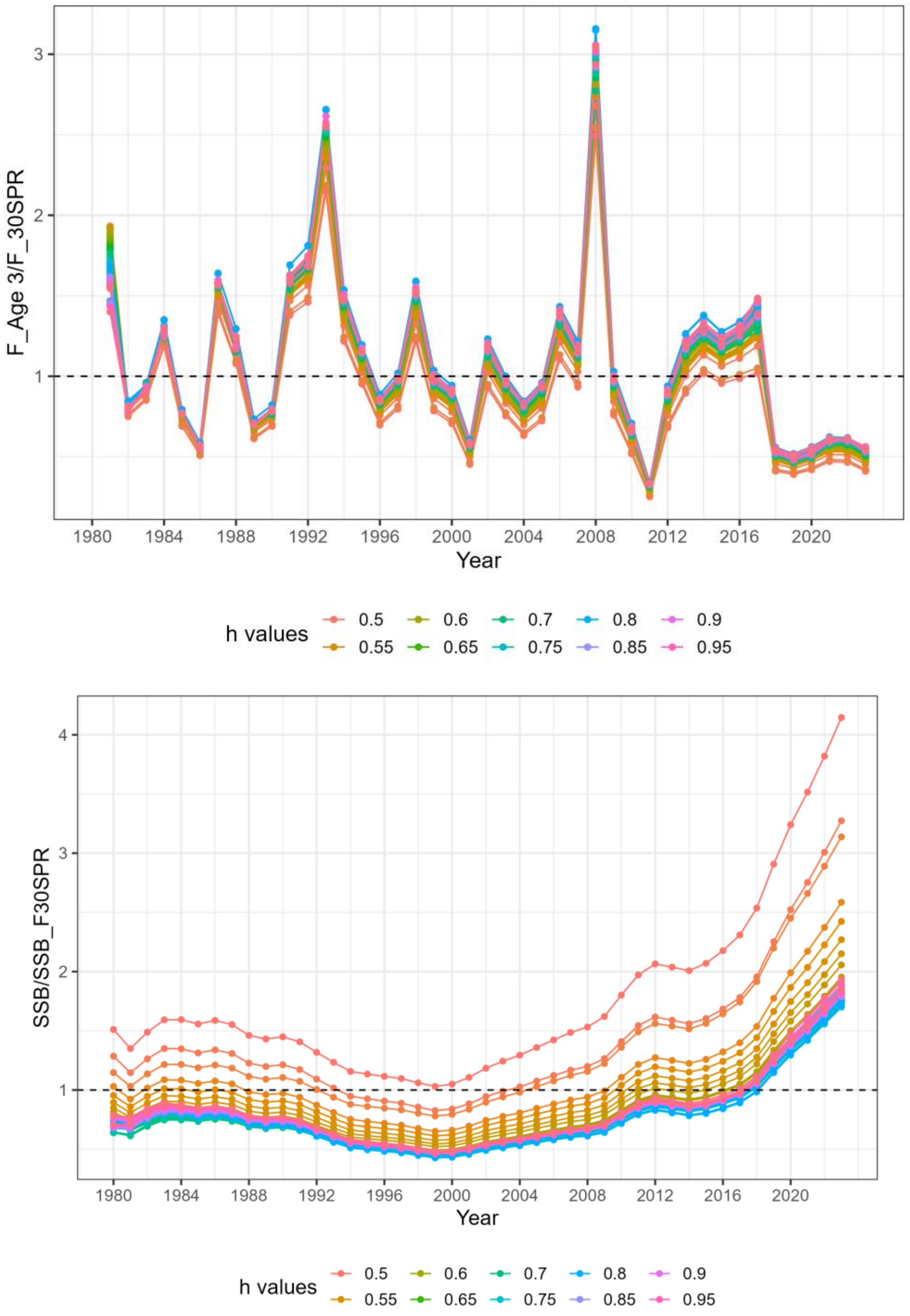


Figure 61. Spawning stock biomass relative to $SSB_{30\%SPR}$ (SSB/SSB_30SPR; top) and age 3 fishing mortality rates relative to $F_{30\%SPR}$ (F/ $F_{30\%SPR}$; bottom) for Southeastern U.S. Mutton Snapper when profiling across a range of fixed steepness (*h*) values in the SEDAR 79 Base Model.

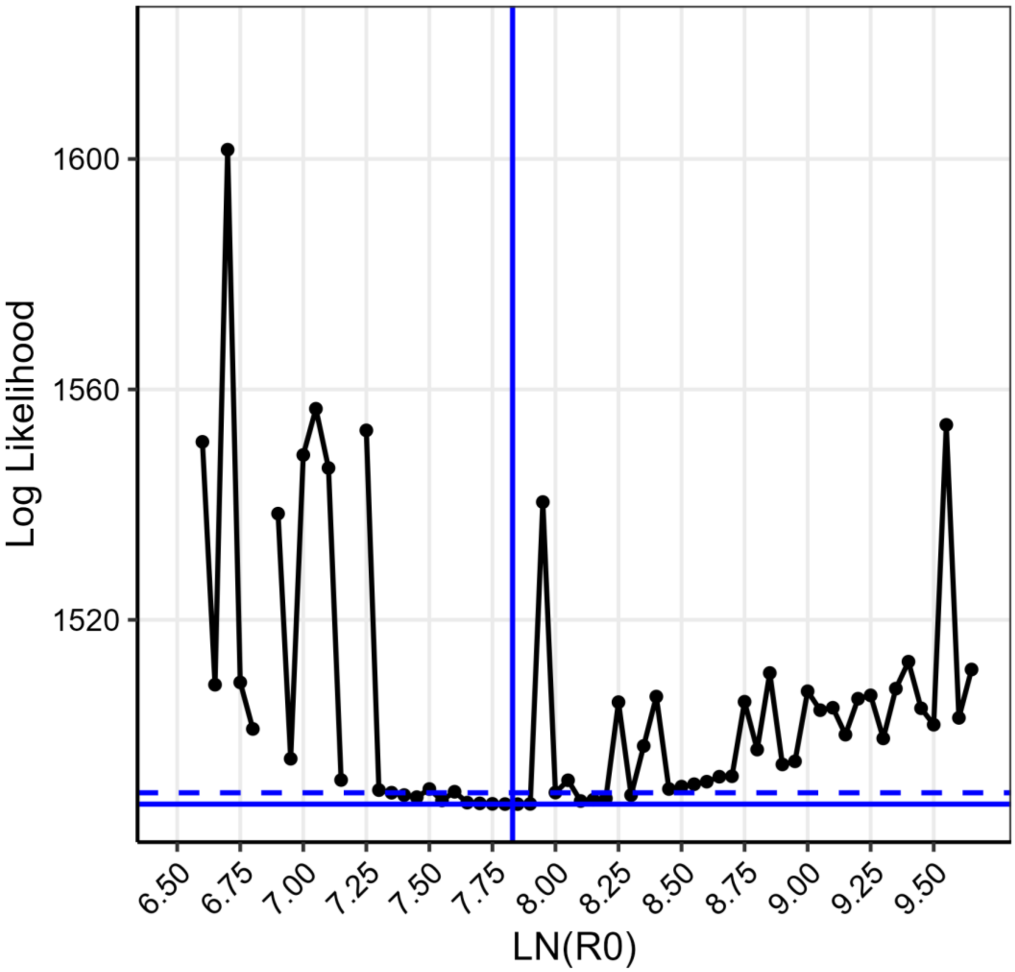


Figure 62. The likelihood profile for the natural log of the virgin recruitment parameter (ln(*R0*)) of the Beverton – Holt stock-recruit function for Southeastern U.S. Mutton Snapper. The black line indicates the negative log-likelihood value across the range of fixed values tested. The estimate of ln(R0) from the SEDAR 79 Base Model was 7.82 (blue vertical line). The solid horizontal line is the SEDAR 79 Base Model log-likelihood value of 1488.01, and the dashed blue line is the approximate 95% confidence interval of the SEDAR 79 Base Model log-likelihood value is 1489.97 (1488.01 + 1.97).

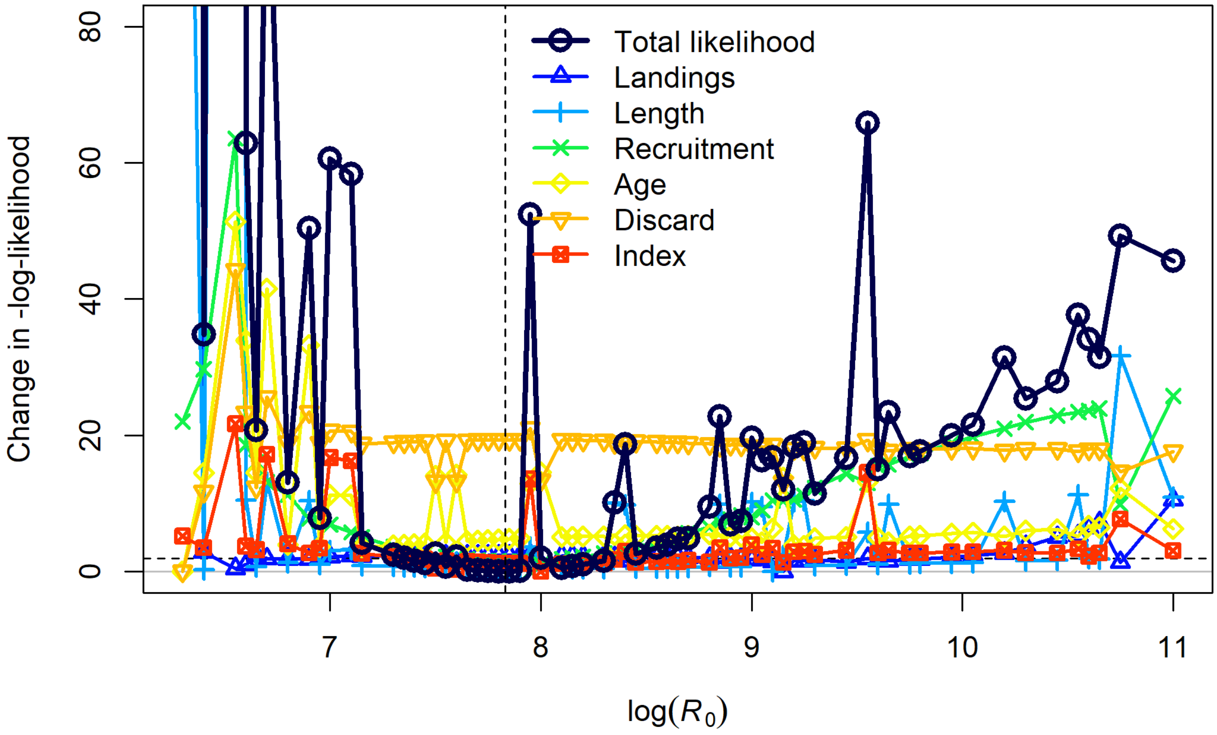
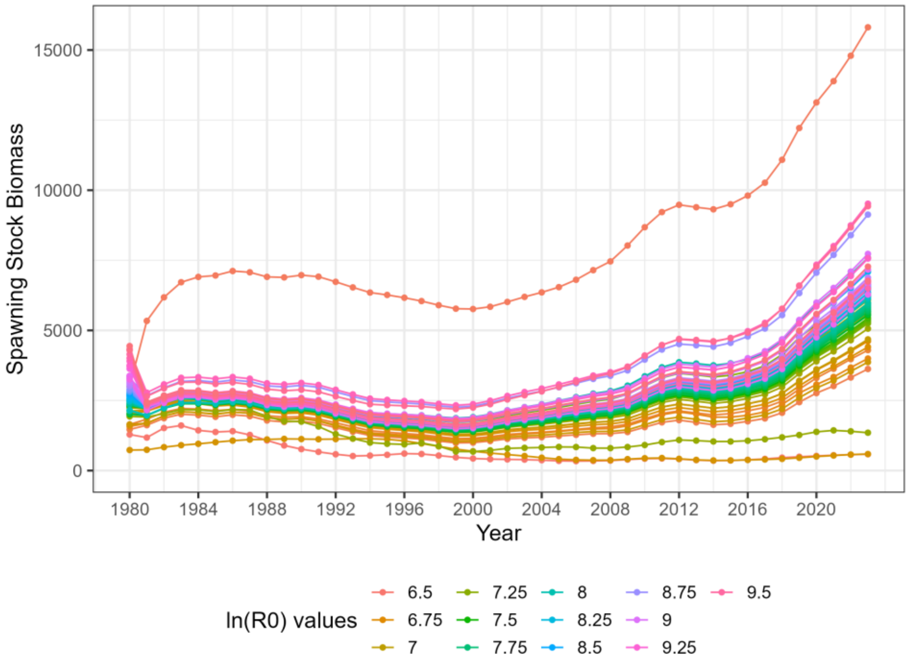


Figure 63. The likelihood profile for the natural log of the virgin recruitment parameter (ln(*R0*)) of the Beverton – Holt stock-recruit function for Southeastern U.S. Mutton Snapper by model component. Colored lines indicate the negative log-likelihood value associated with each model component across the range of fixed values tested. The estimate of ln(*R0*) from the SEDAR 79 Base Model was 7.82. The dashed horizontal line the approximate 95% confidence interval of the SEDAR 79 Base Model log-likelihood value (1.97).



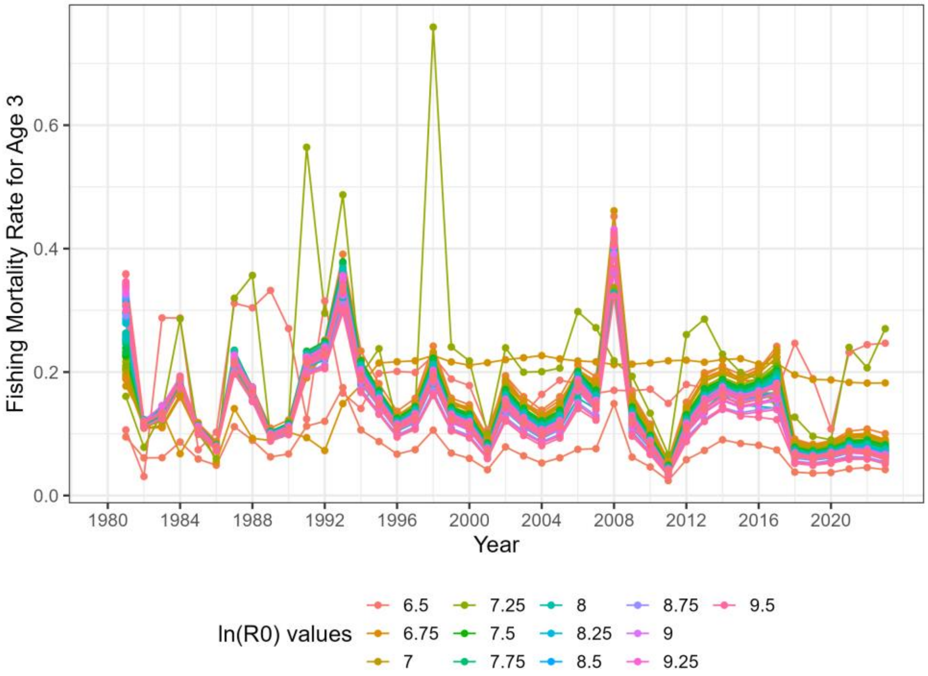
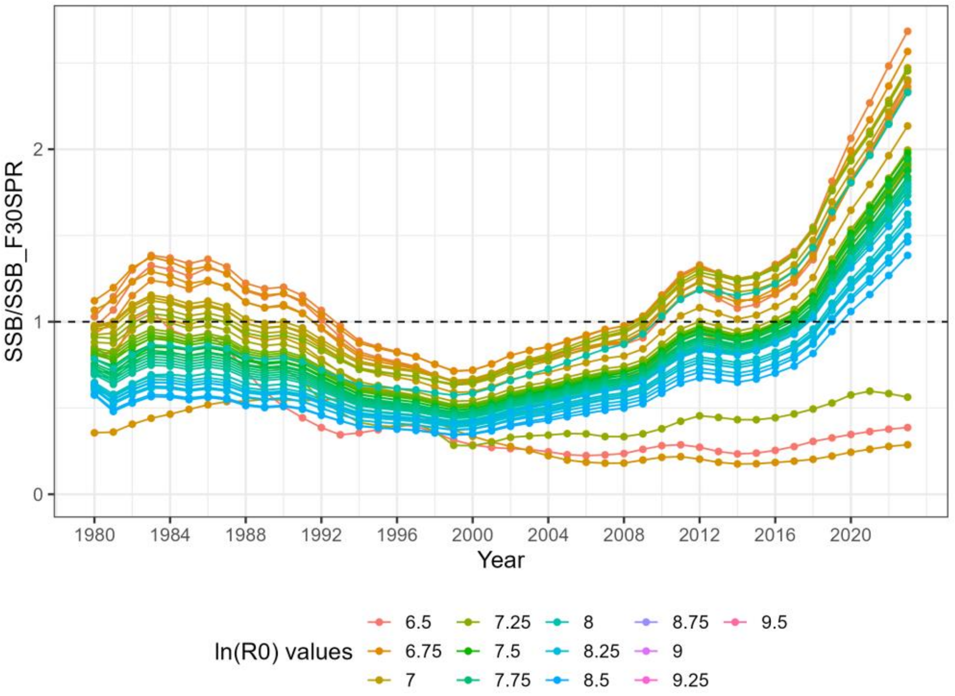


Figure 64. Trends in spawning stock biomass (SSB; top) and age 3 fishing mortality rates (F; bottom) for Southeastern U.S. Mutton Snapper when profiling across a range of fixed virgin recruitment (*ln(R0)*) values in the SEDAR 79 Base Model.



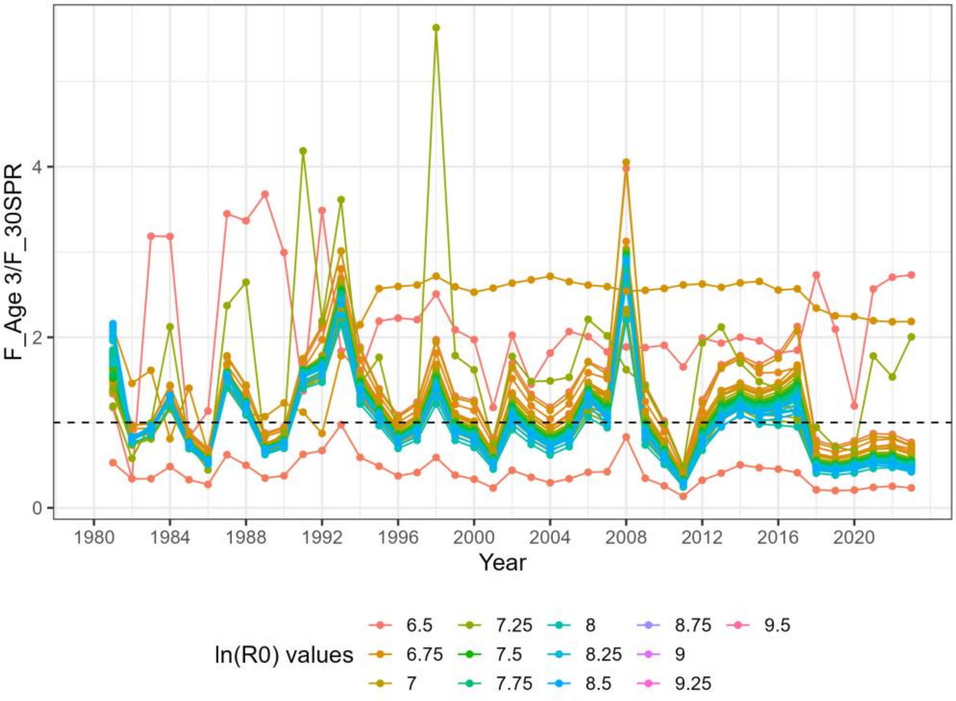


Figure 65. Spawning stock biomass relative to $SSB_{30\%SPR}$ (SSB/SSB_30SPR; top) and age 3 fishing mortality rates relative to $F_{30\%SPR}$ (F/ $F_{30\%SPR}$; bottom) for Southeastern U.S. Mutton Snapper when profiling across a range of fixed virgin recruitment (*ln(R0)*) values in the SEDAR 79 Base Model.

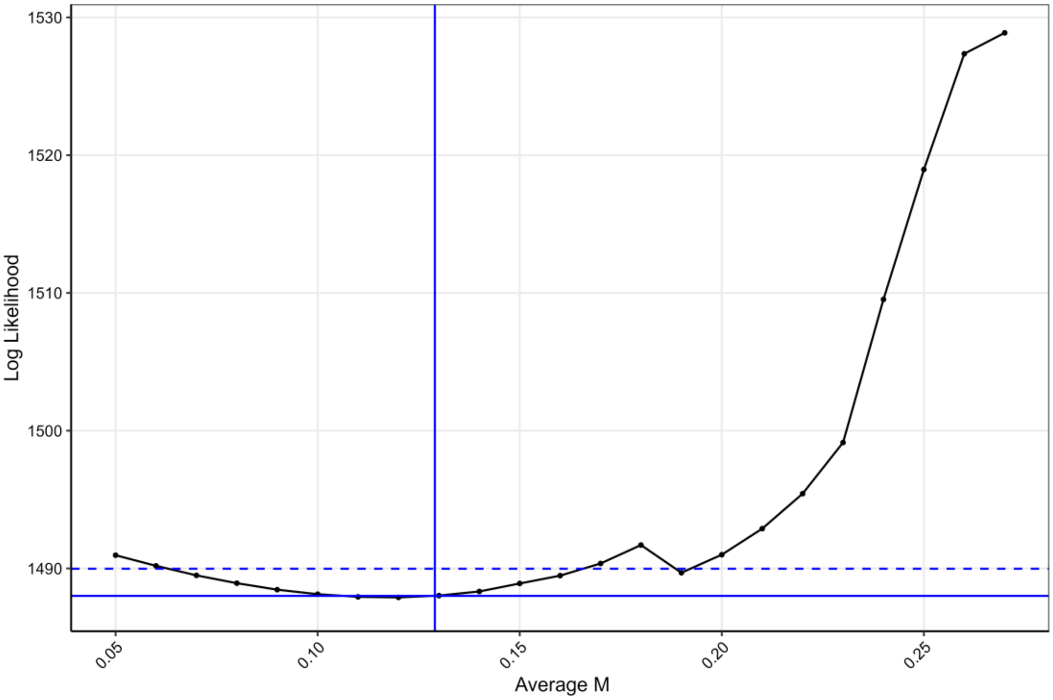


Figure 66. The likelihood profile for the assumed average natural mortality (*Base M*) for Southeastern U.S. Mutton Snapper. The black line indicates the negative log-likelihood value across the range of fixed values tested. The fixed value of *Base M* from the SEDAR 79 Base Model was 0.129 (blue vertical line). The solid horizontal line is the SEDAR 79 Base Model log-likelihood value of 1488.01, and the dashed blue line is the approximate 95% confidence interval of the SEDAR 79 Base Model log-likelihood value is 1489.97 (1488.01 + 1.97).

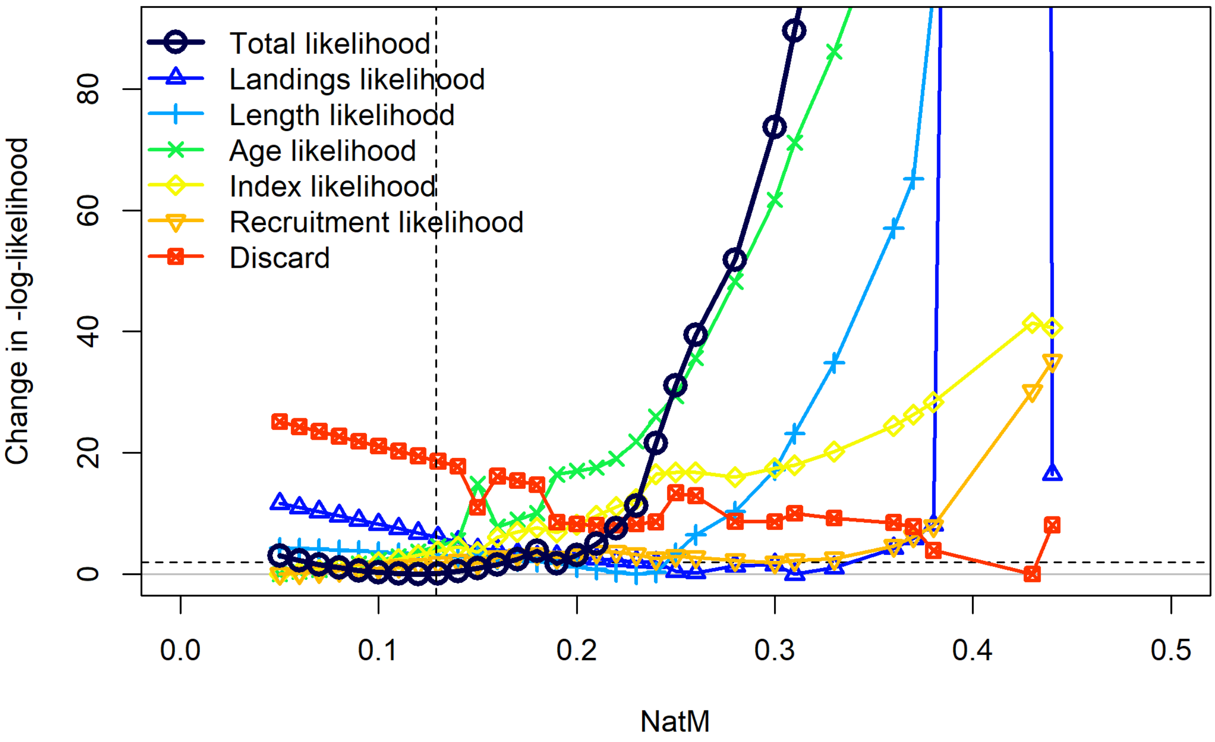
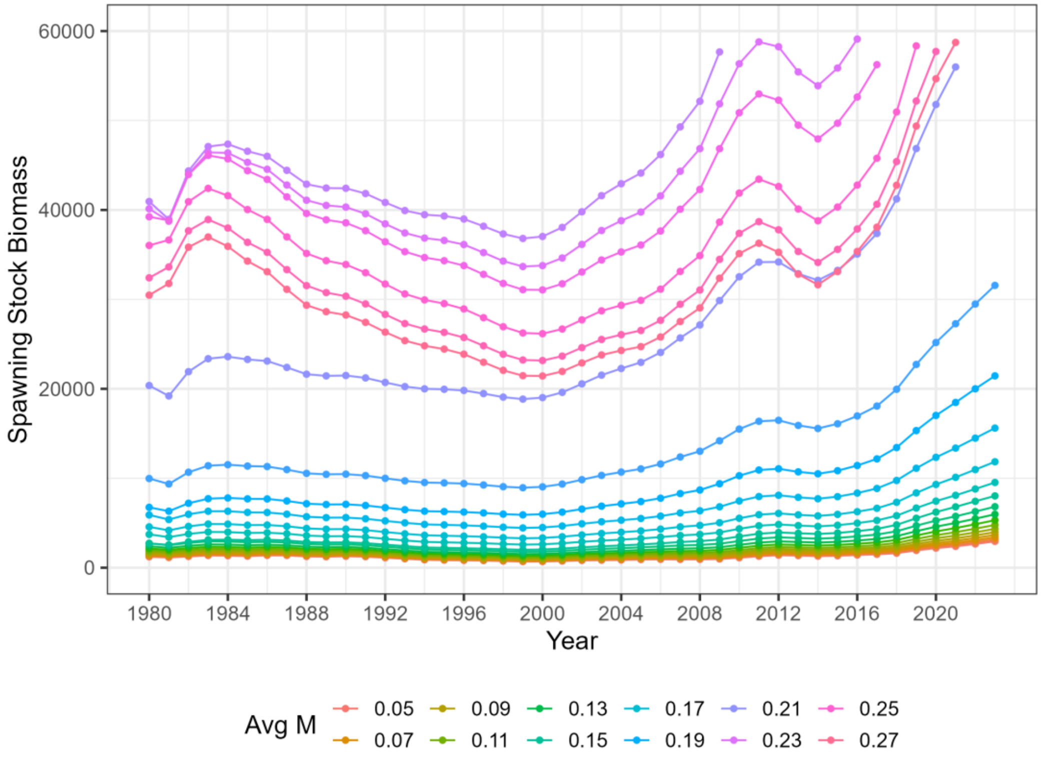


Figure 67. The likelihood profile for the assumed average natural mortality (*Base M*) for Southeastern U.S. Mutton Snapper by model component. Colored lines indicate the negative log-likelihood value associated with each model component across the range of fixed values tested. The fixed value of *Base M* from the SEDAR 79 Base Model was 0.129. The dashed horizontal line the approximate 95% confidence interval of the SEDAR 79 Base Model log-likelihood value (1.97).



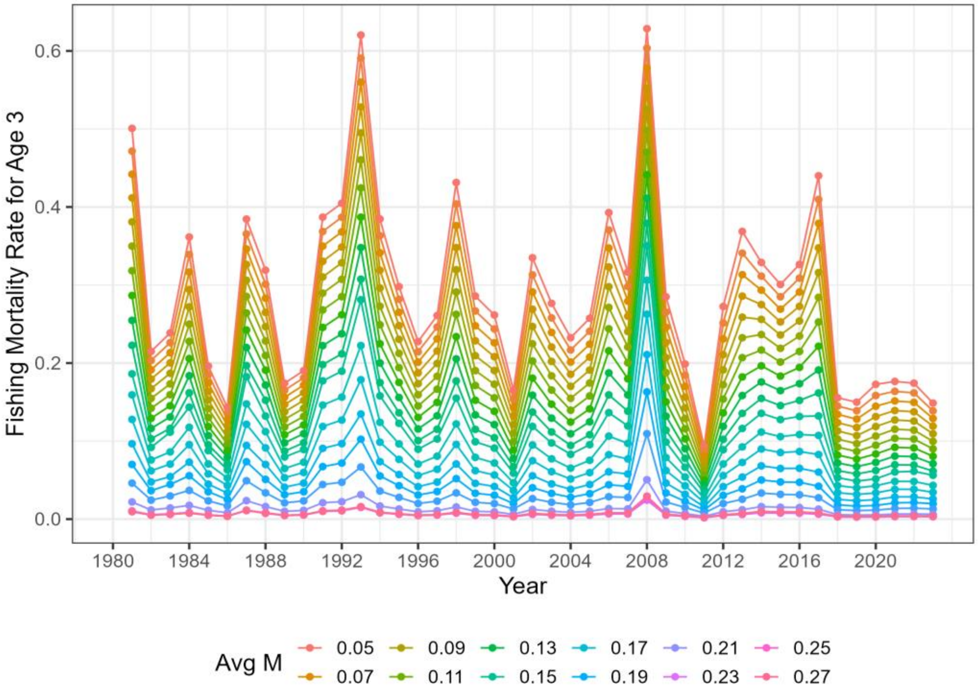
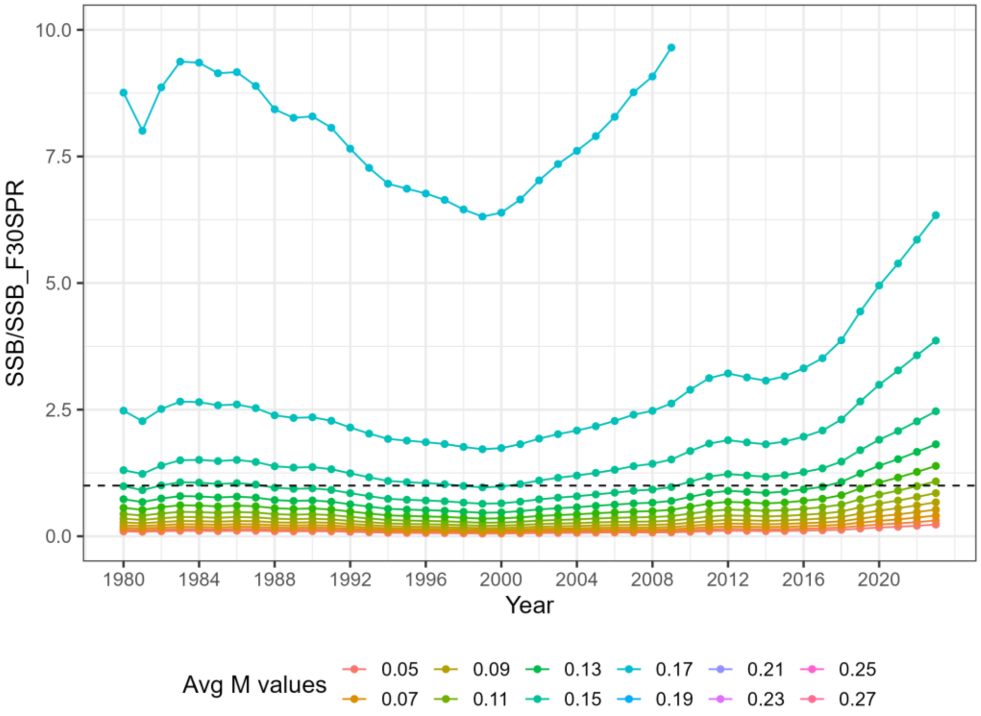


Figure 68. Trends in spawning stock biomass (SSB in metric tons truncated to 60,000 mt; top) and age 3 fishing mortality rates (F; bottom) for Southeastern U.S. Mutton Snapper when profiling across a range of average natural mortality (*Base M*) values in the SEDAR 79 Base Model.



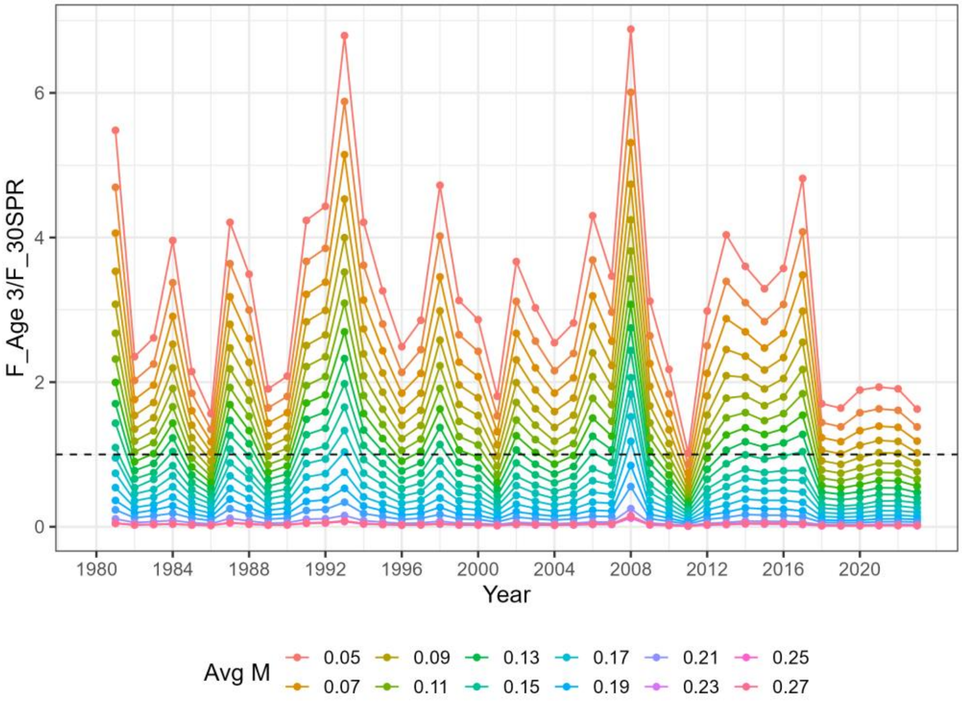


Figure 69. Spawning stock biomass relative to $SSB_{30\%SPR}$ (SSB/SSB_30SPR truncated to 10; top) and age 3 fishing mortality rates relative to $F_{30\%SPR}$ (F/ $F_{30\%SPR}$; bottom) for Southeastern U.S. Mutton Snapper when profiling across a range of average natural mortality (*Base M*) values in the SEDAR 79 Base Model.

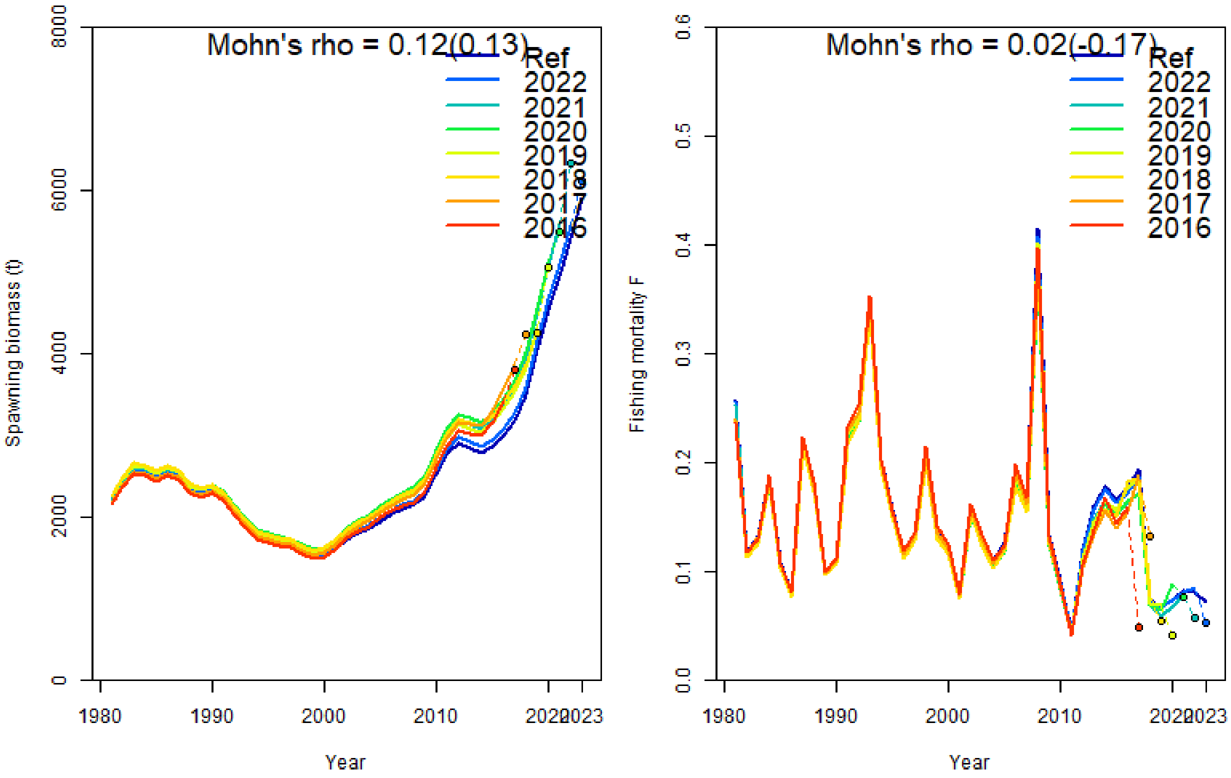


Figure 70. Retrospective analysis of spawning stock biomass and age-3 fishing mortality estimates for Southeastern US Mutton Snapper conducted by removing seven years of observations, one year at a time sequentially. The retrospective results are shown for the entire time series and for the most recent years only. Mohn's rho statistic and the corresponding 'forecast rho' values (in parentheses) 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.

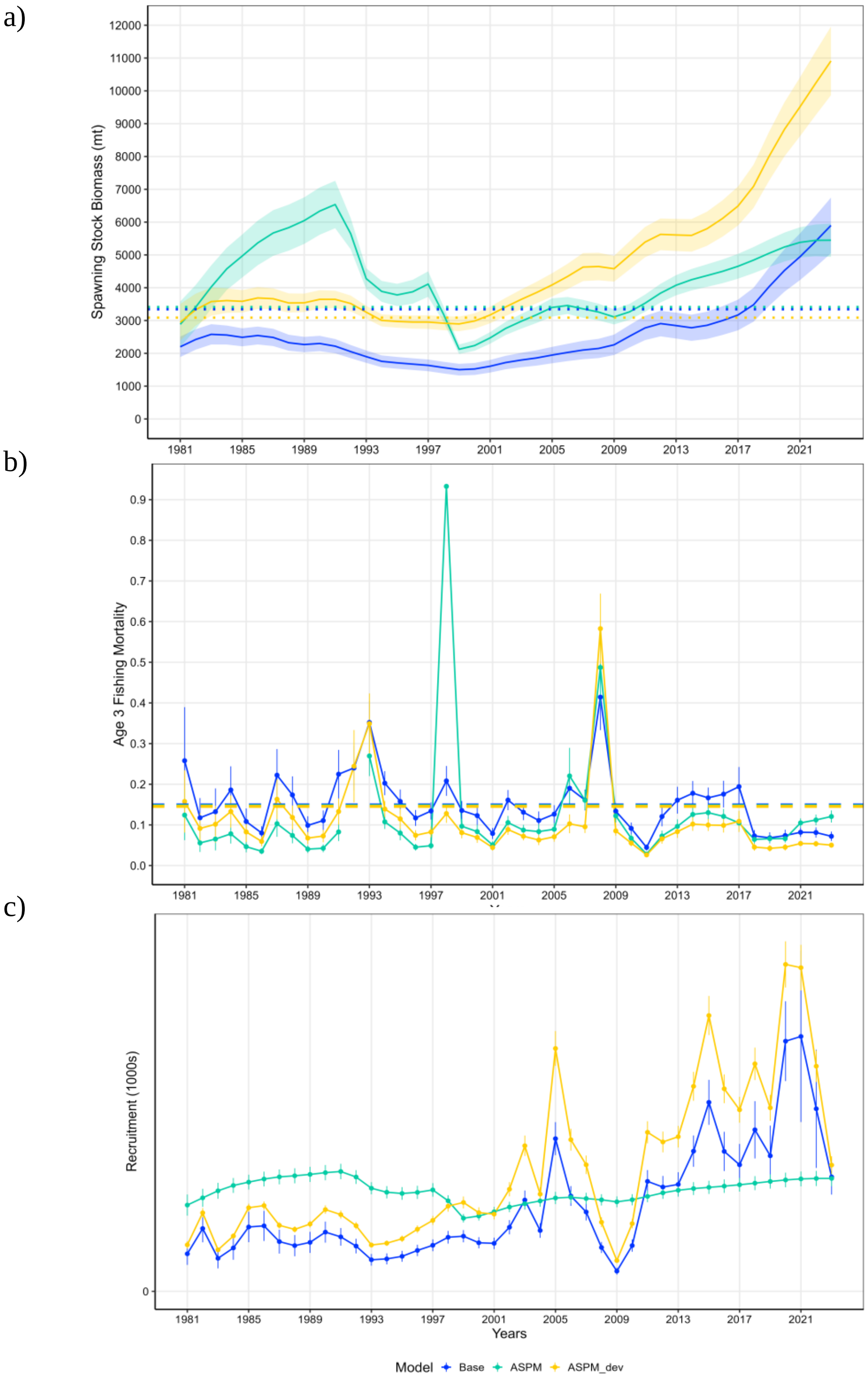


Figure 71. Comparison between the SEDAR 79 Base Model (Base), the deterministic Age-Structured-Production Model (ASPM), and the ASPM with recruitment deviations (ASPM_dev) showing a) spawning stock biomass, b) age-3 fishing mortality rates, and c) estimated recruitment.

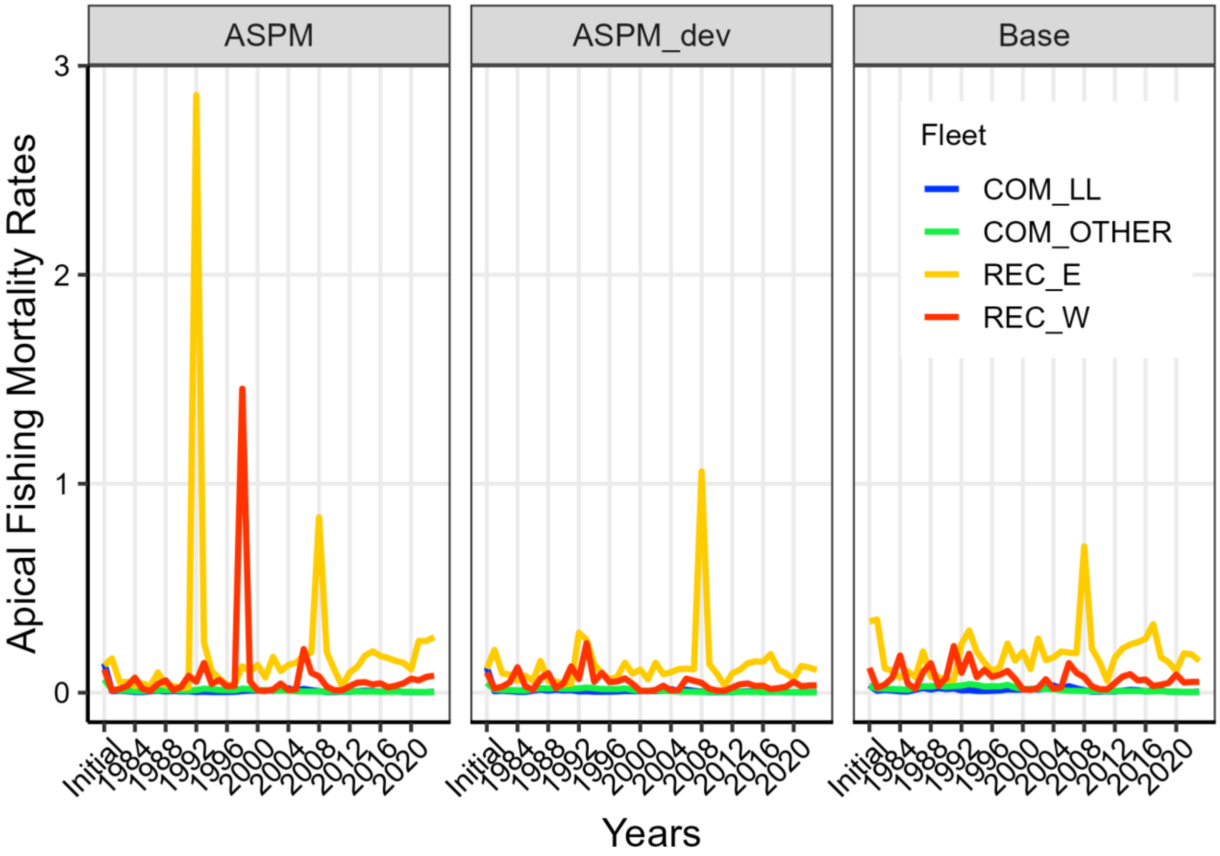


Figure 72. Comparison of apical fishing mortality rates estimated by the SEDAR 79 Base Model (Base), the deterministic Age-Structured-Production Model (ASPM), and the ASPM with recruitment deviations (ASPM_dev).

Figure 73. Comparison of fishing mortality rates (with $F_{30\%SPR}$), spawning stock biomass (with 75%$SSB_{F30\%SPR}$), recruitment deviations, and retained yield at $F_{30\%SPR}$ estimated by the SEDAR 79 Base Model (‘Base’) and the Base Model with steepness fixed at 0.99 (‘steepness-1’).

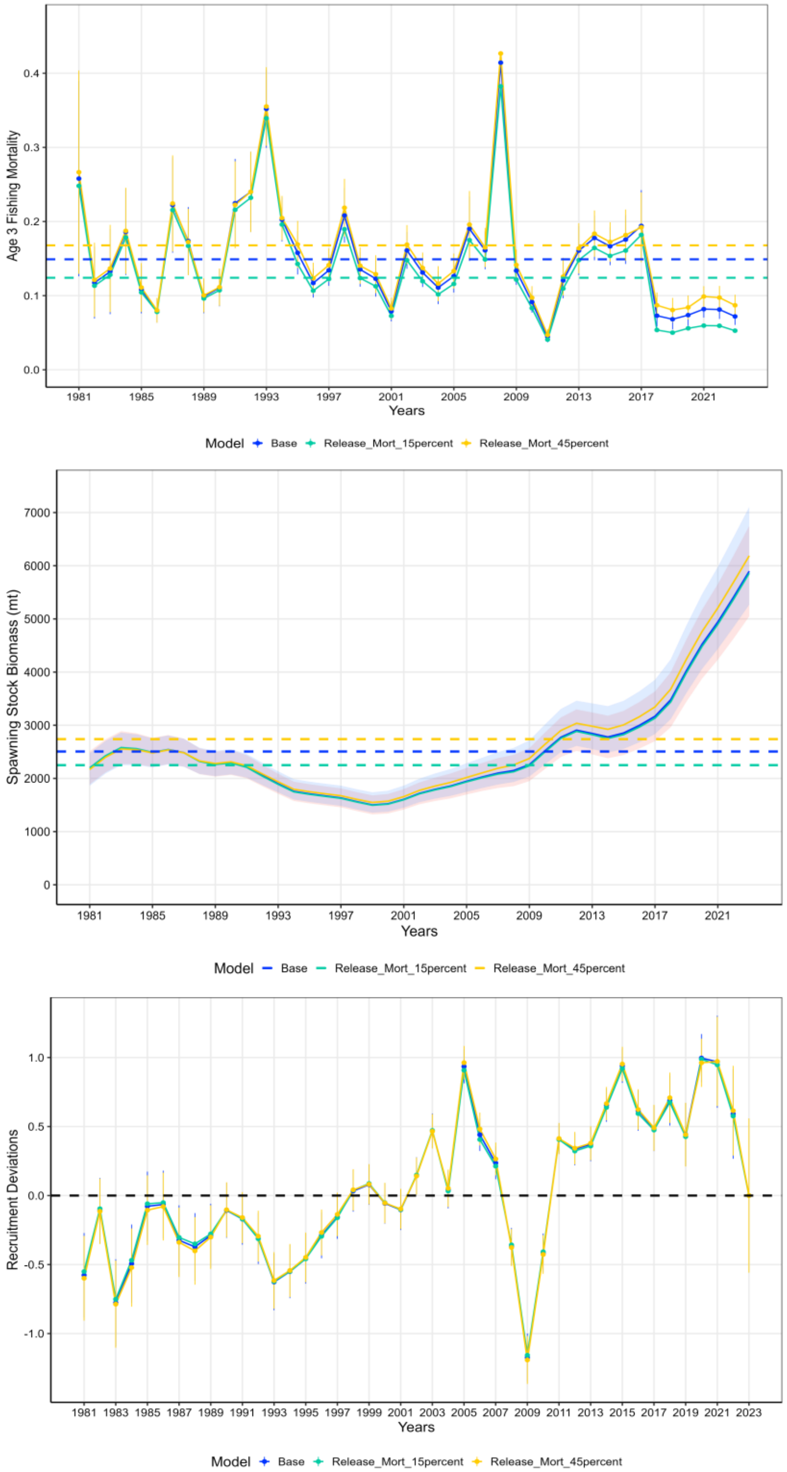


Figure 74. Comparison of fishing mortality rates (with $F_{30\%SPR}$), spawning stock biomass (with $75\%SSB_{F30\%SPR}$), and recruitment deviations by the SEDAR 79 Base Model ('Base' in blue), the Base Model with release mortality fixed at 0.15 ('Release_Mort_15percent' in green), and the Base Model with release mortality fixed at 0.45 ('Release_Mort_45percent' in yellow).

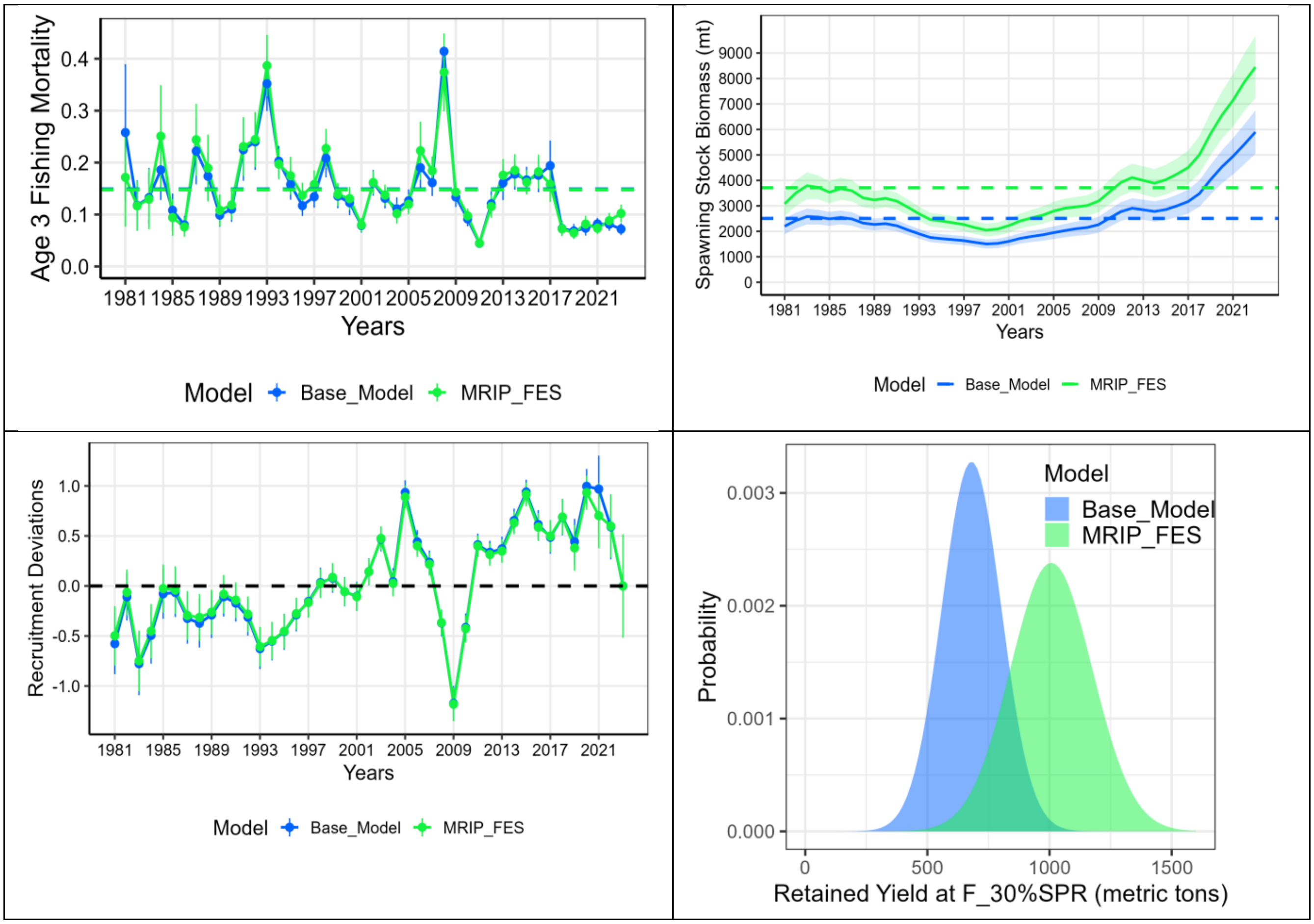


Figure 75. Comparison of fishing mortality rates (with $F_{30\%SPR}$), spawning stock biomass (with 75%$SSB_{F30\%SPR}$), recruitment deviations, and retained yield at $F_{30\%SPR}$ by the SEDAR 79 Base Model (‘Base Model’ in blue) and the Base Model with MRIP-FES Florida-only private mode landings and releases (‘MRIP_FES’ in green).

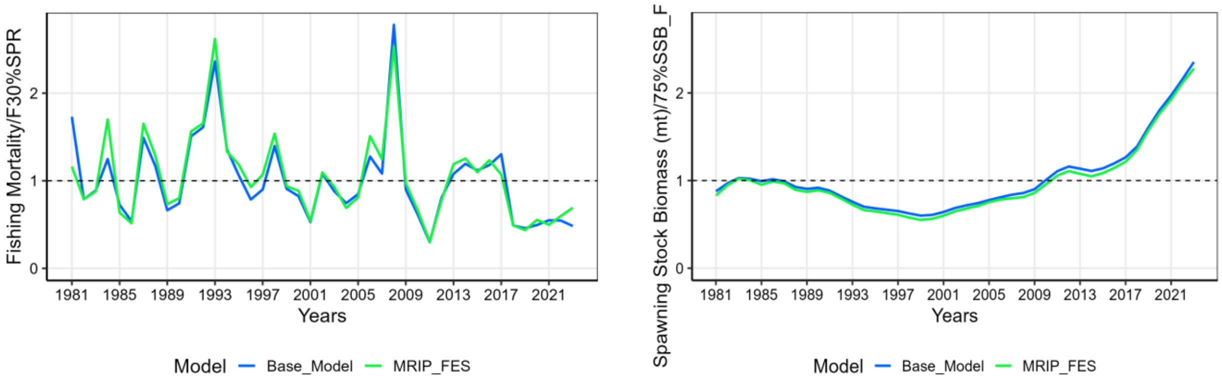


Figure 76. Comparison of fishing mortality rates relative to $F_{30\%SPR}$ and spawning stock biomass relative to $75\%SSB_{F30\%SPR}$ by the SEDAR 79 Base Model ('Base Model' in blue) and the Base Model with MRIP-FES Florida-only private mode landings and releases ('MRIP_FES' in green).

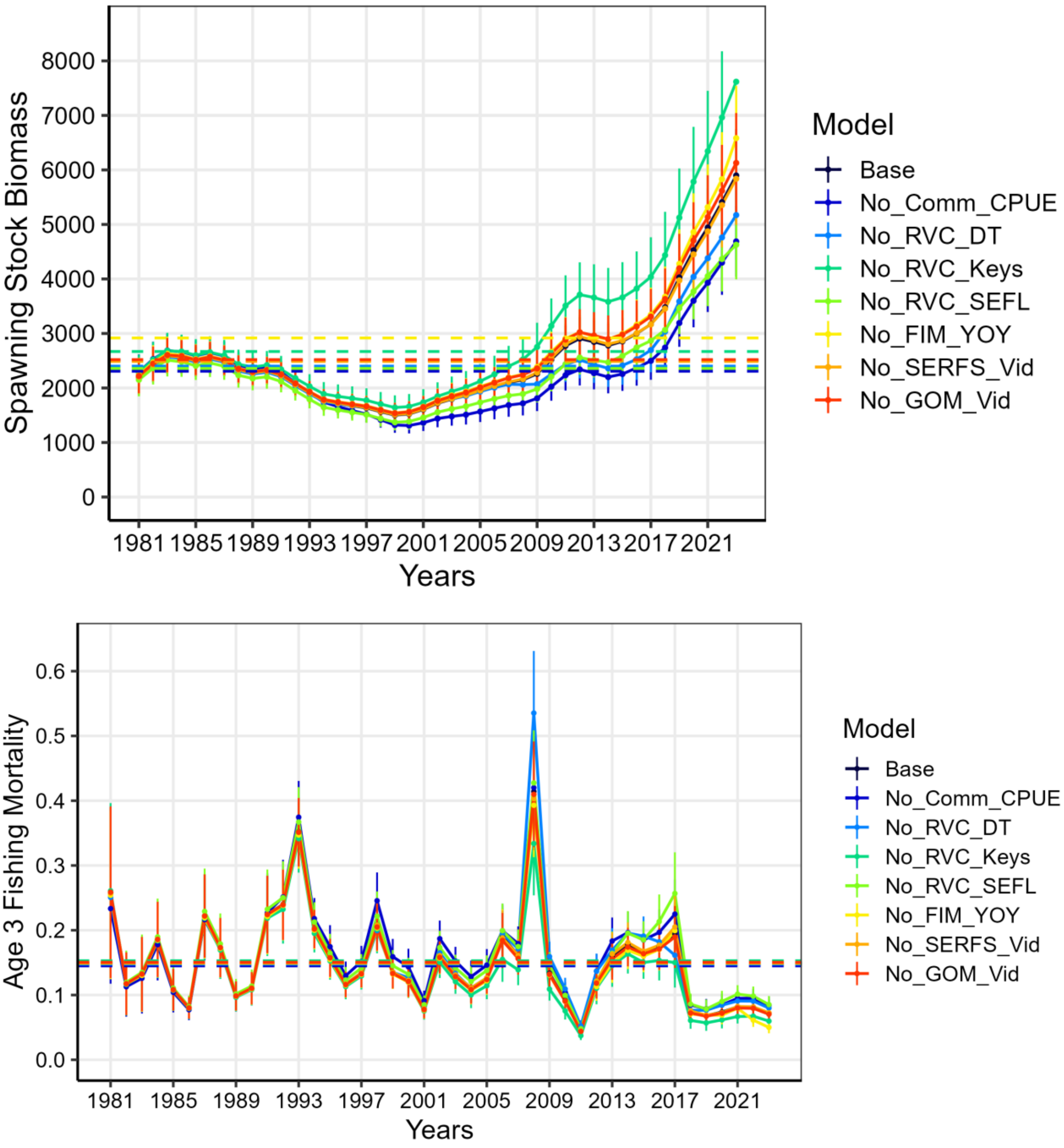


Figure 77. Comparison of fishing mortality rates relative to $F_{30\%SPR}$ and spawning stock biomass relative to $75\%SSB_{F30\%SPR}$ by the SEDAR 79 Base Model (‘Base Model’ in dark blue) and when a single index of abundance is removed.

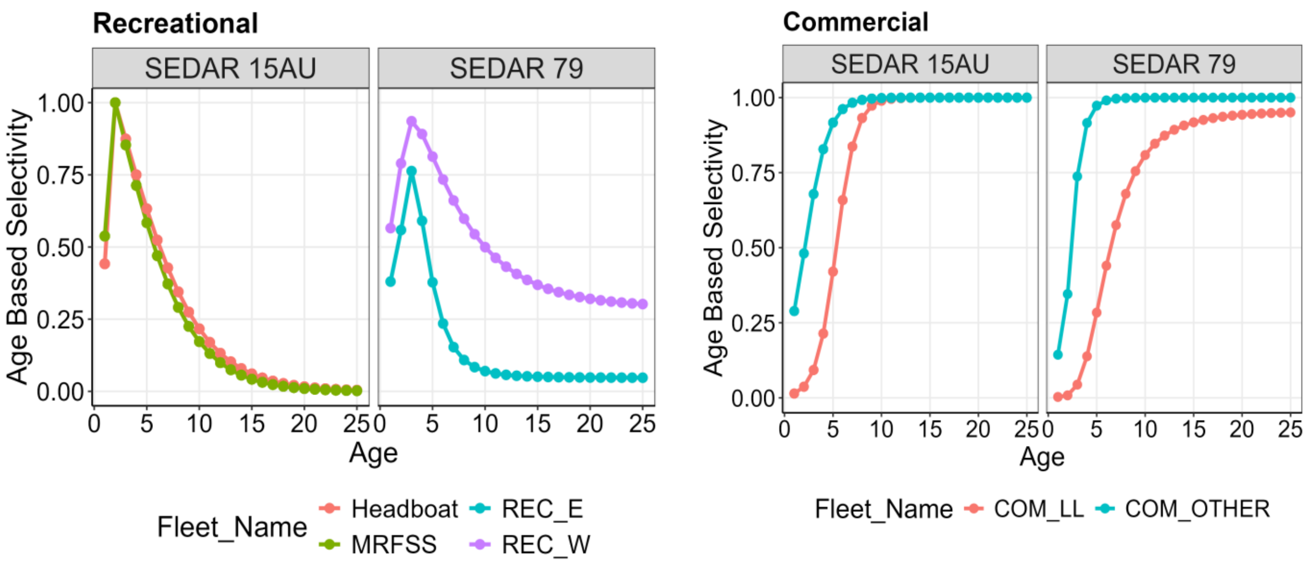


Figure 78. Comparison of age-based selectivity estimated by the SEDAR 79 Base Model and SEDAR 15AU Final Model for each sector (i.e., recreational and commercial).

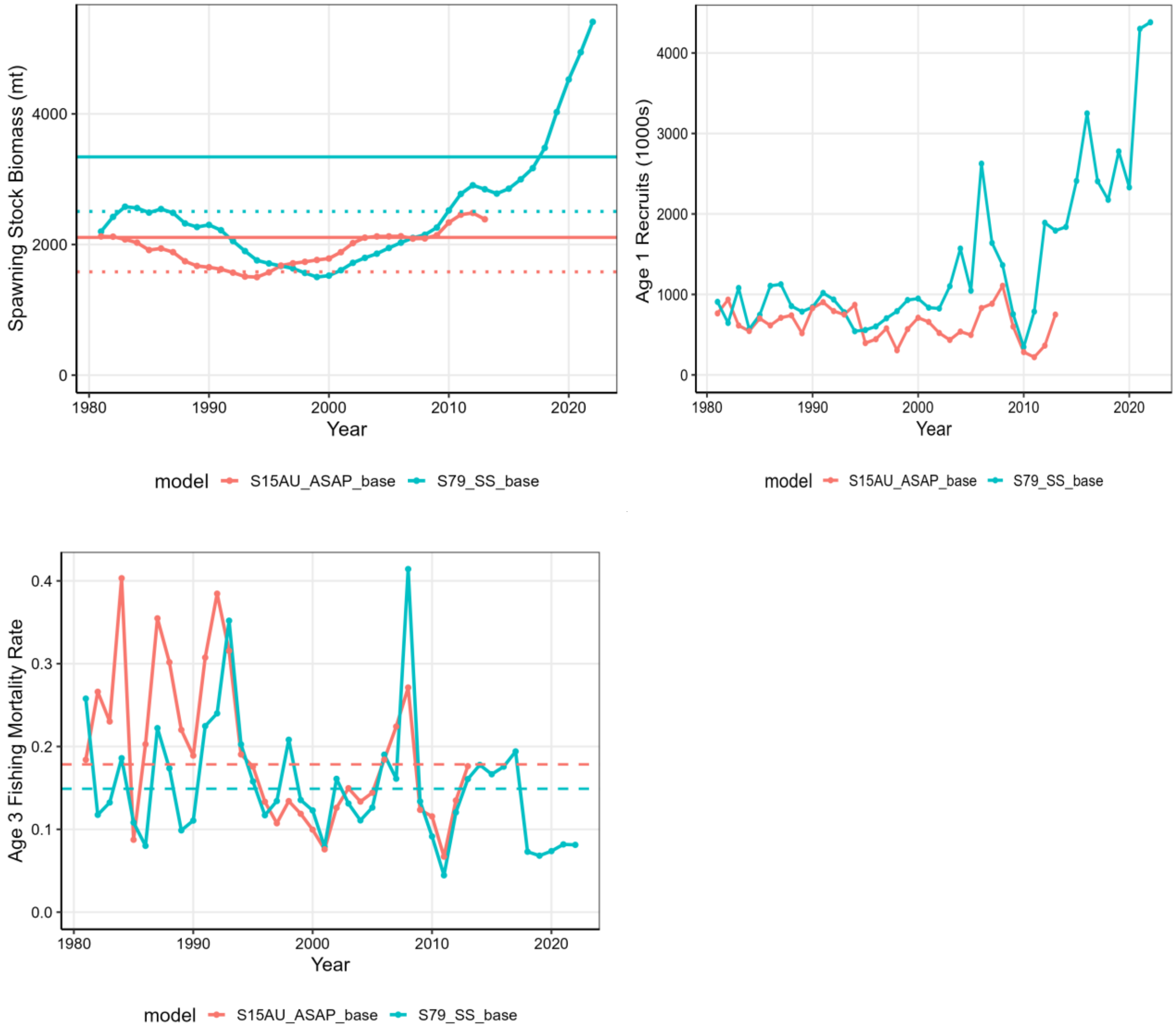


Figure 79. Comparison of spawning stock biomass ($SSB_{30\%SPR}$ shown by solid lines, 75% of $SSB_{30\%SPR}$ shown by dotted lines), age 1 recruits, and age-3 fishing mortality rates ($F_{30\%SPR}$ shown by dashed lines) estimated by the SEDAR 79 Base Model and the SEDAR 15AU Final Model.

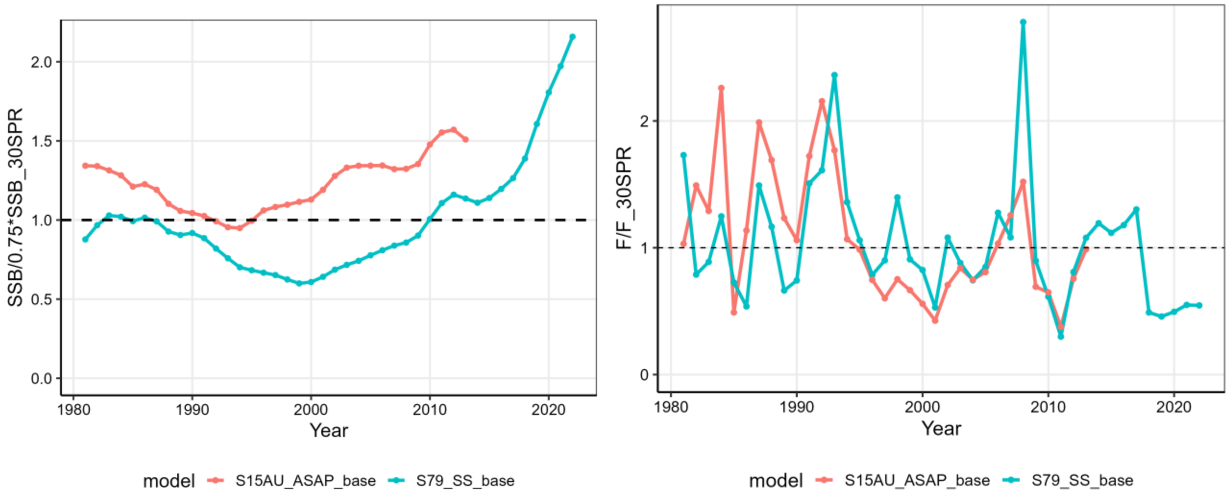


Figure 80. Comparison of spawning stock biomass relative to 75%$SSB_{F30\%SPR}$ and fishing mortality rates relative to $F_{30\%SPR}$ and estimated by the SEDAR 79 Base Model and the SEDAR 15AU Final Model.

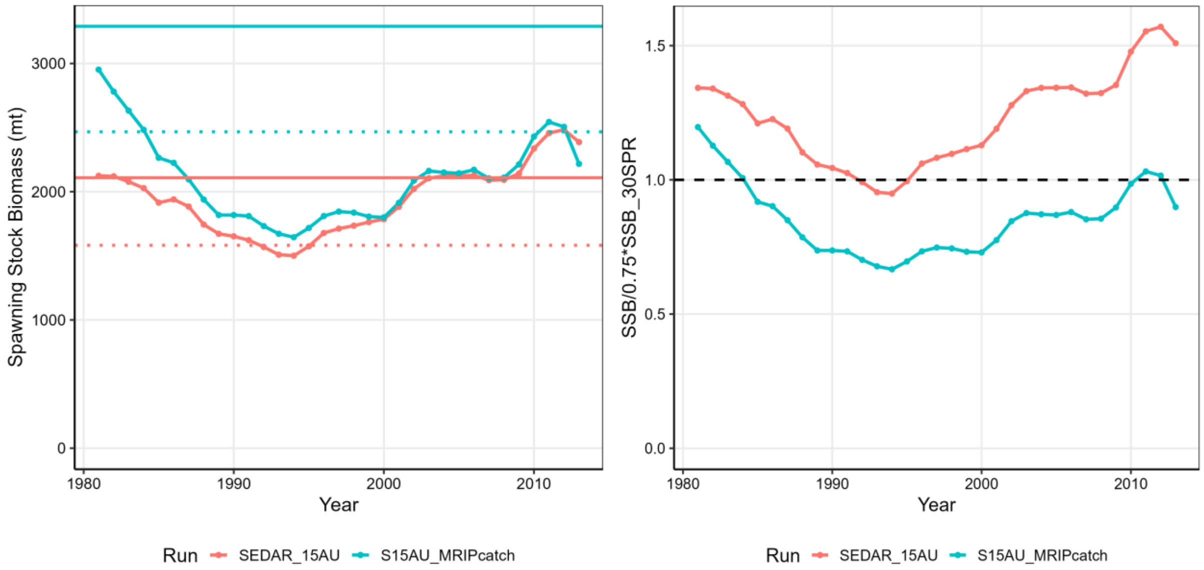


Figure 81. Comparison of spawning stock biomass ($SSB_{30\%SPR}$ shown by solid lines, 75% of $SSB_{30\%SPR}$ shown by dotted lines) and spawning stock biomass relative to 75% $SSB_{30\%SPR}$ estimated by the SEDAR 15AU Final Model and a model with MRIP-FES landings and releases (S15AU_MRIPcatch).

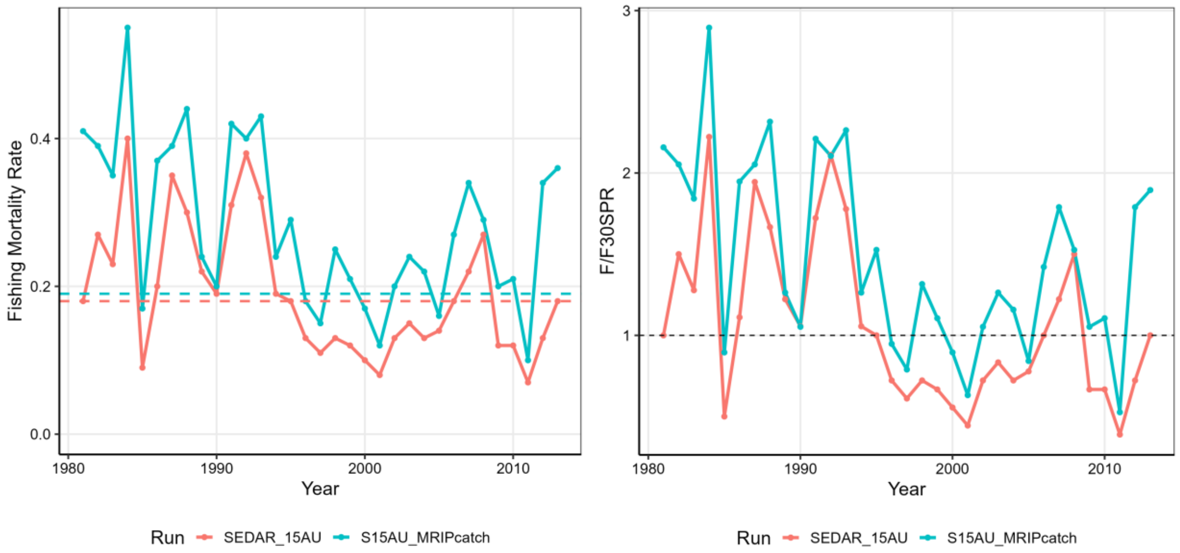


Figure 82. Comparison of fishing mortality rates ($F_{30\%SPR}$ shown by solid lines) and fishing mortality rates relative to $F_{30\%SPR}$ estimated by the SEDAR 15AU Final Model and a model with MRIP-FES landings and releases (S15AU_MRIPcatch).

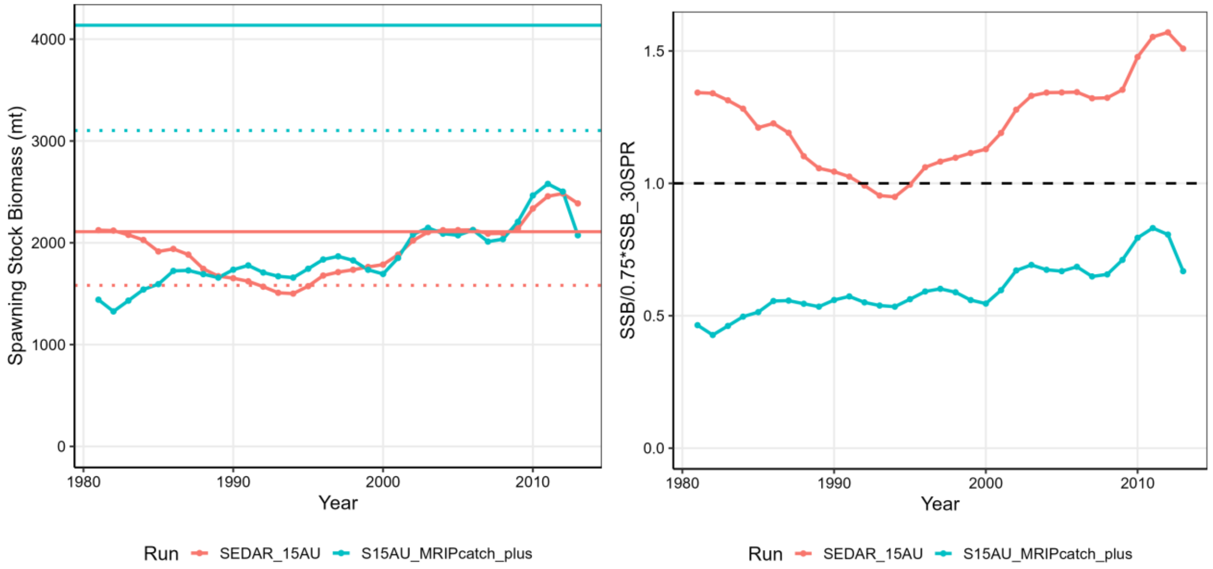


Figure 83. Comparison of spawning stock biomass ($SSB_{30\%SPR}$ shown by solid lines, 75% of $SSB_{30\%SPR}$ shown by dotted lines) and spawning stock biomass relative to 75% $SSB_{30\%SPR}$ estimated by the SEDAR 15AU Final Model and a model with MRIP-FES landings and releases plus updated proportion catch-at-age, release-at-age, and mean weights-at-age (S15AU_MRIPcatch_plus).

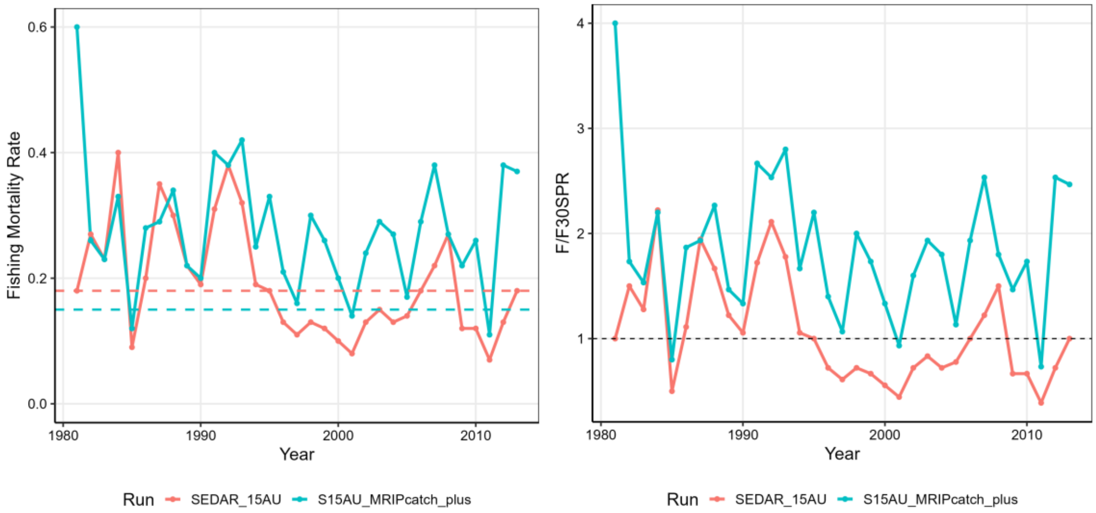


Figure 84. Comparison of fishing mortality rates ($F_{30\%SPR}$ shown by solid lines) and fishing mortality rates relative to $F_{30\%SPR}$ estimated by the SEDAR 15AU Final Model and a model with MRIP-FES landings and releases plus updated proportion catch-at-age, release-at-age, and mean weights-at-age (S15AU_MRIPcatch_plus).

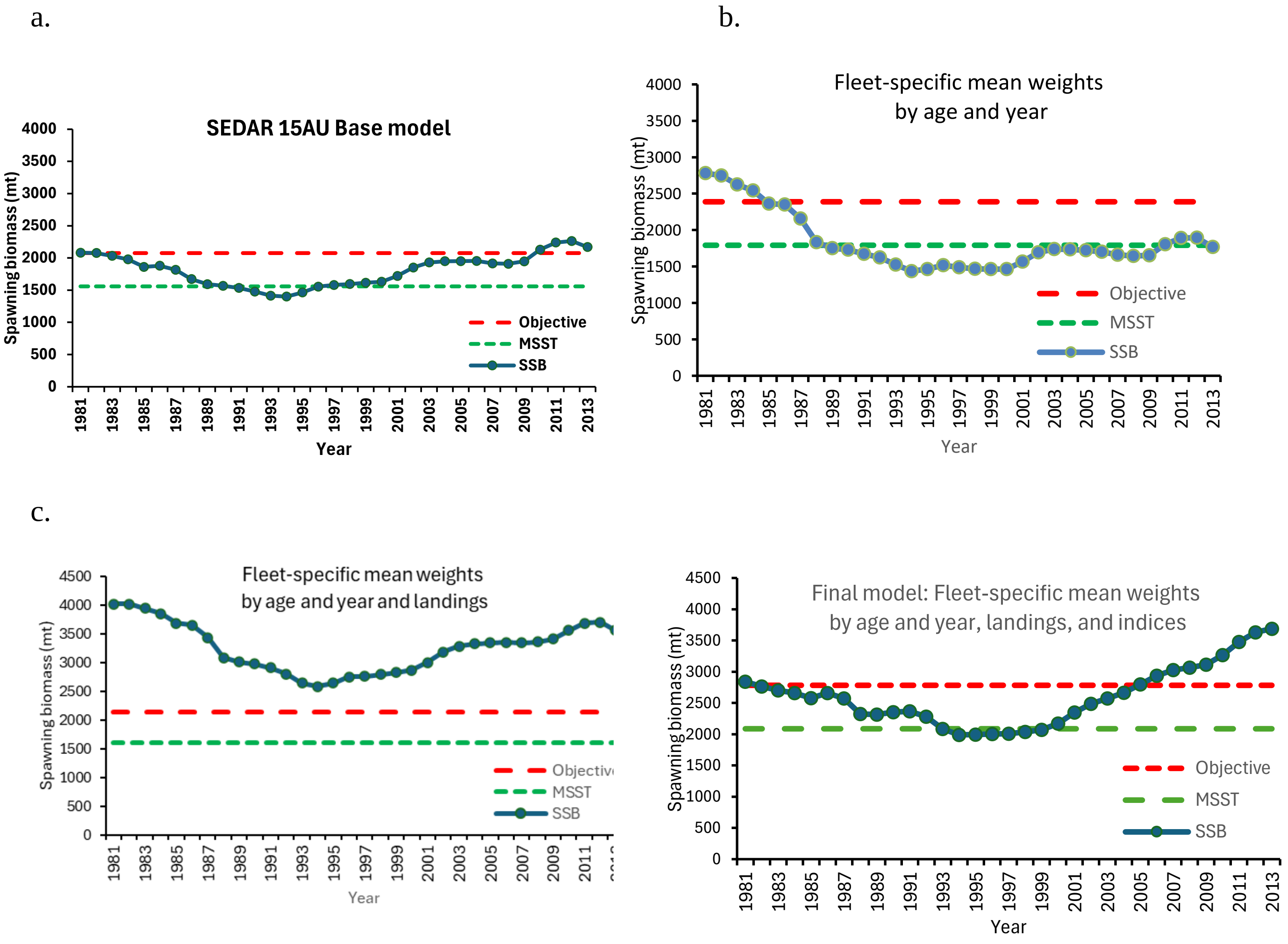
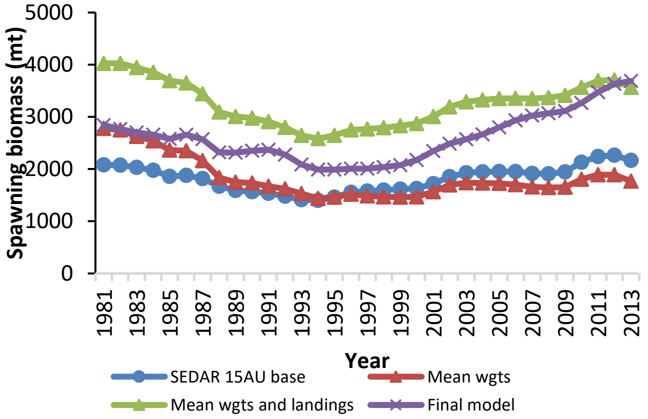
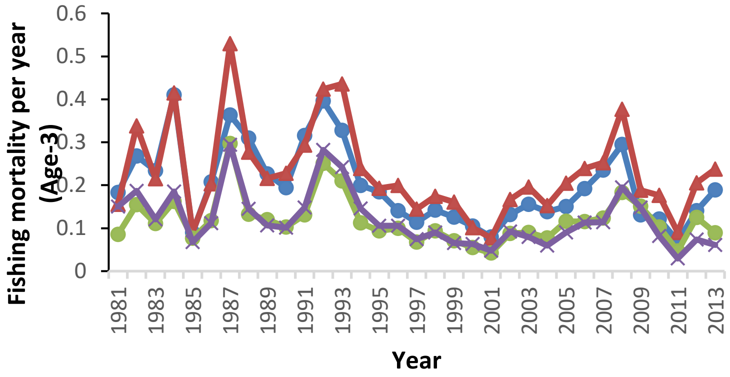


Figure 85. Plots of spawning biomass by year showing the Objective ($SSB_{F30\%SPR}$), the MSST (75% of $SSB_{F30\%SPR}$) and the annual spawning biomass estimates for the SEDAR 15AU base model and the three model bridging models.

a. Spawning biomass



b. Fishing mortality rates



c. Recruitment (Age-1 fish)

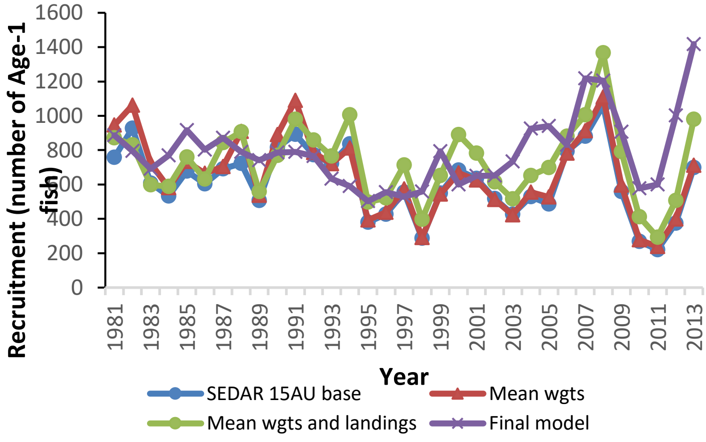


Figure 86. Trajectories of spawning biomass (mt), fishing mortality of age-3 fish (yr^{-1}), and recruitment (Age-1 fish) for the SEDAR 15AU base model and the three model bridging models.

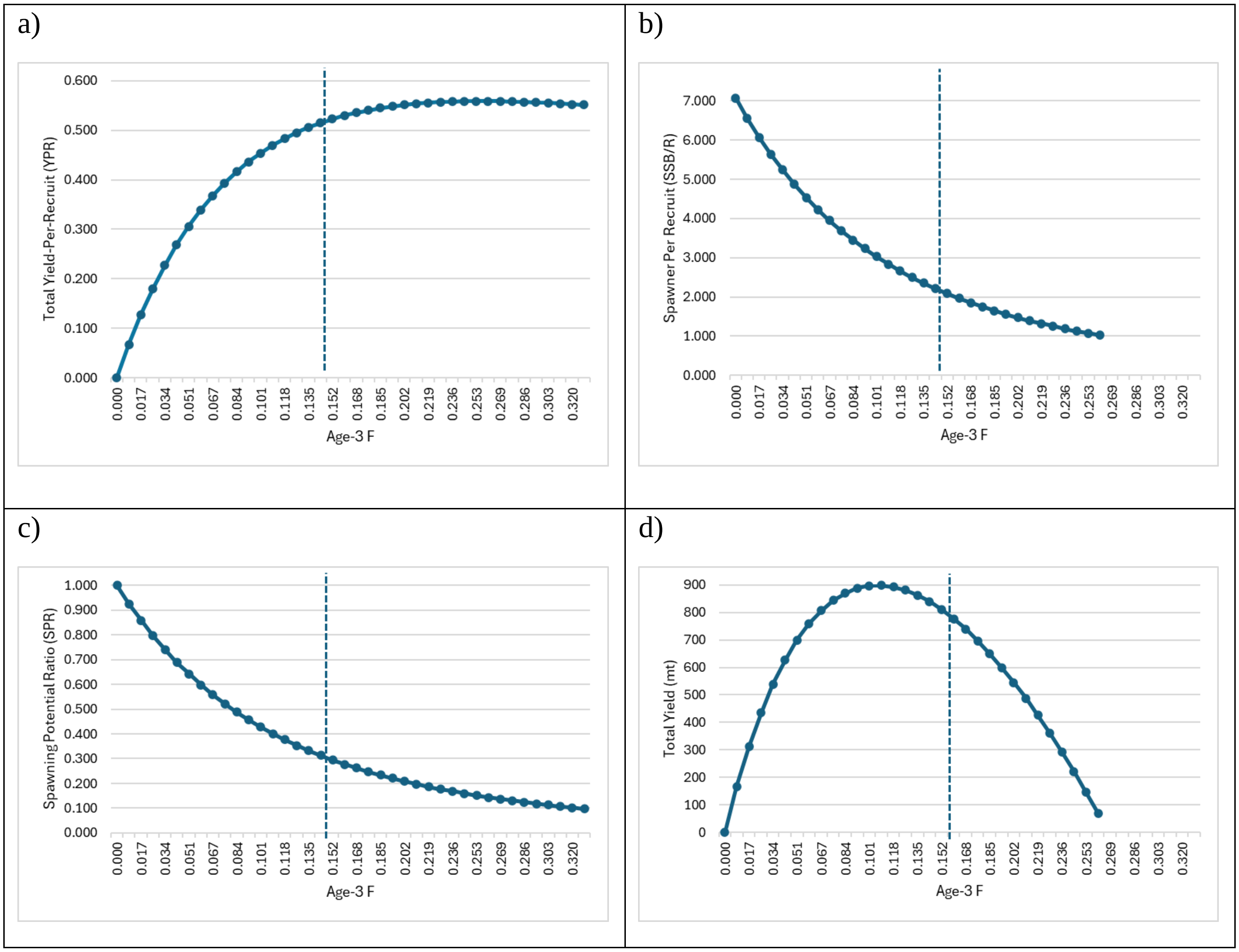
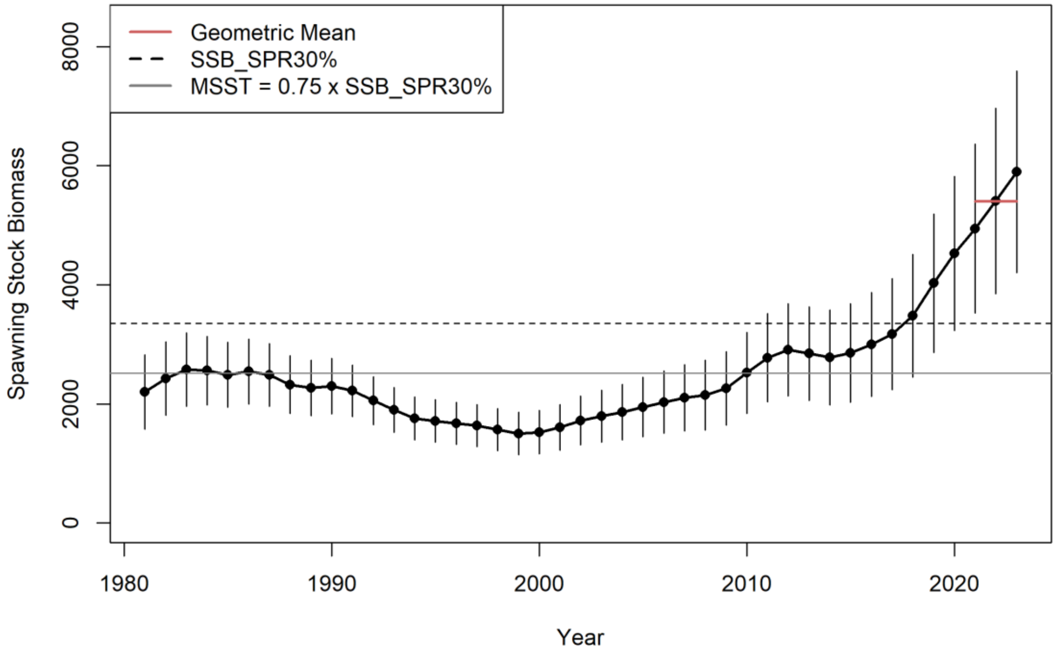


Figure 87. The a) yield-per-recruit, b) spawner-per-recruit, c) spawning potential ratio, and d) total equilibrium yield computed as a function of the instantaneous fishing mortality rate on age-3 Mutton Snapper.



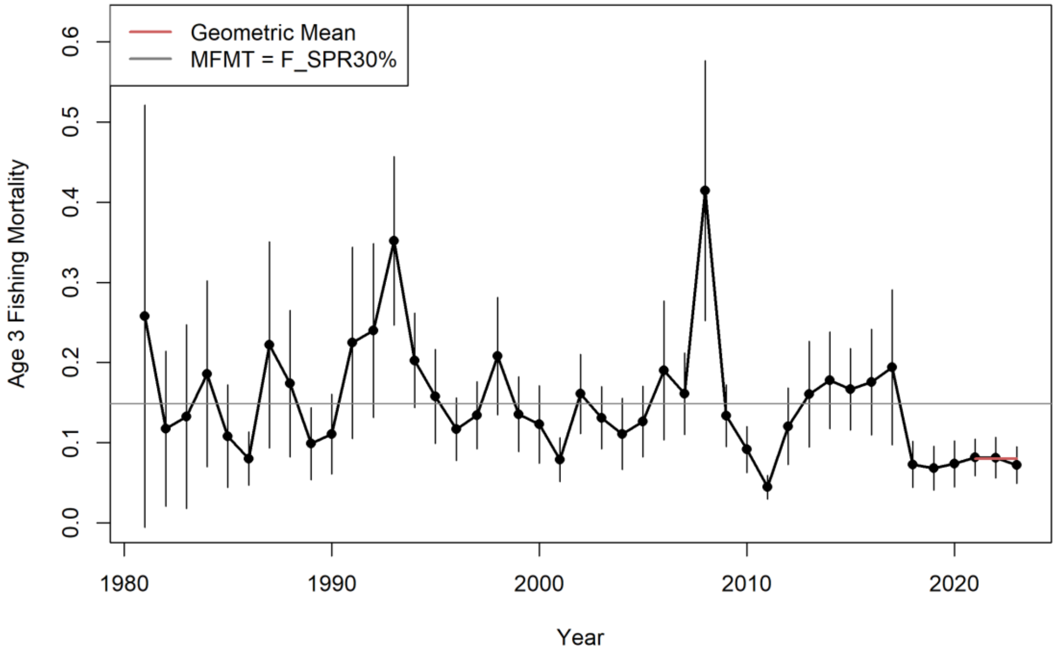


Figure 88. Time series of female spawning stock biomass (in metric tons) and age-3 fishing mortality rates, current spawning stock biomass and fishing mortality rates (red lines), as well as status determination criteria for the SEDAR 79 Southeastern US Mutton Snapper Assessment**.**

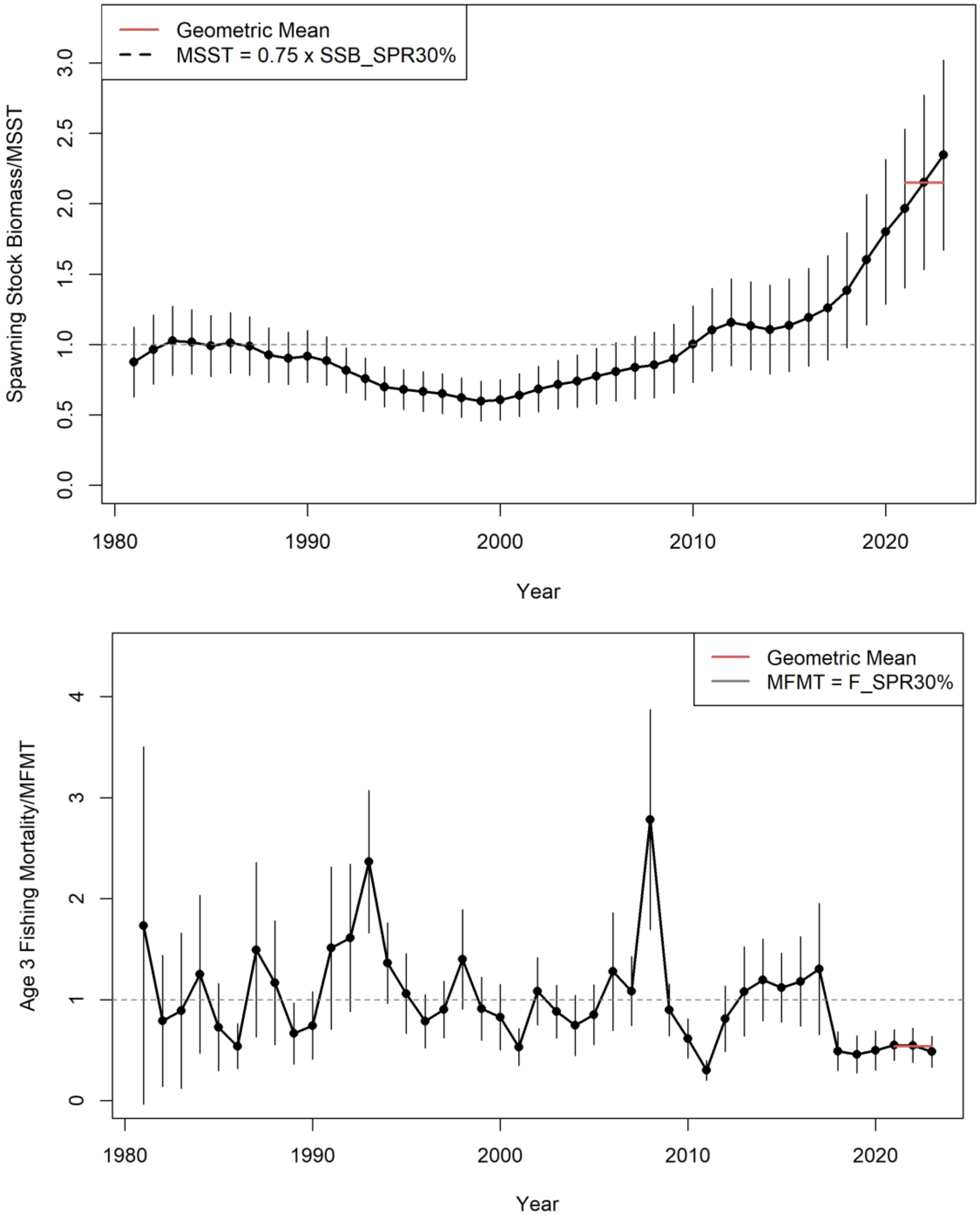


Figure 89. Time series of female spawning stock biomass (in metric tons) and age-3 fishing mortality rates with respect to status determination criteria for the SEDAR 79 Southeastern US Mutton Snapper Assessment**.**

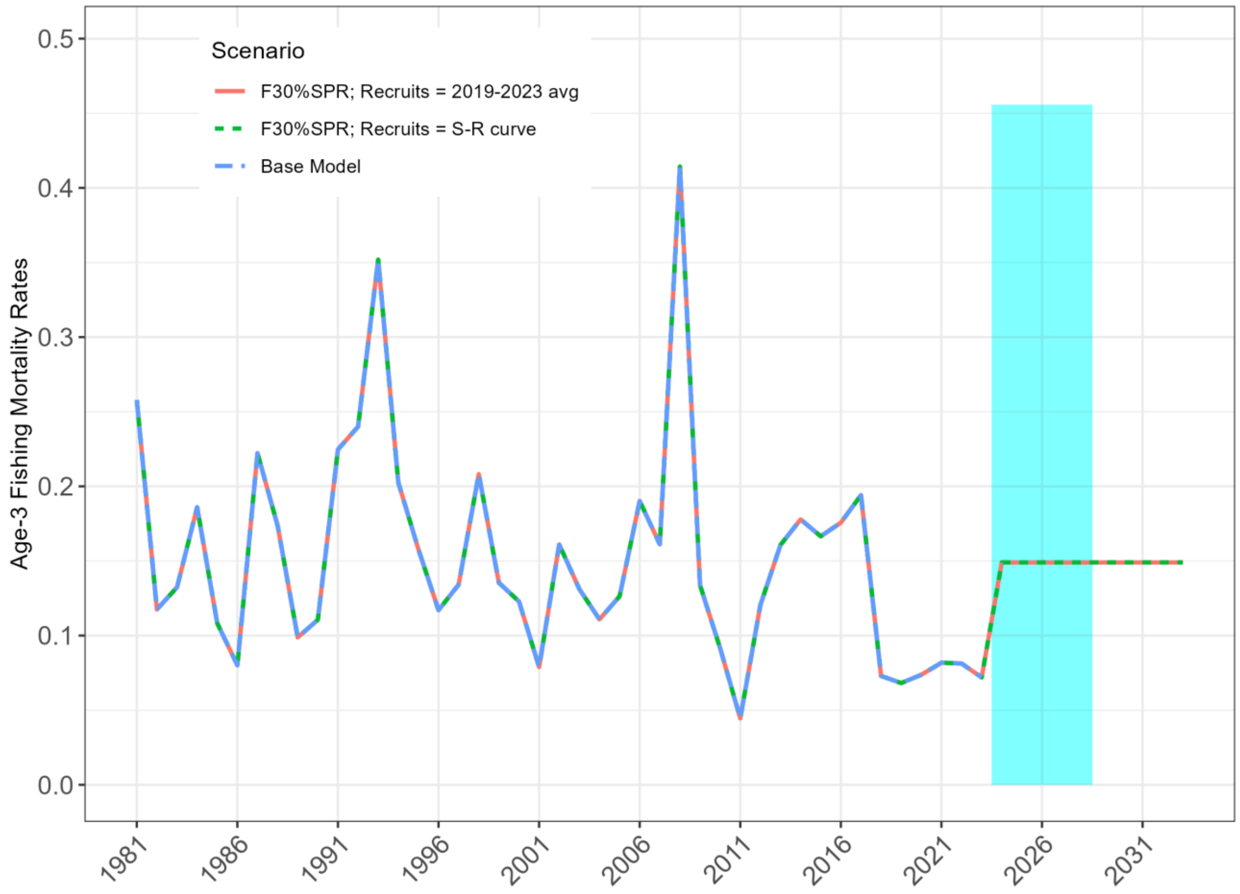


Figure 90. Historical and projected age-3 fishing mortality rates for the long- and short-term projections when constant fishing mortality rates equal $F_{30\%SPR}$ for the SEDAR 79 Southeastern US Mutton Snapper Assessment. The green shaded area identifies the first 5 years of the projections (2024-2028).

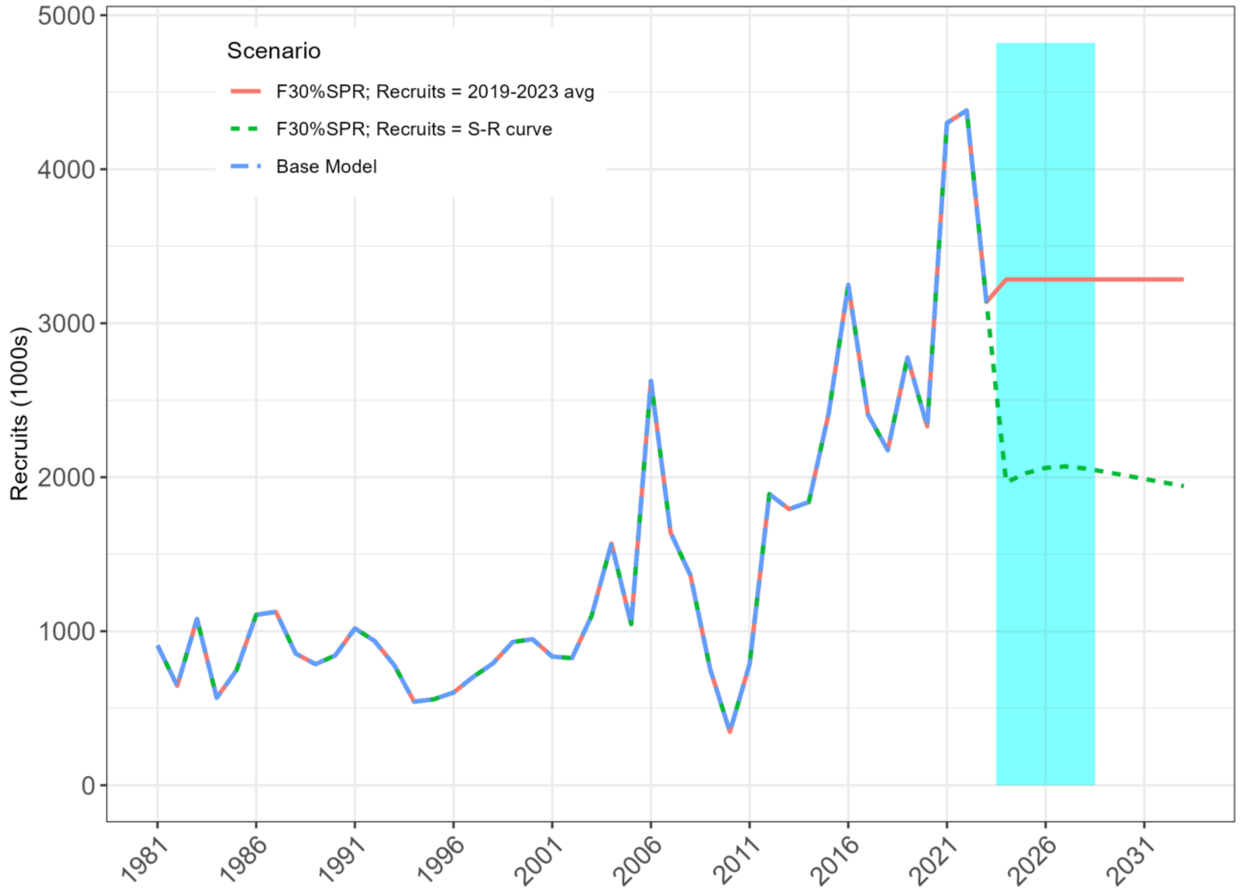


Figure 91. Historical and projected age 1 recruitment for the long- and short-term projections when constant fishing mortality rates equal $F_{30\%SPR}$ for the SEDAR 79 Southeastern US Mutton Snapper Assessment. The green shaded area identifies the first 5 years of the projections (2024-2028).

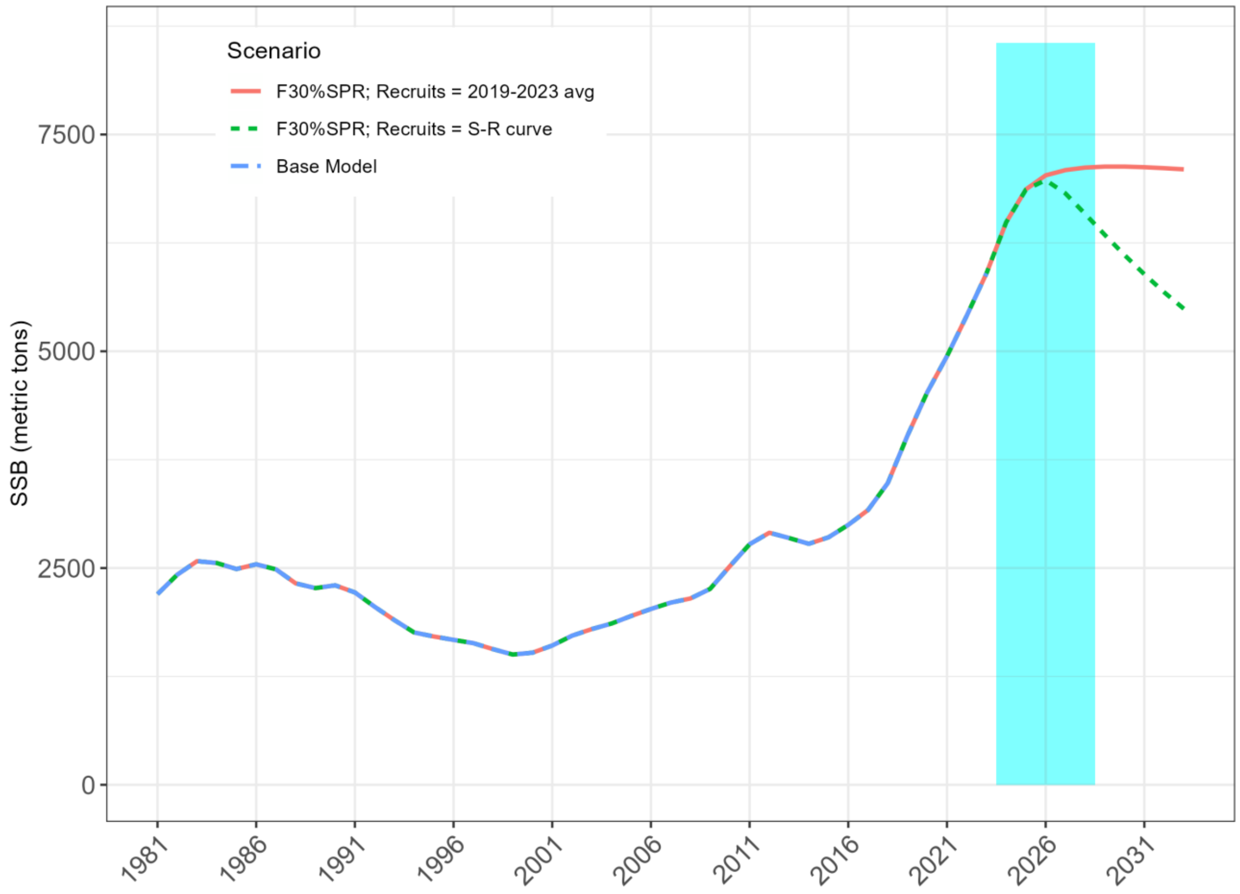
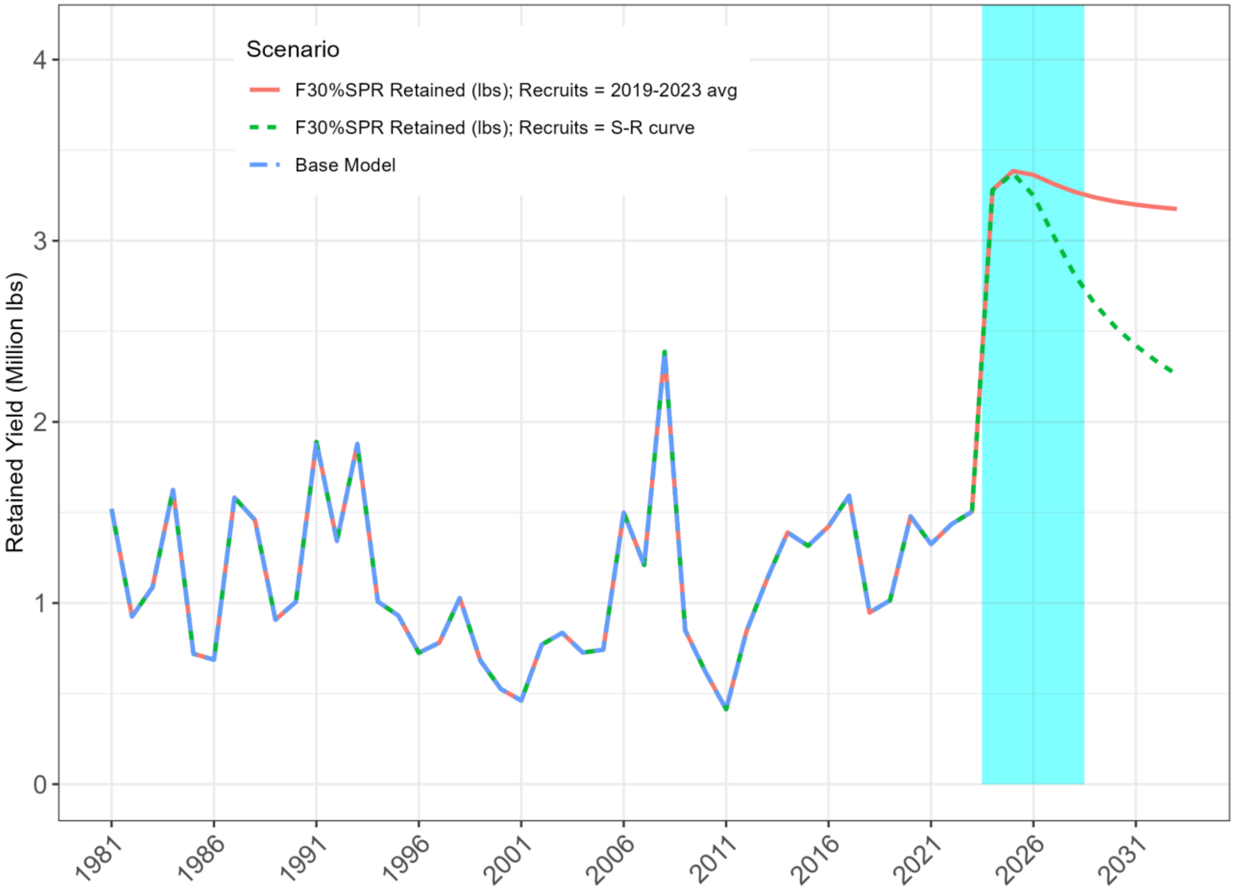
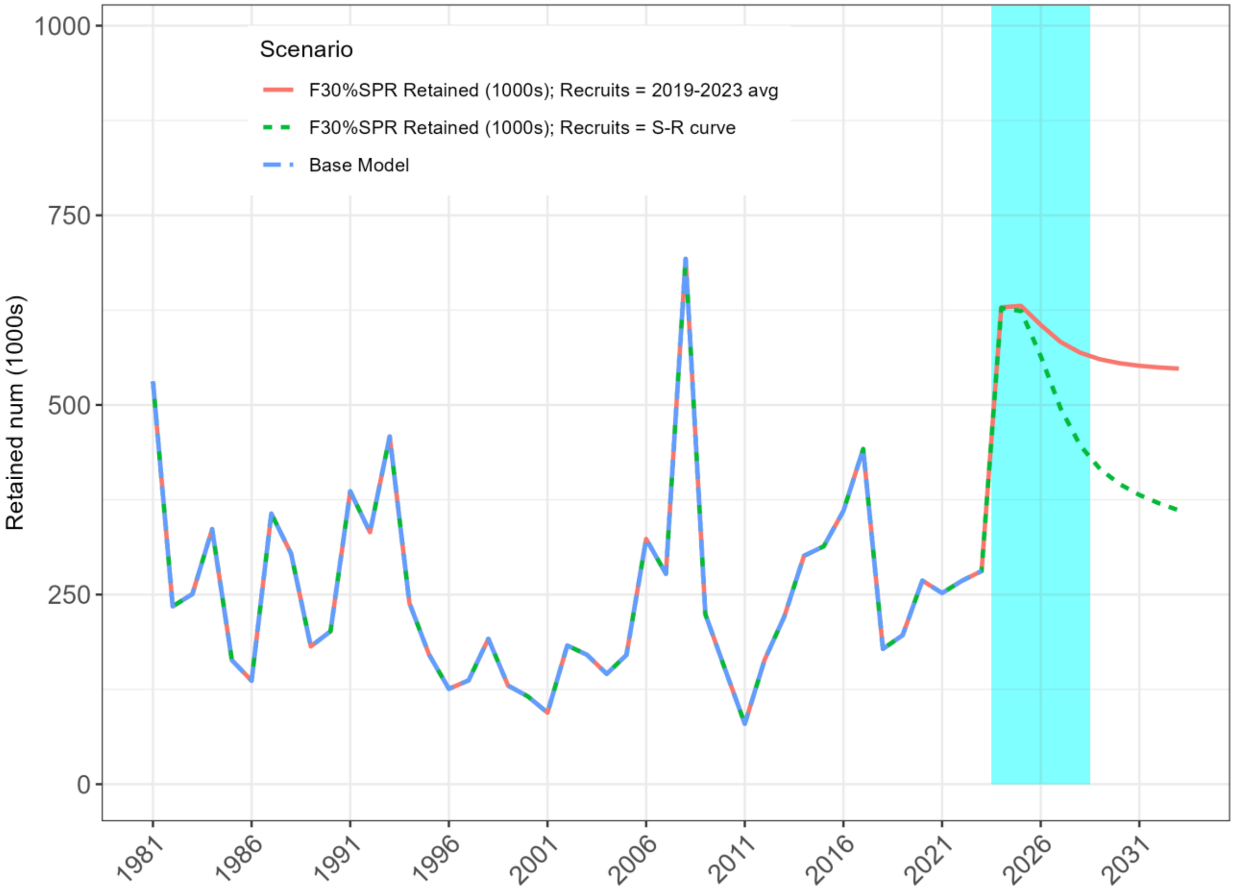


Figure 92. Historical and projected spawning stock biomass for the long- and short-term projections when constant fishing mortality rates equal $F_{30\%SPR}$ for the SEDAR 79 Southeastern US Mutton Snapper Assessment. The green shaded area identifies the first 5 years of the projections (2024-2028).

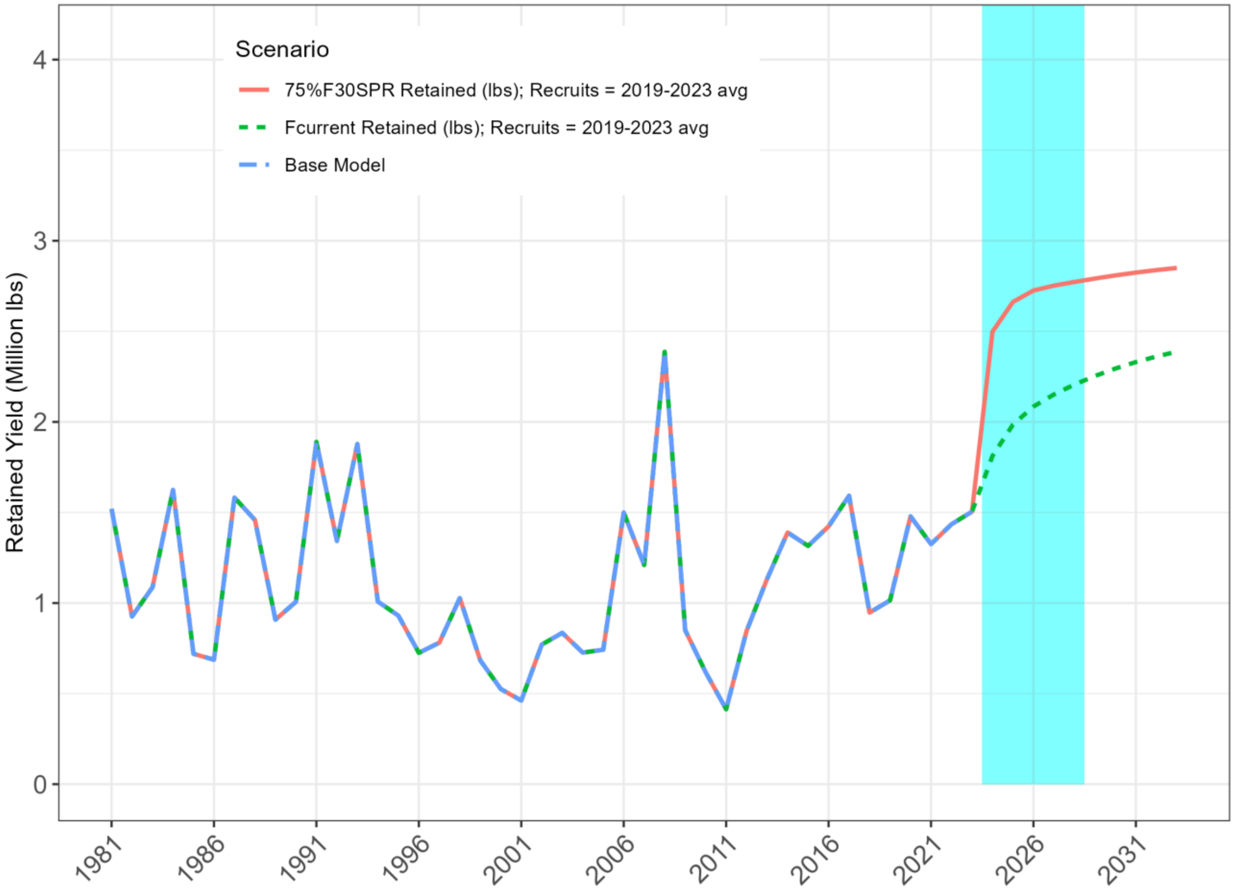

Scenario
F30%SPR Retained (lbs); Recruits = 2019-2023 avg
F30%SPR Retained (lbs); Recruits = S-R curve
Base Model
Retained Yield (Million lbs)
0
1
2
3
4
1981
1986
1991
1996
2001
2006
2011
2016
2021
2026
2031

a)

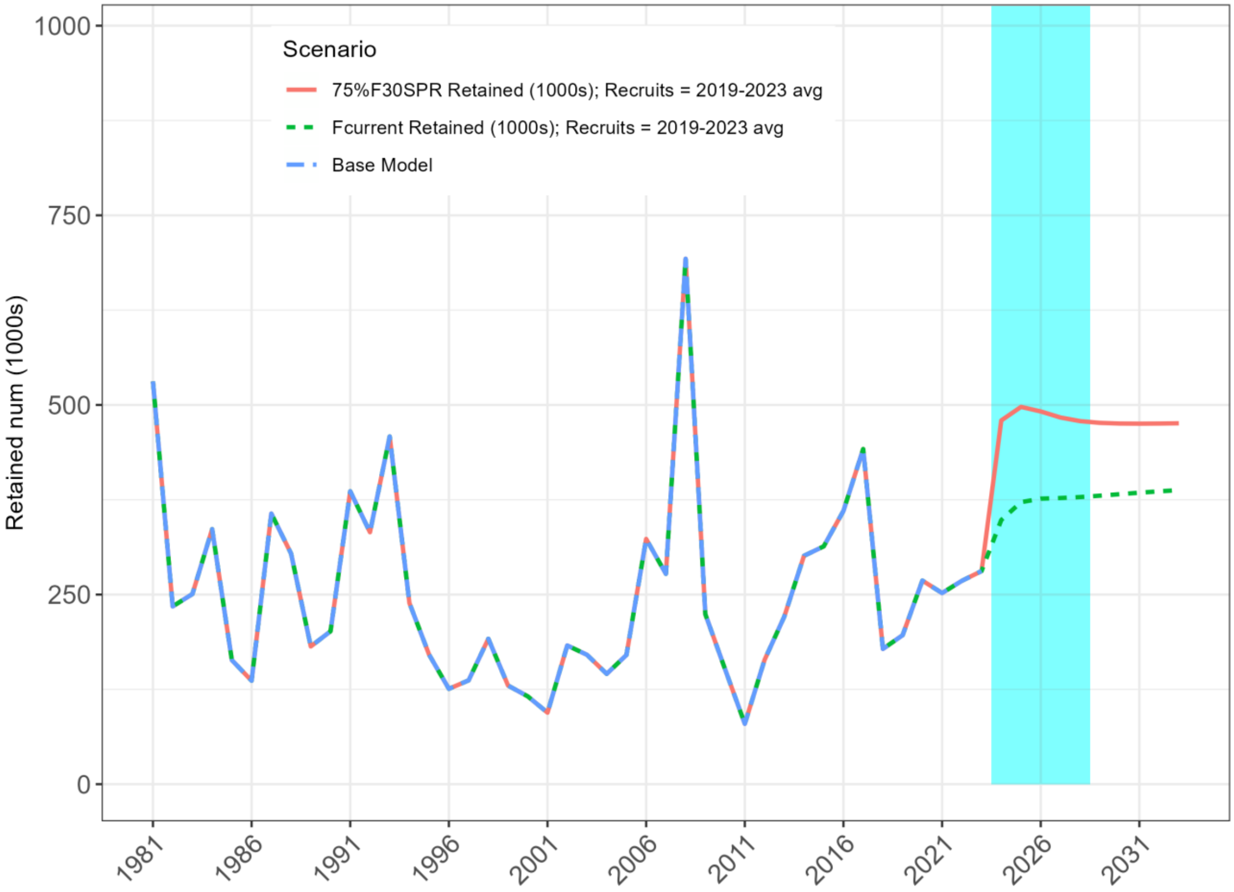


b)

Figure 93. Historical and projected retained yield in millions of pounds (a) and 1000s (b) for the long- and short-term projections when constant fishing mortality rates equal $F_{30\%SPR}$ for the SEDAR 79 Southeastern US Mutton Snapper Assessment. The green shaded area identifies the first 5 years of the projections (2024-2028).


Scenario
75%F30SPR Retained (lbs); Recruits = 2019-2023 avg
Fcurrent Retained (lbs); Recruits = 2019-2023 avg
Base Model
Retained Yield (Million lbs)
0
1
2
3
4
1981
1986
1991
1996
2001
2006
2011
2016
2021
2026
2031

a)



b)

Figure 94. Historical and projected retained yield in millions of pounds (a) and 1000s (b) for short-term projections when constant fishing mortality rates equal 75% of $F_{30\%SPR}$ and $F_{current}$ for the SEDAR 79 Southeastern US Mutton Snapper Assessment. The green shaded area identifies the first 5 years of the projections (2024-2028).

Appendix

Starter File:

```
#V3.30.22.1;_safe;_compile_date:_Jan 30 2024;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_13.1
#_Stock_Synthesis_is_a_work_of_the_U.S._Government_and_is_not_subject_to_copyright_protection_in_the_United_States.
#_Foreign_copyrights_may_apply._See_copyright.txt_for_more_information.
#_User_support_available_at:NMFS.Stock.Synthesis@noaa.gov
#_User_info_available_at:https://vlab.noaa.gov/group/stock-synthesis
#_Source_code_at:_https://github.com/nmfs-ost/ss3-source-code

S79data.dat
S79control.ctl
0 # 0=use init values in control file; 1=use ss.par
1 # run display detail (0 = minimal; 1=one line per iter; 2=each logL)
1 # detailed output (0=minimal for data-limited, 1=high (w/ wtatage.ss_new), 2=brief, 3=custom)
#COND: custom report options: -100 to start with minimal; -101 to start with all; -number to remove, +number to add, -999 to end
0 # write 1st iteration details to echoinput.sso file (0,1)
4 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
2 # write to cumreport.sso (0=no,1=like&timeseries; 2=add survey fits)
0 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
#
3 # Number of datafiles to produce:  0 turns off all *.ss_new; 1st is data_echo.ss_new, 2nd is data_expval.ss, 3rd and higher are data_boot_**N.ss,
20 # Turn off estimation for parameters entering after this phase
#
0 # MCeval burn interval
1 # MCeval thin interval
0 # jitter initial parm value by this fraction
-1 # min yr for sdreport outputs (-1 for styr); #_1979
-2 # max yr for sdreport outputs (-1 for endyr+1; -2 for endyr+Nforecastyrs); #_2123
0 # N individual STD years
#COND: vector of year values if N>0
0.0001 # final convergence criteria (e.g. 1.0e-04)
0 # retrospective year relative to end year (e.g. -4)
1 # min age for calc of summary biomass
1 # Depletion basis:  denom is: 0=skip; 1=X*SPBvirgin; 2=X*SPBmsy; 3=X*SPB_styr; 4=X*SPB_endyr; 5=X*dyn_Bzero;  values>=11 invoke N multiyr (up to 9!) with 10's digit; >100 invokes log(ratio)
0.3 # Fraction (X) for Depletion denominator (e.g. 0.4)
4 # SPR_report_basis:  0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
4 # F_std_reporting_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Apical_F's); 4=mean F for range of ages (numbers weighted); 5=unweighted mean F for range of ages
 3 3 # min and max age over which mean F will be calculated, with F=Z-M
0 # F_std_scaling: 0=no scaling; 1=F/Fspr; 2=F/Fmsy; 3=F/Fbtgt; where F means annual F_std, Fmsy means F_std@msy; values >=11 invoke N multiyr (up to 9!) using 10's digit; >100 invokes log(ratio)
0 # MCMC output detail: integer part (0=default; 1=adds obj func components; 2= +write_report_for_each_mceval); and decimal part (added to SR_LN(R0) on first call to mcmc)
0 # ALK tolerance ***disabled in code
-1 # random number seed for bootstrap data (-1 to use long(time) as seed): # 1722874317
3.30 # check value for end of file and for version control
```

Forecast File:

```
#V3.30.22.1;_safe;_compile_date:_Jan 30 2024;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_13.1
# for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel. endyr
2 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy; 2=calc F_spr,F0.1,F_msy; 3=add F_Blimit;
1 # Do_MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt) or F0.1; 4=set to F(endyr); 5=calc F(MEY) with MSY_unit options
# if Do_MSY=5, enter MSY_Units; then list fleet_ID, cost/F, price/mt, include_in_Fmey_scaling; # -fleet_ID to fill; -9999 to terminate
0.3 # SPR target (e.g. 0.40)
0.1 # Biomass target (e.g. 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF, beg_recr_dist, end_recr_dist, beg_SRparm, end_SRparm (enter actual year, or values of #0 or -integer to be rel. endyr)
 -999 2023 2021 2023 2021 2023 -999 2023 -999 2023
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
1 # Forecast: -1=none; 0=simple_1yr; 1=F(SPR); 2=F(MSY) 3=F(Btgt) or F0.1; 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
# where none and simple require no input after this line; simple sets forecast F same as end year F
100 # N forecast years
1 # Fmult (only used for Do_Forecast==5) such that apical_F(f)=Fmult*relF(f)
-12345  # code to invoke new format for expanded fcast year controls
# biology and selectivity vectors are updated annually in the forecast according to timevary parameters, so check end year of blocks and dev vectors
# input in this section directs creation of means over historical years to override any time_vary changes
# Factors implemented so far: 1=M, 4=recr_dist, 5=migration, 10=selectivity, 11=rel_F, 12=recruitment
# rel_F and Recruitment also have additional controls later in forecast.ss
# input as list: Factor, method (0, 1), st_yr, end_yr
# Terminate with -9999 for Factor
# st_yr and end_yr input can be actual year; <=0 sets rel. to timeseries endyr; Except -999 for st_yr sets to first year if time series
```

```
# Method = 0 (or omitted) continue using time_vary parms; 1  use mean of derived factor over specified year range
# Factor method st_yr end_yr
 1 1 -999 2023 # natmort; use:  1 1 1981 2023
 4 1 -999 2023 # recr_dist; use:  4 1 1981 2023
 10 1 2021 2023 # selectivity; use:  10 1 2021 2023
 11 1 2021 2023 # rel_F; use:  11 1 2021 2023
 12 1 2018 2022 # recruitment; use:  12 1 2018 2022
-9999 0 0 0
#
2 # Control rule method (0: none; 1: ramp does catch=f(SSB), buffer on F; 2: ramp does F=f(SSB), buffer on F; 3: ramp does catch=f(SSB), buffer on catch; 4: ramp does F=f(SSB), buffer on catch)
# values for top, bottom and buffer exist, but not used when Policy=0
0.3 # Control rule inflection for constant F (as frac of Bzero, e.g. 0.40); must be > control rule cutoff, or set to -1 to use Bmsy/SSB_unf
0.1 # Control rule cutoff for no F (as frac of Bzero, e.g. 0.10)
1 # Buffer:  enter Control rule target as fraction of Flimit (e.g. 0.75), negative value invokes list of [year, scalar] with filling from year to YrMax
#
3 #_N forecast loops (1=OFL only; 2=ABC; 3=get F from forecast ABC catch with allocations applied)
3 # First forecast loop with stochastic recruitment
0 # Forecast base recruitment:  0= spawn_recr; 1=mult*spawn_recr_fxn; 2=mult*VirginRecr; 3=deprecated; 4=mult*mean_over_yr_range
# for option 4, set phase for fore_recr_devs to -1 in control to get constant mean in MCMC, else devs will be applied
1 # Value multiplier is ignored
0 # not used
#
2024  # FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output: 0=no; 1=yes
2024 # Rebuilder:  first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2024 # Rebuilder:  year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F:  1=use mean over year range; 2=read seas, fleet, alloc list below
# Note that fleet allocation values is used directly as F if Do_Forecast=4
3 # basis for fcast catch tuning and for fcast catch caps and allocation  (2=deadbio; 3=retainbio; 5=deadnum; 6=retainnum); NOTE: same units for all fleets
# Conditional input if relative F choice = 2
# enter list of: fleet number, max annual catch for fleets with a max; terminate with fleet=-9999
-9999 -1
# enter list of area ID and max annual catch; terminate with area=-9999
-9999 -1
# enter list of fleet number and allocation group assignment, if any; terminate with fleet=-9999
-9999 -1
#_if N allocation groups >0, list year, allocation fraction for each group
# list sequentially because read values fill to end of N forecast
# terminate with -9999 in year field
# no allocation groups
#
3 # basis for input Fcast catch: -1=read basis with each obs; 2=dead catch; 3=retained catch; 99=input apical_F; NOTE: bio vs num based on fleet's catchunits
#enter list of Fcast catches or Fa; terminate with line having year=-9999
#_Yr Seas Fleet Catch(or_F)
-9999 1 1 0
#
999 # verify end of input
```

Control File:

```
#V3.30.22.1;_safe;_compile_date:_Jan 30 2024;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_13.1
#_Stock_Synthesis_is_a_work_of_the_U.S._Government_and_is_not_subject_to_copyright_protection_in_the_United_States.
#_Foreign_copyrights_may_apply._See_copyright.txt_for_more_information.
#_User_support_available_at:NMFS.Stock.Synthesis@noaa.gov
#_User_info_available_at:https://vlab.noaa.gov/group/stock-synthesis
#_Source_code_at:_https://github.com/nmfs-ost/ss3-source-code

#_data_and_control_files: S79data.dat // S79control.ctl
0  # 0 means do not read wtatage.ss; 1 means read and use wtatage.ss and also read and use growth parameters
1  #_N_Growth_Patterns (Growth Patterns, Morphs, Bio Patterns, GP are terms used interchangeably in SS3)
1 #_N_platoons_Within_GrowthPattern
#_Cond 1 #_Platoon_within/between_stdev_ratio (no read if N_platoons=1)
#_Cond sd_ratio_rd < 0: platoon_sd_ratio parameter required after movement params.
#_Cond  1 #vector_platoon_dist_(-1_in_first_val_gives_normal_approx)
#
4 # recr_dist_method for parameters:  2=main effects for GP, Area, Settle timing; 3=each Settle entity; 4=none (only when N_GP*Nsettle*pop==1)
1 # not yet implemented; Future usage: Spawner-Recruitment: 1=global; 2=by area
1 #  number of recruitment settlement assignments
0 # unused option
#GPattern month  area  age (for each settlement assignment)
 1 13 1 1
#
#_Cond 0 # N_movement_definitions goes here if Nareas > 1
#_Cond 1.0 # first age that moves (real age at begin of season, not integer) also cond on do_migration>0
#_Cond 1 1 1 2 4 10 # example move definition for seas=1, morph=1, source=1 dest=2, age1=4, age2=10
#
3 #_Nblock_Patterns
```

```
 2 2 2 #_blocks_per_pattern
# begin and end years of blocks
 1992 2017 2018 2024
 1995 2017 2018 2024
 2016 2019 2020 2024
#
# controls for all timevary parameters
1 #_time-vary parm bound check (1=warn relative to base parm bounds; 3=no bound check); Also see env (3) and dev (5) options to constrain with base bounds
#
# AUTOGEN
 1 1 1 1 1 # autogen: 1st element for biology, 2nd for SR, 3rd for Q, 4th reserved, 5th for selex
# where: 0 = autogen time-varying parms of this category; 1 = read each time-varying parm line; 2 = read then autogen if parm min==-12345
#
#_Available timevary codes
#_Block types: 0: P_block=P_base*exp(TVP); 1: P_block=P_base+TVP; 2: P_block=TVP; 3: P_block=P_block(-1) + TVP
#_Block_trends: -1: trend bounded by base parm min-max and parms in transformed units (beware); -2: endtrend and infl_year direct values; -3: end and infl as
fraction of base range
#_EnvLinks:  1: P(y)=P_base*exp(TVP*env(y));  2: P(y)=P_base+TVP*env(y);  3: P(y)=f(TVP,env_Zscore) w/ logit to stay in min-max;  4: P(y)=2.0/(1.0+exp(-
TVP1*env(y) - TVP2))
#_DevLinks:  1: P(y)*=exp(dev(y)*dev_se;  2: P(y)+=dev(y)*dev_se;  3: random walk;  4: zero-reverting random walk with rho;  5: like 4 with logit transform to stay
in base min-max
#_DevLinks(more):  21-25 keep last dev for rest of years
#
#_Prior_codes:  0=none; 6=normal; 1=symmetric beta; 2=CASAL's beta; 3=lognormal; 4=lognormal with biascorr; 5=gamma
#
# setup for M, growth, wt-len, maturity, fecundity, (hermaphro), recr_distr, cohort_grow, (movement), (age error), (catch_mult), sex ratio
#_NATMORT
6 #_natM_type:_0=1Parm;
1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate;_5=BETA:_Maunder_link_to_maturity;_6=Lorenzen_range
3 #_minimum age for Lorenzen
40 #_maximum age for Lorenzen; read 1P per morph
#
1 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=age_specific_K_incr; 4=age_specific_K_decr; 5=age_specific_K_each; 6=NA; 7=NA;
8=growth cessation
0 #_Age(post-settlement) for L1 (aka Amin); first growth parameter is size at this age; linear growth below this
999 #_Age(post-settlement) for L2 (aka Amax); 999 to treat as Linf
-998 #_exponential decay for growth above maxage (value should approx initial Z; -999 replicates 3.24; -998 to not allow growth above maxage)
0  #_placeholder for future growth feature
#
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
0 #_CV_Growth_Pattern:  0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A); 4 logSD=F(A)
#
2 #_maturity_option:  1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity; 5=disabled; 6=read length-maturity
2 #_First_Mature_Age
5 #_fecundity_at_length option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b; (4)eggs=a+b*L; (5)eggs=a+b*W
0 #_hermaphroditism option:  0=none; 1=female-to-male age-specific fxn; -1=male-to-female age-specific fxn
1 #_parameter_offset_approach for M, G, CV_G:  1- direct, no offset**; 2- male=fem_parm*exp(male_parm); 3: male=female*exp(parm) then old=young*exp(parm)
#_** in option 1, any male parameter with value = 0.0 and phase <0 is set equal to female parameter
#
#_growth_parms
#_ LO HI INIT PRIOR PR_SD PR_type PHASE env_var&link dev_link dev_minyr dev_maxyr dev_PH Block Block_Fxn
# Sex: 1  BioPattern: 1  NatMort
 0.1 0.4 0.129 0.203 0.31 0 -99 0 0 0 0 0 0 0 # NatM_Lorenzen_averageFem_GP_1
# Sex: 1  BioPattern: 1  Growth
 2 40 27.6533 20 10 0 1 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
 50 105 82.2646 84.7 10 0 2 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
 0.05 0.5 0.194626 0.163 0.8 0 2 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
 0.1 0.5 0.16741 0.15 0.8 0 3 0 0 0 0 0 0 0 # CV_young_Fem_GP_1
 0.005 0.4 0.091251 0.05 0.8 0 3 0 0 0 0 0 0 0 # CV_old_Fem_GP_1
# Sex: 1  BioPattern: 1  WtLen
 0 3 6.63e-06 6.63e-06 0.8 0 -99 0 0 0 0 0 0 0 # Wtlen_1_Fem_GP_1
 1 4 3.1601 3.1601 0.8 0 -99 0 0 0 0 0 0 0 # Wtlen_2_Fem_GP_1
# Sex: 1  BioPattern: 1  Maturity&Fecundity
 1 4 3.5 3.5 1.1 0 -99 0 0 0 0 0 0 0 # Mat50%_Fem_GP_1
 -3 -0.05 -2.535 -2.535 0.787 0 -99 0 0 0 0 0 0 0 # Mat_slope_Fem_GP_1
 -3 3 0 0 0.8 0 -99 0 0 0 0 0 0 0 # Eggs_intercept_Fem_GP_1
 -3 3 1 1 0.8 0 -99 0 0 0 0 0 0 0 # Eggs_slope_Wt_Fem_GP_1
# Hermaphroditism
#  Recruitment Distribution
#  Cohort growth dev base
 0 1 1 0 0 0 -99 0 0 0 0 0 0 0 # CohortGrowDev
#  Movement
#  Platoon StDev Ratio
#  Age Error from parameters
#  catch multiplier
#  fraction female, by GP
 0.5 0.5 0.5 0.5 0 0 -99 0 0 0 0 0 0 0 # FracFemale_GP_1
#  M2 parameter for each predator fleet
#
#_no timevary MG parameters
```

```
#
#_seasonal_effects_on_biology_parms
 0 0 0 0 0 0 0 0 0 0 #_femwtlen1,femwtlen2,mat1,mat2,fec1,fec2,Malewtlen1,malewtlen2,L1,K
#_ LO HI INIT PRIOR PR_SD PR_type PHASE
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters
#
3 #_Spawner-Recruitment; Options: 1=NA; 2=Ricker; 3=std_B-H; 4=SCAA; 5=Hockey; 6=B-H_flattop; 7=survival_3Parm; 8=Shepherd_3Parm; 9=RickerPower_3parm
0  # 0/1 to use steepness in initial equ recruitment calculation
0  #  future feature:  0/1 to make realized sigmaR a function of SR curvature
#_          LO            HI          INIT         PRIOR         PR_SD       PR_type      PHASE    env-var    use_dev   dev_mnyr   dev_mxyr     dev_PH      Block    Blk_Fxn #  parm_name
           6.5            11       7.82919             7            10             0          3          0          0          0          0          0          0          0 # SR_LN(R0)
          0.41          0.99      0.644384           0.7           0.9             0          3          0          0          0          0          0          0          0 # SR_BH_steep
           0.1           0.8      0.553219           0.6           0.2             0          6          0          0          0          0          0          0          0 # SR_sigmaR
            -5             5             0             0             0             0        -99          0          0          0          0          0          0          0 # SR_regime
             0             0             0             0             0             0        -99          0          0          0          0          0          0          0 # SR_autocorr
#_no timevary SR parameters
2 #do_recdev:  0=none; 1=devvector (R=F(SSB)+dev); 2=deviations (R=F(SSB)+dev); 3=deviations (R=R0*dev; dev2=R-f(SSB)); 4=like 3 with sum(dev2) adding penalty
1986 # first year of main recr_devs; early devs can precede this era
2022 # last year of main recr_devs; forecast devs start in following year
4 #_recdev phase
1 # (0/1) to read 13 advanced options
 1970 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
 6 #_recdev_early_phase
 -7 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)
 0 #_lambda for Fcast_recr_like occurring before endyr+1
 1966.8 #_last_yr_nobias_adj_in_MPD; begin of ramp
 1986.5 #_first_yr_fullbias_adj_in_MPD; begin of plateau
 2018.4 #_last_yr_fullbias_adj_in_MPD
 2029.7 #_end_yr_for_ramp_in_MPD (can be in forecast to shape ramp, but SS3 sets bias_adj to 0.0 for fcast yrs)
 0.9102 #_max_bias_adj_in_MPD (typical ~0.8; -3 sets all years to 0.0; -2 sets all non-forecast yrs w/ estimated recdevs to 1.0; -1 sets biasadj=1.0 for all yrs w/ recdevs)
 0 #_period of cycles in recruitment (N parms read below)
 -4 #min rec_dev
 4 #max rec_dev
 0 #_read_recdevs
#_end of advanced SR options
#
#Fishing Mortality info
0.3 # F ballpark value in units of annual_F
-2001 # F ballpark year (neg value to disable)
4 # F_Method:  1=Pope midseason rate; 2=F as parameter; 3=F as hybrid; 4=fleet-specific parm/hybrid (#4 is superset of #2 and #3 and is recommended)
3 # max F (methods 2-4) or harvest fraction (method 1)
# read list of fleets that do F as parameter; unlisted fleets stay hybrid, bycatch fleets must be included with start_PH=1, high F fleets should switch early
# (A) fleet, (B) F_starting_value (used if start_PH=1), (C) start_PH for parms (99 to stay in hybrid, <0 to stay at starting value)
# (A) (B) (C)  (terminate list with -9999 for fleet)
 1 0.01 99 # COM_LL
 2 0.05 99 # COM_OTHER
 3 0.0347176 3 # REC_E
 4 0.000365389 3 # REC_W
-9999 1 1 # end of list
4 #_number of loops for hybrid tuning; 4 good; 3 faster; 2 enough if switching to parms is enabled
#
#_initial_F_parms; for each fleet x season that has init_catch; nest season in fleet; count = 4
#_for unconstrained init_F, use an arbitrary initial catch and set lambda=0 for its logL
#_ LO HI INIT PRIOR PR_SD  PR_type  PHASE
 0.0001 0.3 0.0353763 0.01 0.5 1 1 # InitF_seas_1_flt_1COM_LL
 0.001 0.3 0.0325694 0.05 0.5 1 1 # InitF_seas_1_flt_2COM_OTHER
 0.05 0.6 0.3409 0.1 0.5 1 1 # InitF_seas_1_flt_3REC_E
 0.05 0.4 0.118346 0.1 0.5 1 1 # InitF_seas_1_flt_4REC_W
#
#_Q_setup for fleets with cpue or survey data
#_1:  fleet number
#_2:  link type: (1=simple q, 1 parm; 2=mirror simple q, 1 mirrored parm; 3=q and power, 2 parm; 4=mirror with offset, 2 parm)
#_3:  extra input for link, i.e. mirror fleet# or dev index number
#_4:  0/1 to select extra sd parameter
#_5:  0/1 for biasadj or not
#_6:  0/1 to float
#_   fleet      link link_info  extra_se   biasadj     float  #  fleetname
         1         1         0         0         1         1  #  COM_LL
         5         1         0         0         1         1  #  RVC_DT
         6         1         0         0         1         1  #  RVC_KEYS
         7         1         0         0         1         1  #  RVC_SEFL
         8         1         0         0         1         1  #  FIM_YOY
         9         1         0         0         1         0  #  GOM_VID
        10         1         0         0         1         1  #  SERFS_VID
-9999 0 0 0 0 0
#
```

```
#_Q_parms(if_any);Qunits_are_ln(q)
#_       LO        HI      INIT      PRIOR      PR_SD     PR_type    PHASE   env-var   use_dev   dev_mnyr   dev_mxyr    dev_PH     Block   Blk_Fxn  #
parm_name
       -18         5    -7.88225        -7          1          0      -2        0        0        0        0        0        0       0  #  LnQ_base_COM_LL(1)
       -18         5    -7.33485        -8          1          0      -1        0        0        0        0        0        0       0  #  LnQ_base_RVC_DT(5)
       -18         5    -7.54841        -8          1          0      -1        0        0        0        0        0        0       0  #  LnQ_base_RVC_KEYS(6)
       -18         5    -8.04934        -8          1          0      -1        0        0        0        0        0        0       0  #  LnQ_base_RVC_SEFL(7)
       -18         5    -7.45529        -8          1          0      -1        0        0        0        0        0        0       0  #  LnQ_base_FIM_YOY(8)
       -15         5    -7.06752        -8          1          0       3        0        0        0        0        0        3       0  #  LnQ_base_GOM_VID(9)
       -18         5    -7.88324        -8          1          0      -1        0        0        0        0        0        0       0  #  LnQ_base_SERFS_VID(10)
# timevary Q parameters
#_       LO        HI      INIT      PRIOR      PR_SD     PR_type    PHASE  #  parm_name
        -2         2    0.109681        -2          1          0       4  # LnQ_base_GOM_VID(9)_BLK3mult_2016
        -2         2    0.256633        -2          1          0       4  # LnQ_base_GOM_VID(9)_BLK3mult_2020
# info on dev vectors created for Q parms are reported with other devs after tag parameter section
#
#_size_selex_patterns
#Pattern:_0;  parm=0; selex=1.0 for all sizes
#Pattern:_1;  parm=2; logistic; with 95% width specification
#Pattern:_5;  parm=2; mirror another size selex; PARMS pick the min-max bin to mirror
#Pattern:_11; parm=2; selex=1.0  for specified min-max population length bin range
#Pattern:_15; parm=0; mirror another age or length selex
#Pattern:_6;  parm=2+special; non-parm len selex
#Pattern:_43; parm=2+special+2;  like 6, with 2 additional param for scaling (mean over bin range)
#Pattern:_8;  parm=8; double_logistic with smooth transitions and constant above Linf option
#Pattern:_9;  parm=6; simple 4-parm double logistic with starting length; parm 5 is first length; parm 6=1 does desc as offset
#Pattern:_21; parm=2+special; non-parm len selex, read as pairs of size, then selex
#Pattern:_22; parm=4; double_normal as in CASAL
#Pattern:_23; parm=6; double_normal where final value is directly equal to sp(6) so can be >1.0
#Pattern:_24; parm=6; double_normal with sel(minL) and sel(maxL), using joiners
#Pattern:_2;  parm=6; double_normal with sel(minL) and sel(maxL), using joiners, back compatibile version of 24 with 3.30.18 and older
#Pattern:_25; parm=3; exponential-logistic in length
#Pattern:_27; parm=special+3; cubic spline in length; parm1==1 resets knots; parm1==2 resets all
#Pattern:_42; parm=special+3+2; cubic spline; like 27, with 2 additional param for scaling (mean over bin range)
#_discard_options:_0=none;_1=define_retention;_2=retention&mortality;_3=all_discarded_dead;_4=define_dome-shaped_retention
#_Pattern Discard Male Special
 1 0 0 0 # 1 COM_LL
 1 2 0 0 # 2 COM_OTHER
 24 2 0 0 # 3 REC_E
 24 2 0 0 # 4 REC_W
 24 0 0 0 # 5 RVC_DT
 24 0 0 0 # 6 RVC_KEYS
 1 0 0 0 # 7 RVC_SEFL
 0 0 0 0 # 8 FIM_YOY
 1 0 0 0 # 9 GOM_VID
 0 0 0 0 # 10 SERFS_VID
 0 0 0 0 # 11 FI_AGE
#
#_age_selex_patterns
#Pattern:_0; parm=0; selex=1.0 for ages 0 to maxage
#Pattern:_10; parm=0; selex=1.0 for ages 1 to maxage
#Pattern:_11; parm=2; selex=1.0  for specified min-max age
#Pattern:_12; parm=2; age logistic
#Pattern:_13; parm=8; age double logistic. Recommend using pattern 18 instead.
#Pattern:_14; parm=nages+1; age empirical
#Pattern:_15; parm=0; mirror another age or length selex
#Pattern:_16; parm=2; Coleraine - Gaussian
#Pattern:_17; parm=nages+1; empirical as random walk  N parameters to read can be overridden by setting special to non-zero
#Pattern:_41; parm=2+nages+1; // like 17, with 2 additional param for scaling (mean over bin range)
#Pattern:_18; parm=8; double logistic - smooth transition
#Pattern:_19; parm=6; simple 4-parm double logistic with starting age
#Pattern:_20; parm=6; double_normal,using joiners
#Pattern:_26; parm=3; exponential-logistic in age
#Pattern:_27; parm=3+special; cubic spline in age; parm1==1 resets knots; parm1==2 resets all
#Pattern:_42; parm=2+special+3; // cubic spline; with 2 additional param for scaling (mean over bin range)
#Age patterns entered with value >100 create Min_selage from first digit and pattern from remainder
#_Pattern Discard Male Special
 10 0 0 0 # 1 COM_LL
 10 0 0 0 # 2 COM_OTHER
 10 0 0 0 # 3 REC_E
 10 0 0 0 # 4 REC_W
 10 0 0 0 # 5 RVC_DT
 10 0 0 0 # 6 RVC_KEYS
 10 0 0 0 # 7 RVC_SEFL
 0 0 0 0 # 8 FIM_YOY
 10 0 0 0 # 9 GOM_VID
 11 0 0 0 # 10 SERFS_VID
 0 0 0 0 # 11 FI_AGE
#
```

```
#_      LO      HI      INIT     PRIOR    PR_SD    PR_type   PHASE   env-var   use_dev   dev_mnyr   dev_mxyr   dev_PH    Block   Blk_Fxn  #
parm_name
# 1   COM_LL LenSelex
      50     90    61.2887      60       1       0      1      0      0      0      0      0      0      0  #  Size_inflection_COM_LL(1)
       1     40    16.0065      10       1       0      2      0      0      0      0      0      0      0  #  Size_95%width_COM_LL(1)
# 2   COM_OTHER LenSelex
       8     70    35.9227      30       1       0      1      0      0      0      0      0      0      0  #  Size_inflection_COM_OTHER(2)
      -2     66    10.484        3       1       0      2      0      0      0      0      0      0      0  #  Size_95%width_COM_OTHER(2)
       0     60    10           36       1       0     -1      0      0      0      0      0      1      1  #  Retain_L_infl_COM_OTHER(2)
   1e-05     25     1          2.5       1       0     -3      0      0      0      0      0      1      1  #  Retain_L_width_COM_OTHER(2)
     -15     15     9            9       1       0     -3      0      0      0      0      0      0      0  #
Retain_L_asymptote_logit_COM_OTHER(2)
      -1      1     0            0      99       0    -99      0      0      0      0      0      0      0  #  Retain_L_maleoffset_COM_OTHER(2)
     0.5    1.5     1            1       1       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_infl_COM_OTHER(2)
   10000  1e+08   1e+06      1e+06       1       0    -99      0      0      0      0      0      0      0  #
DiscMort_L_width_COM_OTHER(2)
    -1.5      0    -0.4       -0.4       1       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_level_old_COM_OTHER(2)
      -1      2     0            0      99       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_male_offset_COM_OTHER(2)
# 3   REC_E LenSelex
      28     45    34.0405      35       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_peak_REC_E(3)
     -18      3    -5.6816      -3       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_top_logit_REC_E(3)
     -40     20    -10.0177      2       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_ascend_se_REC_E(3)
      -2     10    5.35843       5       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_descend_se_REC_E(3)
     -20     15    -0.720172    -5       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_start_logit_REC_E(3)
     -15      5    -3.05664      0       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_end_logit_REC_E(3)
      10     50    33.2317      42       1       0      2      0      0      0      0      0      2      0  #  Retain_L_infl_REC_E(3)
       0     30    5.74767       2       1       0      2      0      0      0      0      0      2      0  #  Retain_L_width_REC_E(3)
     -15     15     7            9       1       0     -3      0      0      0      0      0      0      0  #  Retain_L_asymptote_logit_REC_E(3)
      -1      1     0            0      99       0    -99      0      0      0      0      0      0      0  #  Retain_L_maleoffset_REC_E(3)
     0.5    1.5     1            1       1       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_infl_REC_E(3)
   10000  1e+08   1e+06      1e+06       1       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_width_REC_E(3)
    -1.5      0    -0.4       -0.4       1       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_level_old_REC_E(3)
      -1      2     0            0      99       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_male_offset_REC_E(3)
# 4   REC_W LenSelex
      20     42    30.012       37       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_peak_REC_W(4)
     -35      3    -16.3605     -5       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_top_logit_REC_W(4)
     -18      5    -10.9752      3       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_ascend_se_REC_W(4)
     -20     20    8.05844      -5       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_descend_se_REC_W(4)
     -15      5    -0.508401   -10       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_start_logit_REC_W(4)
     -15     10    -5.35512     -1       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_end_logit_REC_W(4)
      15     60    37.3415      40       1       0      2      0      0      0      0      0      2      0  #  Retain_L_infl_REC_W(4)
     0.1     20    4.28484       2       1       0      2      0      0      0      0      0      2      0  #  Retain_L_width_REC_W(4)
     -15     15     9            9       1       0     -3      0      0      0      0      0      0      0  #  Retain_L_asymptote_logit_REC_W(4)
      -1      1     0            0      99       0    -99      0      0      0      0      0      0      0  #  Retain_L_maleoffset_REC_W(4)
     0.5    1.5     1            1       1       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_infl_REC_W(4)
   10000  1e+08   1e+06      1e+06       1       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_width_REC_W(4)
    -1.5      0    -0.4       -0.4       1       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_level_old_REC_W(4)
      -1      2     0            0      99       0    -99      0      0      0      0      0      0      0  #  DiscMort_L_male_offset_REC_W(4)
# 5   RVC_DT LenSelex
       5     94    56.0737      40       1       0      2      0      0      0      0      0      0      0  #  Size_DblN_peak_RVC_DT(5)
     -12     25    -2.25168     -1       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_top_logit_RVC_DT(5)
     -10     10    5.11419       4       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_ascend_se_RVC_DT(5)
     -20     35    4.7551        5       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_descend_se_RVC_DT(5)
     -15      5    -2.81808    -10       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_start_logit_RVC_DT(5)
     -35     20    -1.37175      0       1       0      4      0      0      0      0      0      0      0  #  Size_DblN_end_logit_RVC_DT(5)
# 6   RVC_KEYS LenSelex
      17     55    34.1216      40       1       0      2      0      0      0      0      0      0      0  #  Size_DblN_peak_RVC_KEYS(6)
     -30      0    -15.0472     -2       1       0      2      0      0      0      0      0      0      0  #  Size_DblN_top_logit_RVC_KEYS(6)
     -20     30    -6.27337      5       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_ascend_se_RVC_KEYS(6)
     -10     30    6.74308       5       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_descend_se_RVC_KEYS(6)
     -15     20    0.168323    -10       1       0      3      0      0      0      0      0      0      0  #  Size_DblN_start_logit_RVC_KEYS(6)
     -15     10    -2.14379     -2       1       0      4      0      0      0      0      0      0      0  #  Size_DblN_end_logit_RVC_KEYS(6)
# 7   RVC_SEFL LenSelex
      15     70    54.2835      50       1       0      1      0      0      0      0      0      0      0  #  Size_inflection_RVC_SEFL(7)
     -25      5    -9.32302     10       1       0      2      0      0      0      0      0      0      0  #  Size_95%width_RVC_SEFL(7)
# 8   FIM_YOY LenSelex
# 9   GOM_VID LenSelex
       0     95    44.4988      50       1       0      4      0      0      0      0      0      0      0  #  Size_inflection_GOM_VID(9)
      -2     60    18.4935      10       1       0      4      0      0      0      0      0      0      0  #  Size_95%width_GOM_VID(9)
# 10   SERFS_VID LenSelex
# 11   FI_AGE LenSelex
# 1   COM_LL AgeSelex
# 2   COM_OTHER AgeSelex
# 3   REC_E AgeSelex
# 4   REC_W AgeSelex
# 5   RVC_DT AgeSelex
# 6   RVC_KEYS AgeSelex
# 7   RVC_SEFL AgeSelex
# 8   FIM_YOY AgeSelex
# 9   GOM_VID AgeSelex
```

```
# 10   SERFS_VID AgeSelex
           3          3          3          3         99          0       -99        0        0        0        0        0        0        0  #  minage@sel=1_SERFS_VID(10)
          40         40         40         40         99          0       -99        0        0        0        0        0        0        0  #  maxage@sel=1_SERFS_VID(10)
# 11   FI_AGE AgeSelex
#_No_Dirichlet parameters
# timevary selex parameters
#_          LO          HI        INIT       PRIOR       PR_SD     PR_type    PHASE  #  parm_name
            10          45     28.0773           0           1           0      3  # Retain_L_infl_COM_OTHER(2)_BLK1add_1992
            25          50     39.1775           0           1           0      3  # Retain_L_infl_COM_OTHER(2)_BLK1add_2018
            -5          15     1.58399           0           1           0      3  # Retain_L_width_COM_OTHER(2)_BLK1add_1992
            -5           6     1.93547           0           1           0      3  # Retain_L_width_COM_OTHER(2)_BLK1add_2018
            -1           4    0.200757           0           1           0      3  # Retain_L_infl_REC_E(3)_BLK2mult_1995
            -2           5    0.384465           0           1           0      3  # Retain_L_infl_REC_E(3)_BLK2mult_2018
            -4           3    -1.41847           0           1           0      3  # Retain_L_width_REC_E(3)_BLK2mult_1995
            -3           2   -0.645126           0           1           0      3  # Retain_L_width_REC_E(3)_BLK2mult_2018
            -1           1    0.117593           0           1           0      3  # Retain_L_infl_REC_W(4)_BLK2mult_1995
            -1           1    0.207313           0           1           0      3  # Retain_L_infl_REC_W(4)_BLK2mult_2018
          -2.5           2   -0.749728           0           1           0      3  # Retain_L_width_REC_W(4)_BLK2mult_1995
            -3           2   -0.699084           0           1           0      3  # Retain_L_width_REC_W(4)_BLK2mult_2018
# info on dev vectors created for selex parms are reported with other devs after tag parameter section
#
0   #  use 2D_AR1 selectivity? (0/1)
#_no 2D_AR1 selex offset used
#_specs:  fleet, ymin, ymax, amin, amax, sigma_amax, use_rho, len1/age2, devphase, before_range, after_range
#_sigma_amax>amin means create sigma parm for each bin from min to sigma_amax; sigma_amax<0 means just one sigma parm is read and used for all bins
#_needed parameters follow each fleet's specifications
# -9999  0 0 0 0 0 0 0 0 0 0 # terminator
#
# Tag loss and Tag reporting parameters go next
0  # TG_custom:  0=no read and autogen if tag data exist; 1=read
#
# Input variance adjustments factors:
 #_1=add_to_survey_CV
 #_2=add_to_discard_stddev
 #_3=add_to_bodywt_CV
 #_4=mult_by_lencomp_N
 #_5=mult_by_agecomp_N
 #_6=mult_by_size-at-age_N
 #_7=mult_by_generalized_sizecomp
#_Factor  Fleet  Value
      4      1  0.540883
      4      2       0.5
      4      3       0.5
      4      4       0.5
      4      9  0.363863
      5      1  0.172178
      5      2  0.090496
      5      3  0.105103
      5      4   0.10641
      5     11  0.028688
      7      5  0.087615
      7      6 0.0906557
      7      7 0.0659219
 -9999   1    0  # terminator
#
1 #_maxlambdaphase
1 #_sd_offset; must be 1 if any growthCV, sigmaR, or survey extraSD is an estimated parameter
# read 5 changes to default Lambdas (default value is 1.0)
# Like_comp codes:  1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq; 7=sizeage; 8=catch; 9=init_equ_catch;
# 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp; 15=Tag-comp; 16=Tag-negbin; 17=F_ballpark; 18=initEQregime
#like_comp fleet  phase  value  sizefreq_method
 2 2 1 0.01 1
 9 1 1 0 1
 9 2 1 0 1
 9 3 1 0 1
 9 4 1 0 1
-9999  1  1  1  1  #  terminator
#
0 # (0/1/2) read specs for more stddev reporting: 0 = skip, 1 = read specs for reporting stdev for selectivity, size, and numbers, 2 = add options for M,Dyn.  #Bzero,
SmryBio
999
```

Data File:

```
#V3.30.22.1;_safe;_compile_date:_Jan 30 2024;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_13.1
#_Stock_Synthesis_is_a_work_of_the_U.S._Government_and_is_not_subject_to_copyright_protection_in_the_United_States.
#_Foreign_copyrights_may_apply._See_copyright.txt_for_more_information.
#_User_support_available_at:NMFS.Stock.Synthesis@noaa.gov
```

```
#_User_info_available_at:https://vlab.noaa.gov/group/stock-synthesis
#_Source_code_at:_https://github.com/nmfs-ost/ss3-source-code

#_Start_time: Mon Aug  5 12:11:57 2024
#_echo_input_data
#C this comment will be stored because it starts with #C.  It will be written to output files

#V3.30.22.1;_safe;_compile_date:_Jan 30 2024;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_13.1
1981 #_StartYr
2023 #_EndYr
1 #_Nseas
 12 #_months/season
6 #_Nsubseasons (even number, minimum is 2)
6 #_spawn_month
-1 #_Nsexes: 1, 2, -1  (use -1 for 1 sex setup with SSB multiplied by female_frac parameter)
40 #_Nages=accumulator age, first age is always age 0
1 #_Nareas
11 #_Nfleets (including surveys)
#_fleet_type: 1=catch fleet; 2=bycatch only fleet; 3=survey; 4=predator(M2)
#_sample_timing: -1 for fishing fleet to use season-long catch-at-age for observations, or 1 to use observation month;  (always 1 for surveys)
#_fleet_area:  area the fleet/survey operates in
#_units of catch:  1=bio; 2=num (ignored for surveys; their units read later)
#_catch_mult: 0=no; 1=yes
#_rows are fleets
#_fleet_type fishery_timing area catch_units need_catch_mult fleetname
 1 -1 1 1 0 COM_LL  # 1
 1 -1 1 1 0 COM_OTHER  # 2
 1 -1 1 2 0 REC_E  # 3
 1 -1 1 2 0 REC_W  # 4
 3 1 1 2 0 RVC_DT  # 5
 3 1 1 2 0 RVC_KEYS  # 6
 3 1 1 2 0 RVC_SEFL  # 7
 3 1 1 2 0 FIM_YOY  # 8
 3 1 1 2 0 GOM_VID  # 9
 3 1 1 2 0 SERFS_VID  # 10
 3 1 1 2 0 FI_AGE  # 11
#Bycatch_fleet_input_goes_next
#a:  fleet index
#b:  1=include dead bycatch in total dead catch for F0.1 and MSY optimizations and forecast ABC; 2=omit from total catch for these purposes (but still include the mortality)
#c:  1=Fmult scales with other fleets; 2=bycatch F constant at input value; 3=bycatch F from range of years
#d:  F or first year of range
#e:  last year of range
#f:  not used
# a   b   c   d   e   f
#_Catch data: yr, seas, fleet, catch, catch_se
#_catch_se:  standard error of log(catch)
#_NOTE:  catch data is ignored for survey fleets
-999 1 1 28.1073 0.3
1981 1 1 28.1073 0.09
1982 1 1 43.172 0.09
1983 1 1 36.1694 0.08
1984 1 1 23.1971 0.07
1985 1 1 20.6911 0.07
1986 1 1 54.3262 0.06
1987 1 1 85.4651 0.06
1988 1 1 53.4092 0.06
1989 1 1 77.2553 0.07
1990 1 1 59.8519 0.06
1991 1 1 66.1964 0.06
1992 1 1 33.4839 0.07
1993 1 1 34.0614 0.07
1994 1 1 22.6328 0.07
1995 1 1 20.7175 0.06
1996 1 1 23.0134 0.08
1997 1 1 26.5746 0.08
1998 1 1 36.0159 0.07
1999 1 1 33.6414 0.07
2000 1 1 33.4199 0.07
2001 1 1 41.8393 0.04
2002 1 1 36.1604 0.04
2003 1 1 50.4415 0.03
2004 1 1 89.3579 0.03
2005 1 1 54.6663 0.03
2006 1 1 88.0144 0.04
2007 1 1 58.6092 0.04
2008 1 1 33.5329 0.03
2009 1 1 14.7076 0.03
2010 1 1 16.3212 0.04
2011 1 1 24.7919 0.04
```

```
2012 1 1 24.1437 0.05
2013 1 1 38.7738 0.04
2014 1 1 56.4183 0.03
2015 1 1 50.6255 0.03
2016 1 1 26.161 0.03
2017 1 1 43.3655 0.05
2018 1 1 51.5428 0.04
2019 1 1 20.8737 0.04
2020 1 1 22.6201 0.05
2021 1 1 21.9821 0.04
2022 1 1 25.4415 0.04
2023 1 1 38.2131 0.04
-999 1 2 105.948 0.3
1981 1 2 105.948 0.06
1982 1 2 105.558 0.06
1983 1 2 98.7098 0.07
1984 1 2 86.4918 0.06
1985 1 2 78.4306 0.06
1986 1 2 132.036 0.06
1987 1 2 166.559 0.06
1988 1 2 153.796 0.05
1989 1 2 172.553 0.06
1990 1 2 147.193 0.06
1991 1 2 153.394 0.06
1992 1 2 148.39 0.07
1993 1 2 168.166 0.06
1994 1 2 139.68 0.07
1995 1 2 108.485 0.06
1996 1 2 109.286 0.06
1997 1 2 106.089 0.06
1998 1 2 125.411 0.06
1999 1 2 81.1678 0.05
2000 1 2 59.4042 0.05
2001 1 2 63.844 0.03
2002 1 2 69.834 0.03
2003 1 2 70.6345 0.03
2004 1 2 68.062 0.03
2005 1 2 52.7183 0.03
2006 1 2 42.1881 0.03
2007 1 2 41.7486 0.03
2008 1 2 37.8744 0.04
2009 1 2 40.0944 0.03
2010 1 2 41.8264 0.03
2011 1 2 47.3289 0.02
2012 1 2 51.1189 0.03
2013 1 2 43.3779 0.03
2014 1 2 46.9735 0.02
2015 1 2 51.4001 0.02
2016 1 2 42.0148 0.03
2017 1 2 43.6285 0.03
2018 1 2 49.5786 0.03
2019 1 2 41.2034 0.02
2020 1 2 41.78 0.03
2021 1 2 34.5673 0.03
2022 1 2 33.6451 0.02
2023 1 2 34.3669 0.02
-999 1 3 277.206 0.545138
1981 1 3 368.49 0.54
1982 1 3 418.3 0.54
1983 1 3 426.305 0.65
1984 1 3 127.596 0.47
1985 1 3 45.3407 0.53
1986 1 3 48.1879 0.27
1987 1 3 154.804 0.56
1988 1 3 70.1595 0.33
1989 1 3 108.444 0.37
1990 1 3 66.3588 0.25
1991 1 3 89.8824 0.31
1992 1 3 176.786 0.5
1993 1 3 197.667 0.2
1994 1 3 93.3793 0.22
1995 1 3 46.3984 0.25
1996 1 3 39.1106 0.28
1997 1 3 38.342 0.23
1998 1 3 69.405 0.3
1999 1 3 75.7106 0.27
2000 1 3 81.9465 0.26
2001 1 3 71.9623 0.24
2002 1 3 118.189 0.17
2003 1 3 84.4561 0.19
```

```
2004 1 3 98.8773 0.27
2005 1 3 115.55 0.19
2006 1 3 122.364 0.22
2007 1 3 145.233 0.18
2008 1 3 655.374 0.62
2009 1 3 135.423 0.2
2010 1 3 120.933 0.18
2011 1 3 45.4592 0.22
2012 1 3 58.2964 0.25
2013 1 3 103.653 0.28
2014 1 3 164.779 0.29
2015 1 3 173.045 0.26
2016 1 3 179.899 0.27
2017 1 3 112.846 0.36
2018 1 3 82.1955 0.36
2019 1 3 91.7857 0.43
2020 1 3 46.482 0.27
2021 1 3 119.319 0.2
2022 1 3 125.592 0.14
2023 1 3 114.385 0.16
-999 1 4 158.266 0.505741
1981 1 4 260.851 0.508925
1982 1 4 142.504 0.459349
1983 1 4 103.833 0.579679
1984 1 4 222.296 0.484816
1985 1 4 61.8453 0.495938
1986 1 4 149.603 0.475171
1987 1 4 174.929 0.430981
1988 1 4 137.061 0.614924
1989 1 4 112.719 0.533964
1990 1 4 129.349 0.459001
1991 1 4 139.078 0.464344
1992 1 4 94.8465 0.452579
1993 1 4 143.971 0.304926
1994 1 4 59.4878 0.215125
1995 1 4 78.0999 0.385864
1996 1 4 38.4176 0.374758
1997 1 4 30.7183 0.358664
1998 1 4 36.8315 0.388831
1999 1 4 63.818 0.460783
2000 1 4 12.486 0.331838
2001 1 4 14.157 0.324434
2002 1 4 38.9964 0.386515
2003 1 4 60.3428 0.330874
2004 1 4 18.9333 0.225631
2005 1 4 14.5084 0.323808
2006 1 4 117.593 0.509969
2007 1 4 93.3596 0.42034
2008 1 4 101.543 0.409029
2009 1 4 30.6792 0.286181
2010 1 4 31.9895 0.354606
2011 1 4 20.1931 0.207977
2012 1 4 58.9634 0.408031
2013 1 4 65.39 0.302789
2014 1 4 92.3665 0.350579
2015 1 4 98.076 0.304183
2016 1 4 86.9633 0.285139
2017 1 4 27.9031 0.313148
2018 1 4 47.5388 0.261147
2019 1 4 82.3681 0.355807
2020 1 4 118.326 0.519791
2021 1 4 91.3786 0.16947
2022 1 4 54.7873 0.229979
2023 1 4 56.1177 0.238458
-9999 0 0 0 0
#
#_CPUE_and_surveyabundance_and_index_observations
#_Units: 0=numbers; 1=biomass; 2=F; 30=spawnbio; 31=exp(recdev); 36=recdev; 32=spawnbio*recdev; 33=recruitment; 34=depletion(&see Qsetup);
35=parm_dev(&see Qsetup)
#_Errtype:  -1=normal; 0=lognormal; 1=lognormal with bias correction; >1=df for T-dist
#_SD_Report: 0=not; 1=include survey expected value with se
#_note that link functions are specified in Q_setup section of control file
#_Fleet Units Errtype SD_Report
1 1 0 1 # COM_LL
2 0 0 0 # COM_OTHER
3 0 0 0 # REC_E
4 0 0 0 # REC_W
5 0 0 1 # RVC_DT
6 0 0 1 # RVC_KEYS
7 0 0 1 # RVC_SEFL
```

```
8 33 0 1 # FIM_YOY
9 0 0 1 # GOM_VID
10 0 0 1 # SERFS_VID
11 0 0 0 # FI_AGE
#_yr month fleet obs stderr
1993 7 1 0.45 0.3 #_ COM_LL
1994 7 1 0.55 0.31 #_ COM_LL
1995 7 1 0.96 0.24 #_ COM_LL
1996 7 1 0.52 0.26 #_ COM_LL
1997 7 1 0.73 0.25 #_ COM_LL
1998 7 1 0.66 0.25 #_ COM_LL
1999 7 1 0.69 0.29 #_ COM_LL
2000 7 1 0.78 0.28 #_ COM_LL
2001 7 1 0.87 0.26 #_ COM_LL
2002 7 1 1.49 0.29 #_ COM_LL
2003 7 1 1.3 0.26 #_ COM_LL
2004 7 1 1.54 0.26 #_ COM_LL
2005 7 1 1.53 0.24 #_ COM_LL
2006 7 1 1.66 0.24 #_ COM_LL
2007 7 1 1.17 0.26 #_ COM_LL
2008 7 1 0.81 0.28 #_ COM_LL
2009 7 1 1.09 0.33 #_ COM_LL
2010 7 1 1.2 0.31 #_ COM_LL
1999 7 5 0.260035 0.209743 #_ RVC_DT
2000 7 5 0.35831 0.163335 #_ RVC_DT
2004 7 5 0.703498 0.092547 #_ RVC_DT
2006 7 5 0.482901 0.121606 #_ RVC_DT
2008 7 5 0.825004 0.080194 #_ RVC_DT
2010 7 5 1.13756 0.068447 #_ RVC_DT
2012 7 5 1.17051 0.065103 #_ RVC_DT
2014 7 5 0.796631 0.08003 #_ RVC_DT
2016 7 5 1.54748 0.067893 #_ RVC_DT
2018 7 5 1.0678 0.071821 #_ RVC_DT
2021 7 5 2.12635 0.076444 #_ RVC_DT
2023 7 5 2.55878 0.087885 #_ RVC_DT
1997 7 6 0.59 0.255 #_ RVC_KEYS
2000 7 6 0.85 0.139 #_ RVC_KEYS
2001 7 6 0.81 0.123 #_ RVC_KEYS
2002 7 6 0.74 0.118 #_ RVC_KEYS
2003 7 6 0.85 0.132 #_ RVC_KEYS
2004 7 6 0.97 0.16 #_ RVC_KEYS
2005 7 6 0.95 0.112 #_ RVC_KEYS
2006 7 6 0.83 0.126 #_ RVC_KEYS
2007 7 6 1.31 0.093 #_ RVC_KEYS
2008 7 6 1.13 0.099 #_ RVC_KEYS
2009 7 6 0.82 0.091 #_ RVC_KEYS
2010 7 6 0.63 0.127 #_ RVC_KEYS
2011 7 6 0.62 0.105 #_ RVC_KEYS
2012 7 6 0.87 0.096 #_ RVC_KEYS
2014 7 6 1.32 0.089 #_ RVC_KEYS
2016 7 6 1.76 0.097 #_ RVC_KEYS
2018 7 6 1.66 0.092 #_ RVC_KEYS
2022 7 6 2.03 0.121 #_ RVC_KEYS
2013 7 7 0.35 0.105 #_ RVC_SEFL
2014 7 7 0.5 0.114 #_ RVC_SEFL
2015 7 7 0.42 0.138 #_ RVC_SEFL
2016 7 7 0.92 0.097 #_ RVC_SEFL
2018 7 7 1.6 0.076 #_ RVC_SEFL
2021 7 7 1.56 0.094 #_ RVC_SEFL
2022 7 7 1.65 0.093 #_ RVC_SEFL
1999 9.5 8 0.363 0.386 #_ FIM_YOY
2000 9.5 8 0.501 0.326 #_ FIM_YOY
2001 9.5 8 0.573 0.35 #_ FIM_YOY
2002 9.5 8 0.912 0.313 #_ FIM_YOY
2003 9.5 8 0.521 0.339 #_ FIM_YOY
2004 9.5 8 0.721 0.334 #_ FIM_YOY
2005 9.5 8 1.323 0.34 #_ FIM_YOY
2006 9.5 8 0.892 0.308 #_ FIM_YOY
2007 9.5 8 3.535 0.284 #_ FIM_YOY
2008 9.5 8 1.571 0.305 #_ FIM_YOY
2009 9.5 8 0.513 0.343 #_ FIM_YOY
2010 9.5 8 0.597 0.337 #_ FIM_YOY
2011 9.5 8 0.709 0.322 #_ FIM_YOY
2012 9.5 8 1.2 0.303 #_ FIM_YOY
2013 9.5 8 1.27 0.315 #_ FIM_YOY
2014 9.5 8 1.138 0.336 #_ FIM_YOY
2015 9.5 8 0.854 0.332 #_ FIM_YOY
2016 9.5 8 0.297 0.377 #_ FIM_YOY
2017 9.5 8 1.06 0.346 #_ FIM_YOY
2018 9.5 8 1.337 0.331 #_ FIM_YOY
```

```
2019 9.5 8 0.23 0.389 #_ FIM_YOY
2020 9.5 8 1.491 0.316 #_ FIM_YOY
2021 9.5 8 1.06 0.318 #_ FIM_YOY
2022 9.5 8 1.33 0.312 #_ FIM_YOY
1996 7 9 1.081 0.366 #_ GOM_VID
1997 7 9 0.778 0.435 #_ GOM_VID
2002 7 9 1.083 0.304 #_ GOM_VID
2004 7 9 1.131 0.367 #_ GOM_VID
2005 7 9 0.84 0.271 #_ GOM_VID
2006 7 9 1.753 0.248 #_ GOM_VID
2007 7 9 1.092 0.257 #_ GOM_VID
2008 7 9 0.881 0.335 #_ GOM_VID
2009 7 9 0.578 0.31 #_ GOM_VID
2010 7 9 1.015 0.267 #_ GOM_VID
2011 7 9 2.143 0.213 #_ GOM_VID
2012 7 9 1.999 0.206 #_ GOM_VID
2014 7 9 0.886 0.373 #_ GOM_VID
2016 7 9 0.882 0.187 #_ GOM_VID
2017 7 9 0.514 0.234 #_ GOM_VID
2018 7 9 1.021 0.213 #_ GOM_VID
2019 7 9 1.211 0.156 #_ GOM_VID
2020 7 9 0.424 0.197 #_ GOM_VID
2021 7 9 0.334 0.198 #_ GOM_VID
2022 7 9 0.354 0.214 #_ GOM_VID
2011 7 10 0.083 0.46 #_ SERFS_VID
2012 7 10 0.235 0.58 #_ SERFS_VID
2013 7 10 0.263 0.5 #_ SERFS_VID
2014 7 10 0.769 0.26 #_ SERFS_VID
2015 7 10 1.188 0.19 #_ SERFS_VID
2016 7 10 0.581 0.26 #_ SERFS_VID
2017 7 10 1.007 0.24 #_ SERFS_VID
2018 7 10 1.501 0.16 #_ SERFS_VID
2019 7 10 2.248 0.15 #_ SERFS_VID
2021 7 10 1.394 0.16 #_ SERFS_VID
2022 7 10 1.731 0.2 #_ SERFS_VID
-9999 1 1 1 1 # terminator for survey observations
#
3 #_N_fleets_with_discard
#_discard_units (1=same_as_catchunits(bio/num); 2=fraction; 3=numbers)
#_discard_errtype:  >0 for DF of T-dist(read CV below); 0 for normal with CV; -1 for normal with se; -2 for lognormal; -3 for trunc normal with CV
# note: only enter units and errtype for fleets with discard
# note: discard data is the total for an entire season, so input of month here must be to a month in that season
#_Fleet units errtype
2 3 -1 # COM_OTHER
3 3 -2 # REC_E
4 3 -2 # REC_W
#_yr month fleet obs stderr
1993 7 2 5.654 0.491 #_ COM_OTHER
1994 7 2 6.628 0.52 #_ COM_OTHER
1995 7 2 7.58 0.59 #_ COM_OTHER
1996 7 2 6.801 0.538 #_ COM_OTHER
1997 7 2 6.991 0.515 #_ COM_OTHER
1998 7 2 5.706 0.492 #_ COM_OTHER
1999 7 2 5.815 0.529 #_ COM_OTHER
2000 7 2 5.922 0.531 #_ COM_OTHER
2001 7 2 4.713 0.418 #_ COM_OTHER
2002 7 2 4.921 0.401 #_ COM_OTHER
2003 7 2 4.322 0.378 #_ COM_OTHER
2004 7 2 4.157 0.385 #_ COM_OTHER
2005 7 2 3.5 0.325 #_ COM_OTHER
2006 7 2 3.613 0.351 #_ COM_OTHER
2007 7 2 3.505 0.302 #_ COM_OTHER
2008 7 2 3.127 0.252 #_ COM_OTHER
2009 7 2 4.379 0.406 #_ COM_OTHER
2010 7 2 3.975 0.413 #_ COM_OTHER
2011 7 2 3.31 0.257 #_ COM_OTHER
2012 7 2 3.555 0.314 #_ COM_OTHER
2013 7 2 4.204 0.411 #_ COM_OTHER
2014 7 2 5.794 0.64 #_ COM_OTHER
2015 7 2 6.731 0.798 #_ COM_OTHER
2016 7 2 4.934 0.523 #_ COM_OTHER
2017 7 2 3.863 0.369 #_ COM_OTHER
2018 7 2 5.831 0.619 #_ COM_OTHER
2019 7 2 6.339 1.059 #_ COM_OTHER
2020 7 2 6.194 1.104 #_ COM_OTHER
2021 7 2 5.849 1.107 #_ COM_OTHER
2022 7 2 4.472 0.683 #_ COM_OTHER
2023 7 2 5.505 0.96 #_ COM_OTHER
1982 7 3 7.59435 0.83 #_ REC_E
1983 7 3 11.9396 0.84 #_ REC_E
```

```
1984 7 3 9.9796 0.61 #_ REC_E
1985 7 3 79.1706 0.66 #_ REC_E
1986 7 3 72.5409 0.68 #_ REC_E
1987 7 3 111.295 0.72 #_ REC_E
1988 7 3 25.6994 0.6 #_ REC_E
1989 7 3 14.8347 0.49 #_ REC_E
1990 7 3 2.46762 0.7 #_ REC_E
1991 7 3 11.9818 0.39 #_ REC_E
1992 7 3 87.3695 0.36 #_ REC_E
1993 7 3 106.722 0.28 #_ REC_E
1994 7 3 84.5391 0.31 #_ REC_E
1995 7 3 123.184 0.62 #_ REC_E
1996 7 3 39.3114 0.35 #_ REC_E
1997 7 3 65.4761 0.29 #_ REC_E
1998 7 3 133.304 0.34 #_ REC_E
1999 7 3 73.309 0.28 #_ REC_E
2000 7 3 129.356 0.34 #_ REC_E
2001 7 3 56.7523 0.28 #_ REC_E
2002 7 3 200.216 0.28 #_ REC_E
2003 7 3 103.531 0.21 #_ REC_E
2004 7 3 121.658 0.32 #_ REC_E
2005 7 3 155.108 0.3 #_ REC_E
2006 7 3 271.649 0.27 #_ REC_E
2007 7 3 266.895 0.18 #_ REC_E
2008 7 3 1579.12 0.48 #_ REC_E
2009 7 3 237.832 0.18 #_ REC_E
2010 7 3 82.7223 0.24 #_ REC_E
2011 7 3 23.0397 0.3 #_ REC_E
2012 7 3 295.32 0.38 #_ REC_E
2013 7 3 225.268 0.39 #_ REC_E
2014 7 3 393.205 0.27 #_ REC_E
2015 7 3 558.725 0.23 #_ REC_E
2016 7 3 1082.49 0.37 #_ REC_E
2017 7 3 1495.34 0.37 #_ REC_E
2018 7 3 520.083 0.28 #_ REC_E
2019 7 3 428.668 0.27 #_ REC_E
2020 7 3 405.938 0.26 #_ REC_E
2021 7 3 662.443 0.13 #_ REC_E
2022 7 3 783.521 0.22 #_ REC_E
2023 7 3 690.322 0.15 #_ REC_E
1981 7 4 2.3183 0.83 #_ REC_W
1982 7 4 3.92493 0.83 #_ REC_W
1984 7 4 113.03 0.68 #_ REC_W
1985 7 4 21.1946 0.83 #_ REC_W
1986 7 4 3.97637 0.58 #_ REC_W
1987 7 4 41.476 0.68 #_ REC_W
1988 7 4 126.351 0.52 #_ REC_W
1989 7 4 4.40807 0.85 #_ REC_W
1990 7 4 27.0019 0.65 #_ REC_W
1991 7 4 302.921 0.53 #_ REC_W
1992 7 4 79.1091 0.44 #_ REC_W
1993 7 4 342.435 0.6 #_ REC_W
1994 7 4 80.9358 0.43 #_ REC_W
1995 7 4 91.2865 0.6 #_ REC_W
1996 7 4 82.3967 0.46 #_ REC_W
1997 7 4 191.02 0.48 #_ REC_W
1998 7 4 217.035 0.48 #_ REC_W
1999 7 4 52.5881 0.45 #_ REC_W
2000 7 4 14.8099 0.64 #_ REC_W
2001 7 4 6.83238 0.62 #_ REC_W
2002 7 4 15.2123 0.38 #_ REC_W
2003 7 4 61.4045 0.43 #_ REC_W
2004 7 4 22.6327 0.38 #_ REC_W
2005 7 4 291.825 0.69 #_ REC_W
2006 7 4 148.529 0.69 #_ REC_W
2007 7 4 223.654 0.4 #_ REC_W
2008 7 4 134.906 0.28 #_ REC_W
2009 7 4 142.833 0.6 #_ REC_W
2010 7 4 10.79 0.42 #_ REC_W
2011 7 4 21.0959 0.56 #_ REC_W
2012 7 4 59.6665 0.53 #_ REC_W
2013 7 4 186.978 0.39 #_ REC_W
2014 7 4 408.795 0.58 #_ REC_W
2015 7 4 156.976 0.48 #_ REC_W
2016 7 4 291.249 0.44 #_ REC_W
2017 7 4 325.491 0.44 #_ REC_W
2018 7 4 216.569 0.38 #_ REC_W
2019 7 4 181.646 0.32 #_ REC_W
2020 7 4 353.144 0.32 #_ REC_W
2021 7 4 271.643 0.21 #_ REC_W
```

```
2022 7 4 465.466 0.2 #_ REC_W
2023 7 4 726.69 0.26 #_ REC_W
-9999 0 0 0.0 0.0 # terminator for discard data
#
0 #_use meanbodysize_data (0/1)
#_COND_0 #_DF_for_meanbodysize_T-distribution_like
# note:  type=1 for mean length; type=2 for mean body weight
#_yr month fleet part type obs stderr
#  -9999 0 0 0 0 0 0 # terminator for mean body size data
#
# set up population length bin structure (note - irrelevant if not using size data and using empirical wtatage
2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
4 # binwidth for population size comp
8 # minimum size in the population (lower edge of first bin and size at age 0.00)
96 # maximum size in the population (lower edge of last bin)
2 # use length composition data (0/1/2) where 2 invokes new comp_control format
#_mintailcomp: upper and lower distribution for females and males separately are accumulated until exceeding this level.
#_addtocomp:  after accumulation of tails; this value added to all bins
#_combM+F: males and females treated as combined sex below this bin number
#_compressbins: accumulate upper tail by this number of bins; acts simultaneous with mintailcomp; set=0 for no forced accumulation
#_Comp_Error:  0=multinomial, 1=dirichlet using Theta*n, 2=dirichlet using beta, 3=MV_Tweedie
#_ParmSelect:  consecutive index for dirichlet or MV_Tweedie
#_minsamplesize: minimum sample size; set to 1 to match 3.24, minimum value is 0.001
#
#_Using new list format for composition controls
#_use negative fleet value to fill for all higher numbered fleets (recommended!)
#_must enter in fleet, partition order; but only need to enter for used combos
#_fleet = -9999 to terminate list
#_fleet partition mintailcomp addtocomp combM+F CompressBins CompError ParmSelect minsamplesize
 -1 0 0 0.0001 0 0 0 0 0.01
 2 1 0 0.0001 0 0 0 0 0.01
 2 2 0 0.0001 0 0 0 0 0.01
 3 1 0 0.0001 0 0 0 0 0.01
 3 2 0 0.0001 0 0 0 0 0.01
 4 1 0 0.0001 0 0 0 0 0.01
 4 2 0 0.0001 0 0 0 0 0.01
 -5 0 0 0.0001 0 0 0 0 0.01
 -6 0 0 0.0001 0 0 0 0 0.01
 -7 0 0 0.0001 0 0 0 0 0.01
 -8 0 0 0.0001 0 0 0 0 0.01
 -9 0 0 0.0001 0 0 0 0 0.01
 -10 0 0 0.0001 0 0 0 0 0.01
 -11 0 0 0.0001 0 0 0 0 0.01
 -9999 0 0 0 0 0 0 0 0
# sex codes:  0=combined; 1=use female only; 2=use male only; 3=use both as joint sexxlength distribution
# partition codes:  (0=combined; 1=discard; 2=retained
23 #_N_LengthBins; then enter lower edge of each length bin
 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96
#_yr month fleet sex part Nsamp datavector(female-male)
 1991 7 1 0 0 21 0 0 0 0 0 0 0 0 109.328 327.985 546.641 546.641 1967.91 2623.88 3717.16 2623.88 2405.22 2405.22 1202.61 983.954 218.656 0 0
 1992 7 1 0 0 19 0 0 0 0 0 0 0 0 0 27.3198 136.599 382.477 764.955 1447.95 2486.1 2513.42 983.513 327.838 109.279 191.239 54.6396 27.3198 0
 1993 7 1 0 0 25 0 0 0 0 0 0 0 0 0 170.449 340.898 298.285 511.347 639.183 1193.14 1704.49 1747.1 1107.92 511.347 127.837 255.673 42.6122 0
 1994 7 1 0 0 38 0 0 0 0 0 0 0 0 0 78.2548 136.946 176.073 391.274 684.729 880.366 841.239 684.729 704.293 665.165 528.22 176.073 39.1274 0
 1995 7 1 0 0 33 0 0 0 0 0 0 0 0 0 220.872 138.045 386.527 303.699 579.79 690.226 552.181 469.354 635.008 469.354 303.699 165.654 0 0
 1996 7 1 0 0 24 0 0 0 0 0 0 0 0 0 0 48.2838 241.419 386.27 386.27 337.986 675.973 337.986 820.824 1158.81 531.122 96.5676 48.2838 0
 1997 7 1 0 0 29 0 0 0 0 0 0 0 0 34.8503 17.4252 104.551 296.228 348.503 400.779 540.18 731.857 662.157 766.708 853.833 714.432 278.803 52.2755 0
 1998 7 1 0 0 73 0 0 0 0 0 0 0 7.87767 31.5107 70.8991 252.086 417.517 638.091 582.948 669.602 898.055 921.688 905.932 1189.53 1110.75 315.107 31.5107 0
 1999 7 1 0 0 91 0 0 0 0 0 0 0 0 0 149.791 264.631 554.228 689.04 694.033 753.95 828.846 833.839 823.853 873.783 833.839 224.687 34.9513 0
 2000 7 1 0 0 69 0 0 0 0 0 0 0 0 13.2875 59.7936 219.243 385.336 538.142 651.086 850.397 783.96 910.191 876.972 916.835 724.167 152.806 26.5749 0
 2001 7 1 0 0 64 0 0 0 0 0 0 0 0 0 67.4824 242.937 391.398 512.866 701.817 1052.72 1147.2 1174.19 1147.2 1228.18 917.76 404.894 53.9859 0
 2002 7 1 0 0 55 0 0 0 0 0 0 0 0 30.5631 137.534 244.505 397.321 626.544 825.205 840.486 978.021 779.36 718.234 932.176 779.36 336.195 45.8447 0
 2003 7 1 0 0 70 0 0 0 0 0 0 0 0 0 202.863 343.306 514.959 686.613 702.217 842.661 1029.92 1451.25 1451.25 1529.27 1420.04 827.056 202.863 0
 2004 7 1 0 0 62 0 0 0 0 0 0 0 0 35.1453 246.017 843.487 1230.09 1651.83 1616.68 2214.15 2249.3 1932.99 2143.86 2741.33 2143.86 808.342 281.162 0
 2005 7 1 0 0 73 0 0 0 0 0 0 0 0 0 151.595 631.644 1187.49 1591.74 1718.07 1465.42 1566.48 1414.88 985.365 808.505 631.644 480.05 126.329 0
 2006 7 1 0 0 78 0 0 0 0 0 0 0 0 0 286.156 572.312 1017.44 1875.91 2352.84 2098.48 2162.07 2448.23 2034.89 1716.94 1621.55 699.493 190.771 0
 2007 7 1 0 0 54 0 0 0 0 0 0 0 0 0 0 215.089 394.33 1147.14 1398.08 1720.71 2043.35 1828.26 1218.84 1469.78 788.661 250.938 35.8482 0
 2008 7 1 0 0 47 0 0 0 0 0 0 0 0 200.584 229.238 515.786 372.512 458.477 515.786 630.405 974.263 1346.78 888.298 687.715 429.822 143.274 0 28.6548
 2009 7 1 0 0 27 0 0 0 0 0 0 0 0 159.395 371.922 185.961 239.092 292.224 531.316 292.224 478.185 371.922 451.619 159.395 79.6975 132.829 0 0
 2010 7 1 0 0 52 0 0 0 0 0 0 0 0 45.2514 153.855 217.207 253.408 398.212 307.709 262.458 362.011 443.464 380.112 190.056 208.156 135.754 9.05028 0
 2011 7 1 0 0 33 0 0 0 0 0 0 0 0 44.7265 201.269 335.449 626.171 626.171 648.534 603.808 603.808 380.175 290.722 357.812 268.359 111.816 0 0
 2012 7 1 0 0 45 0 0 0 0 0 0 0 0 17.6603 88.3017 229.585 423.848 547.471 494.49 459.169 529.81 900.678 423.848 335.547 406.188 17.6603 0 0
 2013 7 1 0 0 36 0 0 0 0 0 0 0 0 93.5756 62.3837 280.727 249.535 935.756 1310.06 1154.1 1154.1 998.139 717.413 592.645 499.07 124.767 31.1919 0
 2014 7 1 0 0 40 0 0 0 0 0 0 0 45.1932 0 45.1932 135.58 316.353 949.058 1220.22 1988.5 1898.12 1988.5 1988.5 1400.99 1084.64 90.3864 0 0
 2015 7 1 0 0 39 0 0 0 0 0 0 0 0 196.486 392.972 130.991 261.981 720.449 1440.9 916.935 1047.93 1375.4 1768.37 1506.39 916.935 130.991 130.991 0
 2016 7 1 0 0 32 0 0 0 0 0 0 0 0 0 353.595 309.395 618.79 353.595 839.787 883.986 618.79 397.794 530.392 397.794 265.196 44.1993 44.1993 0
 2017 7 1 0 0 50 0 0 0 0 0 0 0 0 34.6835 173.418 381.519 658.987 797.721 936.456 1422.03 901.772 797.721 971.139 1040.51 554.937 173.418 0 0
 2018 7 1 0 0 64 0 0 0 0 0 0 0 0 278.675 712.17 681.206 928.918 1238.56 1269.52 928.918 1269.52 1052.77 897.954 712.17 402.531 123.856 30.9639 0
 2019 7 1 0 0 34 0 0 0 0 0 0 0 0 0 193.665 677.829 193.665 338.915 242.082 532.58 726.245 532.58 435.747 532.58 387.331 48.4164 0 0
 2021 7 1 0 0 26 0 0 0 0 0 0 0 0 0 134.383 201.575 201.575 537.533 604.725 739.108 403.15 537.533 268.767 470.341 470.341 0 0 0
 2022 7 1 0 0 79 0 0 0 0 0 0 0 0 55.3525 424.369 239.861 424.369 645.779 608.877 811.836 774.935 627.328 405.918 239.861 36.9017 18.4508 0 0
```

```
 1989 7 2 0 2 26.634 0 0 0 0 0 2288.9 9127.03 12170.7 8849.43 3553.11 3534.05 2128.97 3783.09 5545.35 3026.47 4252.57 881.957 1225.24 916.748 484.165
666.068 0 0
 1990 7 2 0 2 52.745 0 0 0 0 0 0 4203.55 7835.04 7472.92 5731.27 2958.5 2634.3 3210.77 3873.84 4077.49 3479.51 3030.16 2164.61 808.025 427.918 102.815
205.272 0
 1991 7 2 0 2 62.667 0 0 0 0 0 2404.2 5784.55 9228.98 4943.16 4125.5 4258.44 3872.81 3768.4 4238.35 5278.79 2332.49 1998.69 192.142 1011.97 707.498 10.5822
51.701 10.5822
 1992 7 2 0 2 81.467 0 0 0 0 260.644 1563.87 3437.77 3811.2 4902.1 6207.14 5160.92 3701.92 3406 3038.4 2937.74 3586.62 2952.49 2283.53 1183.53 558.502
64.706 0 0
 1993 7 2 0 2 59.534 0 0 0 0 0 219.591 2756.75 6086.22 4210 3655.09 4199.43 5867.64 4555.24 3396.86 5715.07 7425.92 5355.15 2395.3 1383.05 903.906 119.205
22.9416 0
 1994 7 2 0 2 45.434 0 0 0 103.353 378.825 837.943 1101.88 2387.42 4538.34 4462.58 5282.47 2709.01 2674.83 4151.32 5239.45 5850.72 3949.7 1862.31 690.461
207.495 91.8237 0 0
 1995 7 2 0 2 47 0 0 0 0 0 0 36.7948 1165.83 3298.08 3001.24 3098.27 2455.09 2465.53 2521.53 1620.38 6344.18 3094.93 2843.02 1444.95 740.799 63.3341
63.3341 0
 1996 7 2 0 2 51.701 0 0 0 74.0057 259.02 37.0028 109.388 403.79 2474.89 4039.52 3556.86 3405.61 3136.47 2864.09 4156.99 4516.32 3373.22 1501.4 1074.45
878.025 255.944 36.5179 134.651
 1997 7 2 0 2 68.934 0 0 0 0 0 46.5771 93.1543 754.25 2658.46 2812.66 3992.78 2623.51 3352.88 4610.47 4582.8 4025.71 3325.04 1842.19 922.173 364.764
170.836 0 0
 1998 7 2 0 2 66.845 0 0 0 0 98.5766 255.677 318.517 798.45 4274.53 4573.88 2790.38 2996.2 3321 3804.5 4921.44 5813.75 3844.86 2242.49 614.729 314.115
367.203 67.1566 0
 1999 7 2 0 2 86.168 0 0 0 0 47.9644 143.893 45.9291 1300.26 2307.1 2808.53 2382.81 1587.21 1829.28 2247.5 3062.56 3363.24 2563.4 1096.76 914.803 247.631
84.3635 20.0775 0
 2000 7 2 0 2 96.09 0 0 0 0 0 189.855 144.806 1657.86 3138.73 2229.02 1839 1218.15 1165.13 1537.41 1227.52 1576.24 1295.97 805.828 385.41 271.595 43.2403
15.0166 0
 2001 7 2 0 2 97.657 0 0 0 0 34.4431 101.622 206.659 767.287 4002.82 3863.05 2275.23 1944.86 1497.41 1255.82 1452.91 1379.61 1147.96 612.819 379.468
256.446 31.7395 0 0
 2002 7 2 0 2 90.868 0 0 0 0 0 26.2731 38.8973 1057.4 3003.95 3335.98 2503.59 2499.49 2317.63 2146.49 1873.18 1658.86 1236.29 642.153 366.945 456.487
38.8973 81.0135 0
 2003 7 2 0 2 56.401 0 0 0 10.6929 0 0 42.7021 327.598 2592.42 4091.36 3853.14 2090.12 1702.73 2001.08 1879.42 1770.46 1086.01 759.144 435.195 236.788
180.692 26.2582 0
 2004 7 2 0 2 55.878 0 0 0 0 340.101 0 170.05 612.539 2463.47 2907.75 2225.76 1510.83 1102.08 1093 1443.17 2197.71 1882.88 1331.08 617.807 477.117 186.894
29.2193 0
 2005 7 2 0 2 60.578 0 0 0 0 0 0 0 325.905 2089.33 3854.82 2665.17 1775.48 1650.98 884.403 1097.5 942.923 722.883 376.258 360.111 168.881 35.3485 45.2 0
 2006 7 2 0 2 44.389 0 0 0 0 0 39.4957 0 78.9914 2147.9 1808.96 1040.69 800.001 806.085 1240.18 934.355 1521.7 353.122 725.8 514.82 551.937 0 54.6907 0
 2007 7 2 0 2 50.134 0 0 0 0 0 0 0 81.8977 1910.32 1921.36 2313.67 1288.84 941.924 1592.49 947.702 1074.63 389.209 434.752 129.958 156.658 0 11.0397 0
 2008 7 2 0 2 46.478 0 0 0 0 0 0 0 323.254 3786.92 2565.89 1336.09 916.242 597.265 604.984 685.305 522.063 367.761 606.629 255.225 49.2002 53.5192 0 0
 2009 7 2 0 2 52.223 0 0 0 0 0 0 69.8898 397.846 2542.92 2548.66 2089.51 795.934 925.014 737.927 779.808 666.551 627.155 447.446 305.958 166.089 28.2608 0 0
 2010 7 2 0 2 39.689 0 0 0 0 0 0 0 112.185 1477.18 2702.76 2461.94 1840.77 1407.92 1263.16 776.981 694.023 351.049 499.296 212.205 134.251 15.0042 30.0083 0
 2011 7 2 0 2 54.834 0 0 0 0 0 0 112.942 112.942 1760.57 2064.92 1511.19 2304.13 1426.2 1258.65 854.07 638.978 530.557 481.51 211.937 95.768 0 0 0
 2012 7 2 0 2 67.89 0 0 0 0 0 0 0 26.0009 404.413 976.86 1560.39 1909.52 1708.81 1557.86 2175.11 2235.63 2082.24 658.986 303.809 220.828 38.9894 0 0
 2013 7 2 0 2 64.234 0 0 0 0 0 49.6587 99.3174 133.143 409.265 868.188 910.444 1627.59 1679.82 1114.4 1656.27 1376.59 1516.09 1072.34 437.806 159.032 0 0 0
 2014 7 2 0 2 63.19 0 0 0 0 26.0978 76.5364 26.8777 103.414 1879.82 1190.65 1434.78 1036.42 991.148 1203.61 1801.26 1827.45 941.09 421.739 184.336 256.736
0 0 0
 2015 7 2 0 2 65.801 0 0 0 0 0 45.2298 90.4596 474.538 1393.72 2459.77 1178.44 1621.87 821.392 1331.92 1143.52 1302.77 874.84 623.74 284.58 137.657 14.0929
0 0
 2016 7 2 0 2 51.178 0 0 0 0 0 0 6.91595 227.866 1245.42 1465.46 2120.1 1315.61 1598.82 679.147 1407.02 830.072 909.951 573.732 266.512 62.2436 86.2694 0 0
 2017 7 2 0 2 56.923 0 0 0 0 0 0 0 174.996 643.672 1414.38 957.682 1815.4 929.936 1804.16 1520.45 1160.22 1306.14 840.563 259.085 135.683 82.5569 0 0
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 2011 7 -9 0 0 226 0 0 0 0 1 0 16 33 11 22 39 17 34 25 31 29 13 8 4 4 3 0 5
 2012 7 -9 0 0 226 0 0 0 0 1 0 16 33 11 22 39 17 34 25 31 29 13 8 4 4 3 0 5
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 2019 7 -9 0 0 226 0 0 0 0 1 0 16 33 11 22 39 17 34 25 31 29 13 8 4 4 3 0 5
 2020 7 -9 0 0 226 0 0 0 0 1 0 16 33 11 22 39 17 34 25 31 29 13 8 4 4 3 0 5
 2021 -7 -9 0 0 226 0 0 0 0 1 0 16 33 11 22 39 17 34 25 31 29 13 8 4 4 3 0 5
-9999 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#
40 #_N_age_bins
 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
1 #_N_ageerror_definitions
 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
#_mintailcomp: upper and lower distribution for females and males separately are accumulated until exceeding this level.
#_addtocomp:  after accumulation of tails; this value added to all bins
#_combM+F: males and females treated as combined sex below this bin number
#_compressbins: accumulate upper tail by this number of bins; acts simultaneous with mintailcomp; set=0 for no forced accumulation
#_Comp_Error:  0=multinomial, 1=dirichlet using Theta*n, 2=dirichlet using beta, 3=MV_Tweedie
#_ParmSelect:  consecutive index for dirichlet or MV_Tweedie
#_minsamplesize: minimum sample size; set to 1 to match 3.24, minimum value is 0.001
#
#_mintailcomp addtocomp combM+F CompressBins CompError ParmSelect minsamplesize
0 1e-07 0 0 0 0 0.01 #_fleet:1_COM_LL
0 1e-07 0 0 0 0 0.01 #_fleet:2_COM_OTHER
0 1e-07 0 0 0 0 0.01 #_fleet:3_REC_E
0 1e-07 0 0 0 0 0.01 #_fleet:4_REC_W
0 1e-07 0 0 0 0 0.01 #_fleet:5_RVC_DT
0 1e-07 0 0 0 0 0.01 #_fleet:6_RVC_KEYS
0 1e-07 0 0 0 0 0.01 #_fleet:7_RVC_SEFL
0 1e-07 0 0 0 0 0.01 #_fleet:8_FIM_YOY
0 1e-07 0 0 0 0 0.01 #_fleet:9_GOM_VID
0 1e-07 0 0 0 0 0.01 #_fleet:10_SERFS_VID
0 1e-07 0 0 0 0 0.01 #_fleet:11_FI_AGE
3 #_Lbin_method_for_Age_Data: 1=poplenbins; 2=datalenbins; 3=lengths
# sex codes:  0=combined; 1=use female only; 2=use male only; 3=use both as joint sexxlength distribution
# partition codes:  (0=combined; 1=discard; 2=retained
#_yr month fleet sex part ageerr Lbin_lo Lbin_hi Nsamp datavector(female-male)
 2001 7 1 0 2 1 60 60 7 0 0 0 2 2 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2001 7 1 0 2 1 76 76 5 0 0 0 0 0 0 2 0 2 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2001 7 1 0 2 1 80 80 9 0 0 0 0 0 0 0 0 1 0 1 0 0 2 2 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 1 0
 2001 7 1 0 2 1 84 84 9 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 2 0 0 0 0 0 1 0 0 0 0 0 0 1 0 2 0 0 0 0 0 0 0
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 2002 7 1 0 2 1 68 68 10 0 0 0 0 1 2 4 0 1 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2002 7 1 0 2 1 72 72 6 0 0 0 0 0 1 1 1 1 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2002 7 1 0 2 1 76 76 8 0 0 0 0 0 0 2 0 0 1 1 0 1 1 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2002 7 1 0 2 1 80 80 10 0 0 0 0 0 0 1 0 0 0 0 0 1 1 1 0 1 0 0 0 1 0 1 0 0 0 0 0 1 1 0 1 0 0 0 0 0 0 0 0
 2002 7 1 0 2 1 84 84 15 0 0 0 0 0 0 0 0 0 1 1 0 1 0 1 4 0 0 1 0 0 1 0 0 0 0 1 1 0 0 0 0 0 2 1 0 0 0 0 0
```

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 2001 7 11 0 2 1 52 52 13 0 0 2 3 6 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2001 7 11 0 2 1 56 56 6 0 0 0 1 3 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2001 7 11 0 2 1 60 60 9 0 0 0 1 4 2 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2001 7 11 0 2 1 64 64 5 0 0 0 1 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2001 7 11 0 2 1 68 68 5 0 0 0 0 3 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2001 7 11 0 2 1 72 72 6 0 0 0 0 0 1 2 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2002 7 11 0 2 1 32 32 8 0 6 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2002 7 11 0 2 1 36 36 28 0 7 21 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2002 7 11 0 2 1 40 40 19 0 0 17 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2002 7 11 0 2 1 48 48 13 0 0 1 11 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2002 7 11 0 2 1 52 52 12 0 0 0 7 3 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2002 7 11 0 2 1 60 60 5 0 0 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2002 7 11 0 2 1 64 64 6 0 0 0 0 1 1 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2021 7 11 0 2 1 56 56 6 0 0 0 1 2 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2021 7 11 0 2 1 60 60 12 0 0 0 0 3 8 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2021 7 11 0 2 1 64 64 12 0 0 0 0 5 5 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2021 7 11 0 2 1 68 68 5 0 0 0 0 0 3 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2021 7 11 0 2 1 72 72 7 0 0 0 0 0 1 2 2 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2021 7 11 0 2 1 76 76 11 0 0 0 0 1 0 2 0 1 0 0 0 1 1 2 0 1 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2022 7 11 0 2 1 52 52 5 0 0 0 2 2 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2022 7 11 0 2 1 56 56 5 0 0 0 0 0 2 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2022 7 11 0 2 1 60 60 9 0 0 0 0 0 1 2 5 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2022 7 11 0 2 1 64 64 14 0 0 0 1 2 0 6 3 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2022 7 11 0 2 1 68 68 12 0 0 0 0 1 0 6 2 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2022 7 11 0 2 1 72 72 15 0 0 0 0 0 1 4 2 3 1 1 0 1 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 2022 7 11 0 2 1 76 76 9 0 0 0 0 0 1 0 0 0 1 2 1 0 1 2 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
-9999  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#
0 #_Use_MeanSize-at-Age_obs (0/1)
#
0 #_N_environ_variables
# -2 in yr will subtract mean for that env_var; -1 will subtract mean and divide by stddev (e.g. Z-score)
#Yr Variable Value
#
# Sizefreq data. Defined by method because a fleet can use multiple methods
-3 # N sizefreq methods to read (or -1 for expanded options)
3 # N sizefreq methods to read
# each row below has entry for each sizefreq method
#_ 1 2 3  # Method
 18 18 18 #_Sizefreq N bins
 2 2 2 #_Sizefreq units(1=bio/2=num)
 3 3 3 #_Sizefreq scale(1=kg/2=lbs/3=cm/4=inches)
 1e-07 1e-07 1e-07 #_Sizefreq:  small constant to add to comps
 12 19 7 #_Sizefreq number of obs per method
 0 0 0 #_Comp_Error:  0=multinomial, 1=dirichlet using Theta*n, 2=dirichlet using beta, 3=MV_Tweedie
 0 0 0 #_ParmSelect: consecutive index for dirichlet or MV_Tweedie comp_error
#_Sizefreq bins. one row for each method
```

```
#Note: negative value for first bin makes it accumulate all smaller fish vs. truncate small fish
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
#_method year month fleet sex partition SampleSize <data>
 1 1999 7 5 0 0 29 0 0 0.00156 0 0.0078 0.00156 0.00312 0.01872 0.01092 0.0156 0.00312 0.00624 0.00156 0.00156 0.00156 0 0 0
 1 2000 7 5 0 0 44 0 0 0.00127886 0 0.00895203 0.0102309 0.0115097 0.0214209 0.0246181 0.00895203 0.00767317 0.00511544 0 0.00127886 0 0 0 0
 1 2004 7 5 0 0 127 0.00490452 0 0.00163484 0.0040871 0.00081742 0.00953602 0.0196181 0.0416884 0.0286097 0.02534 0.0188007 0.0188007 0.0138961
0.00735678 0.00245226 0.00081742 0 0
 1 2006 7 5 0 0 93 0.000986667 0 0 0.000986667 0.00296 0.0108533 0.0138133 0.0187467 0.02368 0.0197333 0.0138133 0.0148 0.00690667 0.00493333 0.00296
0.000986667 0 0
 1 2008 7 5 0 0 181 0 0 0.000724673 0.00217402 0.00851491 0.0184792 0.0266317 0.0543505 0.0326103 0.035509 0.0181168 0.0210155 0.00869607 0.00289869
0.00144935 0.00144935 0 0
 1 2010 7 5 0 0 229 0.00137661 0 0.00344152 0.00929211 0.0206491 0.0311458 0.0545481 0.0600546 0.038373 0.0351035 0.0227141 0.0275322 0.00825966
0.00688305 0 0.00137661 0 0
 1 2012 7 5 0 0 279 0.00129427 0 0.000647137 0 0.00582423 0.0129427 0.0388282 0.0627723 0.0679494 0.0530653 0.0271798 0.0310626 0.0155313 0.00970706
0.00323569 0 0 0
 1 2014 7 5 0 0 223 0 0 0 0.000668512 0.00133702 0.0147073 0.0140387 0.0207239 0.030083 0.0407792 0.0314201 0.0354311 0.0193868 0.0100277 0.00401107
0.00200554 0 0
 1 2016 7 5 0 0 215 0 0 0 0.0031618 0.00863928 0.0464027 0.0577888 0.0590499 0.0696932 0.0559184 0.0445324 0.0457205 0.017145 0.00801583 0.013805
0.000890648 0 0.00445324
 1 2018 7 5 0 0 232 0 0 0 0.00299582 0.0104854 0.0314561 0.0322051 0.0411925 0.0441884 0.032954 0.0411925 0.0307072 0.0157281 0.00973642 0.00599164 0 0
0.00224687
 1 2021 7 5 0 0 182 0 0 0 0 0.00666167 0.0366392 0.0549588 0.0932633 0.0899325 0.07994 0.07994 0.0666167 0.0566242 0.0183196 0.0116579 0.00333083 0
0.00166542
 1 2023 7 5 0 0 149 0 0 0 0 0.0081677 0.0326708 0.081677 0.103458 0.138851 0.111625 0.0925672 0.0925672 0.0326708 0.0245031 0.00272257 0 0 0
 2 1997 7 6 0 0 24 0 0 0 0.0133389 0.0044463 0.0311241 0.0289009 0.0333472 0.0044463 0 0.0044463 0 0 0 0 0 0 0
 2 1999 7 6 0 0 29 0 0 0.0106832 0.0133541 0.0213665 0.0240373 0.0133541 0.00534162 0.00267081 0.00801243 0 0 0 0 0 0 0 0
 2 2000 7 6 0 0 61 0 0 0.00786556 0.014158 0.0251698 0.0319877 0.0445725 0.0194028 0.0173042 0.00734014 0.00314622 0.00157311 0 0 0 0 0 0
 2 2001 7 6 0 0 89 0 0 0.00125677 0.00251354 0.00879738 0.00879738 0.0188515 0.0301625 0.0238786 0.0263922 0.0109967 0.016338 0.0106825 0.00345612
0.00125677 0 0 0
 2 2002 7 6 0 0 85 0 0 0.00537887 0.00941302 0.011206 0.00956183 0.0143436 0.0316744 0.0125507 0.0145678 0.016809 0.00986126 0.00896478 0.00268943
0.000896478 0.00179296 0 0
 2 2003 7 6 0 0 64 0 0 0.00353497 0.0118903 0.00385633 0.0102835 0.0244234 0.0154253 0.0205671 0.0244234 0.0162814 0.0167108 0.00642721 0.00514177
0.0089981 0.00385633 0 0
 2 2004 7 6 0 0 42 0 0 0.00676724 0 0.00902299 0.0157902 0.0225575 0.0406034 0.0293247 0.0236853 0.00451149 0.027069 0.00338362 0.00902299 0 0.00451149
0 0
 2 2005 7 6 0 0 86 0 0 0.00615383 0.0205128 0.0123077 0.025641 0.0317948 0.0307691 0.0215384 0.0246153 0.0102564 0.00717947 0 0.00102564 0 0.00102564 0
0
 2 2006 7 6 0 0 75 0 0 0.00118908 0.00594539 0.00713447 0.0202143 0.0285379 0.0303215 0.0249706 0.0261597 0.00832355 0.00772901 0.00237816 0.00475631
0 0 0 0
 2 2007 7 6 0 0 137 0 0 0.00170417 0.00596458 0.0136333 0.0274797 0.0483557 0.0498469 0.0323792 0.0313141 0.0198109 0.0183198 0.00681667 0.00681667
0.000852083 0.00255625 0 0
 2 2008 7 6 0 0 152 0 0 0.0043659 0.00349272 0.0183368 0.0456237 0.0416943 0.0454054 0.0218295 0.0235759 0.00960498 0.00611226 0.0043659 0.00349272 0 0
0 0
 2 2009 7 6 0 0 190 0.000526709 0 0.00158013 0.0121143 0.0184348 0.0268622 0.0294957 0.0305491 0.0158013 0.0121143 0.00526709 0.00632051 0.00210684
0.00263355 0 0 0 0
 2 2010 7 6 0 0 94 0 0 0 0.000882083 0.00617458 0.0149954 0.0229342 0.0344013 0.0220521 0.0132312 0.00352833 0.00441042 0.00176417 0.00264625 0 0 0 0
 2 2011 7 6 0 0 130 0 0 0 0.00174042 0.00638153 0.0121829 0.0179843 0.0365487 0.016824 0.0104425 0.00580139 0.0110226 0.00406097 0.00232056 0 0 0 0
 2 2012 7 6 0 0 168 0 0 0.0011802 0.00472081 0.0112119 0.0324556 0.0247842 0.0253743 0.0230139 0.0147525 0.0141624 0.0112119 0.00531091 0.00531091
0.0017703 0 0 0
 2 2014 7 6 0 0 124 0 0 0.000876367 0.00635366 0.0138028 0.0592284 0.0533234 0.0472607 0.0439744 0.0197919 0.0103078 0.0026291 0.00388055 0.00467454
0.000876367 0 0 0
 2 2016 7 6 0 0 121 0.00123599 0 0.00412079 0.0252364 0.0763224 0.124098 0.0691858 0.0291496 0.0126689 0.00865193 0.00494396 0.00123599 0 0 0 0 0 0
 2 2018 7 6 0 0 185 0.000898121 0 0.00538873 0.00898121 0.0349513 0.0777611 0.0757385 0.0567307 0.0356249 0.0107775 0.0134718 0.0116756 0.00359248 0 0
0 0 0
 2 2022 7 6 0 0 80 0.00540974 0 0.0324584 0.0189341 0.0513925 0.113604 0.0703266 0.0378682 0.0351633 0.0243438 0.00270487 0.00270487 0.0108195
0.00540974 0 0 0 0
 3 2013 7 7 0 0 222 0.000400299 0 0.00426959 0.019481 0.0262845 0.0425646 0.0334914 0.0184138 0.00600449 0.0024018 0.0016012 0.000400299 0 0.000400299
0 0 0 0
 3 2014 7 7 0 0 164 0 0 0.0063473 0.0142814 0.0309431 0.0483981 0.0626796 0.036497 0.0174551 0.0103144 0.00158682 0.000793412 0 0 0 0 0 0
 3 2015 7 7 0 0 118 0.000965759 0 0.00289728 0.0193152 0.0328358 0.0502195 0.0434591 0.0202809 0.0144864 0.000965759 0.00193152 0 0.000965759 0 0 0 0 0
 3 2016 7 7 0 0 180 0.000930167 0 0.0144176 0.0414706 0.0690649 0.0952658 0.0916233 0.0482924 0.0353463 0.0140306 0.0027905 0.00302304 0 0.00186033
0.0027905 0.000930167 0 0
 3 2018 7 7 0 0 242 0 0 0.019458 0.083819 0.176619 0.213289 0.137204 0.0583739 0.0376687 0.00299353 0.00199569 0 0 0.000997845 0 0 0 0
 3 2021 7 7 0 0 148 0.00177455 0 0.0204074 0.047913 0.171245 0.305223 0.0905023 0.031942 0.0177456 0.0124219 0.00354911 0.00354911 0 0 0 0 0 0
 3 2022 7 7 0 0 144 0 0 0.0575885 0.183616 0.155656 0.206568 0.0893039 0.0350539 0.0166923 0 0 0.0050077 0 0 0 0 0 0
#
0 # do tags (0/1/2); where 2 allows entry of TG_min_recap
#
0 #    morphcomp data(0/1)
#  Nobs, Nmorphs, mincomp
#  yr, seas, type, partition, Nsamp, datavector_by_Nmorphs
#
0  #  Do dataread for selectivity priors(0/1)
# Yr, Seas, Fleet,  Age/Size,  Bin,  selex_prior,  prior_sd
# feature not yet implemented
#
999
```