SEDAR

Southeast Data, Assessment, and Review

SEDAR 74

Gulf of Mexico Red Snapper

SECTION III: Data Workshop Report

October 2022

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

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

1 INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 74 Data Workshop was held May 2-6, 2022, in Gulfport, MS. In addition to the in-person workshop, a series for webinars were held before (August 2021, March - April 2022) and after (April-August 2022) the meeting.

1.2 TERMS OF REFERNCE

1. Definition of assessment unit stock will be developed through the red snapper Stock ID process and will be added to TORs once process is complete.

2. Review, discuss, and tabulate available life history information for each stock being assessed.
    - Evaluate age, growth, natural mortality, and reproductive characteristics
        - Explore the validity of age data and methodology across ageing facilities
    - Explore differences in growth parameters, spawning fractions, and fecundity data across area
    - Provide appropriate models to describe population and stock specific (if warranted) growth, maturation, and fecundity by age, sex, or length as applicable.
    - Evaluate and discuss the sources of uncertainty and error, and data limitations (such as temporal and spatial coverage) for each data source. Provide estimates or ranges of uncertainty for all life history information.

3. Provide measures of population abundance that are appropriate for stock assessment.
    - Consider all available and relevant fishery-dependent and -independent data sources
    - Document all programs evaluated; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics.
    - Provide maps of fishery and independent survey coverage.
    - Develop fishery and survey CPUE indices by appropriate strata (e.g., age, size, area, and fishery).
    - Provide appropriate measures of uncertainty for the abundance indices to be used in stock assessment models.
    - Document pros and cons of available indices regarding their ability to represent abundance.
    - Categorize the available indices into one of three tiers: Suitable and Recommended, Suitable and Not Recommended, or Not Suitable; *provide each categorization.*
    - For recommended indices, document any known or suspected temporal patterns in catchability not accounted for by standardization.

4. Provide commercial catch statistics for each stock being assessed, including both landings and discards in both pounds and number.
    - Evaluate and discuss the adequacy of available data for accurately characterizing landings and discards by fishery sector or gear.
    - Provide length and age distributions for both landings and discards if feasible.
    - Provide estimates of uncertainty around each set of landings and discard estimates.

5. Provide recreational catch statistics for each stock being assessed, including both landings and discards in both pounds and number.
   - Evaluate and discuss the adequacy of available data for accurately characterizing landings and discards by fishery sector or gear.
     - Specifically explore the transition from MRIP CHTS to FES
     - Specifically explore the Gulf state-specific data collection programs for red snapper for evaluating catch and effort data (i.e. LA Creel, Tails 'n Scales. Snapper Check, and State Reef Fish Survey)
     - Explore whether the recreational fleet structure can be realigned into individual fleets (private, charter, and headboat) or into a private fleet and a for-hire fleet (charter and headboat combined)
   - Provide length and age distributions for both landings and discards if feasible.
   - Provide estimates of uncertainty around each set of landings and discard estimates.

6. Recommend discard mortality rates.
   - Review available research and published literature.
     - Consider research directed at red snapper as well as similar species from the southeastern United States and other areas.
   - Provide estimates of discard mortality rate by fishery, gear type, depth, and other feasible or appropriate strata.
     - Comment specifically on research detailing the efficacy of descending devices, including their adoption, prevalence of use, and effect on discard mortality
   - Provide estimates of uncertainty around recommended discard mortality rates
   - Document the rationale for recommended rates and uncertainties.

7. Explore the relationship among shrimp bycatch and juvenile red snapper mortality with emphasis on investigation of incorporating potential density-dependent juvenile mortality.

8. Consider the estimates and associated uncertainty derived from the "Great Red Snapper Count" and other independent studies. Provide recommendations for use in the assessment process.

9. Incorporate social and economic information into the stock assessment considerations as practicable.

10. Describe any known evidence regarding ecosystem, climate, species interactions (e.g. predation studies), habitat considerations, species range modifications (expansions or contractions) and/or episodic events (including red tide, upwelling events, and hypoxia) that would reasonably be expected to affect red snapper population dynamics.

11. Develop an updated Connectivity Modeling Simulation recruitment index for recruitment forecasting.

- Explore potential hypotheses to link the ecosystem and climatic events identified to population and fishery parameters.

12. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.

13. Prepare a Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines.

1.3 LIST OF PARTICIPANTS

Assessment Development Team
LaTreese Denson, Co-Lead Analyst .... SEFSC/NMFS
Matt Smith, Co-Lead Analyst .... SEFSC/NMFS
Luiz Barbieri .... GMFMC SSC/FWRI
David Chagaris .... GMFMC SSC/UFL
Paul Mickle .... GMFMC SSC/MS State
Will Patterson .... GMFMC SSC/UFL
Katie Siegfried .... SEFSC/NMFS
Jim Tolan .... GMFMC SSC/TPWD

Data Process Participants
David Die (Chair) .... UM
Jason Adriance .... SSC/LDWF
Sydney Alhale .... NOAA/CIMAS
Robert Allman .... NMFS Panama City
Beverly Barnett .... NMFS Panama City
Donna Bellais .... GSMFC
Ken Brennan .... NMFS Beaufort
Nancy Brown-Peterson .... USM
Matt Campbell .... SEFSC Pascagoula
Rob Cheshire .... NMFS
Francesca Forrestal .... NMFS Miami
Troy Frady .... Alabama CFH
Chris Gardner .... SEFSC/ NMFS
Steve Garner .... SEFSC/NMFS
Carissa Gervasi .... UM/CIMAS
Eric Gigli .... MDMR
Buddy Guindon .... Katie's Seafood
David Hanisko .... NMFS Pascagoula
Erik Lang .... LDWF
Dominique Lazarre .... FL FWC
Susan Lowerre-Barbieri .... FL FWC
John Mareska .... SSC/AL DCNR
Johnny Marquez .... MS Wildlife Fed

Vivian Matter .... SEFSC Miami
Kevin McCarthy .... NMFS Miami
Trevor Moncrief .... MS DMR
Heather Moncrief-Cox .... NMFS/CIMAS
Peter Mudrak .... LGL Ecological Assoc
Jim Nance .... SSC
Craig Newton .... ADCNR/MRD
Matthew Nuttall .... SEFSC Miami
Will Patterson .... SSC/UFL
Adam Pollack .... NMFS Pascagoula
Beverly Sauls .... FWC-FWRI
Eric Schmidt .... Ft. Meyers Charter Captian
Steven Scyphers .... SSC/Northeastern University
Steve Smith .... UM/CIMAS
Molly Stevens .... NMFS Miami
Ted Switzer .... FL FWCC
Kevin Thompson .... FL FWCC
Julie Vecchio .... FWC
David Walker .... Walker Fishing Fleet
Wayne Werner .... Commercial Fisherman - Alachua
Naeem Willett .... SEFSC/NMFS
Johnny Williams .... Williams Party Boats

Workshop Observers
Kevin Anson .... AL DCNR
Scott Bannon .... ADMR
Michael Drexler .... Ocean Conservancy
Martha Guyas .... ASA
Chris Horton .... Congressional Sportsmen's Foundation
Ralph Humphrey .... MS Gulf Fishing Banks
Greg Johnson .... Auburn Univ
Anna Millender .... USM
Bob Zales .... SOFA

Council Representation
Susan Boggs .... GMFMC
Dale Diaz .... GMFMC
Tom Frazer .... GMFMC

Staff
Julie Neer .... SEDAR
Judd Curtis .... SAFMC Staff
Karen Hoak .... GMFMC Staff
Lisa Hollensead .... GMFMC Staff
Michael Larkin .... NMFS/SERO
Ryan Rindone .... GMFMC Staff

Charlotte Schiaffo .... GMFMC Staff
Carrie Simmons .... GMFMC Staff

Other Observers

Mark Albins .... DISL
Lisa Ailloud .... SEFSC/NMFS
Sarina Atkinson .... NMFS Miami
Oscar Ayala .... FWC
Larry Beerkircher .... SEFSC/NMFS
Kristan Blackhart .... NOAA
Harry Blanchet .... LADWF
Chris Bradshaw .... FWC
Richard Cody .... NOAA
Ellie Corbett .... FWC
Tiffanie Cross .... FWC
Matthew Doster .... FWC
Kelly Fitzpatrick .... SEFSC Beaufort
John Foster .... NOAA S&T
Benny Gallaway .... SSC/ LGL Ecological Associates
Bob Gill ....
Wade Hardy .... MS DMR
Mandy Karnauskas .... NMFS Miami
Maxx Lee .... Mote Marine Lab
Alan Lowther .... NMFS Miami
Stephanie Martinez-Rivera .... NMFS Miami
Isabella Masarik .... NOAA
Matt McPherson .... NOAA
Hayden Menendez .... FWC
Carole Neidig .... Mote Marine Lab
Refik Orhun .... SEFSC Miami
Kate Overly .... SEFSC/NMFS
Kellie Ralston .... ASA
Chloe Ramsay .... FWC
Jeff Rester .... GSMFC
Charlie Robertson .... GSMFC
Ashford Rosenberg .... Shareholders Alliance
Jan Mock Schaeffer ....
Skyler Sagarese .... SEFSC/NMFS
Liz Scott-Denton .... SEFSC/NMFS
Tom Sminkey .... NOAA
Carly Somerset .... GMFMC Staff
Ana Vaz .... NOAA

1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS

Document #	Title	Authors	Date Submitted
Documents Prepared for the Stock ID Process			
SEDAR74-SID-01	Hot Spot Maps of General Recreational Landings for Gulf of Mexico Red Snapper	Matthew A. Nuttall and Vivian M. Matter	25 February 2021
SEDAR74-SID-02	A Lagrangian biophysical modeling framework informs stock structure and spawning-recruitment of red snapper (*Lutjanus campechanus*) in the northern Gulf of Mexico	M. Karnauskas and C. B. Paris	12 March 2021
SEDAR74-SID-03	Insights into the Spatial Dynamics of Red Snapper in the Gulf of Mexico from Gulf-Wide Fishery Independent Surveys	Theodore S. Switzer, Adam G. Pollack, Katherine E. Overly, Christopher Gardner, Kevin A. Thompson, Matt Campbell	15 March 2021
SEDAR74-SID-04	Mississippi Red Snapper Data Summary	Trevor Moncrief	12 March 2021
SEDAR74-SID-05	Spatial analysis of Southeast Regional Headboat Survey Catch Records	Nikolai Klibansky	29 July 2021
SEDAR74-SID-06	Some thoughts on dividing the northern Gulf of Mexico red snapper stock into eastern and western components at the statistical area 9/10 border	Benny J. Gallway and Peter A. Mudrak	30 July 2021
Documents Prepared for the Data Workshop			
SEDAR74-DW-01	General Recreational Survey Data for Red Snapper in the Gulf of Mexico	Nuttall, MA	26 January 2022 Updated: 10 June 2022

SEDAR74-DW-02	Reef Fish Observer Program Metadata	Sarina Atkinson, Judy Gocke, Stephanie Martinez, Elizabeth Scott-Denton	15 December 2021
SEDAR74-DW-03	Coastal Fisheries Logbook Program Metadata	Sarina Atkinson, Michael Judge, Refik Orhun	15 December 2021
SEDAR74-DW-04	LA Creel/MRIP Red Snapper Private Mode Landings and Discards Calibration Procedure	Office of Fisheries Louisiana Department of Wildlife and Fisheries	19 January 2022 Updated: 24 February 2022 4 May 2022
SEDAR74-DW-05	Florida State Reef Fish Survey Metadata	Tiffanie Cross	23 January 2022
SEDAR74-DW-06	A description of Florida's Gulf Coast recreational fishery and release mortality estimates for the central and eastern subregions (Mississippi, Alabama, and Florida) with varying levels of descender use	Julie L. Vecchio, Dominique Lazarre, Beverly Sauls, Marie Head, Trevor Moncrief	8 March 2022
SEDAR74-DW-07	Size and age information for Red Snapper, *Lutjanus campechanus*, collected in association with fishery-dependent projects along Florida's Gulf of Mexico coast	Julie Vecchio, Jessica Carrol, Dominque Lazarre, Beverly Sauls	3 March 2022
SEDAR74-DW-08	Electronic Monitoring Documentation of Red Snapper (*Lutjanus campechanus*) Catches in the Eastern Gulf of Mexico Commercial Reef Fish Bottom Longline Fishery	Max Lee, Carole Neidig, and Daniel Roberts	18 March 2022
SEDAR74-DW-09	The Reproductive Biology of Red Snapper in Mississippi Waters	Nancy J. Brown-Peterson and Anna K. Millender	12 April 2022 Updated: 31 May 2022 Updated: 14 June 2022

SEDAR74-DW-10	Methodology Description for a Simple Ratio Calibration of Texas Private Boat Red Snapper Annual Landings Estimates	NMFS Office of Science and Technology	15 April 2022
SEDAR74-DW-11	Evaluating Uncertainty in Gulf Red Snapper Estimates: A Preliminary Sensitivity Analysis of Non-Sampling Errors in the Region's Recreational Fishing Surveys	NMFS Office of Science and Technology	15 April 2022
SEDAR74-DW-12	SEFSC Computation of Uncertainty for General Recreational Landings-in-Weight Estimates, with Application to SEDAR 74 Gulf of Mexico Red Snapper	Matthew Nuttall and Kyle Dettloff	15 April 2022
SEDAR74-DW-13	Standardized Catch Rate Indices for Red Snapper (*Lutjanus campechanus*) during 1981-2019 by the U.S. Gulf of Mexico Charterboat and Private Boat Recreational Fishery	Gulf Fisheries Branch, Sustainable Fisheries Division	14 April 2022
SEDAR74-DW-14	Trip Interview Program Metadata	Sarah Beggerly, Molly Stevens, and Heather Baertlein	15 April 2022
SEDAR74-DW-15	Gulf of Mexico Red Snapper (*Lutjanus campechanus*) Commercial and Recreational Landings Length and Age Compositions	Molly H. Stevens	15 April 2022 Updated: 1 July 2022
SEDAR74-DW-16	System dynamics of red snapper populations in the Gulf of Mexico to support ecosystem considerations in the assessment and management process	Carissa Gervasi, Matthew McPherson, and M. Karnauskas	15 April 2022
SEDAR74-DW-17	Standardized Catch Rate Indices for Red Snapper (*Lutjanus campecanus*) during 1993-2006 by the U.S. Gulf of Mexico Vertical Line Fishery	Gulf of Mexico Branch, Sustainable Fisheries Division	15 April 2022
SEDAR74-DW-18	A Summary of Observer Data from the Size Distribution of Red Snapper Discards from Recreational	Dominique Lazarre	15 April 2022

	Fishery Surveys in the Eastern Gulf of Mexico		
SEDAR74-DW-19	CPUE Expansion Estimation for Commercial Discards of Gulf of Mexico Red Snapper	Stephanie Martínez Rivera, Sarina Atkinson, Steven G. Smith, Kevin J. McCarthy	15 April 2022
SEDAR74-DW-20	Gulf of Mexico Red Snapper (*Lutjanus campechanus*) Smooth Age Length Keys	Lisa E. Ailloud	15 April 2022
SEDAR74-DW-21	Using a Censored Regression Modeling Approach to Standardized Catch Per Unit Effort for Red Snapper (Lutjanus campechanus) during 1986-2019 from the Southeast Region Headboat Survey in the U.S. Gulf of Mexico	Gulf of Mexico Fisheries Branch	18 April 2022 Updated: 27 May 2022
SEDAR74-DW-22	Commercial Landings of Red Snapper (*Lutjanus campechanus*) from the Gulf of Mexico 1964 - 2020	M. Refik Orhun	19 April 2022
SEDAR74-DW-23	Indices of abundance for Red Snapper (*Lutjanus campechanus*) on natural reefs in the eastern Gulf of Mexico using combined data from three independent video surveys	Kevin A. Thompson, Theodore S. Switzer, Mary C. Christman, Sean F. Keenan, Christopher Gardner, Katherine E. Overly, Matt Campbell	20 April 2022 Updated: 27 April 2022 Updated: 26 May 2022
SEDAR74-DW-24	Develop an updated Connectivity Modeling Simulation recruitment index for recruitment forecasting	Ana Vaz and M. Karnauskas	27 April 2022
SEDAR74-DW-25	Summary of Management Actions for Red Snapper (Lutjanus campechanus) from the Gulf of Mexico (1984 - 2022) as Documented within the Management History Database	G. Malone, K. Godwin, S. Atkinson, A. Rios	29 April 2022

SEDAR74-DW-26	Red Snapper Abundance Indices from Bottom Longline Surveys in the Northern Gulf of Mexico	Adam G. Pollack and David S. Hanisko	28 April 2022
SEDAR74-DW-27	Indices of abundance for Red Snapper (*Lutjanus campechanus*) on artificial reefs on the West Florida Shelf from stationary video surveys	Kevin A. Thompson, Theodore S. Switzer, and Sean F. Keenan	29 April 2022
SEDAR74-DW-28	SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Red Snapper	Matthew D. Campbell, Kevin R. Rademacher, Paul Felts, Joseph Salisbury, Jack Prior	29 April 2022 Updated: 4 May 2022
SEDAR74-DW-29	Gulf State Recreational Catch and Effort Surveys Transition Workshop Summary Report	Gulf MRIP Transition Team	29 April 2022
SEDAR74-DW-30	Red Snapper Abundance Indices from Groundfish Surveys in the Northern Gulf of Mexico	Adam G. Pollack and David S. Hanisko	1 May 2022
SEDAR74-DW-31	Red Snapper (*Lutjanus campechanus*) larval indices of relative abundance from SEAMAP Fall Plankton Surveys, 1986 to 2019	David S. Hanisko, Adam G. Pollack, Denice M. Drass, Pamela J. Bond, Christina Stepongzi, Taniya Wallace, Andrew Millet, Christian M. Jones, Glenn Zapfe and Consuela Cowan	2 May 2022 Updated: 13 July 2022
SEDAR74-DW-32	Co-Producing a Shared Characterization of Depredation in the Gulf of Mexico Reef Fish Fishery: 2022 Workshop Summary Report	Marcus Drymon, Ana Osowski, Amanda Jefferson, Alena Anderson, Danielle McAree, Steven Scyphers, Evan Prasky, Savannah Swinea, Sarah Gibbs, Mandy Karnauskas, Carissa Gervasi	2 May 2022

SEDAR74-DW-33	Fisherman Feedback: Red Snapper - Response Summary	Gulf of Mexico Fishery Council Staff	4 May 2022
SEDAR74-DW-34	Description of age, growth, and natural mortality of Red Snapper from the northern Gulf of Mexico 1980 and 1986-2019	Steven Garner, Robert Allman, Beverly Barnett and Naeem Willett	20 May 2022
SEDAR74-DW-35	Red Snapper General Recreational Open and Closed Season Discard Development	Gulf of Mexico Fisheries Branch	24 June 2022
SEDAR74-DW-36	Best practices for standardized reproductive data and methodology to estimate reproductive parameters for Red Snapper in the Gulf of Mexico	Susan Lowerre-Barbieri, Claudia Friess, Nancy Brown-Peterson, Heather Moncrief-Cox, and Beverly Barnett	30 June 2022 Update: 5 July 2022 Updated: 25 July 2022 Updated: 25 August 25
SEDAR74-DW-37	Estimation of length composition of commercial discards for Gulf of Mexico red snapper	Smith, S.G., S. F. Atkinson, and S. Martinez-Rivera	12 August 2022
SEDAR74-DW-38	Estimation of a Post-IFQ Commercial Vertical Line Abundance Index for Gulf of Mexico Red Snapper Using Reef Fish Observer Data	Smith, S.G.	30 August 2022
SEDAR74-DW-39	SEAMAP Vertical Longline Survey (2012-2021): Indices of Abundance of Gulf of Mexico Red Snapper, *Lutjanus campechanus*	Mark Albins, John Mareska, Sean Powers	13 July 2022
SEDAR74-DW-40	Modeling fecundity at age in Gulf of Mexico Red Snapper to help evaluate the best measure of reproductive potential	Susan Lowerre-Barbieri and Claudia Friess	18 July 2022

Reference Documents

SEDAR74-RD01	Data Availability for Red Snapper in Gulf of Mexico and Southeastern U.S. Atlantic Ocean Waters	R. Ryan Rindone, G. Todd Kellison & Stephen A. Bortone
SEDAR74-RD02	Fine-Scale Movements and Home Ranges of Red Snapper around	Maria N. Piraino & Stephen T. Szedlmayer

	Artificial Reefs in the Northern Gulf of Mexico	
SEDAR74-RD03	Influence of Age-1 Conspecifics, Sediment Type, Dissolved Oxygen, and the Deepwater Horizon Oil Spill on Recruitment of Age-0 Red Snapper in the Northeast Gulf of Mexico during 2010 and 2011	Stephen T. Szedlmayer & Peter A. Mudrak
SEDAR74-RD04	Depth and Artificial Reef Type Effects on Size and Distribution of Red Snapper in the Northern Gulf of Mexico	J. Jaxion-Harm & S. T. Szedlmayer
SEDAR74-RD05	A cage release method to improve fish tagging studies	Laura Jay Williams*, Jennifer L. Herbig, Stephen T. Szedlmayer
SEDAR74-RD06	Mortality Estimates for Red Snapper Based on Ultrasonic Telemetry in the Northern Gulf of Mexico	Laura Jay Williams-Grove & Stephen T. Szedlmayer
SEDAR74-RD07	Acoustic positioning and movement patterns of red snapper *Lutjanus campechanus* around artificial reefs in the northern Gulf of Mexico	Laura Jay Williams-Grove & Stephen T. Szedlmayer
SEDAR74-RD08	Depth preferences and three-dimensional movements of red snapper, *Lutjanus campechanus*, on an artificial reef in the northern Gulf of Mexico	Laura Jay Williams-Grove & Stephen T. Szedlmayer
SEDAR74-RD09	A Comparison of Fish Assemblages According to Artificial Reef Attributes and Seasons in the Northern Gulf of Mexico	J. Jaxion-Harm, S. T. Szedlmayer & P.A. Mudrak
SEDAR74-RD10	A Comparison of Fish and Epibenthic Assemblages on Artificial Reefs with and without Copper-Based, Anti-Fouling Paint	Stephen T. Szedlmayer & Dianna R. Miller
SEDAR74-RD11	Movement patterns of red snapper *Lutjanus campechanus* based on acoustic telemetry around oil and gas platforms in the northern Gulf of Mexico	Aminda G. Everett, Stephen T. Szedlmayer, Benny J. Gallaway
SEDAR74-RD12	Changes in Shrimping Effort in the Gulf of Mexico and the Impacts to Red Snapper	Benny J. Gallaway, Scott W. Raborn, Laura Picariello, and Nathan F. Putman

SEDAR74-RD13	Using Common Age Units to Communicate the Relative Catch of Red Snapper in Recreational, Commercial, and Shrimp Fisheries in the Gulf of Mexico	Nathan F. Putman & Benny J. Gallaway
SEDAR74-RD14	Distribution and Age Composition of Red Snapper across the Inner Continental Shelf of the North-Central Gulf of Mexico	Sean P. Powers, J. Marcus Drymon,[1] Crystal L. Hightower, Trey Spearman, George S. Bosarge, and Amanda Jefferson
SEDAR74-RD15	Age and growth of red snapper, *Lutjanus campechanus*, from an artificial reef area off Alabama in the northern Gulf of Mexico	William F. Patterson III, James H. Cowan Jr, Charles A. Wilson, and Robert L. Shipp
SEDAR74-RD16	Red snapper (*Lutjanus campechanus*) demographic structure in the northern Gulf of Mexico based on spatial patterns in growth rates and morphometrics	Andrew J. Fischer, M. Scott Baker Jr., and Charles A. Wilson
SEDAR74-RD17	Temporal Age Progressions and Relative Year-Class Strength of Gulf of Mexico Red Snapper	Robert J. Allman and Gary R. Fitzhugh
SEDAR74-RD18	Age structure of red snapper (*Lutjanus campechanus*) in the Gulf of Mexico by fishing mode and region	Robert J. Allman, Linda A. Lombardi-Carlson, Gary R. Fitzhugh, and William A. Fable
SEDAR74-RD19	Regional differences in the age and growth of red snapper (*Lutjanus campechanus*) in the U.S. Gulf of Mexico	Courtney R. Saari, James H. Cowan Jr., and Kevin M. Boswell
SEDAR74-RD20	A Comparison of Size Structure, Age, and Growth of Red Snapper from Artificial and Natural Habitats in the Western Gulf of Mexico	Matthew K. Streich, Matthew J. Ajemian, Jennifer J. Wetz, Jason A. Williams, J. Brooke Shipley & Gregory W. Stunz
SEDAR74-RD21	A comparison of size and age of red snapper (*Lutjanus campechanus*) with the age of artificial reefs in the northern Gulf of Mexico	Tara S. Syc and Stephen T. Szedlmayer
SEDAR74-RD22	Age and growth of red snapper, *Lutjanus campechanus,* from the northern Gulf of Mexico off Louisiana	Charles A. Wilson and David L. Nieland

SEDAR74-RD23	Cross-shelf habitat shifts by red snapper (*Lutjanus campechanus*) in the Gulf of Mexico	Michael A. Dance and Jay R. Rooker
SEDAR74-RD24	Habitat-Specific Reproductive Potential of Red Snapper: A Comparison of Artificial and Natural Reefs in the Western Gulf of Mexico	Charles H. Downey, Matthew K. Streich, Rachel A. Brewton, Matthew J. Ajemian, Jennifer J. Wetz, and Gregory W. Stunz
SEDAR74-RD25	A meta-analytical review of the effects of environmental and ecological drivers on the abundance of red snapper (*Lutjanus campechanus*) in the U.S. Gulf of Mexico	Brad E. Erisman, Derek G. Bolser, Alexander Ilich, Kaitlin E. Frasier, Cassandra N. Glaspie, Paula T. Moreno, Andrea Dell'Apa, Kim de Mutsert, Mohammad S. Yassin, Sunil Nepal, Tingting Tang, Alexander E. Sacco
SEDAR74-RD26	Daily movement patterns of red snapper (*Lutjanus campechanus*) on a large artificial reef	Catheline Y.M. Froehlich, Andres Garcia, and Richard J. Kline
SEDAR74-RD27	Movement of Tagged Red Snapper in the Northern Gulf of Mexico	William F. Patterson III, J. Carter Watterson, Robert L. Shipp & James H. Cowan Jr.
SEDAR74-RD28	Did the Deepwater Horizon oil spill affect growth of Red Snapper in the Gulf of Mexico?	Elizabeth S. Herdter, Don P. Chambers, Christopher D. Stallings, and Steven A. Murawski
SEDAR74-RD29	Red Snapper Distribution on Natural Habitats and Artificial Structures in the Northern Gulf of Mexico	Mandy Karnauskas, John F. Walter III, Matthew D. Campbell, Adam G. Pollack, J. Marcus Drymon & Sean Powers
SEDAR74-RD30	Comparison of Reef-Fish Assemblages between Artificial and Geologic Habitats in the Northeastern Gulf of Mexico: Implications for Fishery-Independent Surveys	Sean F. Keenan, Theodore S. Switzer, Kevin A. Thompson, Amanda J. Tyler-Jedlund, and Anthony R. Knapp
SEDAR74-RD31	Estimating Exploitation Rates in the Alabama Red Snapper Fishery Using a High-Reward Tag–Recapture Approach	Dana K. Sackett, Matthew Catalano, Marcus Drymon, Sean Powers, and Mark A. Albins
SEDAR74-RD32	Spatial Heterogeneity, Variable Rewards, Tag Loss, and Tagging Mortality Affect the Performance of Mark–Recapture Designs to Estimate Exploitation: an Example using Red	Dana K. Sackett and Matthew Catalano

	Snapper in the Northern Gulf of Mexico	
SEDAR74-RD33	Modeling the spatial distribution of commercially important reef fishes on the West Florida Shelf	S.E. Saul, J.F. Walter III, D.J. Die, D.F. Naar, B.T. Donahue
SEDAR74-RD34	Descriptions of the U.S. Gulf of Mexico Reef Fish Bottom Longline and Vertical Line Fisheries Based on Observer Data	Elizabeth Scott-Denton, Pat F. Cryer, Judith P. Gocke, Mike R. Harrelson, Donna L. Kinsella, Jeff R. Pulver, Rebecca C. Smith, and Jo Anne Williams
SEDAR74-RD35	The potential for unreported artificial reefs to serve as refuges from fishing mortality for reef fishes	Dustin T. Addis, William F. Patterson III, Michael A. Dance, and G. Walter Ingram Jr.
SEDAR74-RD36	Immature and mature female Red Snapper habitat use in the north-central Gulf of Mexico	A.J. Leontiou, Wei Wu, and Nancy J. Brown-Peterson
SEDAR74-RD37	Importance of Depth and Artificial Structure as Predictors of Female Red Snapper Reproductive Parameters	Nancy J. Brown-Peterson, Robert T. Leaf, and Andrea J. Leontiou
SEDAR74-RD38	Demographic differences in northern Gulf of Mexico red snapper reproductive maturation	Melissa W. Jackson, James, H. Cowan, Jr. and David L. Nieland
SEDAR74-RD39	Estimating the Dependence of Spawning Frequency on Size and Age in Gulf of Mexico Red Snapper	C. E. Porch, G. R. Fitzhugh, E. T. Lang, H. M. Lyon & B. C. Linton
SEDAR74-RD40	Regional Differences in Florida Red Snapper Reproduction	Nancy J. Brown-Peterson, Karen M. Burns, and Robin M. Overstreet
SEDAR74-RD41	Multidecadal meta-analysis of reproductive parameters of female red snapper (*Lutjanus campechanus*) in the northern Gulf of Mexico	Nancy J. Brown-Peterson, Christopher R. Peterson, and Gary R. Fitzhugh
SEDAR74-RD42	A Comparison of Red Snapper Reproductive Potential in the Northwestern Gulf of Mexico: Natural versus Artificial Habitats	Hilary D. Glenn, James H. Cowan Jr. & Joseph E. Powers
SEDAR74-RD43	Temporal and spatial comparisons of the reproductive biology of northern Gulf of Mexico (USA) red snapper (*Lutjanus campechanus*) collected a decade apart	Dannielle H. Kulaw, James H. Cowan Jr., and Melissa W. Jackson

SEDAR74-RD44	Effect of circle hook size on reef fish catch rates, species composition, and selectivity in the northern Gulf of Mexico recreational fishery	William F Patterson III, Clay E Porch, Joseph H Tarnecki, and Andrew J Strelcheck
SEDAR74-RD45	Experimental Assessment of Circle Hook Performance and Selectivity in the Northern Gulf of Mexico Recreational Reef Fish Fishery	Steven B. Garner, William F. Patterson III, Clay E. Porch, and Joseph H Tarnecki
SEDAR74-RD46	Simulating effects of hook-size regulations on recreational harvest efficiency in the northern Gulf of Mexico red snapper fishery	Steven B. Garner, William F. Patterson III, John F. Walter, and Clay E. Porch
SEDAR74-RD47	Effect of reef morphology and depth on fish community and trophic structure in the northcentral Gulf of Mexico	Steven B. Garner, Kevin M. Boswell, Justin P. Lewis, Joseph H. Tarnecki, William F. Patterson III
SEDAR74-RD48	Linear decline in red snapper (*Lutjanus campechanus*) otolith D14C extends the utility of the bomb radiocarbon chronometer for fish age validation in the Northern Gulf of Mexico	Beverly K. Barnett, Laura Thornton, Robert Allman, Jeffrey P. Chanton, and William F. Patterson III
SEDAR74-RD49	Changes in Reef Fish Community Structure Following the Deepwater Horizon Oil Spill	Justin P. Lewis, Joseph H. Tarnecki, Steven B. Garner, David D. Chagaris & William F. Patterson III
SEDAR74-RD50	The Utility of Stable and Radioisotopes in Fish Tissues as Biogeochemical Tracers of Marine Oil Spill Food Web Effects	William F. Patterson III, Jeffery P. Chanton, David J. Hollander, Ethan A. Goddard, Beverly K. Barnett, and Joseph H. Tarnecki
SEDAR74-RD51	A Review of Movement in Gulf of Mexico Red Snapper: Implications for Population Structure	William F. Patterson, III
SEDAR74-RD52	Changes in Red Snapper Diet and Trophic Ecology Following the Deepwater Horizon Oil Spill	Joseph H. Tarnecki and William F. Patterson III
SEDAR74-RD53	Population Structure of Red Snapper in the Northern Gulf of Mexico	John R. Gold and Eric Saillant

SEDAR74-RD54	Mitochondrial DNA variation among red snapper (*Lutjanus campechanus*) from the Gulf of Mexico	Jeff Camper, John R. Gold, and Robert C. Barber
SEDAR74-RD55	A molecular approach to stock identification and recruitment patterns in red snapper (*Lutjanus campechanus*)	R.W. Chapman, S.A. Bortone, and C.M. Woodley
SEDAR74-RD56	Stock Structure, connectivity, and effective population size of red snapper (*Lutjanus campechanus*) in the U.S. waters of the Gulf of Mexico	David S. Portnoy
SEDAR74-RD57	Mitochondrial DNA variation among 'red' fishes from the Gulf of Mexico	John R. Gold and Linda R. Richardson
SEDAR74-RD58	Population structure of red snapper (Lutjanus campechanus) in U.S. waters of the western Atlantic Ocean and the northeastern Gulf of Mexico	Christopher M. Hollenbeck, David S. Portnoy, Eric Saillant, John R. Gold
SEDAR74-RD59	Population structure and variance effective size of red snapper (*Lutjanus campechanus*) in the northern Gulf of Mexico	Eric Saillant and John R. Gold
SEDAR74-RD60	Population Structure and Variation in Red Snapper (Lutjanus campechanus) from the Gulf of Mexico and Atlantic Coast of Florida as Determined from Mitochondrial DNA Control Region Sequence	Amber F. Garber, Michael D. Tringall and Kenneth C. Stuck
SEDAR74-RD61	Genetic homogeneity among geographic samples of snappers and groupers: evidence of continuous gene flow	John R. Gold and Linda R. Richardson
SEDAR74-RD62	Population Structure of Red Snapper from the Gulf of Mexico as Inferred from Analysis of Mitochondrial DNA	J. R. Gold, E Sun, and L. R. Richardson
SEDAR74-RD63	DNA Microsatellite Loci and Genetic Structure of Red Snapper in the Gulf of Mexico	Ed Heist and John R. Gold
SEDAR74-RD64	Genetic impacts of shrimp trawling on red snapper (Lutjanus campechanus) in the northern Gulf of Mexico	Eric Saillant, S. Coleen Bradfield, and John R. Gold

SEDAR74-RD65	Genetic variation and spatial autocorrelation among young-of-the-year red snapper (*Lutjanus campechanus*) in the northern Gulf of Mexico	Eric Saillant, S. Coleen Bradfield, and John R. Gold
SEDAR74-RD66	Connections between Campeche Bank and Red Snapper Populations in the Gulf of Mexico via Modeled Larval Transport	Donald R. Johnson, Harriet M. Perry, and Joanne Lyczkowski-Shultz
SEDAR74-RD67	Red snapper, *Lutjanus campechanus*, larval dispersal in the Gulf of Mexico	Donald R. Johnson and Harriet M. Perry
SEDAR74-RD68	Historical population demography of red snapper (*Lutjanus campechanus*) from the northern Gulf of Mexico based on analysis of sequences of mitochondrial DNA	Christin L. Pruett, Eric Saillant, and John R. Gold
SEDAR74-RD69	Microsatellite Variation Among Red Snapper (*Lutjanus campechanus*) from the Gulf of Mexico	John R. Gold, Elena Pak, and Linda R. Richardson
SEDAR74-RD70	Genomics overrules mitochondrial DNA, siding with morphology on a controversial case of species delimitation	Carmen del R. Pedraza-Marron, Raimundo Silva, Jonathan Deeds, Steven M. Van Belleghem, Alicia Mastretta-Yanes, Omar Domınguez-Domı´nguez, Rafael A. Rivero-Vega, Loretta Lutackas, Debra Murie, Daryl Parkyn, Lewis H. Bullock, Kristin Foss, Humberto Ortiz-Zuazaga, Juan Narvaez-Barandica, Arturo Acero, Grazielle Gomes, and Ricardo Betancur-R
SEDAR74-RD71	SEDAR52-WP-20: Use of the Connectivity Modeling System to estimate movements of red snapper (*Lutjanus campechanus*) recruits in the northern Gulf of Mexico	M. Karnauskas, J. F. Walter III, and C. B. Paris
SEDAR74-RD72	Fine-scale partitioning of genomic variation among recruits in an exploited fishery: causes and consequences	Jonathan B. Puritz, John R. Gold & David S. Portnoy

SEDAR74-RD73	Historical Population dynamics of red snapper (*Lutjanus campechanus)* in the northern Gulf of Mexico	J. R. Gold and C. P. Burridge
SEDAR74-RD74	Red Snapper Larval Transport in the Northern Gulf of Mexico	Donald R. Johnson, Harriet M. Perry, Joanne Lyczkowski-Shultz & David Hanisko
SEDAR74-RD75	Talking Smack: the archaeology and history of Pensacola's red snapper fishing industry	Nicole Rae Bucchino
SEDAR74-RD76	Distribution, Abundance, and Age Structure of Red Snapper (*Lutjanus campechanus*) Caught on research Longlines in the U.S. Gulf of Mexico	Karen M. Mitchell, Terry Henwood, Gary R. Fitzhugh, and Robert J. Allman
SEDAR74-RD77	SEDAR31-DW15: Spatio-temporal dynamics in red snapper reproduction on the West Florida Shelf, 2008-2011	Susan Lowerre-Barbieri, Laura Crabtree, Theodore S. Switzer, and Robert H. McMichael, Jr.
SEDAR74-RD78	SEDAR52-WP-15: Reproductive data compiled for the Gulf of Mexico Red Snapper, *Lutjanus campechanus*, SEDAR 52	G.R. Fitzhugh, H.M. Lyon, V.C. Beech, P.M. Colson
SEDAR74-RD79	Trophic ecology of red snapper *Lutjanus campechanus* on natural and artificial reefs: interactions between annual variability, habitat, and ontogeny	Rachel A. Brewton, Charles H. Downey, Matthew K. Streich, Jennifer J. Wetz, Matthew J. Ajemian, Gregory W. Stunz
SEDAR74-RD80	Comparing reproductive capacity of nearshore and offshore red snapper, *Lutjanus campechanus*, on artificial reefs in the western Gulf of Mexico	Ricky J. Alexander
SEDAR74-RD81	Reduction of juvenile red snapper bycatch in the U.S. Gulf of Mexico shrimp trawl fishery	Benny J. Gallaway and John G. Cole
SEDAR74-RD82	A Life History Review for Red Snapper in the Gulf of Mexico with an Evaluation of the Importance of Offshore Petroleum Platforms and Other Artificial Reefs	Benny J. Gallaway, Stephen T. Szedlmayer, and William J. Gazey
SEDAR74-RD83	Delineation of Essential Habitat for Juvenile Red Snapper in the Northwestern Gulf of Mexico	Benny J. Gallaway, John G. Cole, Robert Meyer, and Pasquale Roscigno

SEDAR74-RD84	Retrospective Analysis of Midsummer Hypoxic Area and Volume in the Northern Gulf of Mexico, 1985−2011	Daniel R. Obenour, Donald Scavia, Nancy N. Rabalais, R. Eugene Turner, and Anna M. Michalak
SEDAR74-RD85	Space-Time Geostatistical Assessment of Hypoxia in the Northern Gulf of Mexico	V. Rohith Reddy Matli, Shiqi Fang, Joseph Guinness, Nancy. N. Rabalais, J. Kevin Craig, and Daniel R. Obenour
SEDAR74-RD86	Fusion-Based Hypoxia Estimates: Combining Geostatistical and Mechanistic Models of Dissolved Oxygen Variability	Venkata Rohith Reddy Matli, Arnaud Laurent, Katja Fennel, Kevin Craig, Jacob Krause, and Daniel R. Obenour
SEDAR74-RD87	Application of three-dimensional acoustic telemetry to assess the effects of rapid recompression on reef fish discard mortality	Erin Collings Bohaboy, Tristan L. Guttridge, Neil Hammerschlag, Maurits P. M. Van Zinnicq Bergmann, and William F. Patterson III
SEDAR74-RD88	The Great Red Snapper Count: Estimating the Absolute Abundance of Age-2+ Red Snapper (*Lutjanus campechanus*) in the U.S. Gulf of Mexico	Stunz, G. W., W. F. Patterson III, S. P. Powers, J. H. Cowan, Jr., J. R. Rooker, R. A. Ahrens, K. Boswell, L. Carleton, M. Catalano, J. M. Drymon, J. Hoenig, R. Leaf, V. Lecours, S. Murawski, D. Portnoy, E. Saillant, L. S. Stokes., and R. J. D. Wells
SEDAR74-RD89	Spawning origins and ontogenetic movements for demersal fishes: An approach using eye-lens stable isotopes	Julie L. Vecchio, Ernst B. Peebles
SEDAR74-RD90	Discard mortality of red snapper released with descender devices in the U.S. South Atlantic	Brendan J. Rhunde, Nathan M. Bacheler, Kyle W. Shertzer, Paul J. Rudershausen, Beverly Sauls, and Jeffrey A. Buckel
SEDAR74-RD91	Spatial and Temporal Influences of Nearshore Hydrography on Fish Assemblages Associated with Energy Platforms in the Northern Gulf of Mexico	Ryan T. Munnelly, David B. Reeves, Edward J. Chesney, Donald M. Baltz
SEDAR74-RD92	Lessons learned from practical approaches to reconcile mismatches between biological population structure and stock units of marine fish	Lisa A. Kerr, Niels T. Hintzen, Steven X. Cadrin, Lotte Worsøe Clausen, Mark Dickey- Collas, Daniel R. Goethel, Emma M.C.

		Hatfield, Jacob P. Kritzer, and Richard D.M. Nash
SEDAR74-RD93	Defining spatial structure for fishery stock assessment	Steven X. Cadrin
SEDAR74-RD94	Genomic analysis of red snapper, *Lutjanus campechanus*, population structure in the U.S. Atlantic and Gulf of Mexico	David S. Portnoy, Andrew T. Fields, Jonathan B. Puritz, Christopher M. Hollenbeck, and William F. Patterson, III
SEDAR74-RD95	A simulation framework to assess management trade-offs associated with recreational harvest slots, discard mortality reduction, and bycatch accountability in a multi-sector fishery	Erin C. Bohaboy, Daniel R. Goethel, Shannon L. Cass-Calay, William F. Patterson III
SEDAR74-RD96	Quantifying Delayed Mortality from Barotrauma Impairment in Discarded Red Snapper Using Acoustic Telemetry	Judson M. Curtis, Matthew W. Johnson, Sandra L. Diamond & Gregory W. Stunz
SEDAR74-RD97	Venting and Reef Fish Survival: Perceptions and Participation Rates among Recreational Anglers in the Northern Gulf of Mexico	Steven B. Scyphers, F. Joel Fodrie, Frank J. Hernandez Jr., Sean P. Powers & Robert L. Shipp
SEDAR74-RD98	Testing the efficacy of recompression tools to reduce the discard mortality of reef fishes in the Gulf of Mexico	Oscar E. Ayala
SEDAR74-RD99	Understanding resource-conserving behaviors among fishers: Barotrauma mitigation and the power of subjective norms in Florida's reef fisheries	Chelsey A. Crandall, Taryn M. Garlock, and Kai Lorenzen
SEDAR74-RD100	Recreational angler attitudes and perceptions regarding the use of descending devices in Southeast reef fish fisheries	Judson M. Curtis, Alex K. Tomkins, Andrew J. Loftus, and Gregory W. Stunz
SEDAR74-RD101	Venting or rapid recompression increase survival and improve recovery of red snapper with barotrauma	Karen L. Drumhiller, Matthew W. Johnson, Sandra L. Diamond, Megan M. Reese Robillard and Gregory W. Stunz
SEDAR74-RD102	Descender devices or treat tethers: Does barotrauma mitigation increase opportunities for depredation?	J. Marcus Drymon, Amanda E. Jefferson, Crystal Loualllen-Hightower, and Sean P. Powers
SEDAR74-RD103	Sink or swim? Factors affecting immediate discard mortality for the	J.R. Pulver

	Gulf of Mexico commercial reef fishery	
SEDAR74-RD104	Techniques for minimizing discard mortality of GoM of Mexico red snapper and validating survival with acoustic telemetry	Gregory W. Stunz, Judson M. Curtis, and Alex Tompkins
SEDAR74-RD105	Utility of rapid recompression devices in the Gulf of Mexico red snapper fishery	Alex A. Tompkins
SEDAR74-RD106	Gulf of Mexico Fishery Ecosystem Plan	LGL Ecological Research Associates, Inc.
SEDAR74-RD107	Laser ablation–accelerator mass spectrometry reveals complete bomb 14C signal in an otolith with confirmation of 60-year longevity for red snapper (*Lutjanus campechanus*)	Allen H. Andrews, Christiane Yeman, Caroline Welte, Bodo Hattendorf, Lukas Wacker and Marcus Christl
SEDAR74-RD108	S68-DW-13: Marine Recreational Information Program Metadata for the Atlantic, Gulf of Mexico, and Caribbean regions	Vivian M. Matter and Matthew A. Nuttall
SEDAR74-RD109	S70-WP-03: Texas Parks and Wildlife Department's Marine Sport-Harvest Monitoring Program Metadata	Matthew A. Nuttall and Vivian M. Matter
SEDAR74-RD110	Texas Fishing Effort Survey - Final Project Report	NMFS Office of Science and Technology
SEDAR74-RD111	Artificial Attraction: Linking Vessel Monitoring System and Habitat Data to Assess Commercial Exploitation on Artificial Structures in the Gulf of Mexico	Christopher Gardner, Daniel R. Goethel, Mandy Karnauskas, Matthew W. Smith, Larry Perruso and John F. Walter III
SEDAR74-RD112	S68-DW-11: Estimates of Historic Recreational Landings of Scamp and Yellowmouth Grouper in the South Atlantic Using the FHWAR Census Method	Ken Brennan
SEDAR74-RD113	Understanding and Enhancing Angler Satisfaction with Fisheries Management: Insights from the "Great Red Snapper Count"	Steven B. Scyphers, J. Marcus Drymon, Kelsi L. Furman, Elizabeth Conley, Yvette Niwa, Amanda E. Jefferson, and Gregory W. Stunz

SEDAR74-RD114	Assessing reproductive resilience: an example with South Atlantic red snapper *Lutjanus campechanus*	Susan Lowerre-Barbieri, Laura Crabtree, Theodore Switzer, Sarah Walters Burnsed, Cameron Guenther

2 LIFE HISTORY

2.1 OVERVIEW

The life history group (LHG), comprised of individuals from NOAA Fisheries as well as universities, state agencies, and the private sector, reviewed and discussed available life history data collected since the last Gulf of Mexico red snapper stock assessment (SEDAR 52) was conducted in 2017. Specifically, any new or updated information on age and growth, reproduction, natural mortality, episodic events or meristic conversions was examined to provide recommendations to the SEDAR 74 stock assessment panel. A summary of the data presented, discussed, and recommendations made by the LHG is presented in this document.

2.1.1 Work Group members and participants in Life History webinars

Robert Allman-NOAA Fisheries, Panama City, FL (leader)

Beverly Barnett-NOAA Fisheries Panama City, FL

Nancy Brown-Peterson-University of Southern Mississippi

Steven Garner- NOAA Fisheries, Panama City, FL

Carissa Gervasi- University of Miami/NOAA Fisheries, Miami, FL

Erik Lang- Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA

Sue Lowerre-Barbieri- University of Florida, St. Petersburg, FL

Heather Moncrief-Cox- NOAA Fisheries, Panama City, FL (rapporteur)

Peter Mudrak- LGL Ecological Research Associates, Inc.

Molly Stevens- NOAA Fisheries, Miami, FL

Naeem Willet- NOAA Fisheries, Panama City, FL (rapporteur)

2.1.2 Topics Reviewed by the Life History Group

1. Age
2. Growth
3. Reproduction
4. Natural Mortality

5. Episodic events
6. Conversions

2.2 AGE DATA

Quality age data (i.e., high accuracy and precision) are crucial for informing a variety of parameter estimates in stock assessments, such as size- and egg production-at-age, age-specific natural mortality, and tracking cohorts over time. Several studies have been conducted using sagittal otoliths to age red snapper and provide basic information on growth and annulus formation (Futch and Bruger, 1976; Bortone and Hollingsworth, 1980; Nelson and Manooch, 1982; Wilson and Nieland, 2001; Manooch and Potts, 1997; Patterson et al., 2001; Fischer et al. 2004). Additionally, reader interpretation of red snapper otolith thin sections and the repeatability of age estimates (i.e., precision) have been examined (Allman et al., 2005). Recently, the maximum age of Gulf of Mexico red snapper was validated to at least 45 years using analysis of bomb radiocarbon $\Delta^{14}C$ from otolith cores (Barnett et al. 2018; Andrews et al. 2019). Observed age estimates for otoliths with bomb radiocarbon-derived age estimates were as high as 53 years, but these could not be validated due to the birth year occurring prior to nuclear testing (Barnett et al. 2018). However, the methods for estimating ages from the otolith thin sections used in bomb radiocarbon validation studies were the same as those used to generate red snapper production age estimates.

A total of 239,409 ages were assigned to red snapper sampled from the GOM in 1980 and from 1986 to 2019, which consisted of 96,571 samples from the West, 118,228 from the Central, and 24,610 from the East subregion (Figure 1). The number of age samples by year, subregion, and fishery (commercial, recreational, fishery independent, or unknown) are listed in Table 1. In earlier years, the majority of ages were from the western GOM. In recent years, a greater proportion of age samples were collected east of the Mississippi River (Central and East subregions) with NMFS and GulfFIN sampling programs providing most samples (Fig. 2). The number of age samples by year, subregion, and gear type (vertical line [handline or hook-and-line], longline [bottom longline or vertical longline], other [trap, trawl, spear], or unknown) are listed in Table 2. The size distribution of red snapper lengths was different among all subregions with right-skewed distributions for the West and Central and an approximately normal distribution for the East (Fig. 3). Mean (±SE) fork length (cm) of red snapper was highest (52.7 ± 0.07) in the East and lowest (46.43 ± 0.03) in the Central subregion. Mean age (yr, fractional) of red snapper differed by only 0.6 yr among subregions with the West subregion having the highest (4.95 ± 0.01) and the Central having the lowest (4.30 ± 0.01) mean age. The distribution of ages among subregions was generally similar, but the West subregion had both more and a higher proportion of older fish (Fig. 4). The oldest observed ages (calendar) were 57, 49, and 45 yrs for the West, Central, and East subregions, respectively (Fig. 4). Age distributions by subregion and year are shown in Figures 5-7. All three regions show evidence of a strong 2014 year-class. Red snapper ages from recreational and fishery independent samples were oldest in the West, while fish from commercial samples in the West and East were similarly older than the Central subregion (Fig. 8). Frequency distributions of red snapper age samples by year from the commercial and recreational sectors are shown in Figures 9 and 10.

2.2.1 Research Recommendations

Resources are needed for personnel and database infrastructure to manage large, multi-decade life history datasets that are beginning to exceed the capabilities of standard computers.

Create a data repository with an upload interface for data providers to submit data directly into the SEDAR template. Build in standardized QA/QC methods for all data providers so that erroneous data points and outliers are identified and corrected prior to data workshops.

Resume annual ageing workshops with gulf state agencies and other age data contributors to maintain high-quality age data given standard turnover rates among primary agers.

Expand routine biological sampling, particularly in the eastern GOM subregion, where sample sizes are much lower compared to other subregions.

The current subsampling protocol for red snapper is based on 5-year average landings by grid and is laborious and time consuming. Evaluate the current otolith subsampling protocol and provide alternatives to streamline the process.

Evaluate the sampling design for observer programs.

Investigate new technologies for estimating life history parameters (e.g. FT-NIRS, epigenetics) to increase production ageing efficiency and precision of age estimates.

Increase sampling of sublegal fish through fishery independent surveys and the shrimp observer program to better estimate maturity and fecundity of smaller individuals, as well as samples through tournament intercepts to better estimate batch fecundity of larger/older females.

2.3 GROWTH

Visual inspection of the size-modified von Bertalanffy growth functions (VBGF) plotted against size-at-age data indicated that models fit to inverse weighted data (i.e., 1/age-specific n) provided better fits to the older age classes (15+ yrs), which had disproportionately fewer samples than younger age classes (Fig. 11). Population growth model parameters indicated that the parameter for mean size-at-maximum length (L_∞) had decreased by 3.54 cm since the data were last assessed in SEDAR 52 (Garner et al. 2022, SEDAR74-DW-34). Modeling the size-modified VBGF variance component as a linear function of size-at-age produced the best fit to the inverse weighted size-at-age data based on Akaike’s information criterion corrected for sample size (AICc; Table 3). Different variance forms were best fit to each of the three subregions (Table 4) however, subregion-specific growth models with variance modeled as a linear function of size-at-age had a cumulative AICc value of only 5.5 points higher than the best fit models for the West and East subregions, respectively. Stock Synthesis requires a single functional form for growth, thus, parameters estimated with VBGF models with variance as a linear function of size-at-age were used for the final analyses.

Growth parameters estimated for L_∞ were lowest in the West compared to the other two regions, which had similar values; parameter estimates for k were highest in the East compared to the other two regions, which had similar values (Fig. 12). Mean size-at-age increased at similar rates among regions from 0-5 yrs, then diverged with fish from the East increasing fastest towards the mean maximum length (Fig. 13). Mean size-at-age in the Central and West subregions began to diverge at approximately age-10, where fish from the Central began to approach the same mean maximum size as fish from the East; fish from the West remained smaller-at-age at older ages.

The VBGF parameters also were estimated by time stanza (1991-2008, 2009-2015 and 2016-2019 based on yearly trends in biomass levels that roughly correspond to depletion, rebuilding, and asymptotic recovery of the stock). Age samples from the Central and East were combined due to low sample sizes collected during the most recent time-period. This analysis did not indicate any meaningful divergence in size-at-age among time stanzas within the two subregions (Fig. 14); fish from the most recent time stanza (2016-2019) did have smaller size-at-age for some age classes, but confidence intervals overlapped in most cases.

2.3.1 Recommendations for SEDAR 74

Use inverse weighted age data for fitting growth curves.

Estimate growth separately for each subregion with data from all years combined.

2.4 REPRODUCTION

Reproductive potential plays an important role in stock assessments and biological reference points and is commonly measured as either spawning stock biomass (SSB) or total egg production (TEP). Both measures need an estimate of the sex ratio. Estimates of size- and age-at maturity are needed for SSB, whereas for TEP there is also the need to estimate annual fecundity-at-age.

Both Red Snapper stock assessments and recent publications have reported decreased reproductive productivity in the region west of the Mississippi River and throughout the Gulf of Mexico (GOM or Gulf) as the stock recovers. Fish in the eastern Gulf (east of the Mississippi River) are reported to be younger and to mature earlier than those from the western Gulf (SEDAR 2005; SEDAR 2013; SEDAR 2018). More recently, decreased reproductive output at age has been reported, although with varying intensity depending on region (SEDAR 52). New publications and data since SEDAR 52 support these patterns and include: Brown-Peterson et al., (2019, 2021), Leontiou et al., (2021a,b), Froelich et al., (2021), Millender and Brown-Peterson, (2022), and Brown-Peterson and Millender (2022). Brown-Peterson et al. (2019) conducted a meta-analysis on Red Snapper reproductive data collected from 1991-2017 throughout the GOM and report decreased spawning frequency and batch fecundity in recent years, especially in the western Gulf. Red Snapper spawning activity also has been reported to increase with depth (Glenn et al., 2017; Brown-Peterson et al., 2021; Froehlich et al., 2021; Millender and Brown-Peterson, 2022). In contrast, structure type does not appear to greatly influence Red Snapper reproductive parameters in either the eastern (Brown-Peterson et al., 2021) or western (Downey et al., 2018) GOM.

For SEDAR 74, a total of 169,178 records had a sex assigned as male or female based on macroscopic or histological evaluation. Of these, 11,527 females had a reproductive phase based on histological assessment and 10,527 of these also had length and a calendar age. Samples were not evenly distributed by year or subregion, with Central and West each having more than 5,000 samples and East only having 615 (Figure 15). They were also not evenly distributed by age with 98% being age 15 or younger (Figure 16). Sample size greatly decreased for batch fecundity estimates (1,231 and 1,136 with an age), and 94% of these were for young fish (age 10 y or younger, Figure 17). Immature females were relatively rare (n=344, 341 with ages). The sex ratio, similar to past assessments, was approximately 1:1, with 52% female and 48% male.

Reproductive traits were estimated over three time periods and two regions (Lowerre-Barbieri et al., 2022; Lowerre-Barbieri and Friess, 2022). Given the changes in SSB and SPR over time (SEDAR 52) and potential for reproductive traits to vary with stock status, three stock status time periods were assigned: (1) from 1991-2008, when the stock was severely overfished; (2) from 2009-2016, when the stock was rapidly recovering; and (3) from 2017-2019 as stock abundance began to stabilize. Spatially, reproductive traits were estimated for two regions, West and East of the Mississippi River, due to insufficient data to separate the East into an East and Central region. Standardized terms and methods to estimate and describe reproductive dynamics were adopted (Lowerre-Barbieri et al., 2022), building on Brown-Peterson et al. (2011), Lowerre-Barbieri et al. (2011), and a draft best practices reproductive data template developed to help standardize reproductive data for stock assessments in the Southeast.

Red Snapper have an extended and asynchronous spawning season, with spawning observed as early as January 16th and as late as December 18th, a duration of 337 d. A core spawning season of 218 d from March 17th to October 21st was estimated using the 50% spawning method (Lowerre-Barbieri et al., 2022). Peak spawning months were previously identified as June through August (Kulaw et al., 2017, Glenn et al., 2017; SEDAR52, 2018), but in this assessment, also included September, which had a 59% spawning fraction.

Analysis to assess the best data to include in maturity models indicated that the use of peak spawning months and assignment of early developing as immature was less effective than restricting the reproductive phases used to immature and spawning (Lowerre-Barbieri et al., 2022). Therefore, both age and length at maturity models were calculated using only these reproductive phases and no temporal filter. Age at 50% maturity (A50) increased over time in both regions, with fish in the Western Gulf consistently having higher A50s than those from the Eastern Gulf (Table 5; Figure 18). Estimated A50 in the Eastern Gulf increased from 1.36 y (fractional age) in the overfished period to 1.44 y in the rapidly recovering period, to 1.93 y in the stabilizing period. In the Western Gulf, A50 increased from 1.52 y in the overfished period to 1.71 y in the rapidly recovering period to 2.46 y in the final period. In addition, the shape of the curves changed with time, with more gradual changes in proportion mature as the stock recovered. The A50 estimate for the time-and-space-aggregated model was 1.64 y (Table 5).

As with age-at-maturity, the length-at-maturity models supported the existence of the period-and-region effect and an increasing length at 50% maturity (L50) by period. However, unlike the age model, estimated length-at-maturity was higher in the East than the West for all but the additive model (Table 6). Generally, the L50 estimates were similar between the additive, interaction, and random effects model, with the random effects model estimating a higher L50 for the period/region combinations that the models generally had a hard time fitting (i.e., the early period in the East and the mid period in the West). As with the age model, the predicted relationship of length at maturity became less steep with time (Figure 19). The L50 in the East was estimated to be 25.6 cm in the overfished period, 28 cm in the rapidly recovering period, and 32.8 cm in the stabilizing period. In the West, the estimates were 22 cm in the overfished period, 23.8 cm in the rapidly recovering period, and 31.5 cm in the stabilizing period. The L50 estimate for the time-and-space-aggregated model was 28.3 cm fork length (Table 6).

The models of Porch et al. (2007) and Porch et al. (2015) were extended to model batch fecundity (BF) and spawning frequency over space and time (Lowerre-Barbieri and Friess, 2022). Although BF increased with length and condition (pd = 100% and % in ROPE = 0, table 7), the effects of region and period are not easily summarized due to the interaction between region, period, and length. The fit to the log-transformed values of batch fecundity and fork length was good (Figure 20), as was the fit to the back-transformed values, but higher values of BF tended to be underestimated, especially for the West in the early period (Figure 20) and this was exaggerated when length was converted to age (Figure 21).

Predicted spawning fraction increased with age, was larger in the East than the West, and decreased as the stock recovered for fish younger than age 16 y (Table 8). Models where both slope and intercept were allowed to vary had trouble converging. Predicted spawning fraction was generally similar to observed for younger ages. Spawning fraction at age was better estimated than at length, and both models had high uncertainty when samples were sparce. The length models had trouble fitting the lower proportions with spawning markers at smaller sizes in the East in the middle and later periods, overestimated proportion with spawning markers at larger sizes in the early period in the East, and underestimated proportions with spawning markers at larger sizes in the West in the middle and later period (Figure 22).

Both estimated fecundity-at-length and fecundity-at-age vectors showed a trend of decreasing fecundity over time within region, and higher relative fecundity at length and age in the Eastern than the Western Gulf (Figure 23). The fecundity-at-age vector used in SEDAR 31 and 52 was most similar to model results for the overfished period and quite a bit higher than results observed in the rapidly recovering and stabilizing period. This, in combination with the uncertainty in fecundity estimates due to methodological issues as well as insufficient data for all age groups, particularly fish >10 years, led to our recommendation to use SSB as the best measure of reproductive potential.

2.4.1 Recommendations for SEDAR 74

Adopt the slightly modified reproductive phase names and criteria from Lowerre-Barbieri et al. (2022).

Adopt the standardized methodology from Lowerre-Barbieri et al. (2022) to estimate spawning season and peak spawning months.

Maturity models should only use immature and spawning females (i.e., those with spawning markers) if sample size allows, rather than filtering data by peak spawning season, as recommended in Lowerre-Barbieri et al. (2022).

Given the uncertainty in the fecundity-at-age vectors over time, utilize SSB as the measure of reproductive potential (Lowerre-Barbieri and Friess, 2022).

2.4.2 Research Recommendations

Standardize data fields on the template, as well as limiting them to the data needed. It is especially important that data providers QA/QC their own data prior to submitting to ensure multiple fields are not used for the same parameter.

Additional histological sampling is needed from the east region (FL west coast to Cape San Blas) to allow analyses by three regions.

Conduct batch fecundity estimates only on females in late oocyte maturation without POFs (histological analysis of ovaries used for batch fecundity is needed). Preserve ovaries only in formalin rather than Gilson's or freezing them. Use the washing process presented in Lowerre-Barbieri et al. (1993) for separating out the OM oocytes for fecundity estimates, which works equally well for fresh or preserved ovaries.

Research on Red Snapper spawning marker duration, as well as selectivity of fish with spawning markers is needed to improve estimates of spawning frequency.

2.5 NATURAL MORTALITY

Multiple studies have validated the longevity of different reef fishes using $\Delta^{14}C$ decay curves, with GOM red snapper longevity validated to at least 45 yrs. (Barnett et al. 2018; Andrews et al. 2019). The method used to directly estimate observed age in bomb radiocarbon studies of red snapper otoliths (i.e., observed annuli counts) was the same method used to produce production age estimates as well as to produce the maximum age estimate of 57 yrs. The maximum age sample was evaluated by multiple experienced readers (Allman personal communication). Therefore, the maximum age estimate of 48 used in SEDAR 52 was increased to 57 yrs for SEDAR 74.

Given this new longevity estimate, the average natural mortality rate ($\underline{M}$) over the fishable lifespan of red snapper was estimated from several regression equations of longevity versus size- or weight-at-age. From Hoenig (1983), *M* for red snapper with a max age of 57 resulted in an *M* value of 0.0796 yr^{-1}; *M* was estimated as 0.0526 yr^{-1} with the method of Hewitt and Hoenig (2005). The Then et al. (2015) method is an updated regression equation from Hoenig's (1983) equation, but estimated from a much wider range of fishes, regions, and habitats. The Then et al. (2015) method resulted in an *M* value estimate of 0.1206 yr^{-1} when using the regression equation developed for all fishes (excluding the pygmy goby, *Eviota sigillata*, M = 49.57 yr^{-1}), 0.1207 yr^{-1} from reef fish-specific regression parameters, and 0.1040 yr^{-1} from Lutjanid-specific parameters. The Lutjanid-specific estimate of average *M* was recommended by the life-history group for use as the estimate of *M* in SEDAR 74. Following the recommendations put forth in SEDAR 52, Age-2 was recommended as the first age fully selected by the fishery. Therefore, the Lorenzen age-specific natural mortality function (Lorenzen 1996) was scaled to the Then et al. (2015) estimate for ages 2-57 yrs (Figure 24). Natural mortality for ages 0 and 1 were fixed to 2.0 and 1.2 yr^{-1}, following the recommendation in SEDAR 52. The final natural mortality vector resulted in a maximum age cumulative survival of only 0.1%. However, this estimate was deemed reasonable for a species like red snapper based on its life history (i.e., rapid growth, early maturity, long-lived, low natural mortality, and infrequent strong year classes), and considering that only a very small number of individuals have been observed to exceed 45 yrs of age despite having collected hundreds of thousands of age samples from both fishery independent and dependent sources spanning several decades.

2.5.1 Recommendations for SEDAR 74

Use the observed maximum age of 57 years when estimating age-specific M.

Estimate a single M value and age-specific vector for all regions.

Use the Then et al. (2015) method to estimate M using Lutjanid-specific parameters.

Scale Then et al. (2015) derived estimate of M to age-specific values using Lorenzen function (1996).

While important questions remain about density dependent effects on juvenile red snapper mortality, no new studies of age-0 and age-1 red snapper natural mortality were identified. All of the identified existing studies were considered in previous assessments, and their results are in line with the natural mortality rates for age-0 and age-1 red snapper used in SEDAR 31 and 52. Therefore, we recommend using M = 2.0 for age-0 and M = 1.2 for age-1 red snapper.

2.5.2 Research Recommendations

We recommend additional effort to collect age-0 and age-1 red snapper to better estimate natural mortality rates and density dependent responses.

2.6 EPISODIC EVENTS

Periodic environmental perturbations can influence the survival and catchability of Gulf of Mexico red snapper. Recent studies have described the influence of seasonal hypoxic events and the effects of the Deepwater Horizon (DWH) oil spill on red snapper. A geostatistical modeling approach was used to estimate the extent of hypoxic events during midsummer from 1985-2011 in the northern Gulf of Mexico and found an increasing trend in the thickness of the midsummer hypoxic zone (Obenour et al. 2013). Szedlmayer and Mudrak (2014) recorded that oxygen concentrations fell to as low 0.4 mg/L on experimental artificial reefs off Alabama, which coincided with the almost complete absence of age-0 red snapper in August 2011. Switzer et al. (2015) reported differences in juvenile recruitment annually in the northern Gulf of Mexico with the lowest levels during years with severe hypoxia. However, it was unclear if these declines in juvenile recruitment were observed later in the fishery.

Lewis et al. (2020) noted changes in marine community structure after DWH. In particular, generalist carnivores such as red snapper declined in number with little evidence of recovery 7 years after DWH. They suggested predation by lionfish as a factor contributing to delayed recovery. Tarnecki and Patterson (2015) noted changes in the diet and trophic ecology of red snapper following DWH. Specifically, red snapper consumed less zooplankton on artificial and natural habitats, increased consumption of benthic prey on natural habitats, and increased fish consumption on artificial reefs. Tarnecki and Patterson (2015) stated that changes in red snapper prey abundance following DWH were likely the reason for the observed changes in diet and the resulting trophic level. The abundance of age-0 and age-1 red snapper observed off Alabama the summer after DWH in 2010 and in 2011 did not show evidence of recruitment failure; declines in numbers after DWH for age-0 and age-1 fish were most associated with low dissolved oxygen (Szedlmayer and Mudrak 2014). Herdter et al. (2017) compared growth of adult red snapper from before and after DWH, and found no difference between von Bertalanffy growth curves from the back-calculated pre-period and from after the DWH oil spill. However, increment widths for dominant cohorts (fourth, fifth, and sixth year increments) did decline significantly post-DWH by 13%, 15%, and 22%, respectively, and were significantly smaller than the mean width of each respective increment in years prior to DWH.

The LHG also discussed other episodic events, which may affect the survival and catchability of red snapper. These include the influence of hurricanes on movement patterns, habitat, and changes in fisher behavior. Other topics discussed as potential factors influencing red snapper were increased freshwater discharge through the Bonnet-Carrie spillway in recent years and increased Mississippi River discharge possibly due to climate change. The NOAA Southeast Fisheries Science Center used in-depth conversations with charter captains throughout the Gulf to create conceptual models of the Red Snapper fishery,including important drivers and linkages (Gervasi et al. 2022, SEDAR74-DW-16). Several episodic events were mentioned that may influence red snapper life history and/or fishery dynamics.

Hurricanes have varied impacts on the red snapper fishery according to recreational charter-for-hire captains. Hurricanes can dislodge smaller artificial structures, which are the main habitats anglers target for red snapper in most regions. When the number of structures with known locations declines after a hurricane, it can lead to a decrease in red snapper catchability as anglers have to move to structures further away or locate new structures. This would particularly be the case for regions that have high dependence on artificial structures (Mississippi, Alabama, and the Florida Panhandle). Captains also mentioned that hurricanes may move red snapper around, either moving fish closer to shore or further offshore depending on the direction and intensity of the hurricane. This observation aligns with a tagging study that examined the movements of red snapper during Hurricane Opal off the coast of Alabama (Watterson et al. 1998). The authors found that storm effect was the most significant factor predicting the likelihood of red snapper movement away from the artificial reef study site, as well as the magnitude of movement. Fish that were at liberty during the hurricane moved significantly further than fish that were not at liberty during the hurricane. One captain also mentioned that hurricanes may increase larval recruitment, thereby increasing local abundance of red snapper in the region. However, the mechanisms by which this occurs were unknown. Perhaps hurricane wind speed could be used as a metric for estimating the extent to which artificial structures, and the red snapper associated with them, are redistributed in a given year. Storm energy in the north central GOM, as measured by the accumulated cyclone energy index, was particularly high in recent years (2018 and 2020) which could explain why numerous charter captains mentioned hurricanes as major drivers of the red snapper fishery. Water quality was mentioned by two captains from Alabama and Louisiana as possibly impacting red snapper local abundance. The captains observed that when freshwater flow from the large river systems of the northeastern GOM is high, it can lead to a decrease in water quality and a decrease in the abundance of red snapper close to shore. Brown-Peterson et al. (2022) have shown a decrease in female Red Snapper that have recently spawned with increases in phosphate, dissolved inorganic nitrogen, dissolved oxygen, and salinity in offshore waters, conditions that are likely driven by increased freshwater outflow from river systems.

2.6.1 Research Recommendations

Further research is needed on the effects of episodic events on all life stages of red snapper.

2.7 CONVERSIONS

Length and weight conversions were updated using data through 2019 from the NOAA Panama City biological database and the NOAA Bio Sample Database (Table 9).

2.8 LITERATURE CITED

Allman, R.J., G.R. Fitzhugh, K.J. Starzinger and R.A. Farsky. 2005. Precision of age estimation in red snapper (*Lutjanus campechanus*). Fisheries Research 73:123-133.

Andrews, A.H., C. Yeman, C. Welte, B. Hatterdorf, L. Wacker and M. Christl. 2019. Laser ablation–accelerator mass spectrometry reveals complete bomb $\Delta^{14}C$ signal in an otolith with confirmation of 60-year longevity for red snapper (*Lutjanus campechanus*). Marine and Freshwater Research 70, 1768-1780.

Barnett, B. K., Thornton, L., Allman, R., Chanton, J. P., and Patterson, W. F.III 2018. Linear decline in red snapper (*Lutjanus campechanus*) otolith $\Delta^{14}C$ extends the utility of the bomb radiocarbon chronometer for fish age validation in the Northern Gulf of Mexico. ICES Journal of Marine Science 75, 1664–1671. doi:10.1093/ICESJMS/FSY043

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

Bortone, S.A. and C.L. Hollingsworth. 1980. Ageing red snapper, *Lutjanus campechanus*, with otoliths, scales and vertebrae. Northeast Gulf Science 4(1):60-63.

Brown-Peterson, N.J., R.T. Leaf, and A.J. Leontiou. 2021. Importance of depth and artificial structure as predictors of female Red Snapper reproductive parameters. Transactions of the American Fisheries Society. 150(1):115-129. https://doi.org/10.1002/tafs.10277.

Brown-Peterson, N.J. and A.K. Millender. 2022. The Reproductive Biology of Red Snapper in Mississippi Waters. SEDAR74-DW09. SEDAR, North Charleston, SC. 34 p.

Brown-Peterson, N.J., C.R. Peterson, and G.R. Fitzhugh. 2019. Multidecadal meta-analysis of reproductive parameters of Red Snapper (*Lutjanus campechanus*) in the northern Gulf of Mexico. Fishery Bulletin 117:37-49. https://doi.org/10.7755/FB.117.1.5

Brown-Peterson, N.J., W. Wu, C. Slife, K.S. Dillon and A.J. Leontiou. 2022. Variations in Red Snapper oocyte development and spawning in relation to environmental and habitat parameters. Environmental Biology of Fishes 105:in press.

Brown-Peterson, N.J., D. Wyanski, F. Saborido-Rey, B. Macewicz, and S.K. Lowerre-Barbieri. 2011. A standardized terminology for describing reproductive development in fishes. Marine and Coastal Fisheries: Dynamics. Management, and Ecosystem Science 3:52-70.

Diaz, G.A., C.E. Porch, and M. Ortiz. 2004. Growth models for red Snapper in U.S. Gulf of Mexico waters estimated from landings with minimum size limit restrictions. NMFS/SEFSC/SFD 2004-038, 13 p.

Downey, C.H., M.K. Streich, R.A. Brewton, M.J. Ajemian, J.J. Wetz, and G.W. Stunz. 2018. Habitat-specific reproductive potential of Red Snapper: A comparison of natural and artificial reefs in the western Gulf of Mexico. Transactions of the American Fisheries Society 147:1030-1041. https://doi.org/ 10.1002/tafs.10104

Fischer, A.J., Baker, M.S. and C.A. Wilson 2004. Red snapper (*Lutjanus campechanus*) demographic structure in the northern Gulf of Mexico based on spatial patterns in growth rates and morphometrics. Fishery Bulletin 102:593-603.

Froehlich C.Y.M., A.M. Lee, R. Oquita, C.E. Cintra-Buenrostro, and J.D. Shivley. 2021. Reproductive characteristics of Red Snapper Lutjanus campechanus on artificial reefs in different jurisdictions. Regional Studies in Marine Science 47:101936. https://doi.org/10.1016/j.rsma.2021.101936

Futch, R.B. and G.E. Bruger. 1976. Age, growth and reproduction of red snapper in Florida waters. Pages

165-183 *in*: H.R. Bullis Jr. and A.C. Jones (eds.) Proceedings: Colloquium on snapper-grouper fishery resources of the western central Atlantic Ocean. Florida Sea Grant College Program Report No. 17, Gainesville, Florida.

Garner, S.B., R.J. Allman and B.K. Barnett and N. Willett. 2022. Description of age, growth, and natural mortality of Red Snapper from the northern Gulf of Mexico 1980 and 1986. SEDAR74-DW-34. SEDAR, North Charleston, SC. 33 pp.

Gervasi, C., M. McPherson, and M. Karnauskas. 2022. System dynamics of red snapper populations in the Gulf of Mexico to support ecosystem considerations in the assessment and management process. SEDAR74-DW-16. SEDAR, North Charleston, SC. 21 pp.

Glenn H.D, J.H. Cowan, Jr., and J.E. Powers. 2017. A comparison of Red Snapper reproductive potential in the northwestern Gulf of Mexico: Natural versus artificial habitats. Marine and Coastal Fisheries 9:139–148. https://doi.org/10.1080/19425120.2017.1282896.

Herdter, E.S., D.P. Chambers, C.D. Stallings and S.A. Murawski. 2017. Did the Deepwater Horizon oil spill affect growth of red snapper in the Gulf of Mexico? Fisheries Research 191:60-68.

Hewitt, D.A. and J.M. Hoenig. 2005. Comparison of two approaches for estimating natural mortality based on longevity. Fisheries Bulletin. 103:433-437.

Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fisheries Bulletin. 82:898-903.

Kulaw, D.H., J.H. Cowan, Jr., and M.W. Jackson. 2017. Temporal and spatial comparisons of the reproductive biology of northern Gulf of Mexico (USA) Red Snapper (Lutjanus campechanus) collected a decade apart. PLoS One 12:1–39. https://doi.org/10.1371/journal.pone.0172360.

Leontiou, A.J., W. Wu and N.J. Brown-Peterson. 2021a. Immature and mature female Red Snapper habitat use in the north-central Gulf of Mexico. Regional Studies in Marine Science 44:101715, 8 p. https://doi.org/10.1016/j.rsma.2021.101715.

Leontiou, A.J., W. Wu, and N.J Brown-Peterson. 2021b. The role of maturity in artificial habitat selection by female Red Snapper. Marine and Coastal Fisheries 13:332-344. https://doi.org/10.1002/mcf2.10160.

Lewis, J.P., J.H. Tarnecki, S.B. Garner, D.D. Chagaris and W.F. Patterson III. 2020. Changes in reef fish community structure following the Deepwater Horizon oil spill. Scientific Reports. 10:5621. https://doi.org/10.1038/s41698-020-62574-y

Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. Journal of Fish Biology. 49:627-647.

Lowerre-Barbieri, S. and C. Friess. 2022. Modeling fecundity at age in Gulf of Mexico Red Snapper to help evaluate the best measure of reproductive potential. SEDAR74-DW-36. SEDAR, North Charleston, SC. 43 p.

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

Lowerre-Barbieri, S.K., K. Ganias, F. Saborido-Rey, H. Murua, and J.R. Hunter. 2011. Reproductive timing in marine fishes: variability, temporal scales, and methods. Marine and Coastal Fisheries: Dynamics. Management, and Ecosystem Science 3:71-91.

Manooch, C.S. III and J.C. Potts. 1997. Age and growth of red snapper, *Lutjanus campechanus*, Lutjanidae, collected along the southeastern United States from North Carolina through the east coast of Florida. Journal of the Elisha Mitchell Society 113(3):111-112.

Millender, A.K. and N.J. Brown-Peterson. 2022. Reproductive parameters of female Red Snapper differ across depth. Proceedings of the Gulf and Caribbean Fisheries Institute 74:in press.

Nelson, R.S. and C.S. Manooch III. 1982. Growth and mortality of red snappers in the west-central Atlantic Ocean and northern Gulf of Mexico. Transactions of the American Fisheries Society 111:465-475.

Obenour, D.R., D. Scavia, N.N. Rabalais, R.E. Turner and A.M. Michalak. 2013. Retrospective analysis of midsummer hypoxic area in the northern Gulf of Mexico, 1985-2011. Environmental Science and Technology 47:9808-9815.

Patterson, W.F. III., J.H. Cowan Jr., C.A. Wilson, and R.L. Shipp. 2001. Age and growth of red snapper,

Lutjanus campechanus, from an artificial reef area off Alabama in the northern Gulf of Mexico. U.S. Fishery Bulletin 99:617-627.

Porch, C.E. 2007. An assessment of the Red Snapper fishery in the U.S. Gulf of Mexico using a spatially-explicit age-structured model. American Fisheries Society Symposium 60:355-384.

Porch, C.E., G.R. Fitzhugh, E.T. Lang, H.M. Lyon, and B.C. Linton. 2015. Estimating the dependence of spawning frequency on size and age in Gulf of Mexico Red Snapper. Marine and Coastal Fisheries 7: 233-245.

SEDAR7 2005. Stock Assessment Report of SEDAR 7 Gulf of Mexico Red Snapper (SEDAR One Southpark Circle #306 Charleston, SC 29414 Southeast Data, Assessment, and Review).

SEDAR31 2013. Gulf of Mexico Red Snapper Stock Assessment Report. SEDAR, North Charleston SC. 1103 p.

SEDAR52 2018. SEDAR 52: Stock assessment report Gulf of Mexico Red Snapper. North Charleston, SC 435 p.

Switzer, T.S., E.J. Chesney and D.M. Baltz. 2015. Habitat use by juvenile red snapper in the northern Gulf of Mexico: ontogeny, seasonality, and the effects of hypoxia. Transactions of the American Fisheries Society 144:300-314.

Szedlmayer S.T. and P.A. Mudrak. 2014. Influence of Age-1 Conspecifics, Sediment Type,

Dissolved Oxygen, and the Deepwater Horizon Oil Spill on Recruitment of Age-0 Red Snapper in the Northeast Gulf of Mexico during 2010 and 2011, North American Journal of Fisheries Management, 34:2, 443-452.

Tarnecki, J.H. and Patterson, W.F. III. 2015. Changes in red snapper diet and trophic ecology following the Deepwater Horizon oil spill. Marine and Coastal Fisheries. 7:135-147.

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

Watterson, J.C., W.F. Patterson III, R.L. Shipp, J.H. Cowan Jr. 1998. Movement of red snapper, *Lutjanus campechanus*, in the North Central Gulf of Mexico: Potential effects of hurricanes. Gulf of Mexico Science 16(1):92-104.

Wilson, C.A. and D.L Nieland. 2001. Age and growth of red snapper, *Lutjanus campechanus*, from the northern Gulf of Mexico off Louisiana. Fishery Bulletin 99:653-664

2.9 TABLES

Table 1. Number of red snapper age samples by fishery (commercial, recreational, fishery independent, or unknown), subregion (West, Central, or East), and year.

	COM			REC			FI			UNK		
Year	W	C	E	W	C	E	W	C	E	W	C	E
1980	0	0	0	0	325	0	0	0	0	0	2	0
1986	0	0	0	348	1	1	0	0	0	0	0	0
1987	0	0	0	146	0	0	0	0	0	0	0	0
1988	0	0	0	350	1	0	0	0	0	0	0	0
1989	0	0	0	82	0	1	0	0	0	0	0	0
1990	0	0	0	36	0	0	0	0	0	0	0	0
1991	25	178	12	629	272	2	0	0	0	0	2	0
1992	210	116	34	511	441	5	0	7	0	22	2	0
1993	341	136	43	1236	632	62	5	0	0	0	0	0
1994	500	121	36	540	593	53	0	2	0	0	0	0
1995	97	85	26	147	371	0	0	21	0	0	0	0
1996	0	9	6	0	195	0	1	1	0	0	0	0
1997	0	1	41	0	157	1	36	1	0	0	0	0
1998	1519	235	36	1306	1857	2	1	16	0	0	0	0
1999	1873	902	172	435	1590	14	0	10	0	38	96	0
2000	1037	1381	111	255	647	3	76	115	0	50	77	0
2001	1205	1247	140	74	595	12	83	3	1	9	43	0
2002	4418	1165	182	772	3034	15	73	127	0	0	0	0
2003	3456	1500	177	968	6445	40	58	12	4	0	0	0
2004	3350	989	347	1195	4075	4	47	16	5	0	0	0
2005	2999	1131	379	1442	5331	57	357	423	4	0	0	0
2006	3362	1146	378	1524	3743	88	147	133	3	0	0	0
2007	1931	1211	178	1072	651	22	229	400	24	0	0	0
2008	2020	1147	343	940	542	63	355	234	30	0	0	0
2009	2528	949	1275	1178	960	372	253	450	337	13	22	6
2010	2293	1149	1461	876	1563	375	396	1487	460	0	0	35
2011	1695	2896	1052	1203	1403	385	2118	1385	311	0	0	17
2012	3110	3581	869	1512	2194	141	1890	1134	132	1	206	16
2013	1614	2063	1225	2399	2765	183	2656	1119	221	2	0	0
2014	1203	1792	1876	1986	4039	196	1445	1380	102	0	1	0
2015	1750	2386	1373	1834	4794	344	466	1544	141	0	0	0
2016	1806	2769	1633	1632	2486	73	566	1806	184	0	1	0
2017	1372	3167	1696	2032	1865	491	2308	1739	225	0	0	18
2018	1802	4253	1267	2178	2756	483	409	1828	307	0	0	0
2019	1801	4430	1730	1981	2750	410	331	1174	28	0	0	0

Table 2. Number of red snapper age samples by fishing mode (vertical line, longline, other, or unknown), subregion (West, Central, or East) and year (1980-2019).

	VL			LL			OT			UNK		
Year	W	C	E	W	C	E	W	C	E	W	C	E
1980	0	325	0	0	0	0	0	2	0	0	0	0
1986	348	1	1	0	0	0	0	0	0	0	0	0
1987	146	0	0	0	0	0	0	0	0	0	0	0
1988	350	1	0	0	0	0	0	0	0	0	0	0
1989	82	0	1	0	0	0	0	0	0	0	0	0
1990	36	0	0	0	0	0	0	0	0	0	0	0
1991	654	450	2	0	0	12	0	2	0	0	0	0
1992	721	544	23	0	0	15	22	22	1	0	0	0
1993	1548	768	75	29	0	30	5	0	0	0	0	0
1994	1034	714	81	0	0	8	6	2	0	0	0	0
1995	236	476	7	0	0	19	8	1	0	0	0	0
1996	0	205	0	1	0	6	0	0	0	0	0	0
1997	0	159	32	0	0	10	36	0	0	0	0	0
1998	2479	2054	13	347	0	25	0	54	0	0	0	0
1999	2232	2496	84	76	6	102	38	96	0	0	0	0
2000	950	2137	32	418	1	82	50	82	0	0	0	0
2001	1100	1830	77	262	15	76	9	43	0	0	0	0
2002	3173	4228	29	413	98	168	1106	0	0	571	0	0
2003	2354	7918	49	314	39	172	1396	0	0	418	0	0
2004	3059	5044	117	687	34	239	375	2	0	471	0	0
2005	4094	6761	127	252	35	313	18	89	0	434	0	0
2006	4102	4889	238	586	1	204	138	132	27	207	0	0
2007	2637	2016	89	392	93	135	70	153	0	133	0	0
2008	2517	1538	96	352	182	315	345	203	25	101	0	0
2009	3294	2112	1109	333	22	684	211	247	197	134	0	0
2010	2914	3484	1193	158	665	1082	320	50	56	173	0	0
2011	4104	4584	1135	867	981	572	25	119	58	20	0	0
2012	4585	5948	849	1257	995	253	607	166	56	64	6	0
2013	4053	4939	901	2041	927	679	577	81	49	0	0	0
2014	3303	5853	962	1216	1122	1124	115	237	88	0	0	0
2015	3508	7136	916	538	1348	808	4	240	134	0	0	0
2016	3421	5353	983	576	1450	860	7	209	47	0	50	0
2017	5279	5253	1698	433	1325	566	0	193	166	0	0	0
2018	3900	7110	1418	489	1663	588	0	64	51	0	0	0
2019	3249	7083	1361	864	1194	778	0	77	22	0	0	7

Table 3. Parameter estimates from von Bertalanffy size modified growth models (Diaz et al. 2004) fit to red snapper length (FL cm)-at-age (fractional, yr) data for a single stock, one region (Gulf of Mexico) model. The population model runs include all observations with year-specific size limits input for commercial and recreational fisheries. The fishery model runs include only observations from commercial or recreational fisheries. Variance parameter(s) were modeled with constant sigma, constant coefficient of variation (CV), CV as a linear function of age, or CV as a linear function of size-at-age. Weighting was used for a subset of each population or fishery model by taking the inverse of the count for each age-class in the dataset.

Model	Variance parameter	Parameters	Weighting	Region	N	Objective function value	AICc	ΔAICc	L_{∞}	k	t_0	varpar[1]	varpar[2]	Max gradient component
Population	Constant sigma	4	--	GOM	229519	732323.0	1464650.0	6000.0	77.50	0.2066	-0.170	7.553	--	3.20E-02
	Constant CV	4	--	GOM	229519	730571.0	1461150.0	2500.0	80.52	0.1680	-0.913	0.157	--	5.96E-02
	CV as linear function of age	5	--	GOM	229519	729418.0	1458850.0	200.0	81.59	0.1649	-0.884	0.172	0.001	1.97E-01
	CV as linear function of size-at-age	5	--	GOM	229519	729318.0	1458650.0	0.0	80.63	0.1731	-0.728	0.208	0.115	3.50E-04
	Constant sigma	4	Inverse	GOM	229519	3377.3	6762.6	4.2	81.00	0.1544	-1.121	6.010	--	1.16E-03
	Constant CV	4	Inverse	GOM	229519	3391.2	6790.5	32.0	79.97	0.1739	-0.980	0.079	--	1.13E-03
	CV as linear function of age	5	Inverse	GOM	229519	3375.2	6760.4	2.0	81.59	0.1458	-1.275	0.115	0.011	9.36E-07
	CV as linear function of size-at-age	5	Inverse	GOM	229519	3374.2	6758.4	0.0	**82.10**	**0.1407**	**-1.062**	**0.395**	**0.057**	8.64E-09

Table 4. Parameter estimates from von Bertalanffy size modified growth models (Diaz et al. 2004) fit to red snapper length (FL cm)-at-age (fractional, yr) data for a three subregion (West, Central, or East Gulf of Mexico) model. The population model runs include all observations with year-specific size limits input for commercial and recreational fisheries. Variance parameter(s) were modeled with constant sigma, constant coefficient of variation (CV), CV as a linear function of age, or CV as a linear function of size-at-age. Weighting was used for a subset of each population or fishery model by taking the inverse of the count for each age-class in the dataset.

Model	Variance parameter	Parameters	Weighting	Region	N	Objective function value	AICc	ΔAICc	L_∞	k	t_0	varpar[1]	varpar[2]	Max gradient component
Population	Constant sigma	4	--	West	92690	299932.0	599873.0	676.0	76.56	0.2103	-0.056	7.899	--	3.30E-05
	Constant CV	4	--	West	92690	302351.0	604710.0	5513.0	76.71	0.1841	-0.732	0.156	--	7.27E+04
	CV as linear function of age	5	--	West	92690	300730.0	601471.0	2274.0	79.49	0.1717	-0.759	0.185	0.005	5.53E-04
	CV as linear function of size-at-age	5	--	West	92690	299593.0	599197.0	0.0	78.58	0.1847	-0.450	0.283	0.087	1.21E-03
	Constant sigma	4	--	Central	112434	350543.0	701095.0	9064.0	80.66	0.1789	-0.429	7.379	--	2.36E-01
	Constant CV	4	--	Central	112434	346092.0	692190.0	159.0	87.46	0.1354	-1.300	0.150	--	1.01E-02
	CV as linear function of age	5	--	Central	112434	346057.0	692124.0	93.0	87.77	0.1336	-1.331	0.148	0.202	1.01E-02
	CV as linear function of size-at-age	5	--	Central	112434	346011.0	692031.0	0.0	87.85	0.1323	-1.381	0.138	0.172	3.69E-06
	Constant sigma	4	--	East	24490	77592.3	155193.0	0.0	80.28	0.2092	-0.541	6.084	--	2.00E-03
	Constant CV	4	--	East	24490	78731.7	157471.0	2278.0	76.41	0.2206	-0.757	0.136	--	2.30E+04
	CV as linear function of age	5	--	East	24490	78043.6	156097.0	904.0	83.01	0.1825	-0.938	0.131	0.006	6.39E-03
	CV as linear function of size-at-age	5	--	East	24490	77703.0	155416.0	223.0	80.91	0.2010	-0.674	0.192	0.068	9.95E-05
	Constant sigma	4	Inverse	West	92690	159.5	327.0	14.3	81.30	0.1496	-1.150	5.460	--	4.65E-09
	Constant CV	4	Inverse	West	92690	168.3	344.6	31.8	80.30	0.1667	-0.997	0.094	--	4.48E-06
	CV as linear function of age	5	Inverse	West	92690	151.4	312.8	0.0	82.26	0.1449	-1.144	0.150	0.001	2.47E-05
	CV as linear function of size-at-age	5	Inverse	West	92690	153.1	316.3	3.5	**81.88**	**0.1361**	**-1.092**	**0.394**	**0.041**	1.00E-05
	Constant sigma	4	Inverse	Central	112434	165.9	339.8	2.9	85.55	0.1443	-1.133	6.198	--	1.05E+00
	Constant CV	4	Inverse	Central	112434	175.8	359.6	22.6	84.63	0.1506	-1.255	0.103	--	6.86E-06
	CV as linear function of age	5	Inverse	Central	112434	169.0	347.9	11.0	84.67	0.1499	-1.221	0.137	0.039	9.15E-06
	CV as linear function of size-at-age	5	Inverse	Central	112434	163.5	337.0	0.0	**85.43**	**0.1471**	**-1.020**	**0.318**	**0.057**	4.28E-05
	Constant sigma	4	Inverse	East	24490	104.8	217.6	0.0	85.77	0.1678	-0.794	6.054	--	1.38E-06
	Constant CV	4	Inverse	East	24490	112.3	232.5	14.9	84.11	0.1862	-0.694	0.113	--	1.34E-06
	CV as linear function of age	5	Inverse	East	24490	106.9	223.7	6.1	85.55	0.1726	-0.757	0.147	0.028	2.26E-06
	CV as linear function of size-at-age	5	Inverse	East	24490	104.8	219.6	2.0	**85.99**	**0.1659**	**-0.736**	**0.252**	**0.063**	2.64E-07

Table 5. Select age-at-maturity model comparison results. Covariate terms were period and region. The interaction model is the preferred mode with the lowest expected log pointwise density (elpd) based on 10-fold cross-validation, but it produced biologically unrealistic inflection point estimates for some period-region combinations. The random effects model where group-specific intercepts and slopes for region and period were estimated was chosen as the preferred model. 1– overfished (1991-2008; 2– rapidly recovering (2009-2016); 3–stabilizing (2017-2019).

Model	elpd_kfold	R^2	A50					
No covariates	-700.9	0.32	1.64					
			East			*West*		
			1	*2*	*3*	*1*	*2*	*3*
Interaction	-574.6	0.43	0.57	1.63	2.00	1.71	0.76	2.06
Additive terms	-619.9	0.40	0.77	1.11	2.00	1.41	1.76	2.64
Random effects	-597.9	0.42	1.36	1.44	1.93	1.52	1.71	2.46

Table 6. Select length-at-maturity model comparison results. Covariate terms were period and region. The interaction model is the preferred mode with the highest expected log pointwise density (elpd) based on 10-fold cross-validation. We chose the random effects model as the best model to be consistent with age model results. Period 1– overfished (1991-2008; 2– rapidly recovering (2009-2016); 3–stabilizing (2017-2019).

Model	elpd_kfold	R^2	l50					
No covariates	-626.5	0.43	28.3					
			East			*West*		
			1	*2*	*3*	*1*	*2*	*3*
Interaction	-463.5	0.57	23.7	28.5	32.9	21.9	21.3	31.0
Additive terms	-489.3	0.54	22.3	26.5	32.7	22.7	26.9	33.1
Random effects	-473.9	0.56	25.6	28.0	32.8	22.0	23.8	31.5

Table 7. Model parameter estimates and mcmc fit diagnostics for the batch fecundity-at-length model. The mean of the posterior predictive distribution (11.3) was nearly identical to the mean of the observed log batch fecundities (11.34). Rhat values (all less than 1.1) and effective sample size (n_eff) values (all greater than 1000) suggest convergence and a large enough sample size for analysis, respectively. mcse = Monte Carlo standard error. Parameter estimates with certain direction (pd > 0.975) and significance (% in ROPE < 0.025) are highlighted. Pd=probability of direction. %ROPE= the percent of the posterior samples that fall within the region of practical equivalence.

	mean	sd	10%	50%	90%	mcse	Rhat	n_eff	pd	% in ROPE
(Intercept)	**-12.60**	**1.90**	**-15.10**	**-12.60**	**-10.20**	**0**	**1**	**3429**	**1.00**	**0.00**
log_fl	**3.90**	**0.30**	**3.60**	**3.90**	**4.20**	**0**	**1**	**2192**	**1.00**	**0.00**
period1	**6.60**	**1.70**	**4.50**	**6.70**	**8.80**	**0**	**1**	**1888**	**1.00**	**0.00**
period2	-0.20	2.10	-2.90	-0.30	2.50	0	1	1824	0.55	0.06
region1	**-6.70**	**1.60**	**-8.80**	**-6.60**	**-4.60**	**0**	**1**	**1643**	**1.00**	**0.00**
method1	-0.30	0.20	-0.50	-0.30	0.00	0	1	4442	0.95	0.28
month5	**1.30**	**0.40**	**0.70**	**1.30**	**1.80**	**0**	**1**	**1279**	**1.00**	**0.00**
month6	**1.30**	**0.40**	**0.80**	**1.40**	**1.90**	**0**	**1**	**1221**	**1.00**	**0.00**
month7	**1.00**	**0.40**	**0.40**	**1.00**	**1.50**	**0**	**1**	**1238**	**0.99**	**0.00**
month8	0.60	0.40	0.10	0.60	1.20	0	1	1243	0.93	0.12
month9	0.20	0.40	-0.30	0.20	0.80	0	1	1234	0.71	0.28
month10	-0.80	0.60	-1.50	-0.80	0.00	0	1	1910	0.90	0.10
log_rw	**1.80**	**0.30**	**1.40**	**1.80**	**2.20**	**0**	**1**	**5851**	**1.00**	**0.00**
log_fl:period1	**-1.70**	**0.40**	**-2.20**	**-1.70**	**-1.10**	**0**	**1**	**1884**	**1.00**	**0.00**
log_fl:period2	-0.20	0.50	-0.90	-0.20	0.50	0	1	1833	0.65	0.24
log_fl:region1	**1.50**	**0.40**	**0.90**	**1.50**	**2.00**	**0**	**1**	**1627**	**1.00**	**0.00**
period1:region1	-1.70	2.50	-4.90	-1.80	1.40	0.1	1	1730	0.76	0.05
period2:region1	0.20	3.10	-3.60	0.20	4.20	0.1	1	1741	0.52	0.05
log_fl:period1:region1	0.50	0.60	-0.30	0.50	1.20	0	1	1721	0.77	0.17
log_fl:period2:region1	0.00	0.80	-1.00	0.10	1.00	0	1	1731	0.53	0.19
sigma	**1.20**	**0.00**	**1.10**	**1.20**	**1.20**	**0**	**1**	**5416**	**1.00**	**0.00**
mean_PPD						0.0	1	4250		
log-posterior						0.1	1	1401		

Table 8. Predicted average daily spawning fraction by age, period, and region. Early–1991-2008, when the stock was severely overfished; Mid–2009-2016, when the stock was rapidly recovering; Late–from 2017-2019 as stock abundance began to stabilize.

Age	East, Early	East, Mid	East, Late	West, Early	West, Mid	West, Late
2	0.213	0.184	0.162	0.093	0.069	0.055
4	0.261	0.241	0.223	0.155	0.124	0.103
6	0.290	0.278	0.268	0.218	0.189	0.167
8	0.304	0.298	0.293	0.264	0.245	0.228
10	0.310	0.308	0.305	0.291	0.280	0.271
12	0.313	0.312	0.311	0.304	0.299	0.294
14	0.314	0.314	0.313	0.311	0.308	0.306
16	0.315	0.315	0.315	0.313	0.312	0.311
18	0.315	0.315	0.315	0.315	0.314	0.314
20	0.315	0.315	0.315	0.315	0.315	0.315

Table 9. Length and weight conversions for Gulf of Mexico red snapper.

Conversion	Units	Equation	n	a	b	Fit statistic	Data range	
MTL to FL	cm	FL=a+b*MTL	21286	0.138	0.926	$r^2 = 0.998$	MTL=4.1-99.4	FL=3.8-92.5
MTL to FL	in	FL=a+b*MTL		0.054	0.926		MTL=1.6-39.1	FL=1.5-36.4
SL to FL	cm	FL=a+b*SL	2842	1.756	1.137	$r^2 = 0.987$	SL=7.8-79.0	FL=9.5-89.0
SL to FL	in	FL=a+b*SL		0.692	1.137		SL=3.1-31.1	FL=3.7-35.0
NTL to FL	cm	FL=a+b*NTL	22327	-8.51E-02	0.930	$r^2 = 0.993$	NTL=16.3-97.6	FL=15.4-92.0
NTL to FL	in	FL=a+b*NTL		-3.35E-02	0.930		NTL=6.4-38.4	FL=6.1-36.2
SL to MTL	cm	MTL=a+b*SL	2253	1.968	1.228	$r^2 = 0.986$	SL=7.9-79.0	MTL=10.2-95.4
SL to MTL	in	MTL=a+b*SL		0.775	1.228		SL=3.1-31.1	MTL=4.0-37.6
SL to NTL	cm	NTL=a+b*SL	563	2.843	1.214	$r^2 = 0.970$	SL=23.5-77.5	NTL=31.1-92.0
SL to NTL	in	NTL=a+b*SL		1.119	1.214		SL=9.3-30.5	NTL=12.2-36.2
FL to NTL	cm	NTL=a+b*FL	22327	0.499	1.067	$r^2 = 0.993$	FL=15.4-92.0	NTL=16.3-97.6
FL to NTL	in	NTL=a+b*FL		0.196	1.067		FL=6.1-36.2	NTL=6.4-38.4
FL to MTL	cm	MTL=a+b*FL	21286	-4.86E-02	1.078	$r^2 = 0.998$	FL=3.8-92.5	MTL=4.1-99.4
FL to MTL	in	MTL=a+b*FL		-1.92E-02	1.078		FL=1.5-36.4	MTL=1.6-39.1
NTL to MTL	cm	MTL=a+b*NTL	NA	NA	NA	NA	NA	NA
NTL to MTL	in	MTL=a+b*NTL		0.133*	1.022*		NA	NA
GW to WW	kg	WW=a+b*GW	229	-0.123	1.115	$r^2 = 0.996$	GW=0.1-14.7	WW=0.1-16.5
GW to WW	lbs	WW=a+b*GW		-0.271	1.115		GW=0.1-32.4	WW=0.1-36.4
WW to GW	kg	GW=a+b*WW	229	0.1261	0.8934	$r^2 = 0.996$	GW=0.1-14.7	WW=0.1-16.5
WW to GW	lbs	GW=a+b*WW		0.2779	0.8934		GW=0.1-32.4	WW=0.1-36.4
SL to WW	kg, cm	WW=a*(SL^b)	2799	6.78E-05	2.7667	RSE = 0.598	SL=12.1-79.0	WW=0.05-13.0
SL to WW	lbs, in	WW=a*(SL^b)		1.97E-03	2.767	RSE = 1.319	SL=4.8=31.1	WW=0.1-28.7
FL to WW	kg, cm	WW=a*(FL^b)	42716	1.60E-05	3.016	RSE = 0.343	FL=3.8-92.5	WW=0.001-16.5
FL to WW	lbs, in	WW=a*(FL^b)		5.88E-04	3.016	RSE = 0.757	FL=1.5-36.4	WW=0.002-36.4
NTL to WW	kg, cm	WW=a*(NTL^b)	27238	1.26E-05	3.020	RSE = 0.377	NTL=10.6-98.4	WW=0.02-15.5
NTL to WW	lbs, in	WW=a*(NTL^b)		4.64E-04	3.020	RSE = 0.830	NTL=4.2-38.7	WW=0.04-34.2
MTL to WW	kg, cm	WW=a*(MTL^b)	15407	1.01E-05	3.076	RSE = 0.380	MTL=4.1-98.5	WW=0.001-16.5
MTL to WW	lbs, in	WW=a*(MTL^b)		3.92E-04	3.076	RSE = 0.837	MTL=1.6-38.8	WW=0.002-36.4
SL to GW	kg, cm	GW=a*(SL^b)	NA	NA	NA	NA	NA	NA
SL to GW	lbs, in	GW=a*(SL^b)		NA	NA	NA	NA	NA
FL to GW	kg, cm	GW=a*(FL^b)	69896	1.45E-05	3.036	RSE = 0.208	FL=14.6-95.5	GW=0.06-15.9
FL to GW	lbs, in	GW=a*(FL^b)		5.40E-04	3.036	RSE = 0.458	FL=5.7-37.6	GW=0.1-35.1
NTL to GW	kg, cm	GW=a*(NTL^b)	2971	1.76E-05	2.929	RSE = 0.235	NTL=31.0-83.0	GW=0.3-8.7
NTL to GW	lbs, in	GW=a*(NTL^b)		5.94E-04	2.929	RSE = 0.517	NTL=12.2-32.7	GW=0.7-19.2
MTL to GW	kg, cm	GW=a*(MTL^b)	4906	7.08E-06	3.159	RSE = 0.320	MTL=15.4-99.4	GW=0.06-15.6
MTL to GW	lbs, in	GW=a*(MTL^b)		2.97E-04	3.159	RSE = 0.705	MTL=6.1-39.1	GW=0.1-34.4

* Values from SEDAR 31

2.10 FIGURES

Figure 1. Number of age samples by West (W), Central (C), or East (E) subregion collected from the Gulf of Mexico in 1980 and from 1986 to 2019.

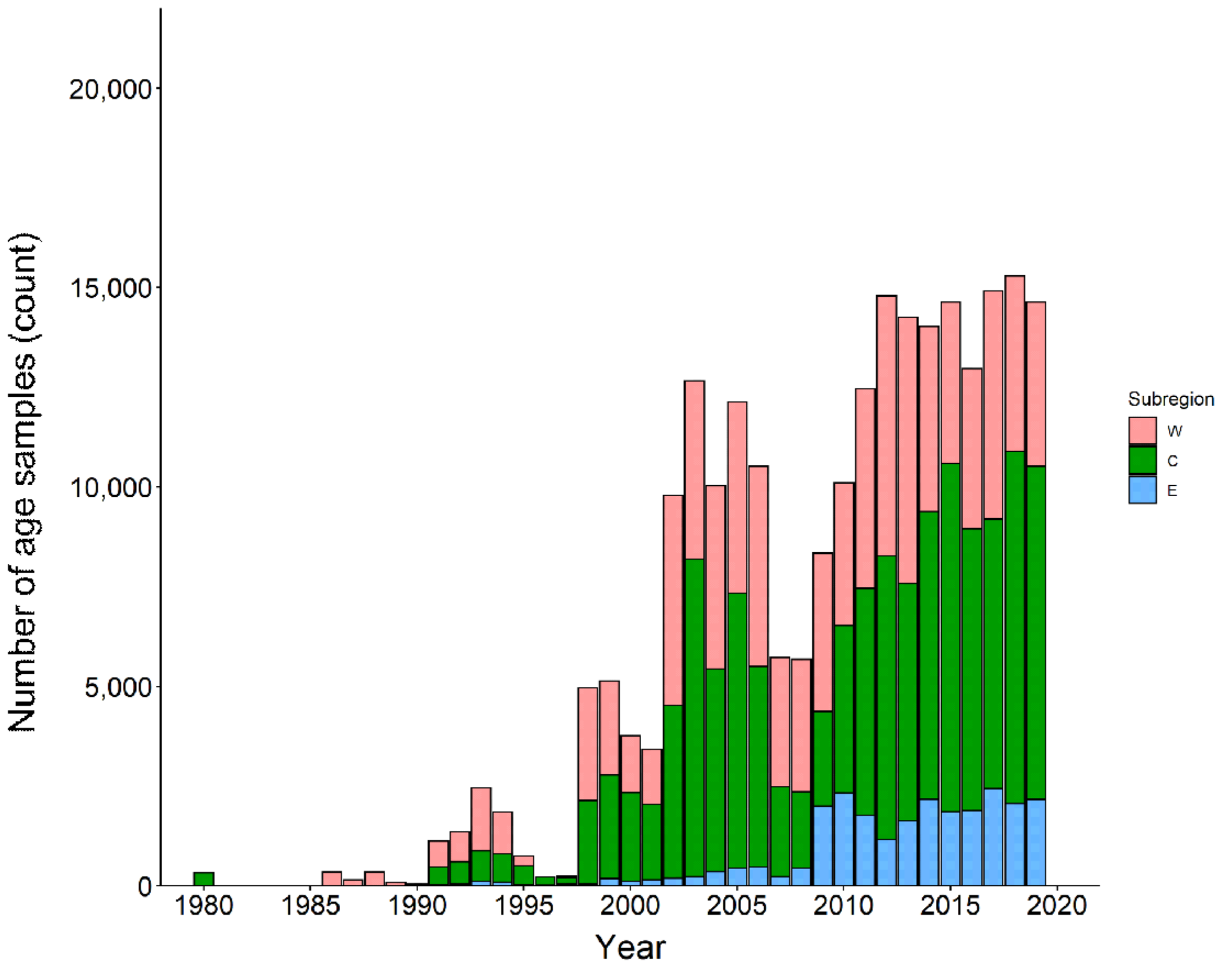


Figure 2. Proportion of red snapper age samples by state and data provider collected from the Gulf of Mexico in 1980 and from 1986 to 2019. Multiple labels from the same source indicate separate studies.

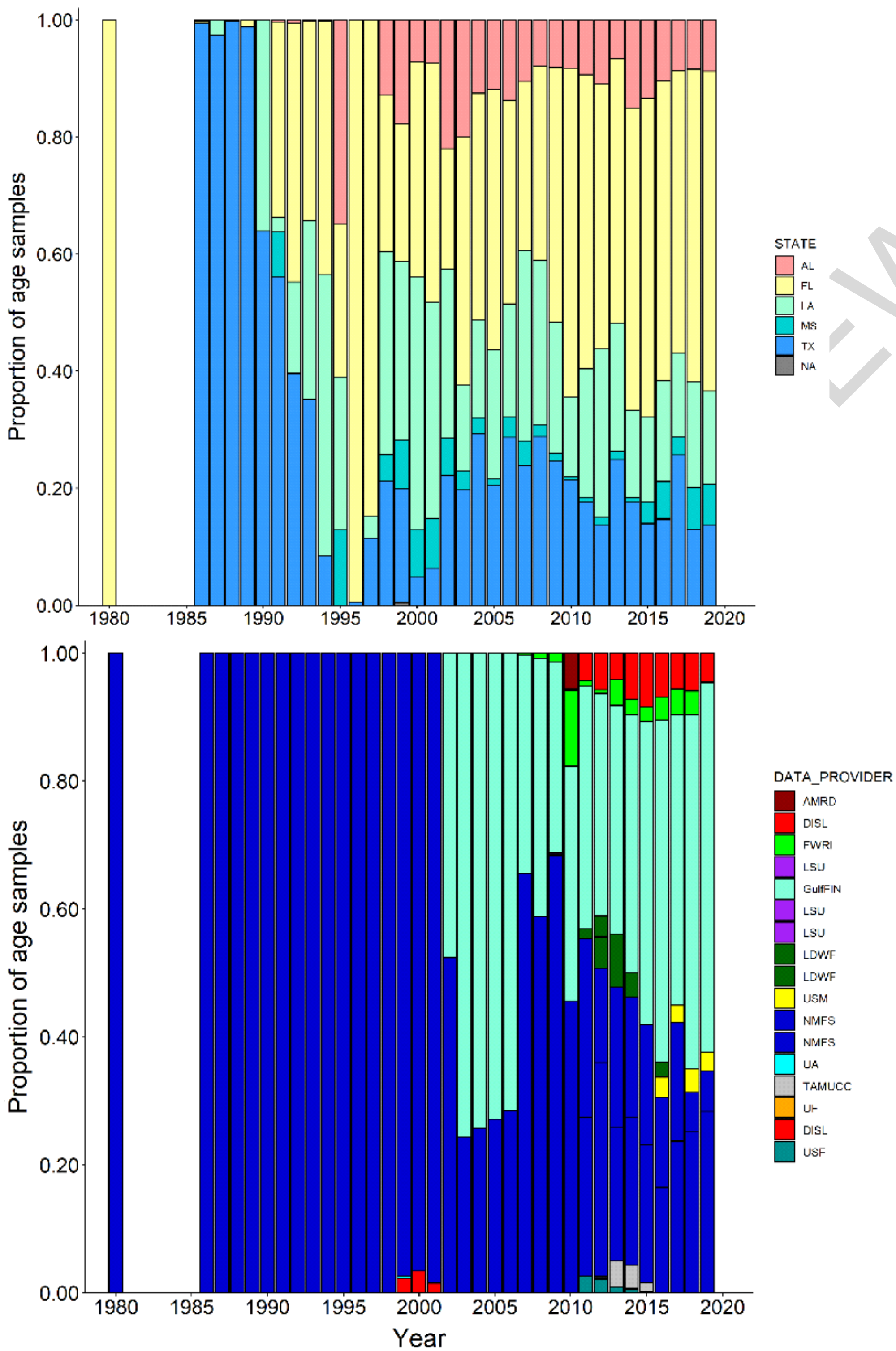


Figure 3. Frequency (%) histograms of final fork length (cm) by subregion (West, Central, or East) for red snapper age samples collected in the Gulf of Mexico in 1980 and from 1986 to 2019. Bin increments are equal to 2 cm.

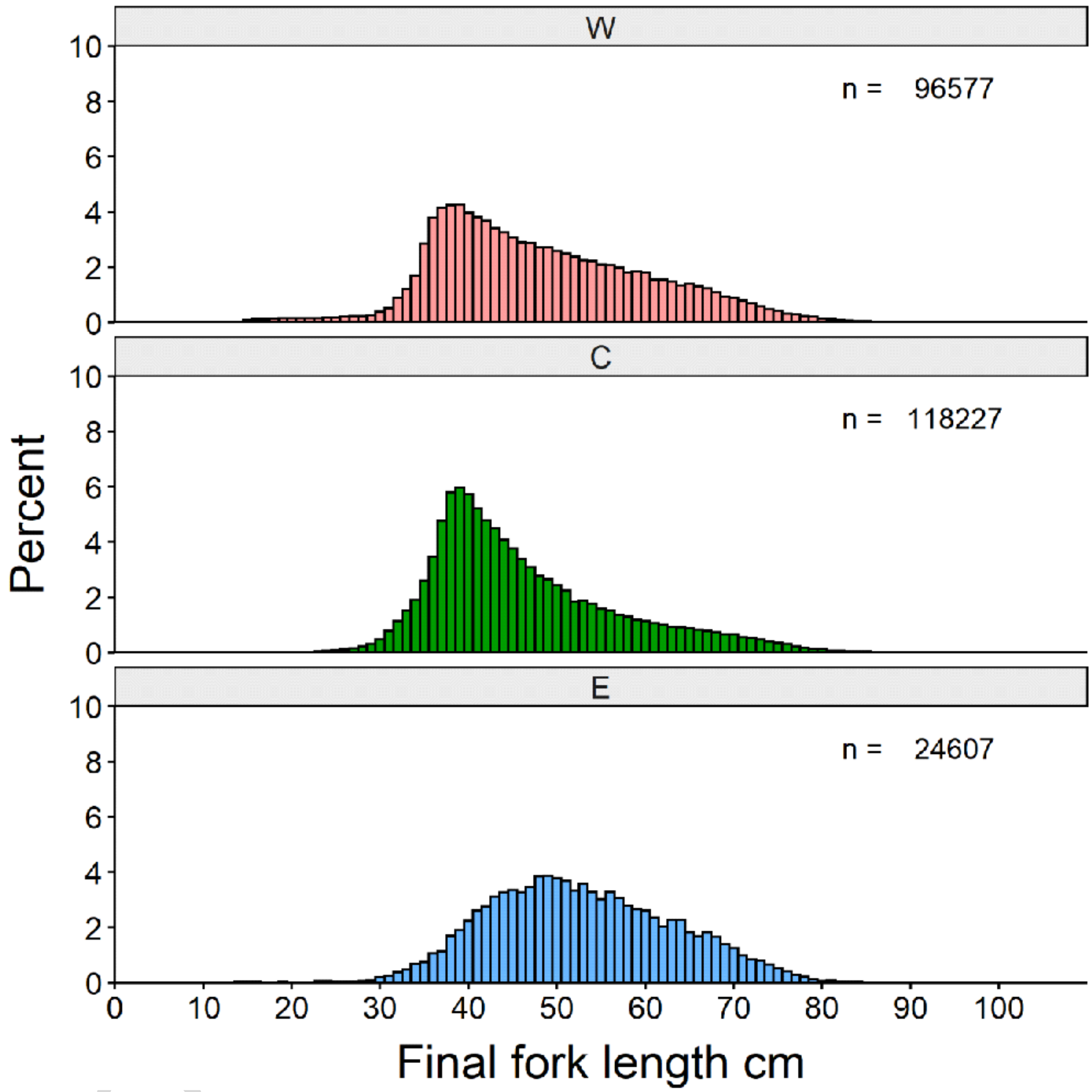


Figure 4. Frequency (%) histograms of calendar age (yr) by subregion (West, Central, or East) for red snapper age samples collected in the Gulf of Mexico in 1980 and from 1986 to 2019. Bin increments are equal to 1 yr. Arrows represent maximum age observed in the West (57 yr), Central (49 yr), or East (45 yr) subregion.

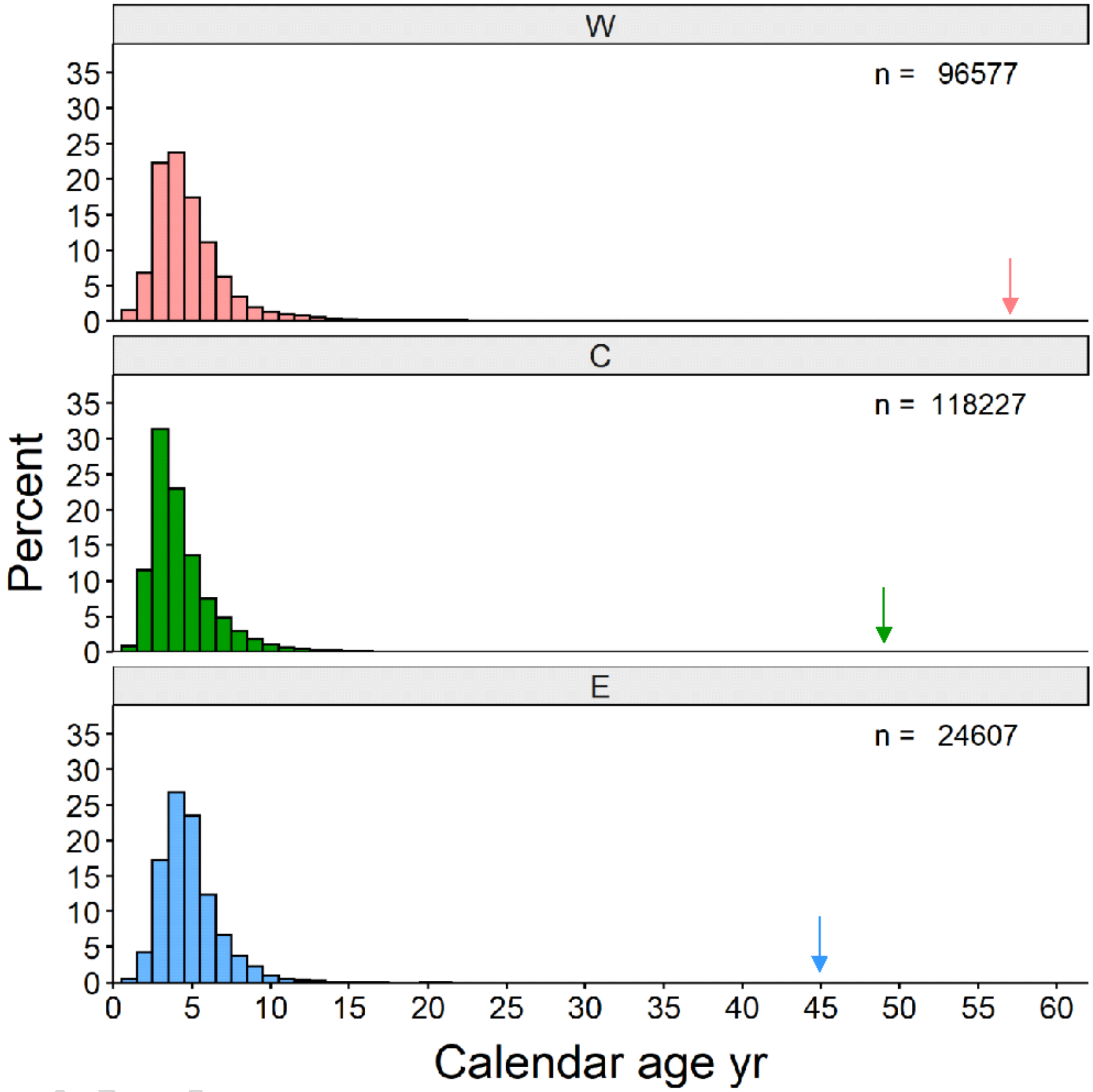


Figure 5. Frequency (%) histograms of calendar age (0 to 20 yrs) for red snapper age samples collected from the West subregion Gulf of Mexico in 1980 and from 1986 to 2019. Bin increments are equal to 1 yr. Years with <5 observations are not shown.

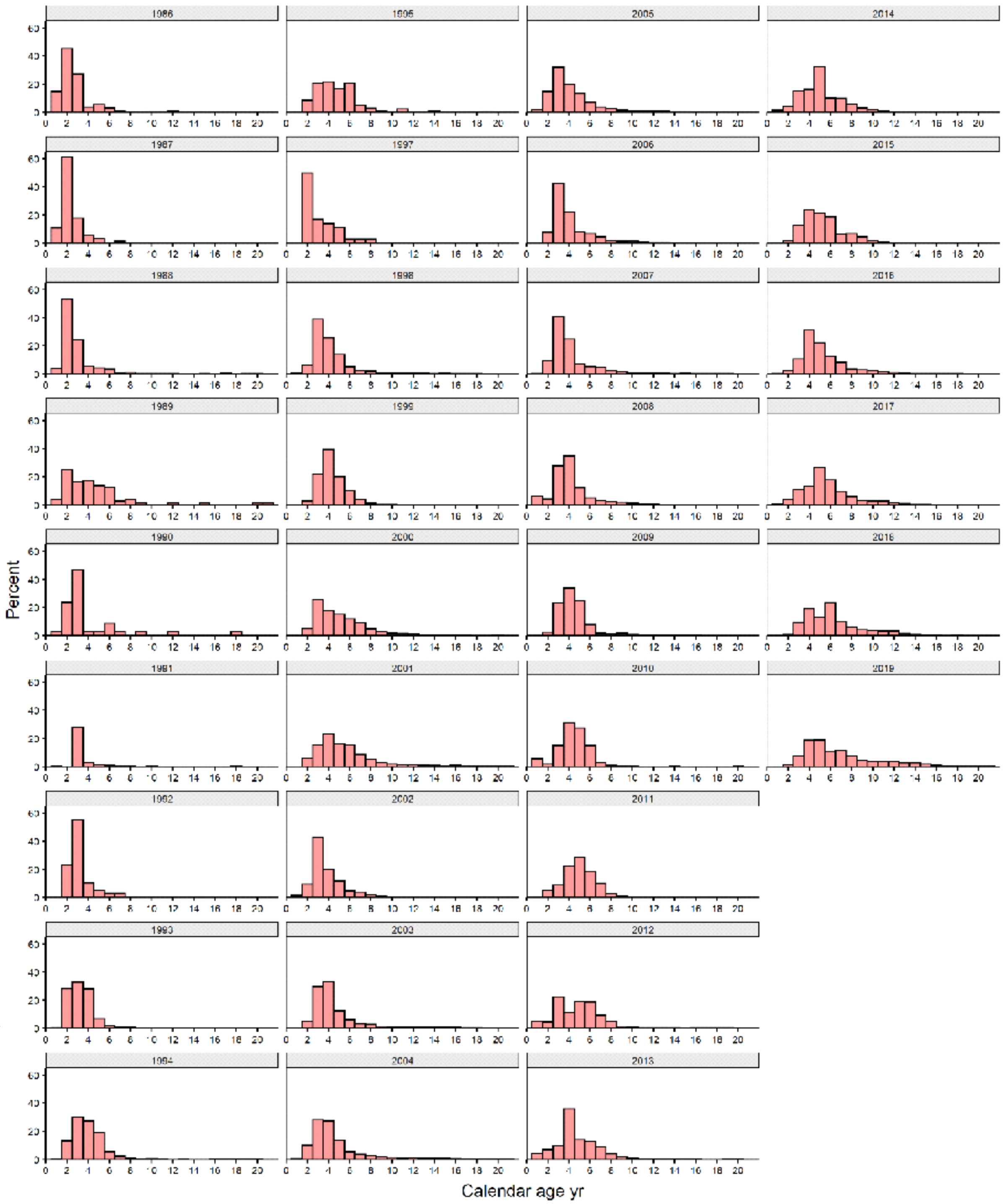


Figure 6. Frequency (%) histograms of calendar age (0 to 20 yrs) for red snapper age samples collected from the Central subregion Gulf of Mexico in 1980 and from 1991 to 2019. Bin increments are equal to 1 yr. Years with < 5 observations are not shown.

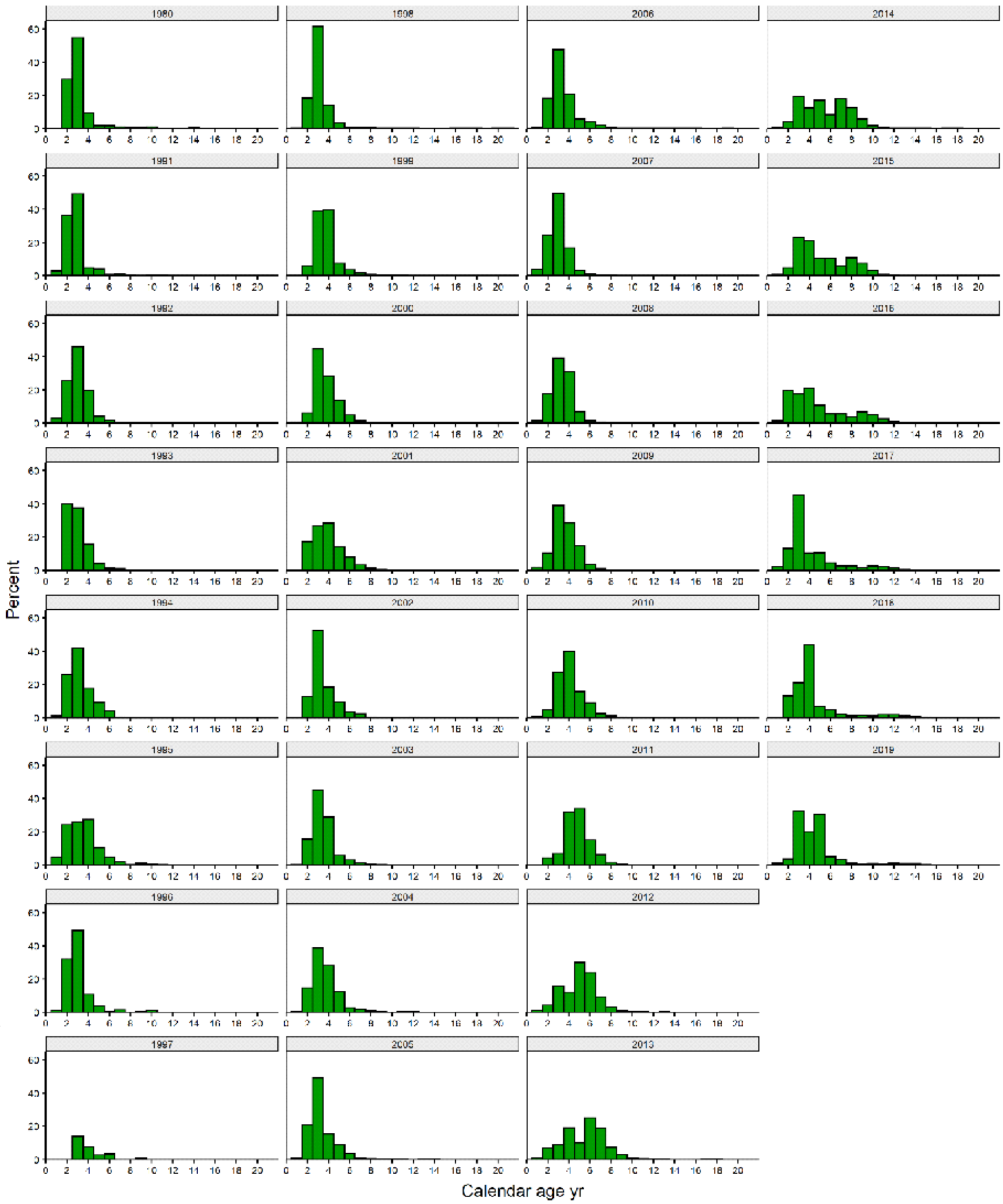


Figure 7. Frequency (%) histograms of calendar age (0 to 20 yrs) for red snapper age samples collected from the East subregion Gulf of Mexico from 1991 to 2019. Bin increments are equal to 1 yr. Years with <5 observations are not shown.

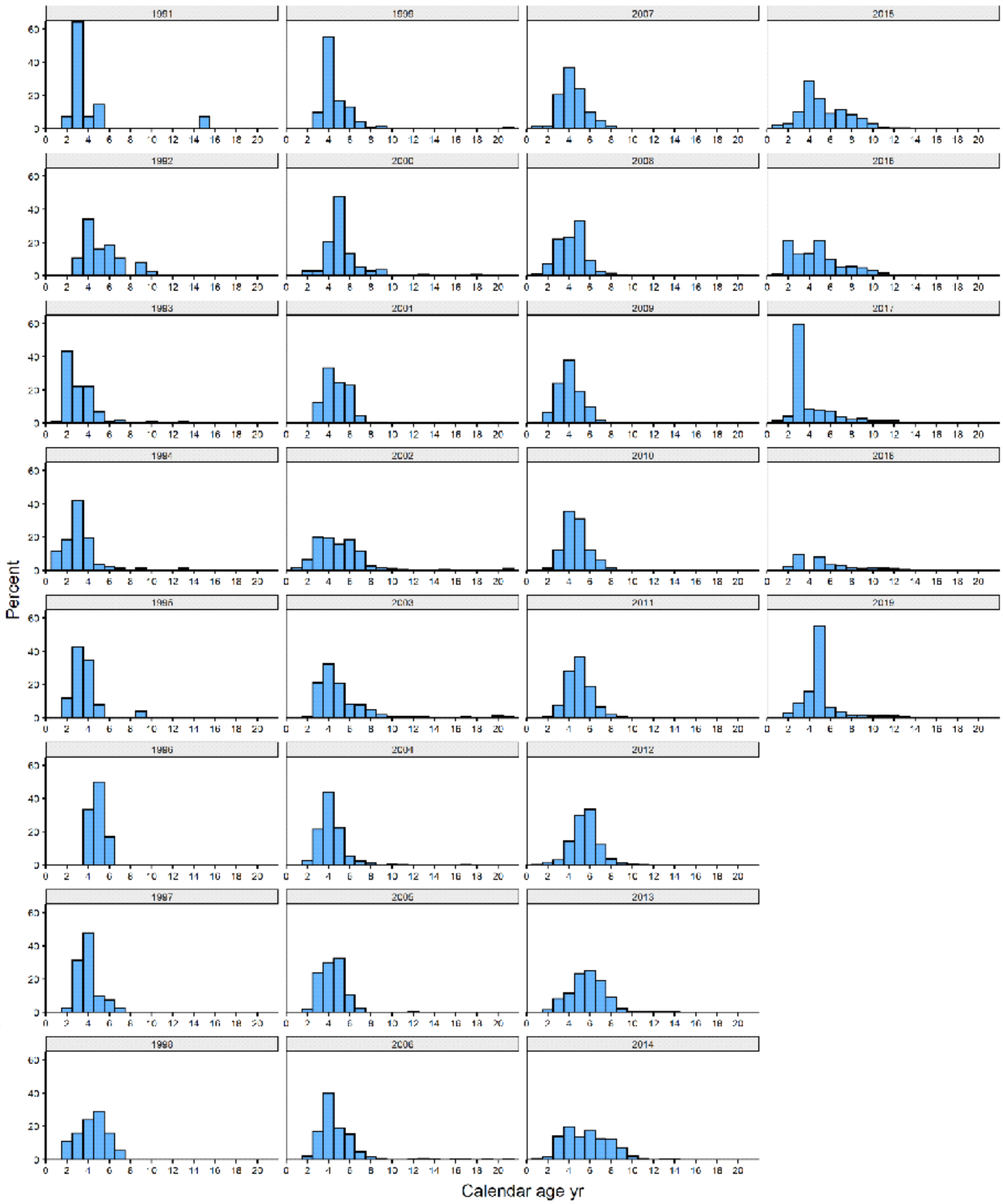


Figure 8. Boxplots of fractional age (yr) by subregion (West, Central, or East) and fishery (commercial, fishery independent, recreational, or unknown) for red snapper age samples collected in the Gulf of Mexico in 1980 and from 1986 to 2019. Upper and lower hinges indicate the first and third quartiles and whiskers extend to 1.5*IQR. Outliers are indicated by filled circles.

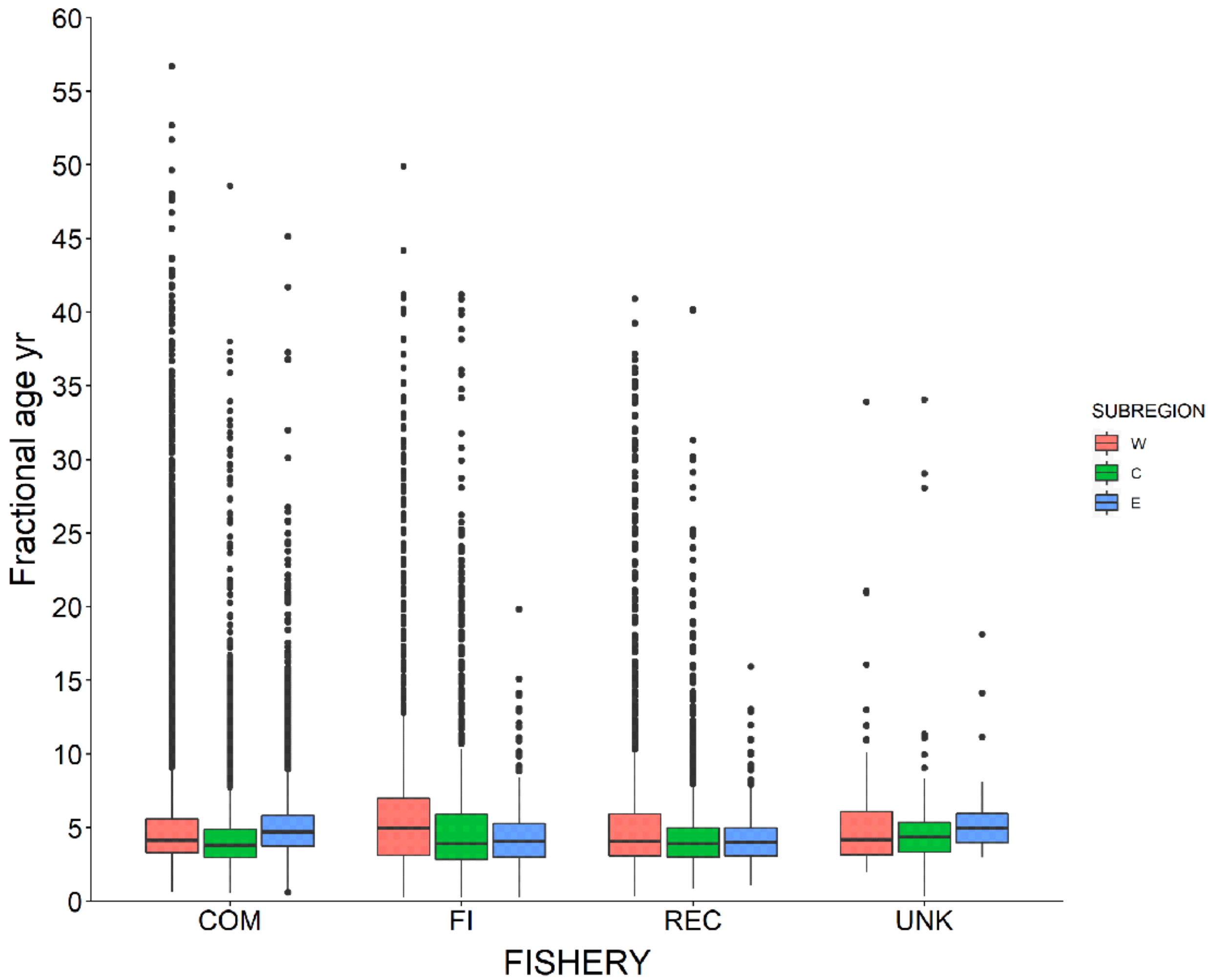


Figure 9. Frequency (%) histograms of calendar age (yr) for red snapper age samples collected from the commercial fishery in Gulf of Mexico from 1991 to 2019. Bin increments are equal to 1 yr. Years with <5 observations are not shown.

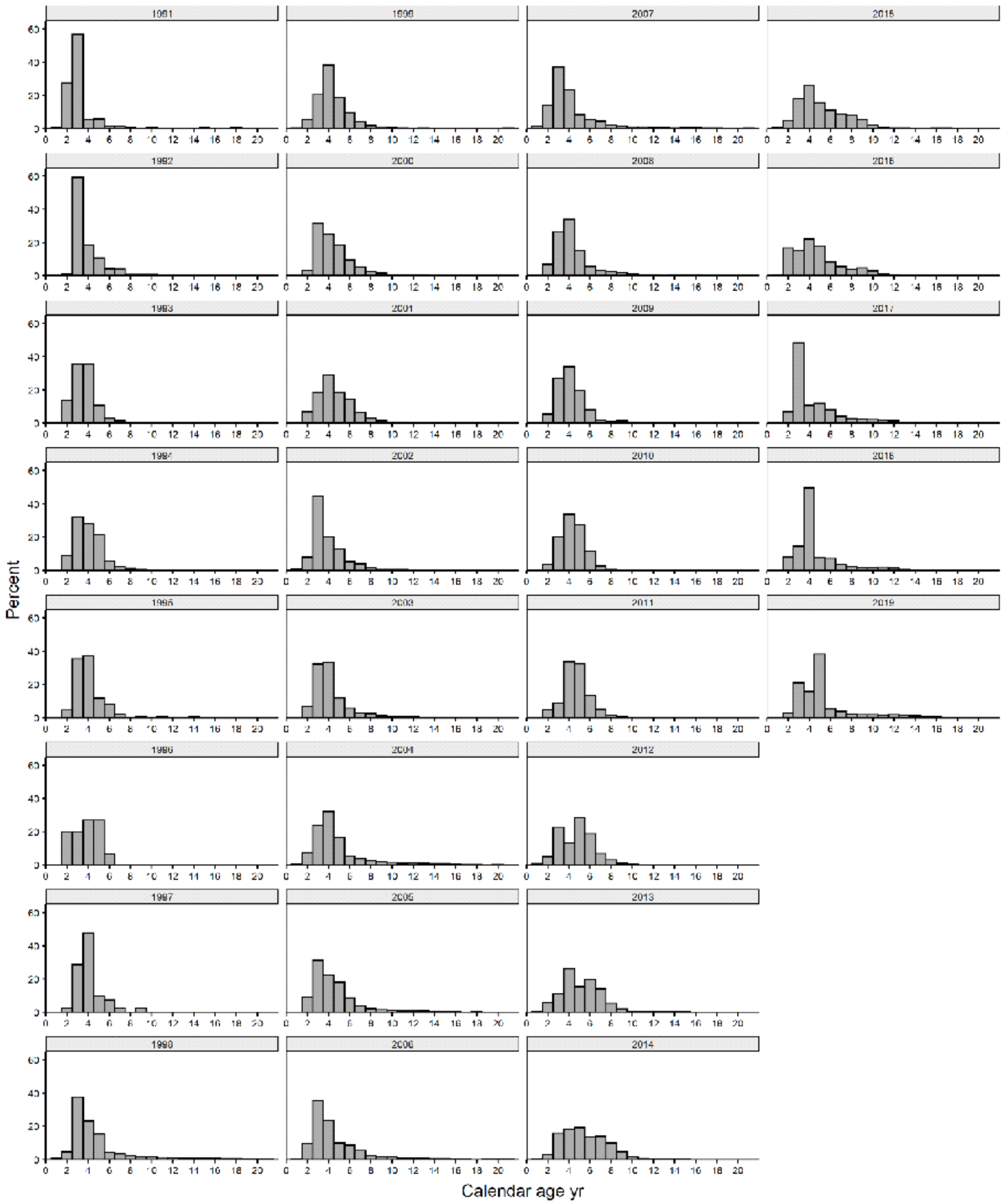


Figure 10. Frequency (%) histograms of calendar age (yr) for red snapper age samples collected from the recreational fishery in Gulf of Mexico in 1980 and from 1986 to 2019. Bin increments are equal to 1 yr.

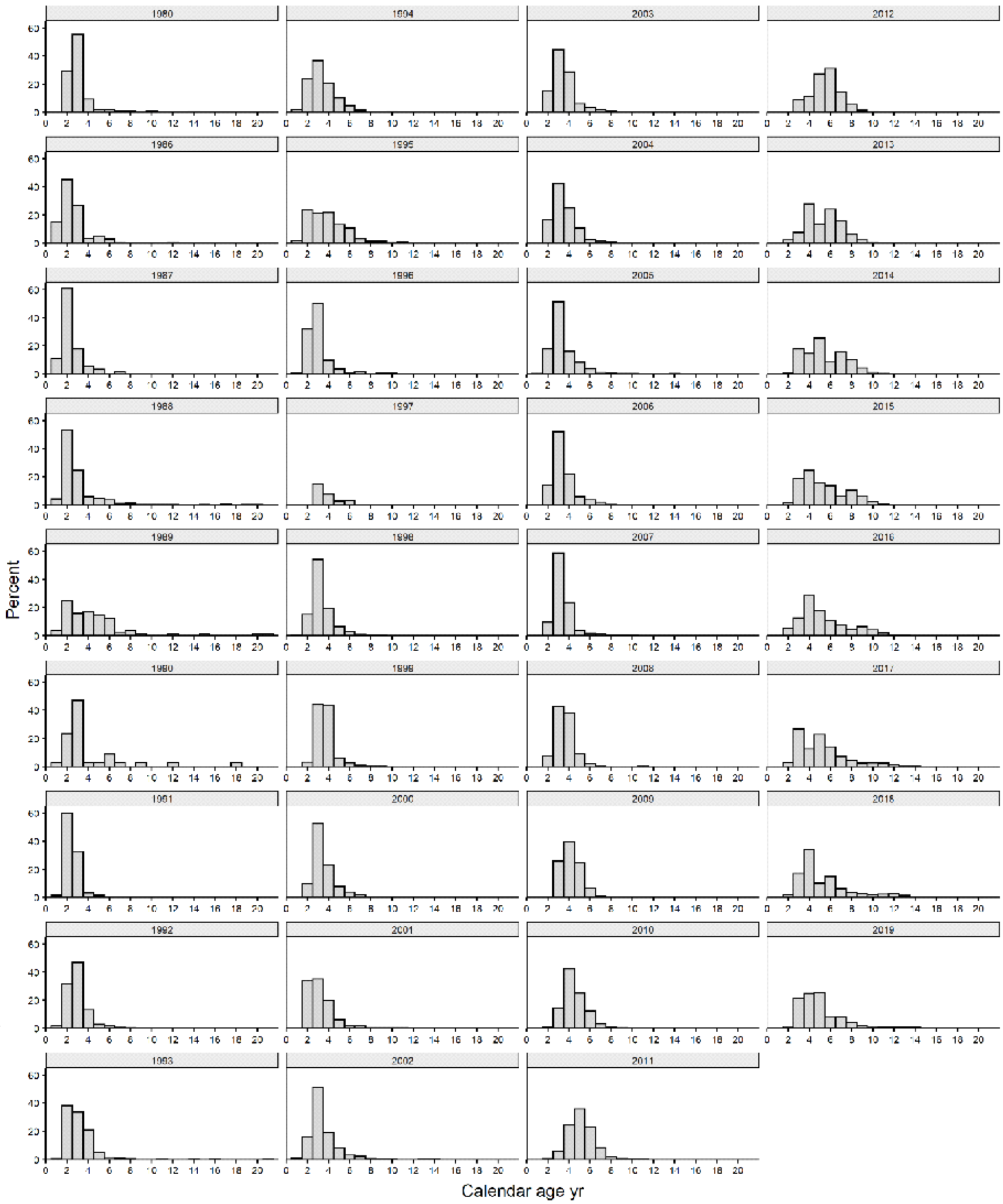


Figure 11. Scatter plot of fractional age (yr) versus final fork length (cm) for red snapper age samples collected in 1980 and from 1986 to 2019 from the Gulf of Mexico. Lines indicate best fit parameters from size-modified von Bertalanffy growth models (Diaz et al. 2004). Parameter values are listed in Table 3.

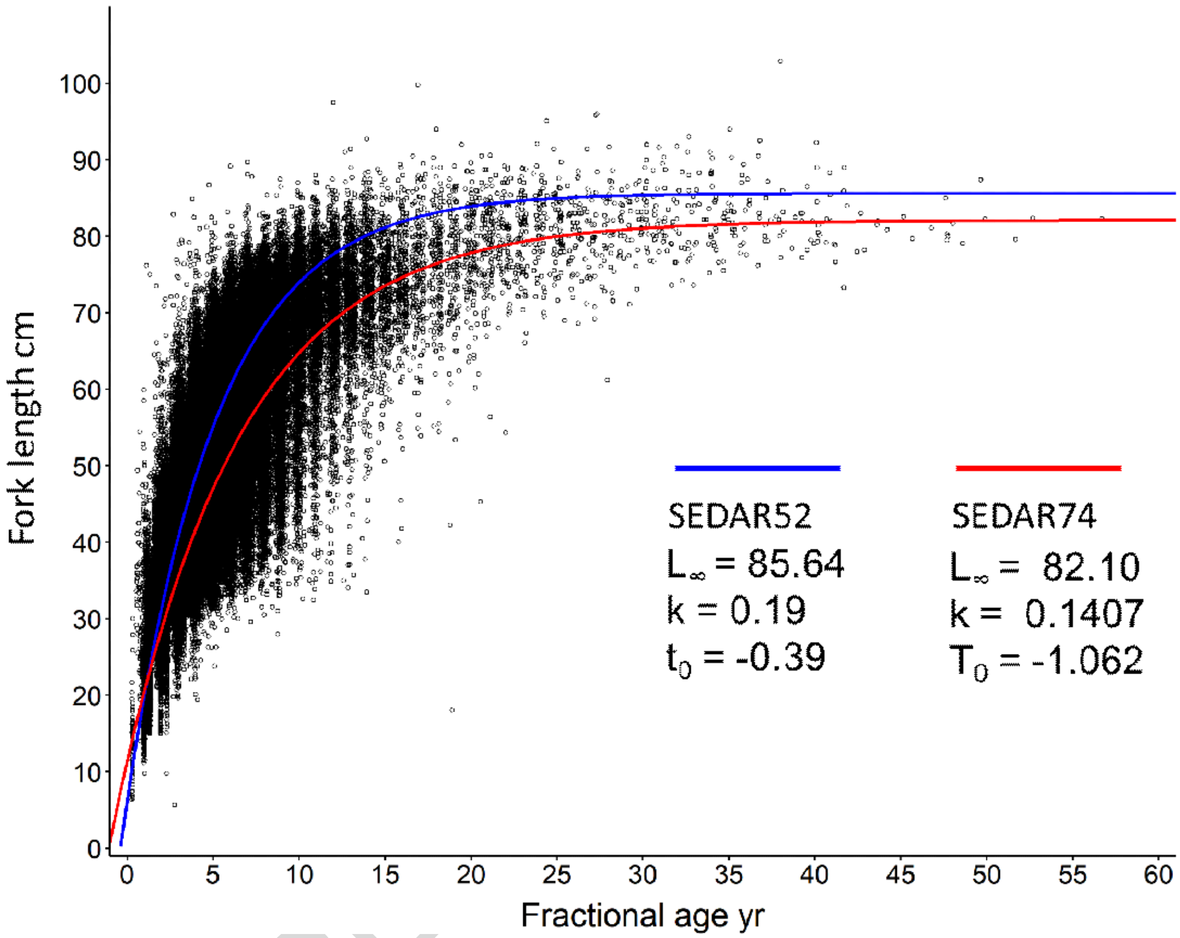


Figure 12. Scatter plot of fractional age (yr) versus fork length (cm) for red snapper age samples collected in 1980 and from 1986 to 2019 from the West, Central, or East subregion of the Gulf of Mexico. Lines indicate best fit parameters from size-modified von Bertalanffy growth models (Diaz et al. 2004) with inverse weighting of age data. Parameter values are shown on the plot and listed in Table 4.

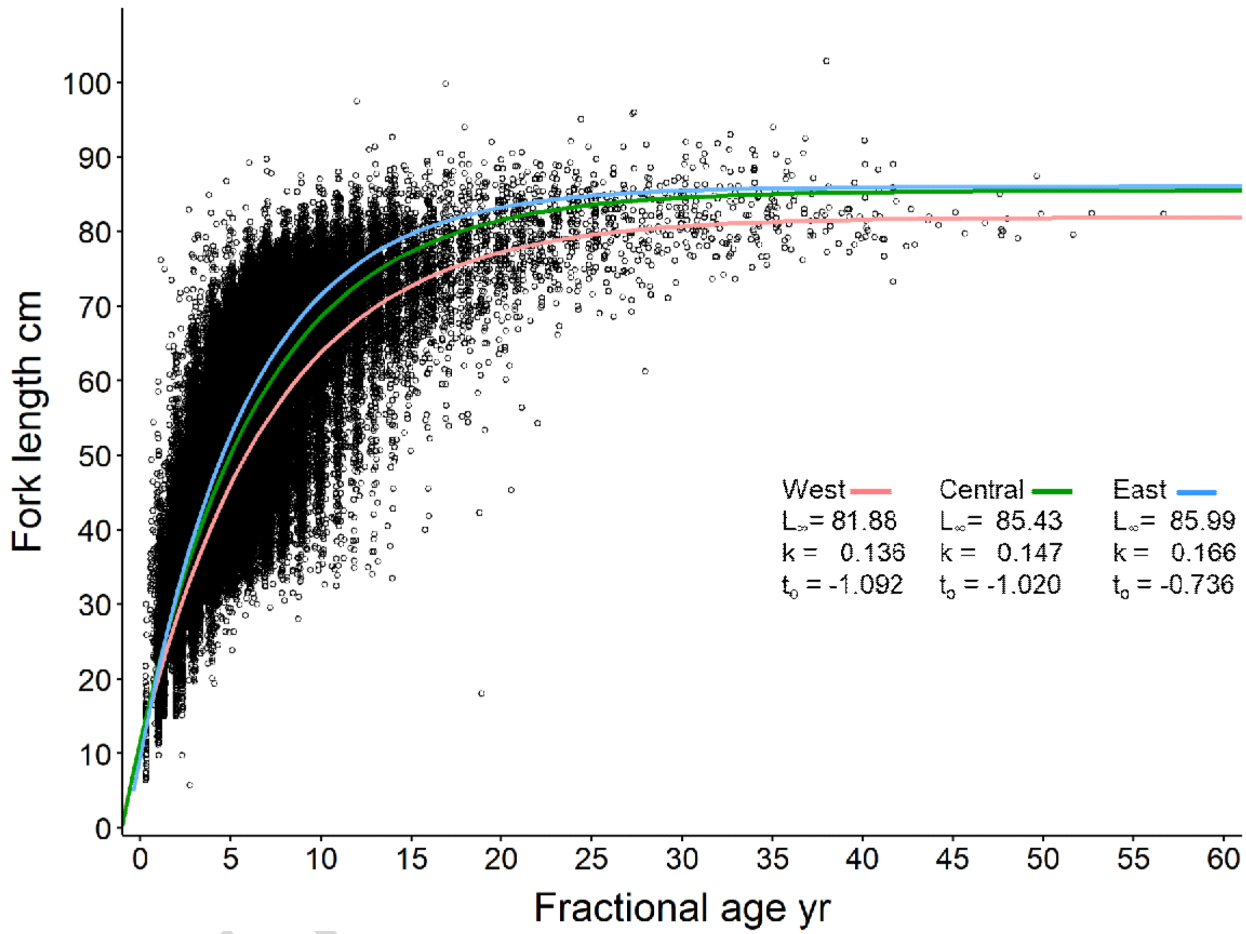


Figure 13. Mean size (FL, cm) at age (calendar, yr) of red snapper by subregion (West, Central, or East) for age samples collected in 1980 and from 1986 to 2019 from the Gulf of Mexico. Error bars indicate 95% CIs.

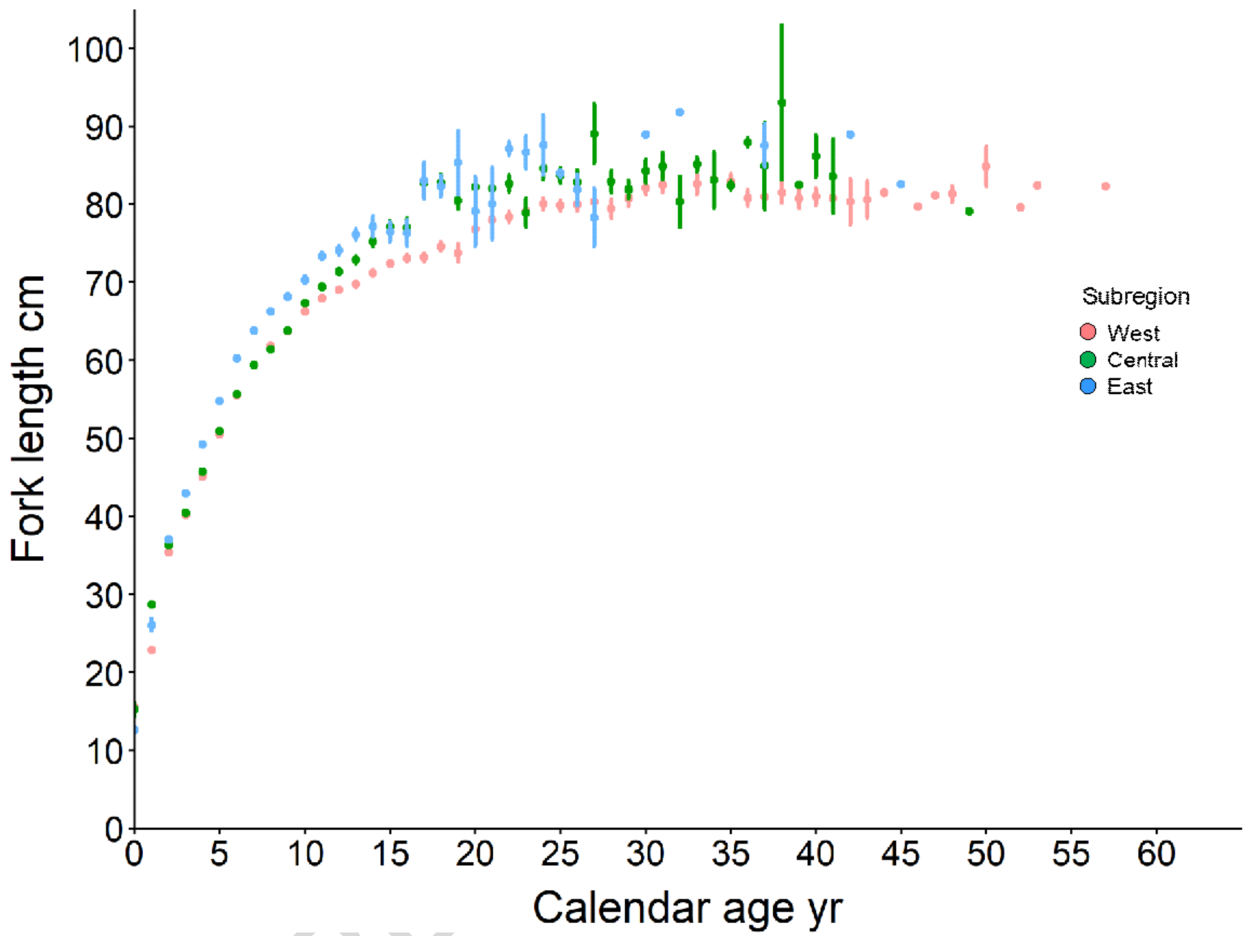


Figure 14. Mean size (FL, cm) at age (calendar, yr) of red snapper age samples collected from each time stanza from the West or East (combining Central and East) subregion of the Gulf of Mexico. Error bars are 95% CI.

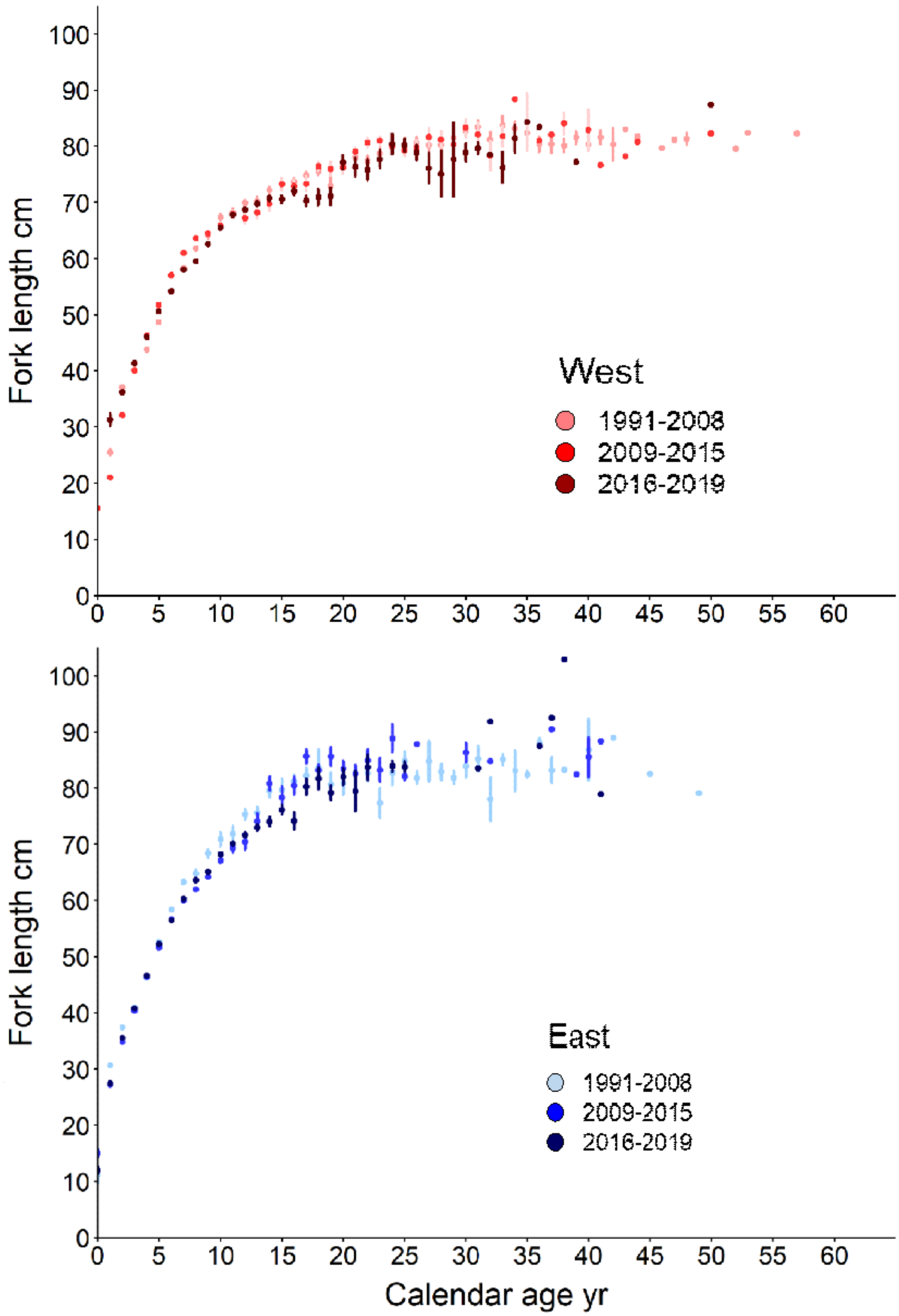


Figure 15. Samples sizes of reproductive data varied by year and area. Most samples came from the West (W) or the central (C) areas, with very few samples from the East (E).

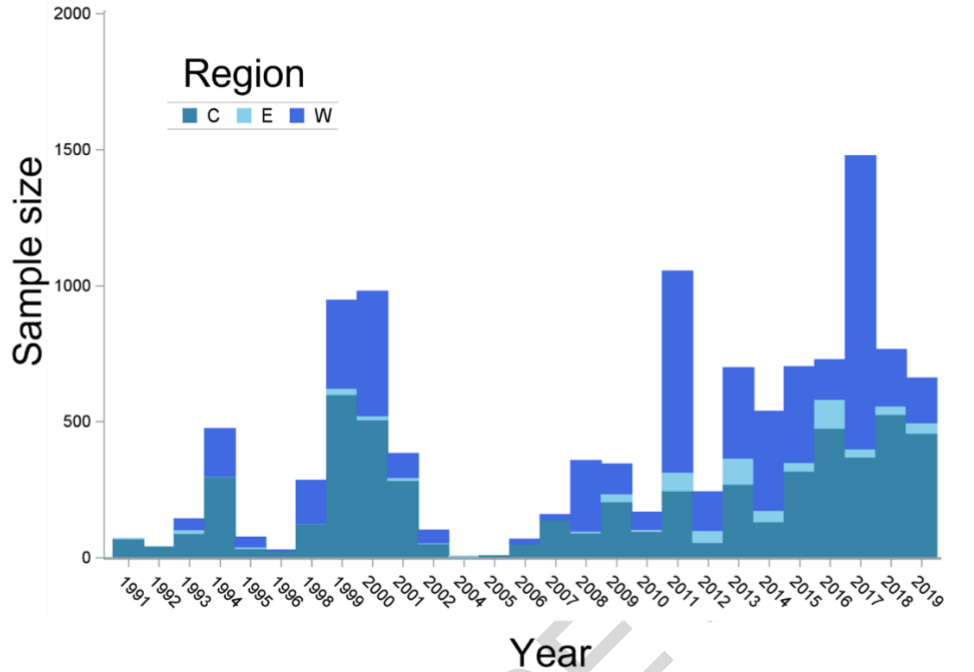


Figure 16. Reproductive sample size varied with age, with very few samples for fish older than age 15 y in any region. c-central; e-east; w-west.

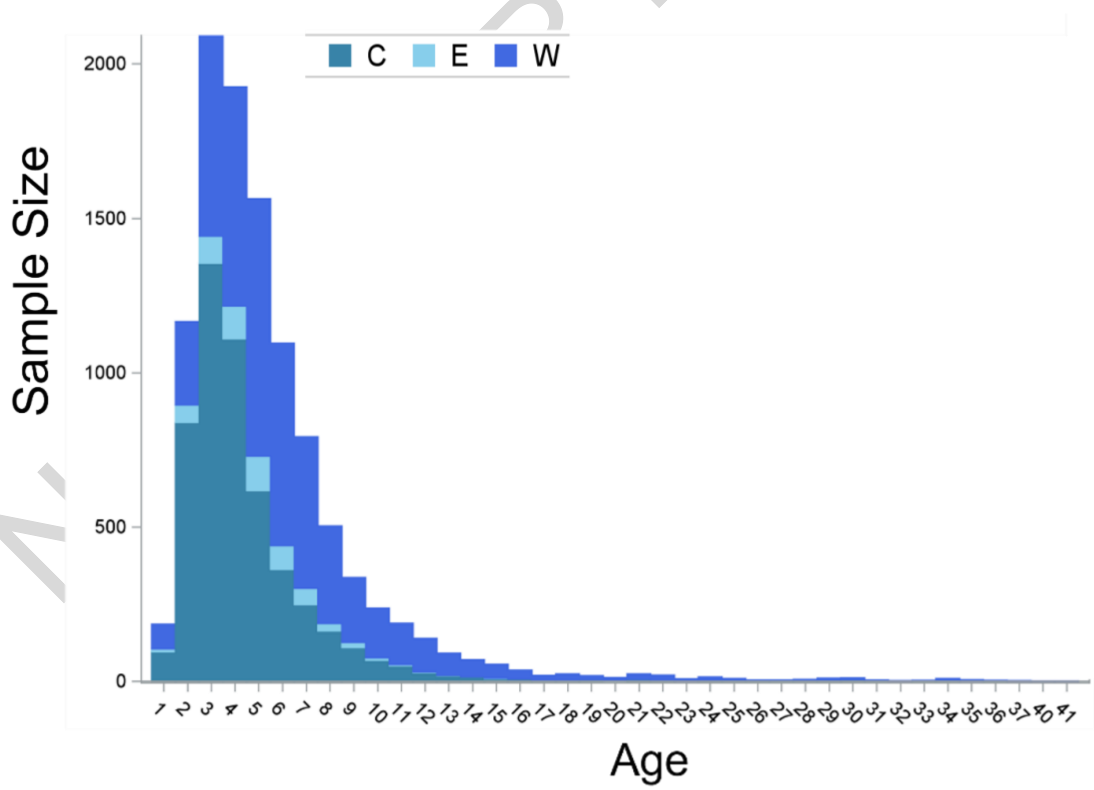


Figure 17. Of the reproductive samples, a much smaller sub-sample had batch fecundity estimates. These were mainly for fish age 10 y or younger, and few samples were from the east (E) compared to the central (C) or west (W) regions.

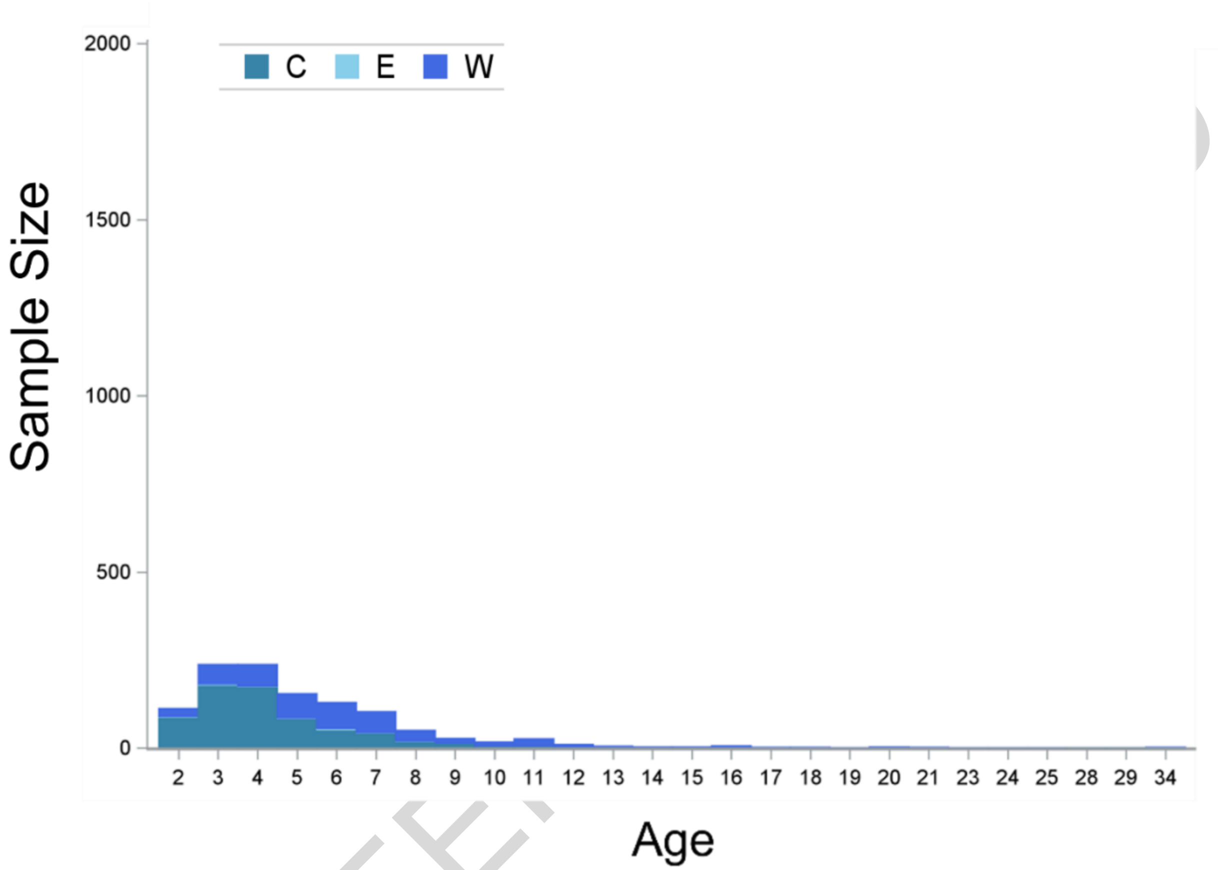


Figure 18. Observed and predicted age at maturity for eastern (E) and western (W) populations from a logistic binomial regression that estimated period-and-region-specific slopes and intercepts in a Bayesian modeling framework. The blue shaded area represents the upper and lower 2.5% quantiles from the posterior distribution of parameter estimates. Period 1– overfished (1991-2008); 2– rapidly recovering (2009-2016); 3–stabilizing (2017-2019).

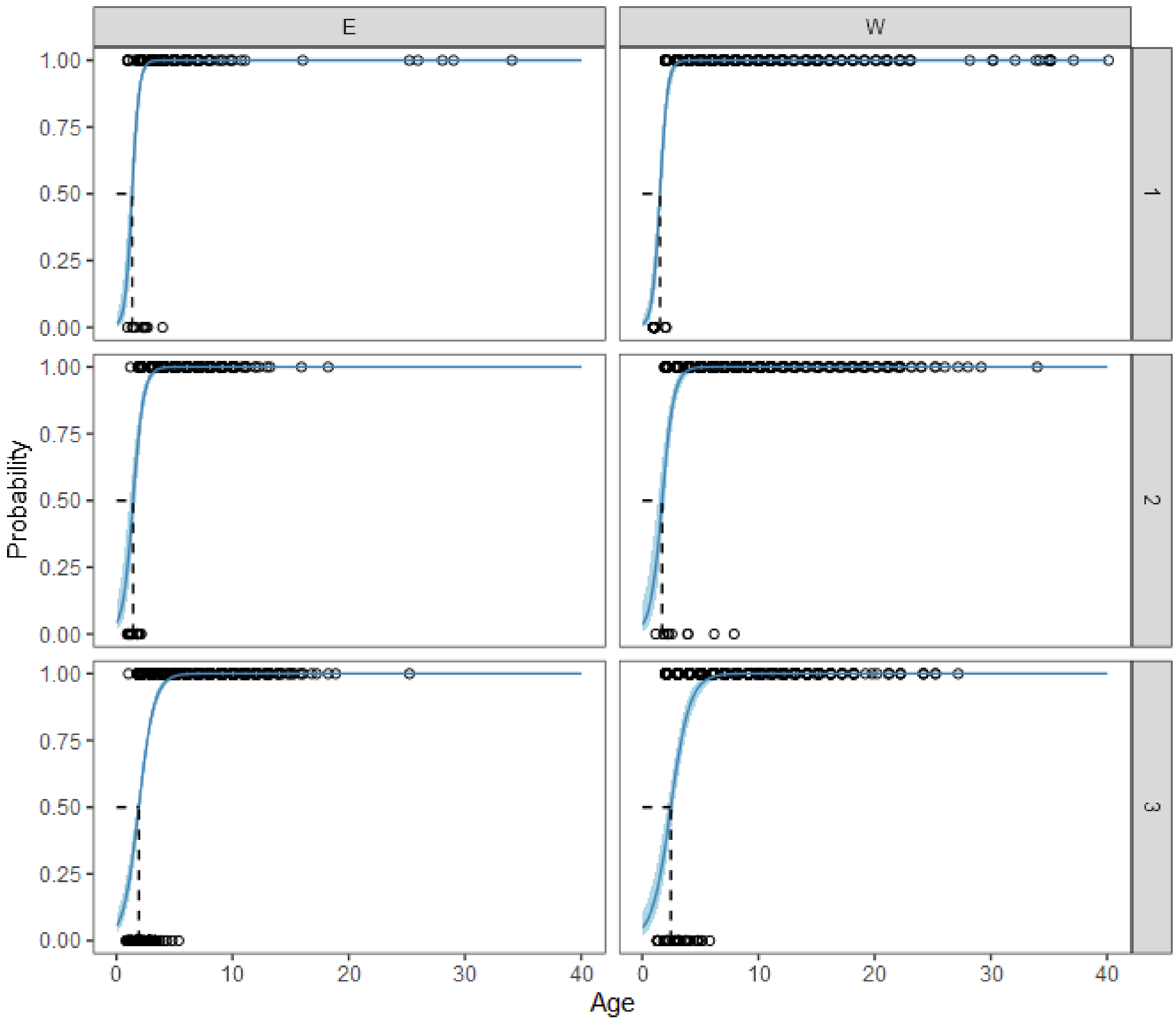


Figure 19. Observed and predicted size at maturity results for eastern (E) and western (W) populations from a logistic binomial regression that estimated period-and-region-specific slopes and intercepts in a Bayesian modeling framework. These models used data collected from throughout the year but only immature and spawning reproductive phases. The blue shaded area represents the upper and lower 2.5% quantiles from the posterior distribution of parameter estimates. Period 1– overfished (1991-2008); 2– rapidly recovering (2009-2016); 3–stabilizing (2017-2019).

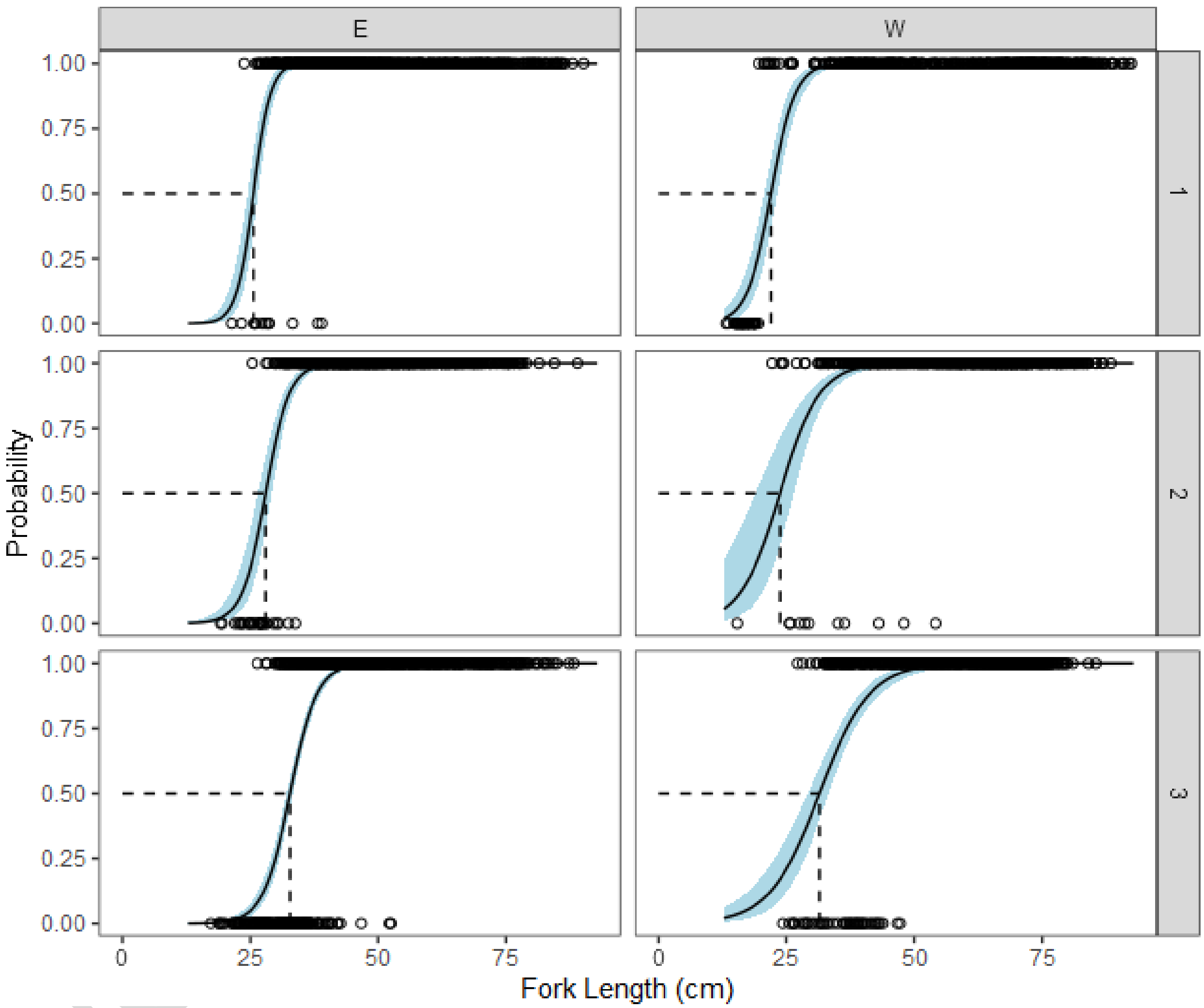


Figure 20. Observed (black points) and predicted (red lines) batch fecundity model fits by region and period of log-transformed batch fecundity to log-transformed fork length. The shaded blue areas are the 2.5% and 97.5% quantiles of predicted values from the posterior draws.

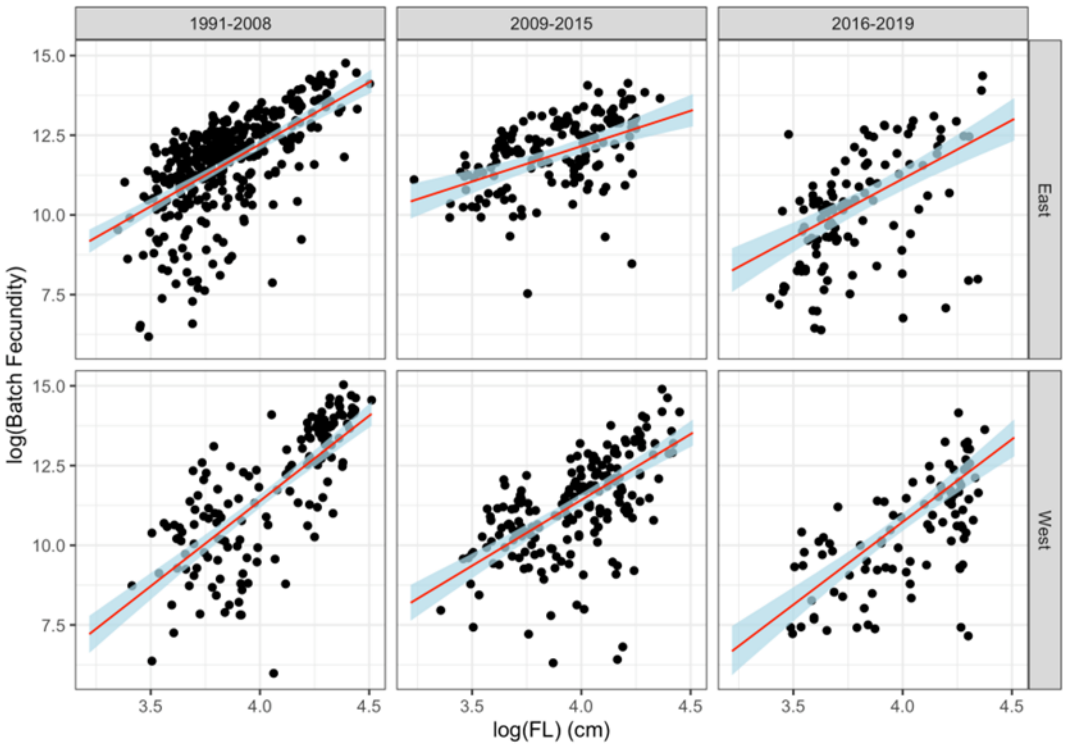


Figure 21. Observed (black points) and predicted (red lines) batch fecundity model fits by region and period to back-transformed batch fecundity (BF) and age. Period-and-region-specific von Bertalanffy growth parameters were used to obtain BF at age from BF at length. Red Snapper exhibit high variation of length at age. To reflect the uncertainty due to that variation, VB growth models were fitted to the 1st and 99th quantile of fork length at age and used to predict BF at those lower and upper ranges of length at age; these are reflected in the blue shaded area. Observed points are drawn transparently to better illustrate that the majority of observations occurred at young ages and low BF values which the model is fitting fairly well in all cases.

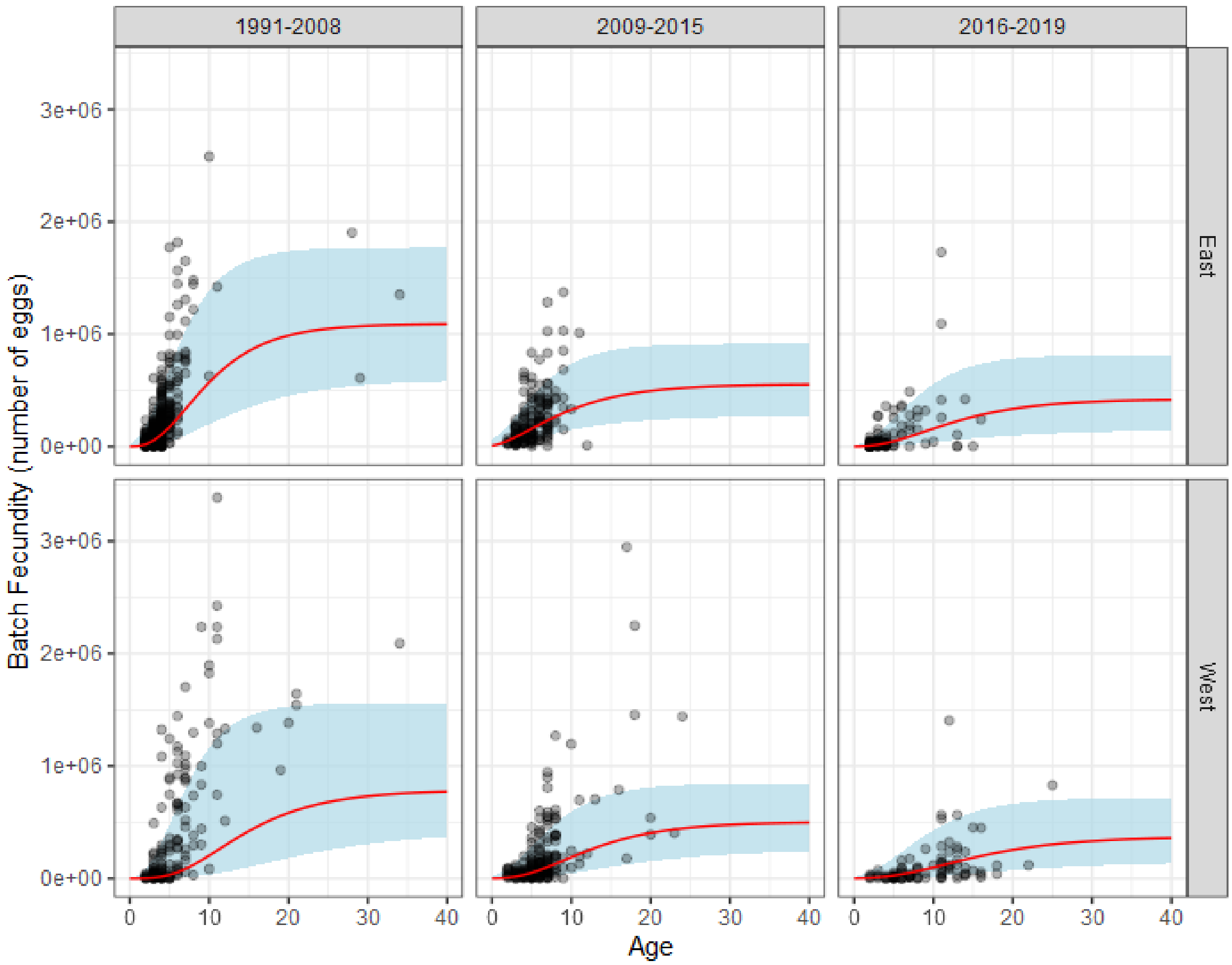


Figure 22. Observed (open circles) and estimated (closed circles) proportion with spawning markers by age. Closed circles represent mean values from posterior draws, and vertical lines indicate the 95th quantile of estimated values.

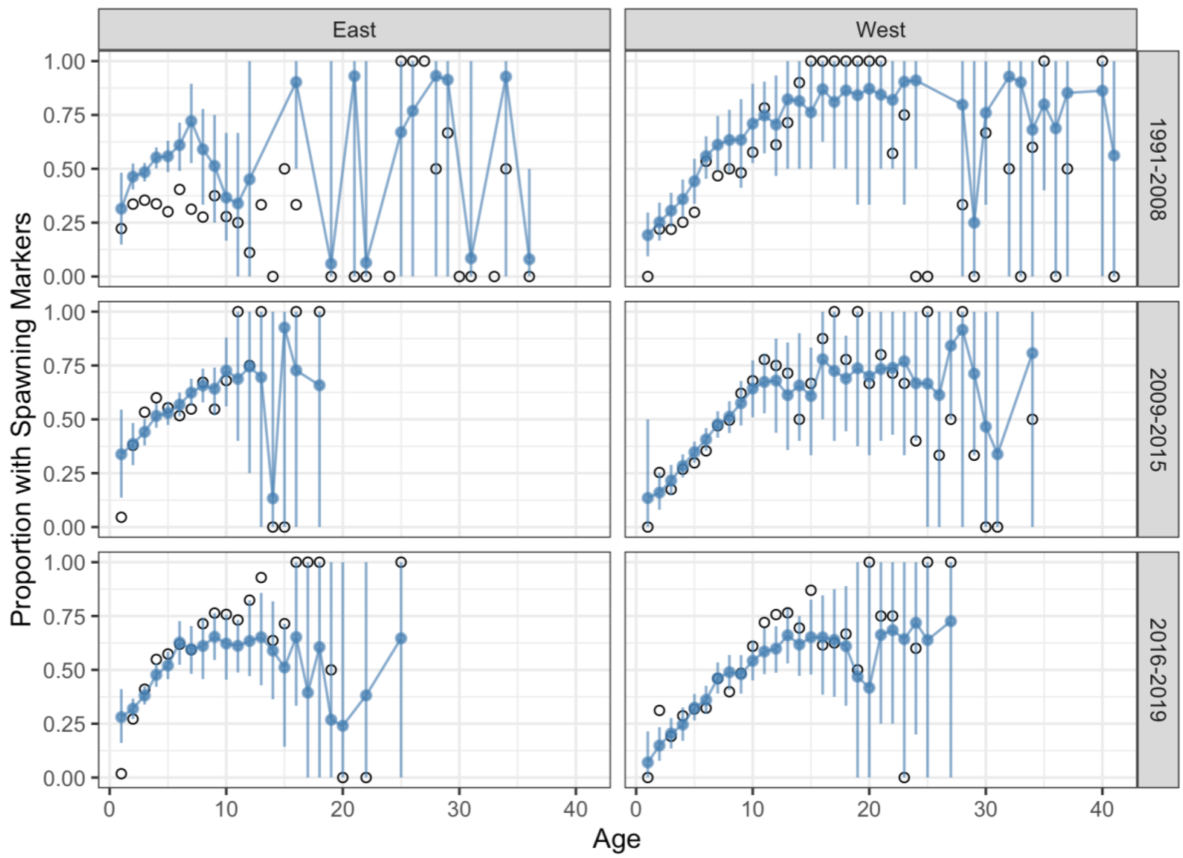


Figure 23. Estimated annual fecundity at length (top panels) and age (bottom panels), obtained by combining results from the batch fecundity and spawning fraction models. For comparison, the annual fecundity calculated by Porch et al. (2015) is shown as dashed black lines (note: the 2015 fecundity at length relationship was for total length rather than fork length and spawning frequency was based on data from the Congressional supplemental Red Snapper survey conducted in 2011 (n=1,002).

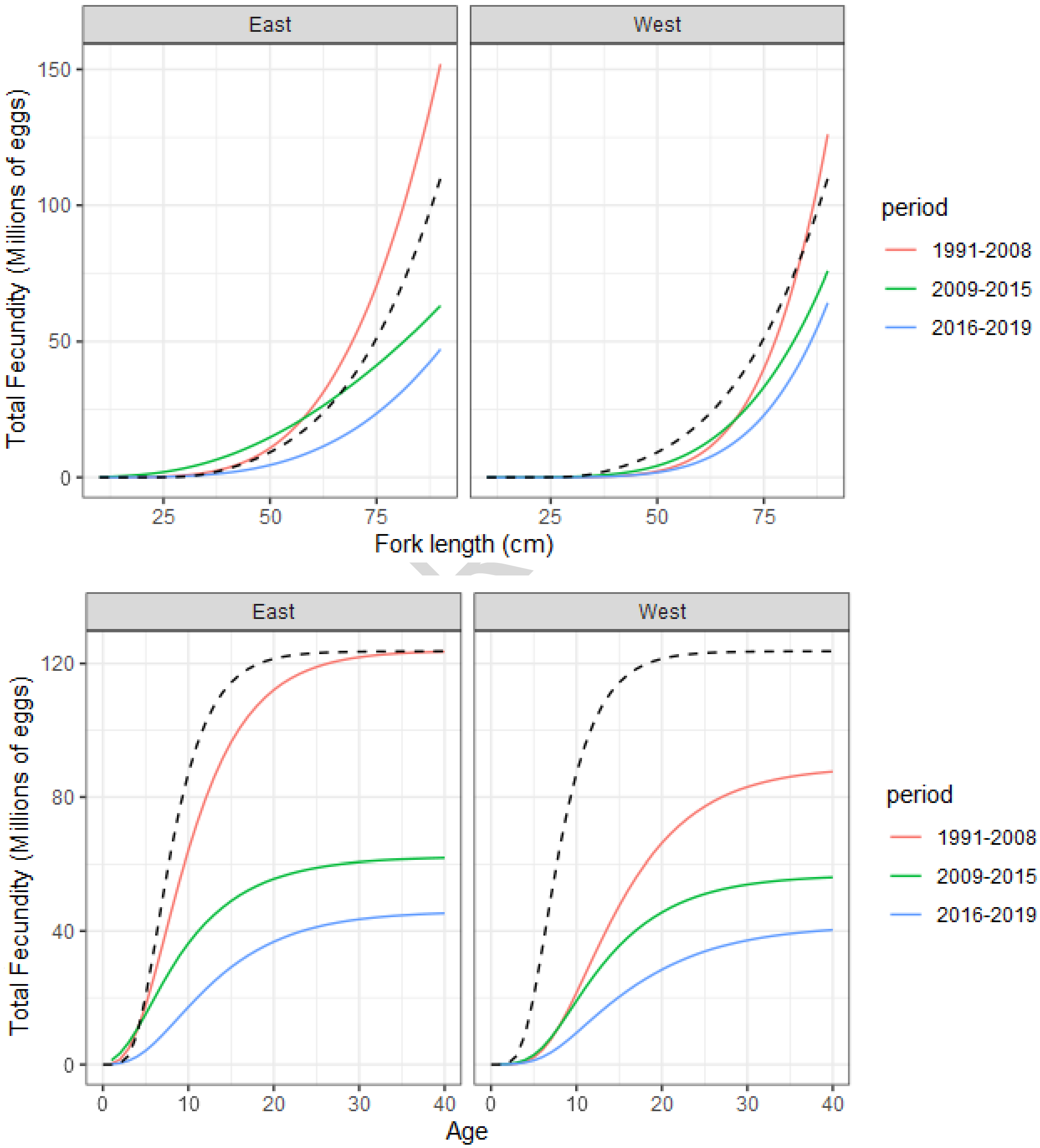
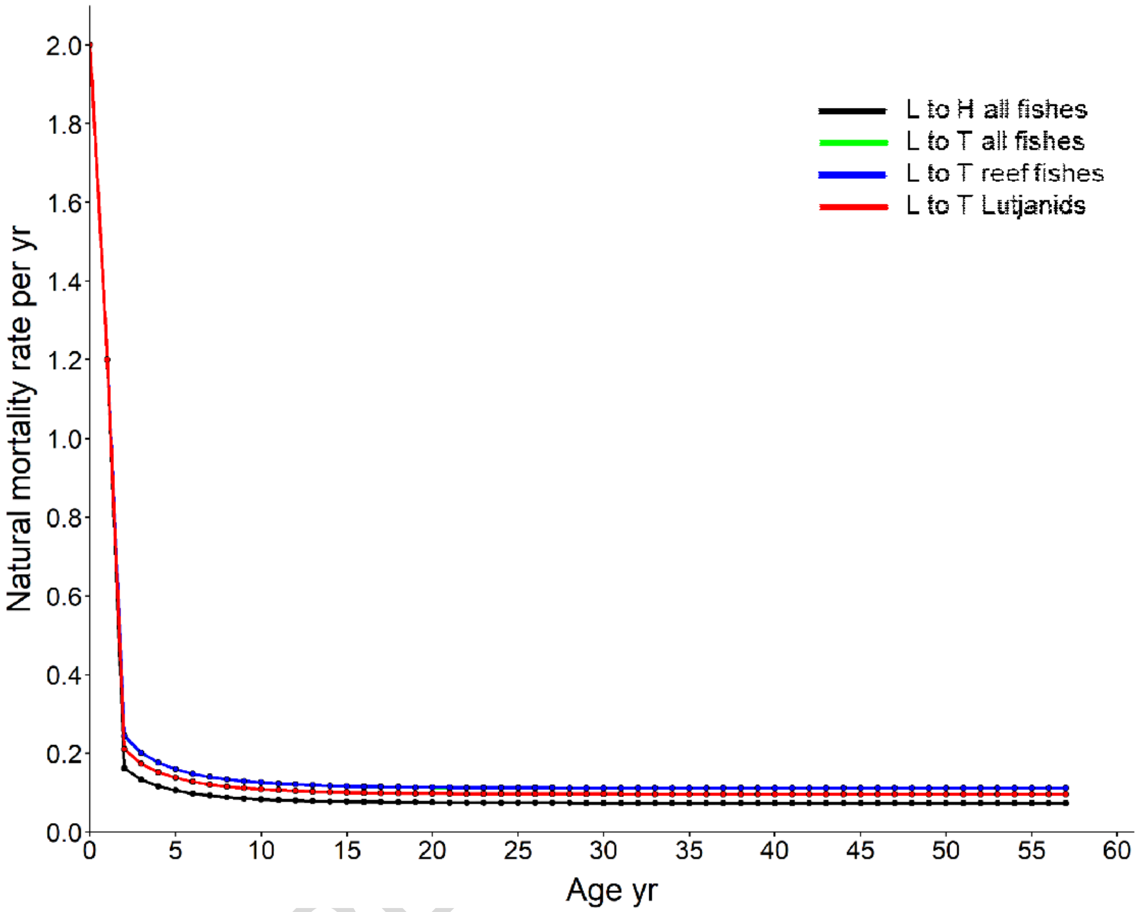


Figure 24. Age-specific natural mortality estimates for Gulf of Mexico red snapper. Lorenzen (L) natural mortality curves are shown scaled to the average natural mortality rate yr^{-1} based on longevity from Hoenig (H) or Then (T) for all fishes, reef fishes, or Lutjanids. Ages 0 and 1 were assigned fixed values of 2.0 and 1.2 yr^{-1}, respectively in all cases. Note that age-specific estimates for L to T reef fishes (blue) visually overlap estimates for L to T all fishes (green).



3 COMMERCIAL FISHERY STATISTICS

3.1 OVERVIEW

Commercial landings of Red Snapper for the Gulf of Mexico were compiled from the Accumulated Landings System (ALS), a continuous commercial landings database of that began in the 1962. It is being maintained by the NOAA Fisheries' Southeast Fisheries Science Center (SEFSC) in Miami, Florida (Gloeckner 2014, Poffenberger 2004) and provided the landings from 1962 to 2020 for this assessment.

Historical landings of Red Snapper in the Gulf of Mexico starting in 1872 had been previously reported by Porch (2004) and were also used in reconstructing the time series up to 1962.

Starting in 1990, gear and area information from the Coastal Fisheries Logbook Program (CFLP) (Poffenberger 2003, Atkinson 2021b) were used to assign gear and area to the landing as has been the case since decision was made in the SEDAR 7 assessment.

When water body information was not available, port of landing was used to assign area of catch (also a SEDAR 7 decision) and ALS Florida (General) Canvass data were used to assign gear and area to FL landings prior to Florida's Trip Ticket Program (FL_TTP) in 1985 (Donaldson 2004).

Starting in 2007, an Individual Fishing Quota (IFQ) Program (Stephenson 2012) also known as Individually Transferable Quota (ITQ) was initiated for Red Snapper in the Gulf of Mexico and is managed by NOAA Fisheries' Southeast Regional Office (SERO). The IFQ landings were deemed the most accurate and are used to reapportion ALS landings data across all strata.

Discards were estimated for vertical line and bottom longline fleets by zone/subregion/stock, i.e. West, Central and East, using the discard information from the Reef Fish Observer Program (Atkinson et al 2021a) and the effort information from the coastal logbook program (CFLP).

Length frequency distributions were constructed for Red Snapper in the years 1984-2019 using available length data from Trip Interview Program (TIP) database. Length frequencies were provided by year, for vertical line and bottom longline fleets, Handline+/Vertical Line+ (VL+) and long Line (LL) by zone/subregion/stock, i.e. West, Central and East.

3.1.1 Commercial Workgroup Participants

Below are the workgroup participant of the commercial workgroup and their affiliations:

Sydney Alhale	University of Miami/CIMAS
Donna Bellais	Gulf States Marine Fisheries Commission (GMFMC)
Buddy Guindon	Commercial Fisherman
Stephanie Martinez Rivera	NMFS Miami
Kevin McCarthy	NMFS Miami (Group Co-lead)
Paul Mickle	North Gulf Institute/Mississippi State University
Refik Orhun	NMFS Miami (Group Co-lead)
Steve Smith	University of Miami/CIMAS
Molly Stevens	NMFS Miami
David Walker	Gulf States Marine Fisheries Commission (GMFMC)
Wayne Werner	Commercial Fisherman

3.1.2 Issues Discussed at the Data Workshop

Issues discussed at the workshop in terms of commercial landings included historical landings, time lines regarding

- Uncertainties and CV's of commercial landing over whole

In addition, taking the proportioning the commercial landing into the

- New three subregions back in time prior to 1962 into historical landings and
- Reapportioning of landings by subregions between 1883 and 1909
- Shrimp Bycatch, reapportioning of bycatch between Central and East
- Reef fish observer data to inform discard size composition
- Gear selectivity using kept and discarded size data from reef fish observer program

3.2 REVIEW OF WORKING AND REFERENCE PAPERS

The workgroup considered data and analyses presented from these data workshop working papers:

SEDAR4-DW-29: This document describes SEFSC's Coastal Fisheries Logbook Program.

SEDAR7-DW-23: This document the commercial landings of Red Snapper including a description of the ALS.

SEDAR7-AW-29: This document describes the historical landings 1872-1962.

SEDAR-PW6-RD-57. This document describes the commercial landing programs in the Southeast and the ALS Database.

SEDAR32-DW-11. This document describes the calculated commercial discards of Blueline Tilefish.

SEDAR41-DW-36. This document describes the calculated commercial discards of Red Snapper.

SEDAR74-DW-02: This document provides Reef Fish Observer Program (RFOP) metadata.

SEDAR74-DW-03: This document provides Coastal Logbook Fisheries Program (CLFP) metadata.

SEDAR74-DW-15: This document describes the length and age compositions of commercial (and recreational) landings.

SEDAR74-DW-19: This document describes the CPUE expansion estimation of commercial discards using observer data from 2007-2019.

SEDAR74-DW-22: This document describes the commercial landings from 1964 to 2020.

SEDAR74-DW-37: This document describes the commercial discards lengths from 1964 to 2020.

3.3 COMMERCIAL LANDINGS

The SEDAR 74 Gulf of Mexico Red Snapper was a research track assessment and therefore preceded by a SEDAR 74 Stock ID Workshop (http://sedarweb.org/sedar-74-gulf-mexico-red-snapper-stock-id-process). During the SEDAR 74 Stock ID process, the previous definition of the western and eastern Red Snapper stock units adopted by SEDAR 7 in 2004 was changed after the Stock ID Workshop Panels decisions to a three-stock unit definition of a Western, Central and Eastern stock.

The Map in Figure 3.1 shows the Gulf of Mexico Fisheries Management Council region and the NMFS statistical areas 1-21 stretching from the Florida Keys in the East to the US border between Texas and Mexico in the West.

Decision 1: The Gulf of Mexico Red Snapper data will be divided into three stock units, i.e. a Western, Central and Eastern stock. This subregion/zone will be defined by the NFMS Statistical areas 1-6 for the East, 7-12 for the Central, and the 13-21 for the Western stocks/subregions/zones (Figure 3.1).

Commercial landings for the Gulf of Mexico Red Snapper from 1872 - 2020 in whole pounds were aggregated by the three new subregions, West, Central and East. The decisions below provide detail on how the landings were compiled for red snapper.

Decision 2: Using the landings by subregions East and Central from 1964 to 1968, an average proportion based on those 5 years, was calculated, i.e. 57.3% of landings assigned to the Central and 43.7% of landings assigned to the "new" East. This proportion of landings was applied back in time to the landings of the historical East from 1910 to 1961.

In SEDAR7, historical landings of red snapper were constructed from 1880-1962 using various data sources. Further detail can be found in SEDAR7-AW22 (Porch et. al 2004).

Landings data were by port, but were assigned to region based upon several historical references. All landings prior to 1980 are grouped into Handline+/Vertical Line+ as the use of Long Line gear did not start for Red Snapper until 1980.

Decision 3: Based on information from Porch (2004), landings by subregions from 1872-1909 were reapportioned based on these principles.

- Prior to 1880 all landings were assigned to the Central.
- In 1880, the fishery expanded to the West.

- In 1883, the fishery expanded to the East (and South on FL peninsula).
- Landings to the Central and East 1883 to 1909 were apportioned using linear interpolation to match 1910 landings estimated for the Central and the East.

In SEDAR 7, historical landings of red snapper were constructed from 1880-1962 using various data sources. Landings data were by port, but were assigned to region based upon several historical references. Further detail can be found in SEDAR7-AW22 (Porch et. al 2004). A table of the all landing by region and gear from 1872 to 2020 can be found in Table 3.1 and Figure 3.3.1

3.3.1 Data Source

Historical commercial landings collected prior to 1962 (Porch 2004) are housed in a database in the National Marine Fisheries Service's Office of Science and Technology (S&T). Commercial landings for the modern time period (1962 to present) are maintained in the Accumulated Landings System (ALS) at the Southeast Fisheries Science Center (SEFSC). Data collected prior to the advent of the trip ticket programs in each state are generally referred to as the NMFS General Canvass data (Gloeckner 2014, Poffenberger 2004). General Canvass data were collected by port agents stationed in each county. The port agents would collect total landings from dealers and use local knowledge to proportion the landings into the proper fishing areas and gears. The ALS uses trip level data after the advent of trip ticket programs in each state.

Implementation of the individual state trip ticket programs started with Florida (FL_TTP) coming into full implementation in 1986, after which the FL_TTP provided the West Florida commercial landing to the ALS, where the landings data are kept as monthly summaries of the landings. In the Gulf of Mexico, trip ticket data were available directly from the state trip ticket program or through the Gulf of Mexico Fisheries Information Network (GulfFIN) housed at the Gulf States Marine Fisheries Commission (GSMFC). The implementation of other Non-FL state Trip Ticket Programs varied by state and is shown Table 3.3.

3.3.2 Boundaries

The Red Snapper has been managed as separate Gulf of Mexico and South Atlantic stocks, where the stock boundary lays in fishing areas 1 and 2 off the southern tip of Florida. The Gulf of Mexico landings from areas 1 and 2 are taken from water bodies north of highway U.S. 1 in the Florida Keys and north of the boundary line that extends from Key West to the Dry Tortugas. Waters west of the Dry Tortugas are considered to be the Gulf of Mexico. Gulf of Mexico landings are spatially distributed using the fishing areas 1 to 21, reaching from fishing area 1 in the Florida Keys, northwestern to fishing area 21 bordering Mexico (Figure 3.2).

3.3.3 Commercial Gears

In agreement with prior SEDARS, i.e. 7, 31 and 52, it was the workgroup's recommendation to then categorize landings into two gear groups: Handline+ (or Vertical Line+) and Long Line.

The list of gear codes included in each category can be found in a data workshop working paper SD74-DW-22 (Orhun 2022).

3.3.4 Landings in Numbers

Commercial landings of Gulf of Mexico Red Snapper were also estimated in numbers of fish based on the average individual weight of Red Snapper from TIP data. Weights of five-year time periods were averaged from 1984 to 2020 (except for the first time period, 1984-1990) and applied to the landings in whole pounds. Landings in numbers of fish from 1984 to 2020 are shown in Table 3.2 and Figure 3.3.2.

3.4 COMMERCIAL DISCARDS AND BYCATCH

The number of Red Snapper discarded from commercial fishing vessels was calculated using methods developed during SEDAR 32 (McCarthy 2015, 2013). Those methods have become the standard approach for commercial fishery discard calculation for species where observer reported data are insufficient for discard calculation. The commercial discard logbook data were used to estimate discards for the period 1995-2006. Discards were not estimated prior to 1995 because of a change in the minimum size of commercially landed Red Snapper. No discard data were available to inform the discard rate of Red Snapper prior to 1995. Reef fish observer data were used to estimate commercial discards beginning in 2007. Fishers have reported changes in fishing behavior due to the implementation of management through IFQs. Those behavioral changes likely affected discard rates. The first full year of the reef fish observer program was 2007, the same year that Red Snapper IFQ began, therefore using discard rates from the reef fish observer program to estimate discards prior to 2007 was not recommended.

3.4.1 Discards in Pre-IFQ Years

Red snapper discard rate was calculated using discards and effort data reported to the discard logbook program. A random selection of 20% of commercial fishers, by region (Gulf of Mexico, South Atlantic) and gear are required to report to the discard logbook program each year. Total effort for the commercial fleet by gear was available from the coastal logbook program. Those two data sources were used to estimate total discards from the commercial fleet.

Red Snapper discards were reported from to the discard logbook program in sufficient numbers of trips to estimate total discards from only vertical line (handline and electric/hydraulic reels) and bottom longline vessels. Data were also stratified by region as defined by the SEDAR 74 stock identification workshop panel and Red Snapper season (open/closed). After limiting the data set to those gears, data filtering followed the methods recommended during SEDARs 32 and 41 (SEDAR32-DW-11, SEDAR41-DW36). Data were filtered to exclude trips landing only Red Snapper because it was generally believed by the SEDAR 32 and 41 panels that for trips targeting Red Snapper only, the likelihood of catching species other than Red Snapper was extremely low. To avoid removing mixed effort trips, however, only trips with 100% Red Snapper landings were excluded for the analytical data set.

A final data filter designed to address possible underreporting of commercial discards was included in this analysis following the recommendation of SEDARs 32 and 41. Fishers remain in reporting compliance by returning discard logbooks with reports of "no discards". The percentage of discard reports returned with "no discards" from vertical line trips has increased from 7.5 to 11.8 percent during the period 2002-2006. Reports of no discards from bottom longline vessels varied among years from 5.9 (2006) to 22.4% (2005; all other years 12.7 – 16.4%). During the SEDAR32 data workshop the issue of possible underreporting of commercial discards was discussed at length. The working group recommended that data be filtered to remove records from vessels that never reported discards of any species during a year. The SEDAR 32 working group acknowledged that some commercial fishing trips may not have had discards of any species and discussed the likely maximum number of trips by a vessel without a report of discards. Following the SEDAR 32 and 41 commercial working groups' recommendations, data from commercial vertical line vessels that reported more than four, two, or three (east, central, and west regions, respectively) trips without reporting discards of any species (the mean number of trips prior to the first trip with reported discards plus two standard deviations above that mean) were excluded. Similarly, data from bottom longline vessels with no discards reported for more than six (east region) or four (central and west regions) trips without reporting discards of any species were excluded.

Discard rates of vertical line vessels were calculated as the mean rate (discards per hook hour fished) within each region and gear over the years 2002-2006. Yearly total effort (vertical line: hook hours; bottom longline: hooks fished) of all trips by gear within each region for each year 1995-2006 was multiplied by the mean discard rate from the appropriate gear and region to calculate total discards of Red Snapper by commercial vertical line and bottom longline vessels. Discards in number of fish by gear and region are provided in Tables 3.4.1.1 (vertical line) and 3.4.1.2 (bottom longline).

Weights of commercial discards were not reported to the discard logbook data, however, discard mean weights were available from the reef fish observer data. Due to a minimum size change in 2008, only those reef fish observer program data from 2007 were appropriate to inform the conversion of estimated discards in number of fish to discards in weight. Mean weight of discards was available by gear and by those vessels with IFQ allocation (some fished were landed) and those vessels without IFQ allocation (all fish discarded). The mean weight of fish discarded from vessels with IFQ allocation was used as a proxy for the mean weight of fish discarded from vessels during Red Snapper open seasons prior to 2007. The mean weight of fish discarded from vessels without IFQ allocation was used as a proxy for the mean weight of fish discarded from vessels during Red Snapper closed seasons prior to 2007. Discard mean weights are provided in Table 3.4.1.3. Discards in weight (whole pounds) by gear, region, and Red Snapper season (open/closed) are provided in Tables 3.4.1.4 (vertical line) and 3.4.1.5 (bottom longline).

Decision 4: Recommended the estimated discards for use in the assessment model(s) with a CV of 0.6. The recommended CV matches the highest CV calculated for discards estimated using the reef fish observer data. The work group recommended that magnitude of CV for the discards estimated using discard logbook data due to the low confidence in those self-reported data.

3.4.2 Discards during IFQ Years

The general approach for estimating discards for the commercial reef fish fleet in the Gulf of Mexico utilizes catch-per-unit-effort (CPUE) from the coastal Reef Fish Observer Program (RFOP) and total fishing effort from the Coastal Fisheries Logbook Program (CFLP) to estimate total catch.

For discard estimation, CPUE was computed for total discards, including fish released alive, released dead, released in unknown condition, and used for bait. The principal focus of this study was to apply recently developed discard estimation methods for Gulf of Mexico red grouper, gray triggerfish, and vermilion snapper to Gulf of Mexico Red Snapper. Discard estimation was conducted separately for two gears, vertical line (VL) and bottom longline (BLL). A verification step compared the annual total landed catch from logbook data with the estimated observer annual total landed catch. Once verified, Red Snapper annual total discards in weight and number were estimated for the observer data period 2007-2019, for each of the zones (East, Central, and West). Full details of the methodology applied to the Gulf of Mexico Red Snapper are described in a data workshop working paper (Martinez et al. 2022).

CPUE expansion estimates for annual discards in weight and number of GOM Red Snapper for 2007-2019 by subregion are provided in Table 3.4.2.1 for vertical line gear. For VL, the annual average of discards in weight accounted for about 11%, 12%, and 44% of the total catch for West, Central, and East, respectively (Fig. 3.4.2.1).

CPUE expansion estimates for annual discards in weight and numbers of GOM Red Snapper for 2007-2019 are provided in Table 3.4.2.2 for (bottom) longline gear (LL). For bottom LL, the average of discards to total catch was 61%, 118%, and 127%, for central, east, and west, respectively (Fig. 3.4.2.2).

3.4.3 Discards from the Shrimp Fishery

An investigative team from NOAA SEFSC's Fisheries Statistics Division is currently refining data processing and analysis procedures to improve accuracy of red snapper bycatch estimates from the shrimp trawl fishery. This research is anticipated to be completed and reviewed for producing revised shrimp trawl bycatch estimates for red snapper for the 2023 operational assessment. In the meantime, bycatch estimates from SEDAR 52 for statistical zones 1-12 (previous East subregion) were apportioned into the new Central (statistical zones 7-12) and East (statistical zones 1-6) subregions (Table 3.4.3). For 1985-2016, shrimp trawl effort was estimated for the new Central and East subregions (L. Coggins, NOAA SEFSC), and these were used to apportion bycatch estimates by subregion. For 1972-1984, the average proportion effort by subregion was computed for years 1985-1989 and then applied to the historical time-series of red snapper bycatch estimates.

3.5 COMMERCIAL EFFORT

Commercial logbooks for the period 1993-2019 were used to evaluate the number of trips landing red snapper for two principal gears, vertical lines and bottom longlines. Average annual trips were estimated by statistical zone for 4 time periods: (i) 1993-1999, (ii) 2000-2006, (iii) 2007-2013, and (iv) 2014-2019. The resulting maps are shown in Fig. 3.5.1 for vertical lines and in Fig. 3.5.2 for bottom longlines.

3.5.1 Shrimp Trawl Effort

An investigative team from NOAA SEFSC's Fisheries Statistics Division is currently refining data processing and analysis procedures to improve accuracy of shrimp trawl effort in the Gulf of Mexico. This research is anticipated to be completed and reviewed for producing revised shrimp trawl effort estimates for the 2023 operational assessment. In the meantime, updated shrimp trawl effort estimates (L. Coggins, NOAA SEFSC) were used to produce a time-series for the period 1945-2019 for 3 subregions (Table 3.5). For 1985-2016, shrimp trawl effort was estimated for the West subregion (statzones 13-21) and new Central (statzones 7-12) and East (statzones 1-6) subregions. For 1960-1984, updated effort estimates were provided for the West subregion and the previous East (statzones 1-12) subregion. The updated effort for 1960-1970 was used in Clay Porch's SEDAR 52 procedure to estimate effort for 1945-1959 in the West and previous East subregions. The average proportion effort for the new Central (statzones 7-12) and East (statzones 1-6) subregions was computed for years 1985-1989, and then used to apportion effort accordingly from the previous East subregion (statzones 1-12) into the new Central and East subregions for the period 1945-1984.

3.6 BIOLOGICAL SAMPLING

Biological sample data for red snapper were obtained from the TIP database housed at NMFS-SEFSC (1984-2019) and the Gulf States Marine Fisheries Commission's Fisheries Information Network (GulfFIN, 2002-2019). Data were filtered to eliminate records that included a size or effort bias and non-random collection of length data.

3.6.1 Length Distribution of Commercial Landings

Red Snapper length samples were reviewed for the years 1984-2019 using available TIP length data. Commercial landings nominal length frequency distributions were provided by year and fleet, which was defined as unique combinations of gear (Vertical Line, Longline) and stock (West, Central, East). Each fleet was analyzed at the finest spatial resolution possible by time period to ensure appropriate aggregation for the assessment model.

In the previous red snapper assessment, SEDAR52, the VL "eastern stock" length compositions were weighted by landings along the approximate boundary between the current Central and East stocks. Adding this additional stock boundary means that the nominal compositions are on a finer resolution and are appropriate to represent the landings from each of the three stocks. West and Central length compositions are approximately equal within their respective stocks, while the East stock may require weighting in the future, particularly if sampling effort diverges from landings disproportionately (Figure 3.6.1).

All LL fleets have minimal landings and sample sizes compared to VL. In the previous red snapper assessments, nominal compositions were provided for East and West stocks because there were insufficient samples to weight landings in the East. Due to these limitations, the Central LL fleet will have data gaps (Figure 3.6.2).

Recommendations: Provide nominal length compositions for each commercial fleet. If VL compositions continue to diverge, they may require weighting in future assessments.

3.6.2 Size Frequency Data from Commercial Fisheries Observers

Commercial discard lengths from observer data were provided for 2007-2019.

3.6.3 Age Distribution

Age samples are collected as part of the TIP sampling protocol for the vertical line and longline gears. The number of Red Snapper aged from the commercial fishery by year and stock is summarized in Table 3.6.1. The number of trips these ages were collected from are summarized in Table 3.6.2. The final commercial age composition inputs will be determined in the assessment phase.

3.7 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES (KEVIN/STEVE)

Overall the workgroup felt the landings data were appropriate and recommended for use in the assessment model. The landings time series ran from 1872-2020. As part of new discussion of the research track SEDAR 74 assessment, an effort was made to assign uncertainty in the commercial landings given the best available information and science.

Decision 5 : It was decided that for the historical commercial landings 1872 – 1961, the uncertainty or Coefficient of Variation (CV) around the landings agreed to be set to 0.5 for landings in the Western subregion, 0.6 for the Central and Eastern subregions.

With the annual reporting to the ALS, the workgroup agreed that commercial landings were more certain and CV was assumed to drop to 0.25. Additional certainty in the landing were assumed for the period 1977 to 1985 when landings began to be reported monthly and the CV was reduced to 0.2. Starting in 1986, Florida's state Trip Ticket Program (TTP) was the first state in the Southeastern region where commercial landings data collections came officially into effect (Donaldson 2004). It was decided that with the onset of trip level data collection of the state TTPs, the landings CV should drop to 0.15 for the Eastern subregion starting in 1986. As the TTPs in the other four states, Texas, Louisiana, Mississippi, and Alabama became official, the CV of the West and Central subregions were reduced to 0.15. With the onset of the IFQ program in 2007, the group decided that CV could be set to 0.05 for the time period after the IFQ became into effect to the final year, which is 2020.

The Commercial Work Group recommended uncertainties/CVs for the whole time series are shown in Table 3.7.

The provided discard and bycatch estimates were also recommended by the Work Group for use in the assessment models. Uncertainty of those discard estimates, however, was greater than the level of uncertainty of the landings. There is a higher level of uncertainty in the discards for the period 1995 through 2006 as these estimates are based upon data from self-reported discard logbooks. Estimates of discards for the years 2007-2020 from the reef fish observer data were assumed by the Work Group to have less uncertainty than the estimates from discard logbook data. New methods are in development for estimating bycatch from the shrimp fishery, therefore the bycatch estimates provided at the Data Workshop were considered to be temporary proxy values to be replaced upon completion of the new estimation methods. Shrimp fishery bycatch estimates using newly developed methods should be available for use in the operational assessment to follow the research track assessment.

The Work Group recommend that the length composition data be used in the assessment models. Size composition data was adequate in most strata; however some strata did have small sample sizes. This was especially the case for longline samples in the western Gulf. Length distribution data of discarded fish from samples obtained from the observer program were recommended for use in the assessment models.

3.8 RESEARCH RECOMMENDATIONS

- Explore estimating gear selectivity using kept and discarded size data from the reef fish observer program.
- Investigate improving biological sampling of observer program by expanding sampling of otoliths paired with length data. Sampling should be completed without affecting fishing behavior and that may be possible by having sampling occur during breaks in fishing activity.
- Consider issuing research permits to fishers to retain catch below minimum size to collect samples for age length keys.
- Observer sampling may be supplemented by buying a percentage of catch for fish that cannot be extracted without causing damage to fish.

- Investigate trip ticket data for market category compared to length compositions. This analysis may provide some signal of age classes within the data.
- Consideration of the effect that resolutions of market category on trip tickets differ among states.

3.9 LITERATURE CITED

Atkinson, S., Gocke, J. Martinez, S., Scott-Denton, E. 2021. Reef Fish Observer Program Metadata. SEDAR74-DW-02. SEDAR, North Charleston, SC. 20pp.

Atkinson, S., Judge, M, Orhun, R. 2021.Coastal Fisheries Logbook Program Metadata. SEDAR74-DW-03. SEDAR, North Charleston, SC. 19pp.

Donaldson, D.M. 2004. Overview of the State Trip Tickets Programs in the Gulf of Mexico. SEDAR7-DW-20. SEDAR, North Charleston, SC. 11pp.

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

Martinez, S.R., Atkinson, S., Smith, S.G. McCarthy, K.J. 2022. CPUE Expansion Estimation for Commercial Discards of Gulf of Mexico Red Snapper. SEDAR74-DW-19. SEDAR, North Charleston, SC. 36pp.

McCarthy, K. 2013. Calculated discards of gray triggerfish and blueline tilefish from US South Atlantic commercial fishing vessels. SEDAR32-DW-11. 17 pp.

McCarthy, K. 2015. Discards of Red Snapper Calculated for Commercial Vessels with Federal Fishing Permits in the US South Atlantic. SEDAR41-DW36. 18 pp.

Orhun, M.R. 2022. Commercial Landings of Red Snapper (*Lutjanus campechanus)* from the Gulf of Mexico 1964-2020. SEDAR74-DW-22. SEDAR, North Charleston, SC. 11pp.

Poffenberger, J. 2003. Description of the Southeast Fisheries Science Center's Logbook Program for Coastal Fisheries. SEDAR4-DW-29. SEDAR, North Charleston, SC. 9pp.

Poffenberger, J. 2004. Commercial landings Statistics – Red Snapper in the Gulf of Mexico. SEDAR7-DW-23. SEDAR, North Charleston, SC. 13pp.

Porch, C.E., S.C. Turner, M.J. Schirripa. 2004. The Commercial landings of red snapper in the Gulf of Mexico from 1872 to 1962. SEDAR7-AW-22. SEDAR, North Charleston, SC. 12pp.

Smith, S.G., S. F. Atkinson, and S. Martinez-Rivera. 2022. Estimation of length composition of commercial discards for Gulf of Mexico red snapper. SEDAR Working Paper SEDAR74-DW-37. SEDAR, North Charleston, SC.

Stephen, J.A. 2012. Brief overview on Gulf of Mexico Red Snapper IFQ Program. SEDAR31-DW02. SEDAR, North Charleston, SC. 6 pp.

Stevens, M.H. 2022. Gulf of Mexico Red Snapper (*Lutjanus campechanus)* Commercial and Recreational Landings Length and Age Compositions. SEDAR74-DW-14. SEDAR, North Charleston, SC. 23pp.

3.10 TABLES

Table 3.1. Annual Red Snapper landings in Whole Weight (Pounds) from 1872 – 2020 by the three subregions, West, Central and East.

Year	Handline+ West	Longline West	Handline+ Central	Longline Central	Handline+ East	Longline East
1872	-	-	521,326	-	-	-
1873	-	-	781,989	-	-	-
1874	-	-	1,172,984	-	-	-
1875	-	-	1,433,647	-	-	-
1876	-	-	1,694,310	-	-	-
1877	-	-	1,433,647	-	-	-
1878	-	-	1,303,315	-	-	-
1879	-	-	1,433,647	-	-	-
1880	891,034	-	1,824,641	-	-	-
1881	801,943	-	2,052,381	-	-	-
1882	711,859	-	2,282,108	-	-	-
1883	634,313	-	2,465,047	-	44,814	-
1884	556,765	-	2,639,862	-	97,760	-
1885	478,225	-	2,806,549	-	158,841	-
1886	400,672	-	2,966,948	-	228,197	-
1887	203,970	-	3,117,344	-	305,582	-
1888	212,884	-	2,926,314	-	351,111	-
1889	269,327	-	3,048,054	-	435,377	-
1890	242,531	-	3,593,495	-	598,832	-
1891	269,541	-	3,208,053	-	614,220	-
1892	293,175	-	3,294,330	-	716,054	-
1893	311,969	-	3,320,641	-	811,591	-
1894	324,863	-	3,321,819	-	905,812	-
1895	333,838	-	3,167,749	-	957,542	-
1896	340,888	-	3,125,835	-	1,041,778	-
1897	340,642	-	3,029,925	-	1,108,327	-
1898	544,671	-	3,294,715	-	1,317,664	-
1899	722,625	-	3,584,410	-	1,562,166	-
1900	889,976	-	3,850,529	-	1,823,612	-

1901	1,020,372	-	3,982,390	-	2,044,639	-
1902	1,126,034	-	4,039,710	-	2,243,865	-
1903	1,059,802	-	3,576,584	-	2,145,539	-
1904	1,011,726	-	3,210,050	-	2,076,681	-
1905	940,928	-	2,802,901	-	1,953,139	-
1906	867,673	-	2,423,615	-	1,817,329	-
1907	791,605	-	2,072,276	-	1,670,828	-
1908	735,773	-	1,801,929	-	1,561,322	-
1909	632,940	-	1,497,218	-	1,393,639	-
1910	538,109	-	1,396,230	-	1,040,471	-
1911	527,520	-	1,406,985	-	1,048,487	-
1912	517,874	-	1,417,281	-	1,056,158	-
1913	508,475	-	1,427,388	-	1,063,690	-
1914	498,829	-	1,436,712	-	1,070,639	-
1915	489,183	-	1,445,549	-	1,077,224	-
1916	478,596	-	1,453,869	-	1,083,425	-
1917	468,950	-	1,420,616	-	1,058,644	-
1918	459,305	-	1,428,233	-	1,064,320	-
1919	471,382	-	1,557,947	-	1,160,984	-
1920	483,458	-	1,692,885	-	1,261,539	-
1921	496,724	-	1,832,988	-	1,365,944	-
1922	508,800	-	1,978,094	-	1,474,077	-
1923	520,876	-	2,124,292	-	1,583,024	-
1924	503,176	-	2,075,056	-	1,546,333	-
1925	485,474	-	2,078,452	-	1,548,864	-
1926	467,525	-	2,024,027	-	1,508,307	-
1927	585,907	-	2,210,393	-	1,647,186	-
1928	426,871	-	1,973,519	-	1,470,668	-
1929	417,093	-	2,096,492	-	1,562,308	-
1930	553,559	-	1,279,793	-	953,702	-
1931	342,794	-	1,289,125	-	960,656	-
1932	411,305	-	1,384,389	-	1,031,648	-
1933	447,623	-	1,251,639	-	932,722	-

1934	464,740	-	1,125,866	-	838,997	-
1935	675,130	-	1,381,517	-	1,029,508	-
1936	871,388	-	1,589,492	-	1,184,491	-
1937	946,575	-	1,408,686	-	1,049,753	-
1938	935,330	-	1,822,353	-	1,358,018	-
1939	854,469	-	2,138,838	-	1,593,863	-
1940	815,871	-	1,430,754	-	1,066,199	-
1941	737,892	-	1,301,736	-	970,055	-
1942	544,639	-	1,041,916	-	776,437	-
1943	371,388	-	828,715	-	617,559	-
1944	279,690	-	956,927	-	713,103	-
1945	153,741	-	833,832	-	621,373	-
1946	323,401	-	1,329,247	-	990,555	-
1947	478,181	-	1,393,647	-	1,038,547	-
1948	595,421	-	1,489,045	-	1,109,637	-
1949	869,794	-	1,781,114	-	1,327,287	-
1950	1,476,048	-	970,157	-	722,961	-
1951	1,476,048	-	970,157	-	722,961	-
1952	1,477,540	-	1,155,693	-	861,224	-
1953	1,654,176	-	1,286,408	-	958,632	-
1954	1,358,592	-	1,161,167	-	865,303	-
1955	1,365,982	-	1,079,068	-	804,123	-
1956	1,492,039	-	1,207,112	-	899,540	-
1957	2,017,420	-	1,444,456	-	1,076,409	-
1958	2,013,517	-	1,296,064	-	965,827	-
1959	3,357,390	-	2,134,188	-	1,590,399	-
1960	3,431,602	-	1,952,699	-	1,455,152	-
1961	3,601,182	-	2,187,041	-	1,629,784	-
1962	3,612,712	-	2,367,407	-	1,764,194	-
1963	3,818,000	-	1,720,146	-	1,281,854	-
1964	3,590,301	-	1,949,662	-	1,657,008	-
1965	3,646,081	-	2,087,968	-	1,624,596	-
1966	3,041,229	-	1,659,432	-	1,439,333	-

1967	4,230,951	-	1,883,080	-	1,023,864	-
1968	5,160,886	-	1,555,387	-	1,062,159	-
1969	4,187,460	-	1,501,106	-	940,836	-
1970	4,652,728	-	1,360,293	-	949,161	-
1971	5,366,029	-	1,424,258	-	799,311	-
1972	4,841,776	-	1,508,522	-	865,800	-
1973	4,867,197	-	1,952,058	-	760,974	-
1974	4,433,800	-	1,942,947	-	1,824,618	-
1975	3,932,964	-	1,960,575	-	1,616,049	-
1976	3,325,599	1,074	1,740,786	-	1,547,340	-
1977	2,873,097	-	1,347,609	-	916,140	-
1978	2,694,000	-	1,238,528	-	757,823	-
1979	2,472,483	-	1,280,359	-	757,536	-
1980	2,516,508	44,054	1,302,555	60,601	593,193	33,404
1981	3,143,304	49,261	1,572,572	88,141	555,083	91,717
1982	3,661,535	71,617	1,754,198	81,139	537,709	145,435
1983	3,820,146	98,736	1,954,159	108,273	433,381	336,750
1984	2,906,413	762,672	1,230,559	104,198	401,357	264,251
1985	1,846,043	604,890	1,211,465	30,978	412,307	83,360
1986	1,933,384	831,375	719,097	32,293	140,734	43,604
1987	1,474,284	734,038	691,675	28,380	105,143	35,094
1988	2,355,109	670,131	752,113	54,320	105,845	22,346
1989	1,891,961	454,743	609,907	54,811	63,178	23,762
1990	1,757,785	120,420	577,232	13,473	120,384	61,318
1991	1,724,709	72,592	370,173	5,597	25,005	15,111
1992	2,674,495	19,820	392,018	902	14,476	4,788
1993	2,901,543	20,291	400,297	2,315	36,561	12,921
1994	2,671,459	15,809	503,057	2,580	24,067	5,379
1995	2,735,402	17,506	159,714	1,232	13,027	7,228
1996	4,044,132	27,362	224,209	4,090	9,772	3,498
1997	4,589,500	31,418	176,250	1,190	8,161	3,437
1998	4,267,518	27,224	365,877	2,254	13,526	3,261
1999	4,227,816	91,321	501,877	704	48,427	5,811

2000	3,979,513	184,426	632,529	1,039	32,093	7,519
2001	3,705,640	124,972	749,136	662	35,447	9,418
2002	3,565,505	146,691	1,016,265	6,572	36,180	11,608
2003	3,204,760	170,163	969,243	3,675	52,540	10,293
2004	3,224,112	456,817	898,310	3,594	54,376	15,760
2005	3,000,269	282,912	725,355	1,817	74,012	19,334
2006	3,615,632	256,820	670,201	1,110	95,144	15,511
2007	2,101,832	189,356	816,734	10,048	55,734	5,642
2008	1,582,401	56,204	754,661	18,686	55,910	14,509
2009	1,498,216	51,763	809,500	6,476	109,326	8,151
2010	1,880,162	38,356	1,188,292	11,069	208,566	64,568
2011	1,879,064	18,391	1,360,013	4,678	254,480	77,772
2012	2,120,547	13,504	1,612,829	1,284	237,573	50,662
2013	2,997,578	50,717	1,985,033	2,277	304,678	108,228
2014	3,261,930	55,486	1,712,170	7,850	414,051	112,624
2015	3,970,288	49,943	2,364,981	39,192	541,447	210,646
2016	3,950,774	71,219	2,119,735	20,997	398,291	162,467
2017	3,997,846	65,565	2,243,309	7,117	494,756	169,188
2018	3,936,448	66,639	2,098,679	45,579	570,560	257,489
2019	4,120,426	157,549	2,206,933	32,976	751,388	385,610
2020	3,931,978	68,747	2,234,664	22,477	696,916	410,612

Table 3.2 Commercial landings of Red Snapper in the Gulf of Mexico in numbers of fish based on average weights calculated from TIP program 1984 – 2020.

YEAR	W_VL+	C_VL+	E_VL+	W_LL+	C_LL+	E_LL+
1984	1,019,794	449,109	54,980	96,297	10,236	26,035
1985	647,734	442,141	56,480	76,375	3,043	8,213
1986	678,380	262,444	19,279	104,972	3,172	4,296
1987	517,293	252,436	14,403	92,682	2,788	3,458
1988	826,354	274,494	14,499	84,613	5,336	2,202
1989	663,846	222,594	8,655	57,417	5,384	2,341
1990	616,767	210,669	16,491	15,205	1,323	6,041
1991	511,783	133,156	4,014	7,690	985	1,606
1992	793,619	141,014	2,324	2,100	159	509
1993	860,992	143,992	5,869	2,149	408	1,373
1994	792,718	180,956	3,863	1,675	454	572
1995	811,692	57,451	2,091	1,854	217	768
1996	993,644	63,157	2,305	2,853	288	426
1997	1,127,641	49,648	1,925	3,276	84	419
1998	1,048,530	103,064	3,190	2,839	159	397
1999	1,038,775	141,374	11,421	9,523	50	708
2000	977,767	178,177	7,569	19,231	73	916
2001	1,052,739	222,957	6,856	12,051	87	1,292
2002	1,012,928	302,460	6,998	14,146	860	1,592
2003	910,443	288,465	10,162	16,409	481	1,412
2004	915,941	267,354	10,518	44,052	470	2,162
2005	852,349	215,879	14,316	27,282	238	2,652
2006	1,033,038	228,738	19,988	27,526	177	2,332
2007	600,523	278,749	11,709	20,295	1,605	848
2008	452,115	257,563	11,746	6,024	2,985	2,182
2009	428,062	276,280	22,968	5,548	1,035	1,226
2010	537,189	405,560	43,816	4,111	1,768	9,709
2011	431,969	346,059	36,251	1,837	693	9,770
2012	487,482	410,389	33,842	1,349	190	6,365
2013	689,098	505,097	43,401	5,067	337	13,596
2014	749,869	435,667	58,982	5,543	1,163	14,149

2015	912,710	601,776	77,129	4,989	5,806	26,463
2016	906,141	568,294	70,494	5,896	2,378	22,850
2017	916,937	601,423	87,567	5,428	806	23,796
2018	902,855	562,649	100,984	5,516	5,162	36,215
2019	945,052	591,671	132,989	13,042	3,735	54,235
2020	901,830	599,106	123,348	5,691	2,546	57,751

Table 3.3. Beginning year of adoption of State Trip Ticket Programs (TTP) in the Gulf of Mexico Fisheries Management Council (GMFMC) region.

Year	State
1986	Florida
2000	Louisiana
2002	Alabama
2006	Texas
2012	Mississippi

Table 3.4.1.1. Calculated yearly total discards of Red Snapper from vertical line vessels by region and Red Snapper season (open/closed). Discards are reported as number of fish.

Year	VL east closed season	VL central closed season	VL west closed season	VL east open season	VL central open season	VL west open season
1995	49,407	814,917	97,838	7,949	131,749	367,594
1996	44,801	776,910	86,785	13,888	154,510	639,217
1997	45,591	625,567	146,697	10,113	150,278	771,885
1998	40,922	613,507	112,030	10,295	166,751	867,539
1999	45,994	715,912	141,937	11,262	206,946	926,415
2000	43,318	568,572	140,452	10,981	259,730	843,145
2001	35,597	524,182	96,650	9,214	314,874	978,141
2002	34,744	506,465	113,240	12,238	366,366	962,175
2003	30,947	602,113	113,700	13,150	439,970	979,275
2004	47,398	462,990	89,771	12,099	396,933	1,022,326
2005	24,559	320,799	71,675	13,601	387,232	1,062,369
2006	26,249	341,403	44,702	15,648	426,410	1,178,932

Table 3.4.1.2. Calculated yearly total discards of Red Snapper from bottom longline vessels by region and Red Snapper season (open/closed). Discards are reported as number of fish.

Year	BLL east closed season	BLL central closed season	BLL west closed season	BLL east open season	BLL central open season	BLL west open season
1995	10,629	596	710	2,106	48	1,608
1996	10,995	531	564	3,343	74	1,031
1997	13,103	588	348	3,238	65	662
1998	13,039	410	398	2,528	52	744
1999	14,040	275	786	3,432	51	2,331
2000	11,891	534	590	2,959	54	2,014
2001	11,817	507	410	2,660	62	1,192
2002	9,608	498	517	3,151	92	1,881
2003	10,705	642	656	2,831	94	3,543
2004	9,411	404	560	3,604	138	5,294
2005	6,199	430	465	3,151	94	4,387
2006	7,622	403	334	4,153	117	4,110

Table 3.4.1.3. Mean weight (pounds whole weight) of discards as reported from the reef fish observer program. Mean weights are by gear (bottom longline and vertical line) and amount of IFQ allocation. Sample size in number of fish and standard errors are also provided.

Gear	No IFQ (discard only trips)			IFQ (discards & kept trips)		
	N fish	Mean weight pounds (wwt)	SE	N fish	Mean weight pounds (wwt)	SE
Bottom Longline	190	6.22	0.092	53	5.22	0.174
Vertical Line	482	3.3	0.035	1,520	1.57	0.016

Table 3.4.1.4. Calculated yearly total discards of Red Snapper from vertical line vessels by region and Red Snapper season (open/closed). Discards are reported in whole pounds.

Year	VL east closed season	VL central closed season	VL west closed season	VL east open season	VL central open season	VL west open season
1995	163,059	2,689,484	322,898	12,478	206,805	577,008
1996	147,857	2,564,047	286,416	21,801	242,533	1,003,373
1997	150,466	2,064,569	484,146	15,874	235,889	1,211,620
1998	135,054	2,024,767	369,734	16,160	261,747	1,361,767
1999	151,794	2,362,737	468,437	17,679	324,841	1,454,183
2000	142,965	1,876,469	463,536	17,236	407,695	1,323,475
2001	117,480	1,729,967	318,975	14,463	494,254	1,535,378
2002	114,666	1,671,494	373,729	19,210	575,081	1,510,315
2003	102,134	1,987,164	375,245	20,641	690,616	1,537,157
2004	156,429	1,528,012	296,272	18,992	623,061	1,604,735
2005	81,054	1,058,737	236,551	21,349	607,835	1,667,590
2006	86,631	1,126,738	147,532	24,562	669,332	1,850,557

Table 3.4.1.5. Calculated yearly total discards of Red Snapper from bottom longline vessels by region and Red Snapper season (open/closed). Discards are reported in whole pounds.

Year	BLL east closed season	BLL central closed season	BLL west closed season	BLL east open season	BLL central open season	BLL west open season
1995	66,106	3,707	4,415	10,995	249	8,397
1996	68,383	3,304	3,508	17,450	388	5,382
1997	81,489	3,657	2,166	16,902	340	3,456
1998	81,095	2,552	2,473	13,199	274	3,883
1999	87,319	1,707	4,888	17,917	268	12,167
2000	73,953	3,320	3,669	15,449	280	10,513
2001	73,492	3,154	2,547	13,887	324	6,221
2002	59,755	3,094	3,218	16,449	478	9,819
2003	66,578	3,991	4,078	14,777	492	18,496
2004	58,530	2,516	3,482	18,814	722	27,640
2005	38,555	2,673	2,894	16,450	491	22,904
2006	47,406	2,507	2,077	21,681	609	21,457

Table 3.4.2.1. Time-series of CPUE expansion estimates for GOM Red Snapper vertical line discards in weight (lbs.) and numbers (with associated standard errors) for each of the three sub-regions or zones, i.e. a) West, b) Central and c) East.

WEST

Year	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2007	711,751	421,446	466,911	266,427
2008	281,484	107,565	131,928	62,846
2009	238,446	91,118	111,757	53,237
2010	196,645	75,145	92,165	43,904
2011	194,100	74,172	90,972	43,336
2012	220,756	84,358	103,466	49,287
2013	215,423	82,321	100,966	48,097
2014	65,024	29,304	27,537	12,480
2015	78,156	35,222	33,730	15,286
2016	72,909	32,857	31,153	14,118
2017	71,023	32,007	30,071	13,628
2018	62,115	27,993	25,897	11,736
2019	66,023	29,754	27,497	12,462

CENTRAL

Year	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2007	118,238	22,475	83,383	13,829
2008	143,175	38,570	49,728	12,146
2009	149,013	40,143	51,756	12,642
2010	168,285	45,335	58,449	14,276
2011	204,447	55,076	71,009	17,344
2012	223,893	60,315	77,763	18,994
2013	179,491	48,353	62,341	15,227
2014	122,821	44,250	66,197	19,524
2015	120,115	43,275	66,713	19,676
2016	132,360	47,687	72,065	21,255
2017	135,196	48,709	74,438	21,954
2018	112,937	40,689	62,429	18,413
2019	113,501	40,892	63,248	18,654

Table 3.4.2.1 Cont'd

EAST

Year	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2007	31,260	7,571	8,544	1,950
2008	45,852	10,876	8,598	2,143
2009	66,779	15,841	12,487	3,113
2010	99,671	23,643	18,723	4,667
2011	114,624	27,190	21,726	5,416
2012	112,653	26,722	21,279	5,304
2013	128,029	30,369	24,330	6,065
2014	60,809	19,402	24,623	10,420
2015	58,352	18,618	22,530	9,534
2016	69,996	22,334	29,146	12,333
2017	66,261	21,142	28,138	11,907
2018	58,186	18,566	25,139	10,638
2019	55,768	17,794	24,532	10,381

Table 3.4.2.2. Time-series of CPUE expansion estimates for GOM Red Snapper bottom longline discards in weight (lbs.) and number (with associated standard errors) for each sub-region.

Zone (West)

Year	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2007	8,588	8,109	878	785
2008	18,541	17,507	1,808	1,617
2009	31,730	29,960	3,042	2,720
2010	11,467	10,827	1,090	975
2011	3,804	3,591	364	325
2012	9,074	8,568	858	767
2013	31,045	29,312	2,955	2,643
2014	18,954	17,896	1,844	1,649
2015	56,136	53,004	5,293	4,733
2016	31,561	29,800	3,057	2,734
2017	33,425	31,560	3,195	2,857
2018	12,538	11,838	1,230	1,100
2019	32,446	30,635	3,163	2,829

Table 3.4.2.2 Cont'd

Zone (Central)

Year	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2007	20,092	4,691	2,798	618
2008	20,934	4,887	2,916	644
2009	7,802	1,821	1,087	240
2010	10,874	2,539	1,515	335
2011	5,772	1,348	804	178
2012	1,476	345	206	45
2013	2,226	520	310	69
2014	8,917	2,082	1,242	274
2015	28,049	6,548	3,907	863
2016	13,158	3,072	1,833	405
2017	5,066	1,183	706	156
2018	24,336	5,682	3,390	749
2019	15,805	3,690	2,201	486

Zone (East)

Year	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2007	21,132	4,884	2,953	645
2008	29,300	6,772	4,094	895
2009	13,483	3,116	1,884	412
2010	74,562	17,234	10,418	2,277
2011	98,725	22,819	13,795	3,014
2012	61,825	14,290	8,639	1,888
2013	102,890	23,782	14,377	3,141
2014	128,268	29,648	17,923	3,916
2015	191,681	44,305	26,783	5,852
2016	194,079	44,859	27,118	5,926
2017	199,460	46,103	27,870	6,090
2018	197,191	45,579	27,553	6,021
2019	241,854	55,902	33,794	7,384

Table 3.4.3: Annual bycatch estimates of red snapper from shrimp trawls for 3 subregions for 1972-2016.

Year	West	Central	East
1972	16020	689.5	234.3
1973	14460	908.3	308.7
1974	17550	516.9	175.6
1975	8357	907.6	308.4
1976	30000	808.3	274.7
1977	11320	1125.5	382.5
1978	6575	180.9	61.5
1979	21970	812.0	276.0
1980	25550	333.4	113.3
1981	53210	977.7	332.3
1982	23920	1207.6	410.4
1983	17560	853.8	290.2
1984	12510	611.4	207.8
1985	10440	506.1	191.1
1986	5441	165.7	51.8
1987	11760	233.5	91.5
1988	9602	282.3	98.5
1989	10500	517.8	137.5
1990	40970	1725.7	456.3
1991	40890	1402.2	435.8
1992	31660	944.2	345.8
1993	34900	486.7	264.3
1994	34400	702.3	388.7
1995	47470	934.2	527.8
1996	36260	493.6	567.4
1997	26290	1078.9	610.1
1998	56070	972.9	645.1
1999	23870	1396.5	467.5
2000	11960	1657.8	469.2
2001	23970	1633.5	682.5
2002	22140	1476.2	704.8
2003	30510	892.3	380.7
2004	27840	1019.9	393.1
2005	12250	423.0	202.5
2006	11430	1417.7	420.3
2007	6812	1056.0	161.0
2008	2710	126.6	33.9
2009	3726	282.8	68.6
2010	2779	119.9	70.3

2011	6389	453.8	151.6
2012	8494	314.9	71.6
2013	5979	395.0	114.0
2014	20170	95.1	32.4
2015	17260	563.4	163.0
2016	17260	583.3	143.1

Table 3.5. Annual estimates of GOM shrimp trawl effort for three subregions for 1945-2019.

Year	West	Central	East
1945	0.0	0.0	0.0
1946	1231.6	0.0	0.0
1947	6281.2	0.0	0.0
1948	16503.4	0.0	0.0
1949	26664.1	0.0	0.0
1950	32206.3	7356.1	2499.8
1951	33869.0	12673.7	4306.9
1952	39965.4	14978.0	5089.9
1953	38980.1	16543.8	5622.0
1954	51419.2	21211.5	7208.2
1955	42428.6	25052.0	8513.3
1956	55360.3	31728.6	10782.2
1957	69400.6	34741.9	11806.2
1958	107025.9	36750.8	12488.9
1959	114353.9	39882.3	13553.1
1960	98971.0	37083.9	12602.1
1961	82563.0	27194.6	9241.4
1962	100395.0	37087.6	12603.4
1963	111607.0	35832.2	12176.8
1964	136393.0	39752.2	13508.8
1965	113703.0	36909.3	12542.7
1966	115141.0	34528.3	11733.7
1967	133882.0	33713.3	11456.7
1968	142411.0	39873.1	13549.9
1969	159864.0	37369.0	12699.0
1970	135727.0	36050.9	12251.1
1971	143404.0	33587.2	11413.8
1972	176738.0	34950.8	11877.2
1973	165055.0	38978.2	13245.8
1974	169015.0	36077.8	12260.2
1975	150291.0	37011.5	12577.5
1976	163522.0	34241.7	11636.3
1977	167604.0	39835.0	13537.0

1978	192585.0	38975.9	13245.1
1979	226170.0	43560.9	14803.1
1980	161176.0	24633.8	8371.2
1981	181392.0	37780.3	12838.7
1982	177880.0	45253.6	15378.4
1983	180270.0	50527.4	17170.6
1984	187681.0	59484.6	20214.4
1985	185608.0	53429.7	20174.3
1986	244961.0	52409.3	16386.7
1987	258137.0	56902.7	22307.3
1988	231807.0	57259.0	19987.0
1989	234643.0	55050.5	14614.5
1990	239721.0	53072.1	14031.9
1991	246245.0	40889.7	12710.3
1992	261284.0	42922.6	15721.4
1993	232179.0	36929.0	20055.0
1994	240070.0	38039.7	21052.3
1995	183997.0	42780.9	24172.1
1996	188947.0	30015.5	34499.5
1997	222347.0	44273.1	25034.9
1998	207839.0	43770.5	29024.5
1999	208345.0	46547.9	15581.1
2000	208085.0	40543.7	11474.3
2001	220819.0	40251.1	16818.9
2002	233599.0	48082.1	22957.9
2003	200594.0	37856.0	16149.0
2004	168423.0	33361.2	12858.8
2005	117922.0	21706.3	10389.7
2006	114549.0	18920.3	5609.7
2007	99479.0	22464.5	3425.5
2008	81207.0	20262.9	5417.1
2009	100377.0	26171.2	6353.8
2010	84455.0	15103.1	8845.9
2011	95262.0	19897.1	6645.9
2012	94891.0	18079.8	4114.2
2013	84389.0	18111.5	5229.5
2014	96053.0	9893.3	3371.7
2015	92785.0	14526.3	4201.7
2016	102428.0	19298.7	4733.3
2017	94538.0	14257.1	7959.9
2018	93398.0	14938.8	8943.2
2019	78864.0	16701.9	7205.1

Table 3.6.1. Annual number of age samples for commercial vertical line (VL) and longline (LL) gears by stock.

Year	W_VL	W_LL	C_VL	C_LL	E_VL	E_LL
1991	25	0	178	0	0	12
1992	210	0	116	0	18	15
1993	312	29	136	0	13	30
1994	500	0	121	4	28	4
1995	97	0	85	0	7	19
1996	0	0	9	0	0	6
1997	0	0	1	3	31	7
1998	1,172	347	181	0	11	25
1999	1,797	76	902	0	70	102
2000	695	342	1,381	0	29	82
2001	1,026	179	1,233	14	65	75
2002	2,420	340	1,155	11	14	167
2003	1,393	256	1,473	27	9	168
2004	1,891	640	969	18	113	234
2005	2,313	252	1,097	34	68	311
2006	2,599	556	1,146	0	153	202
2007	1,446	352	1,077	93	54	124
2008	1,577	342	933	182	24	315
2009	2,124	270	929	20	595	678
2010	2,038	82	1,148	1	451	1,004
2011	1,660	14	2,776	120	599	453
2012	2,911	148	3,521	60	649	219
2013	1,499	115	1,922	133	640	585
2014	1,129	74	1,708	39	759	1,110
2015	1,646	104	2,285	63	556	800
2016	1,694	112	2,634	27	804	828
2017	1,240	132	3,123	21	1,114	528
2018	1,496	306	4,112	116	731	536
2019	1,120	681	4,329	76	948	775

Table 3.6.2. Annual number of commercial vertical line (VL) and longline (LL) gear trips sampled for ages by stock.

Year	W_VL	W_LL	C_VL	C_LL	E_VL	E_LL
1991	1	0	12	0	0	2
1992	16	0	4	0	6	4
1993	31	2	16	0	7	10
1994	54	0	23	1	6	3
1995	9	0	16	0	2	7
1996	0	0	3	0	0	4
1997	0	0	1	1	2	2
1998	45	6	7	0	3	6
1999	76	2	29	0	3	12
2000	37	14	56	0	4	7
2001	43	9	57	1	3	17
2002	105	15	55	2	5	37
2003	56	13	385	2	3	38
2004	71	24	51	2	11	40
2005	85	10	52	2	8	51
2006	80	17	53	0	43	40
2007	55	15	180	5	29	27
2008	108	25	110	36	23	81
2009	54	17	148	9	88	48
2010	68	5	367	1	179	614
2011	55	1	1,826	34	253	254
2012	115	9	1,690	17	266	111
2013	238	10	1,514	19	406	123
2014	221	10	1,286	17	389	110
2015	254	15	1,813	11	281	154
2016	250	16	2,124	12	689	712
2017	227	19	2,476	17	1,019	471
2018	241	20	3,422	69	714	511
2019	222	33	3,900	32	895	661

Table 3.7 Expert opinion of uncertainty for the commercial fisheries landings from 1872-2020 based on differences in the collection of data over time (see text in Section 3.8).

YEAR	WEST	CENTRAL	EAST
1872-1961	0.50	0.60	0.60
1962-1976	0.25	0.25	0.25
1977-1985	0.20	0.20	0.20
1986	0.20	0.17	0.15
1987	0.20	0.17	0.15
1988	0.20	0.17	0.15
1989	0.20	0.16	0.15
1990	0.20	0.16	0.15
1991	0.20	0.16	0.15
1992	0.20	0.16	0.15
1993	0.20	0.17	0.15
1994	0.20	0.17	0.15
1995	0.20	0.18	0.15
1996	0.20	0.18	0.15
1997	0.20	0.18	0.15
1998	0.20	0.18	0.15
1999	0.20	0.16	0.15
2000	0.17	0.16	0.15
2001	0.17	0.16	0.15
2002	0.17	0.15	0.15
2003	0.17	0.15	0.15
2004	0.18	0.15	0.15
2005	0.18	0.15	0.15
2006	0.18	0.15	0.15
2007 to present	0.05	0.05	0.05

3.11 FIGURES

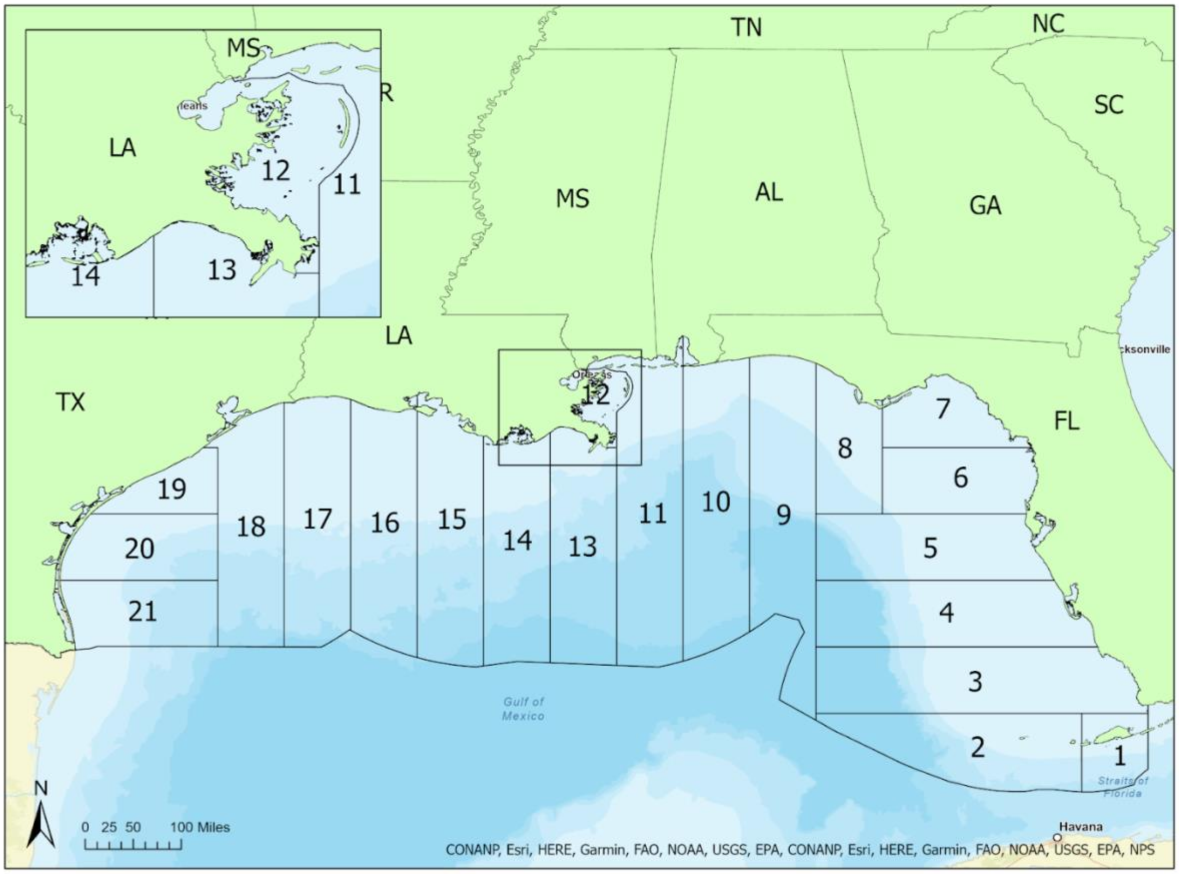
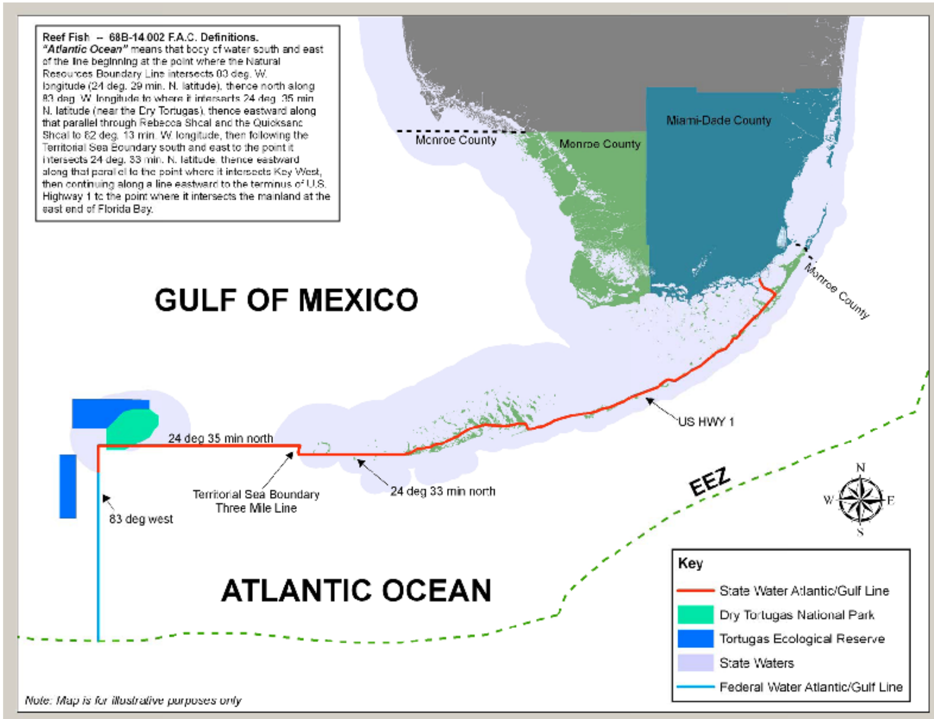


Figure 3.1. Map of NMFS Statistical Areas 1-21 in the Gulf of Mexico including a detail of the Areas 11-14 around outflow of the Mississippi.

a



b

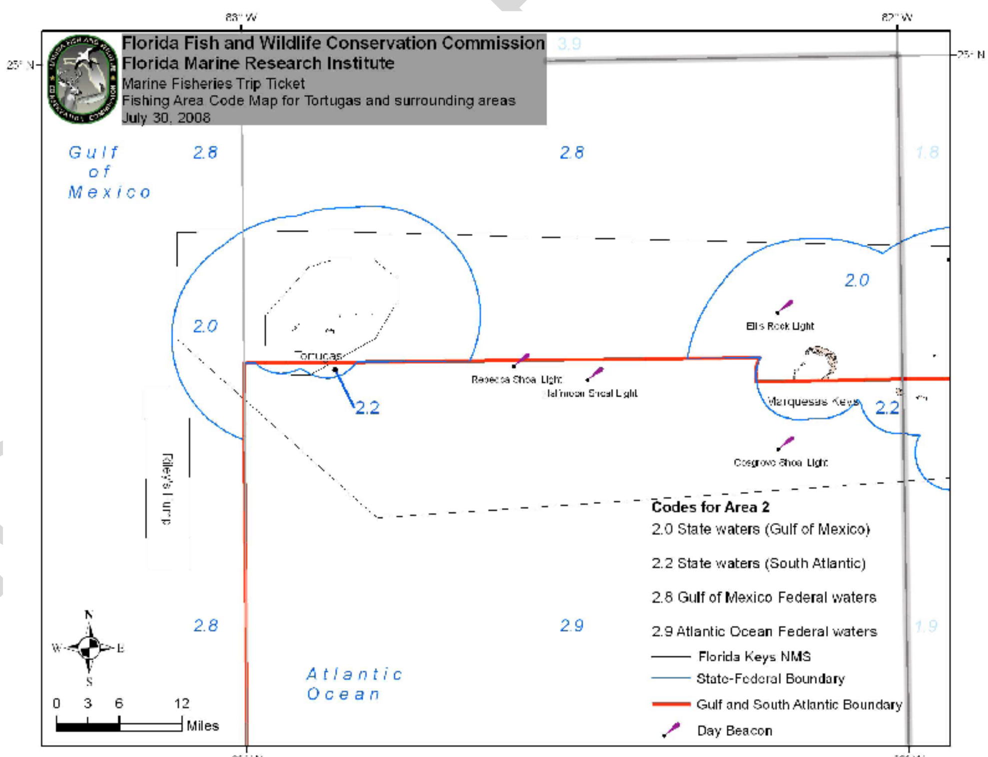


Figure 3.2 a,b) Maps are showing the GMFMC and SAFMC boundaries in the Florida Keys, namely US1 and its extension westward to Riley's Humb and the Tortugas to the North

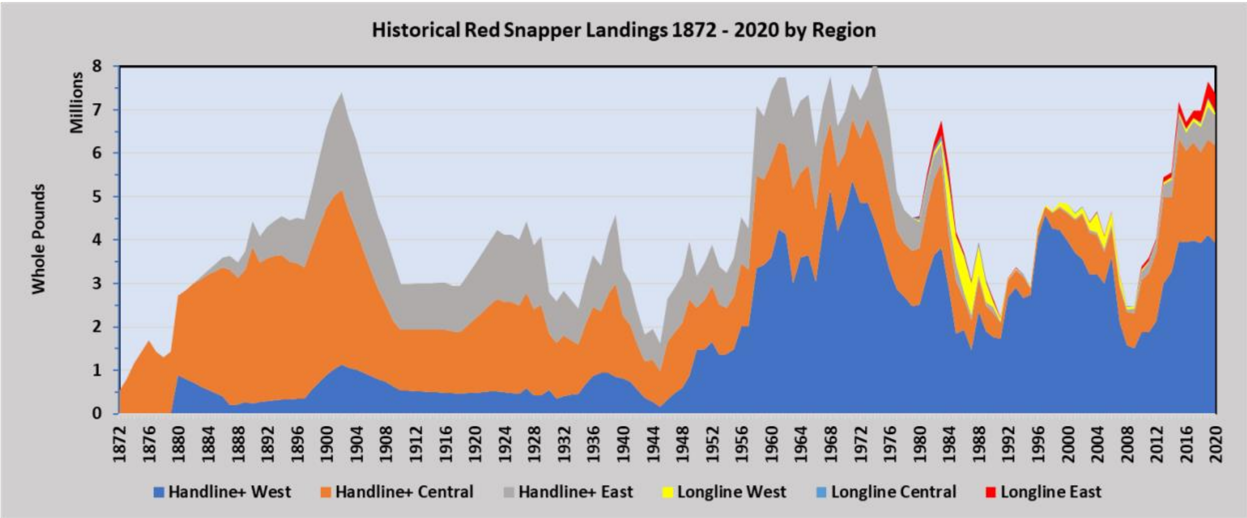


Figure 3.3.1 Commercial landings of Gulf of Mexico Red Snapper by stock/zone/subregion in whole pounds 1872 to 2020 with expert opinion uncertainty/CV's as also shown in Table 3.7.

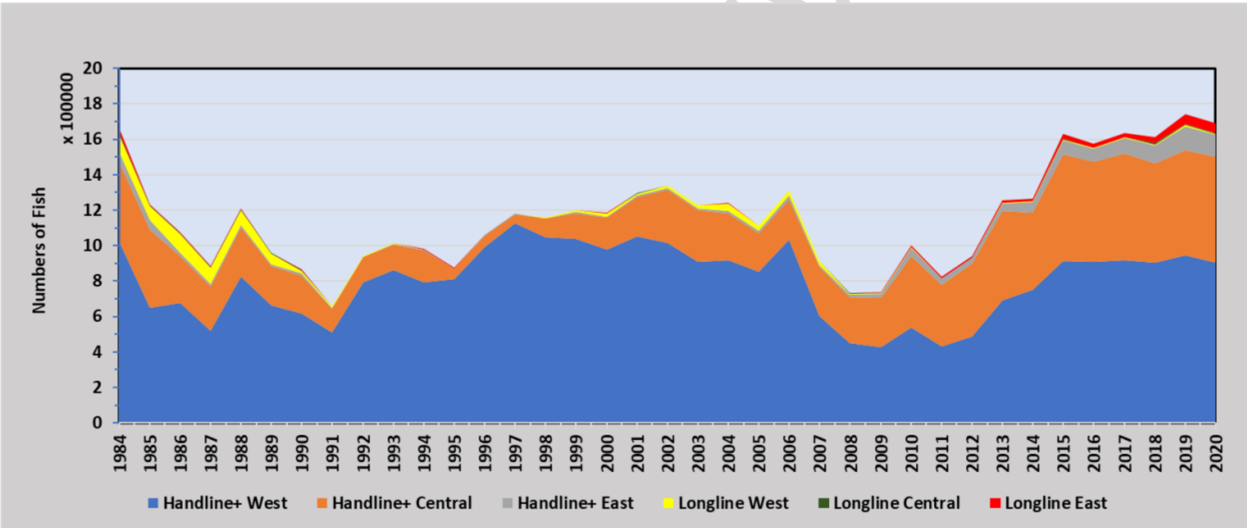
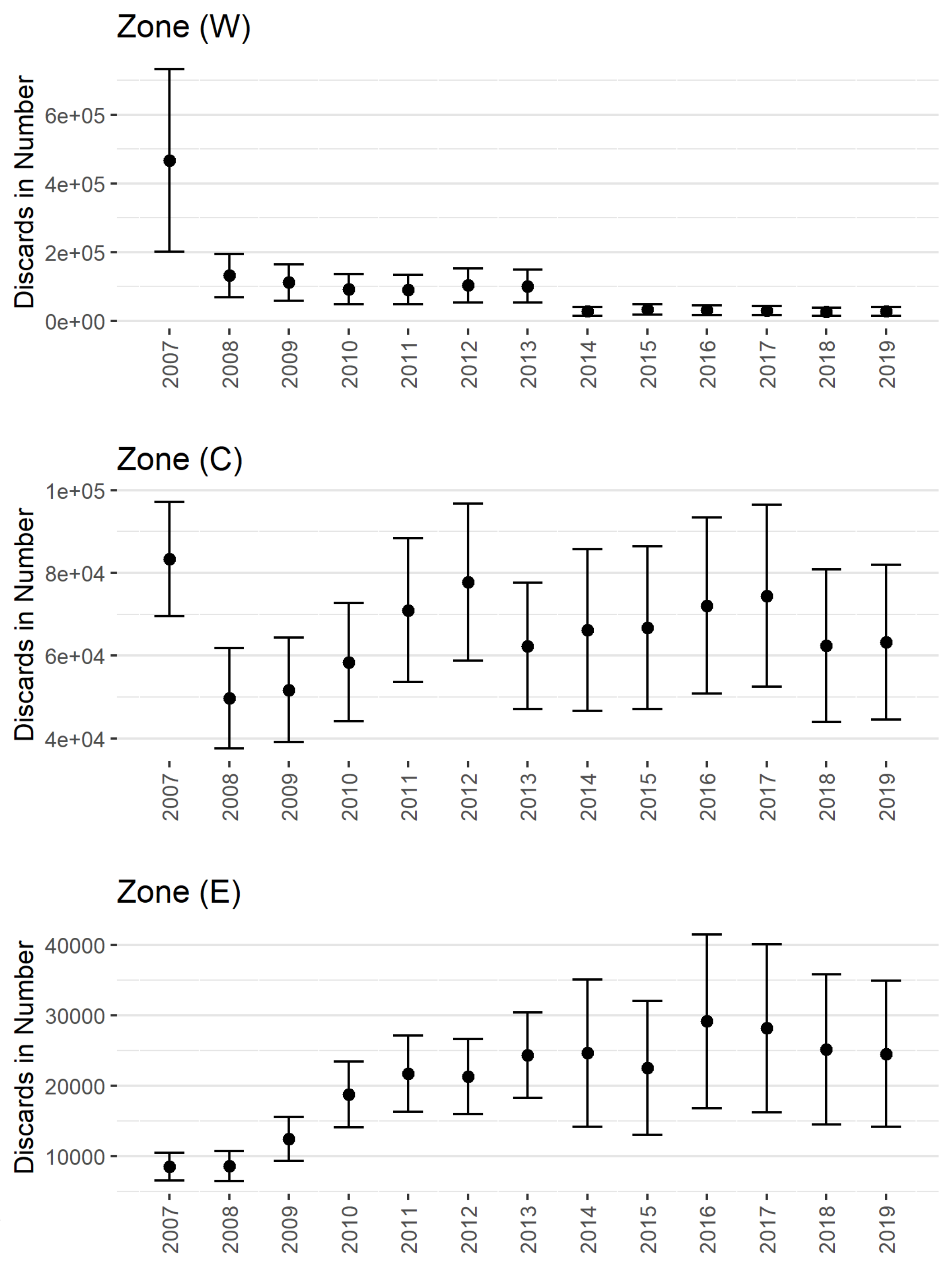


Figure 3.3.2 Commercial landings of Gulf of Mexico Red Snapper by /stock/zone/subregion in numbers of fish 1984-2020 based average weights obtained from the TIP Observer Program.

Discards in Numbers (A)



Discards in Weight, Percentage of Total Catch (B)

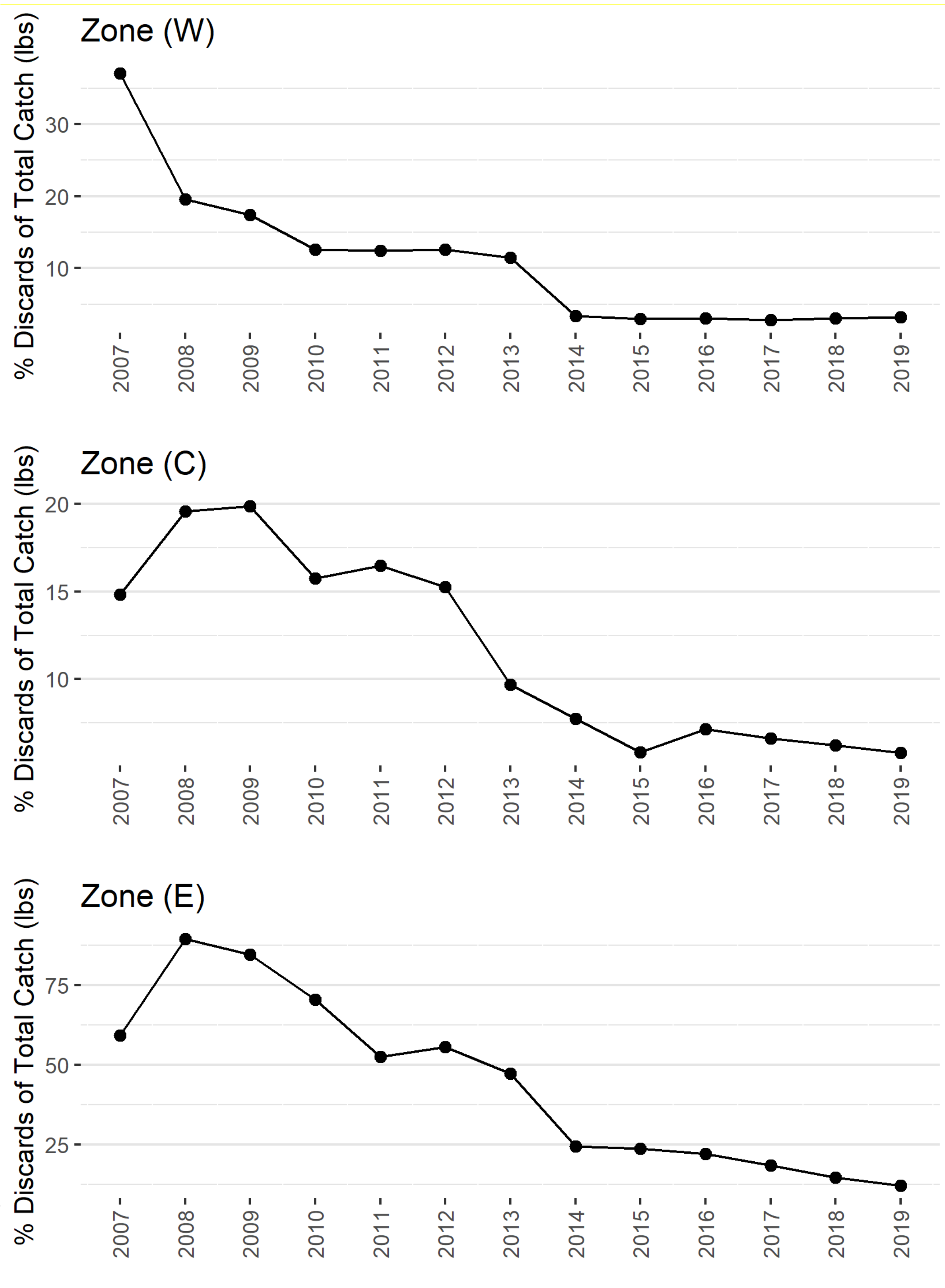
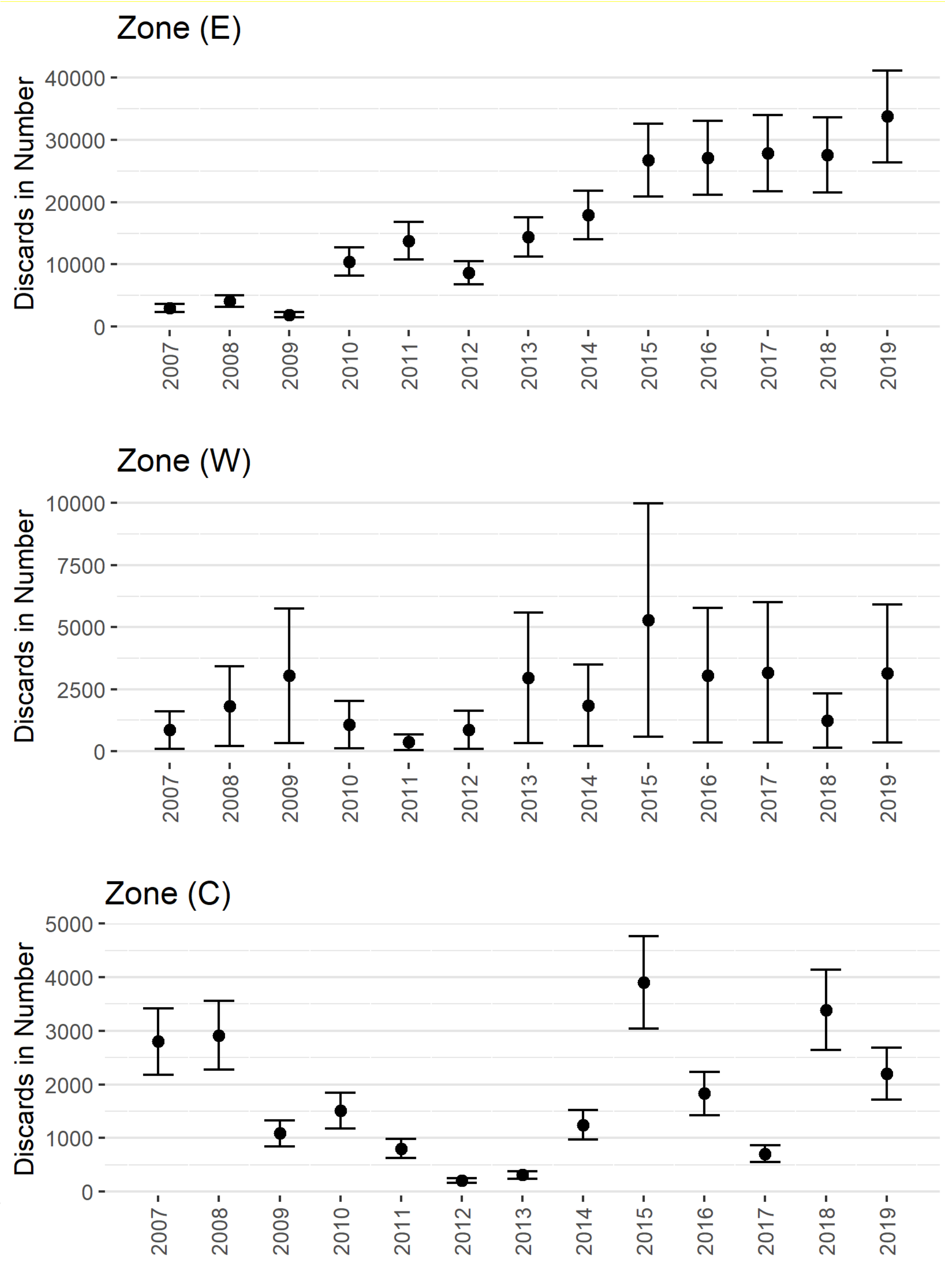


Figure 3.4.3.1. Observer CPUE expansion estimates of GOM Red Snapper vertical line annual discards (+/-SE) in (A) number and (B) weight expressed as percentage of total catch (kept + discards) for 2007 - 2019.

Discards in Number (A)



Discards in Weight, Percentage of Total Catch (B)

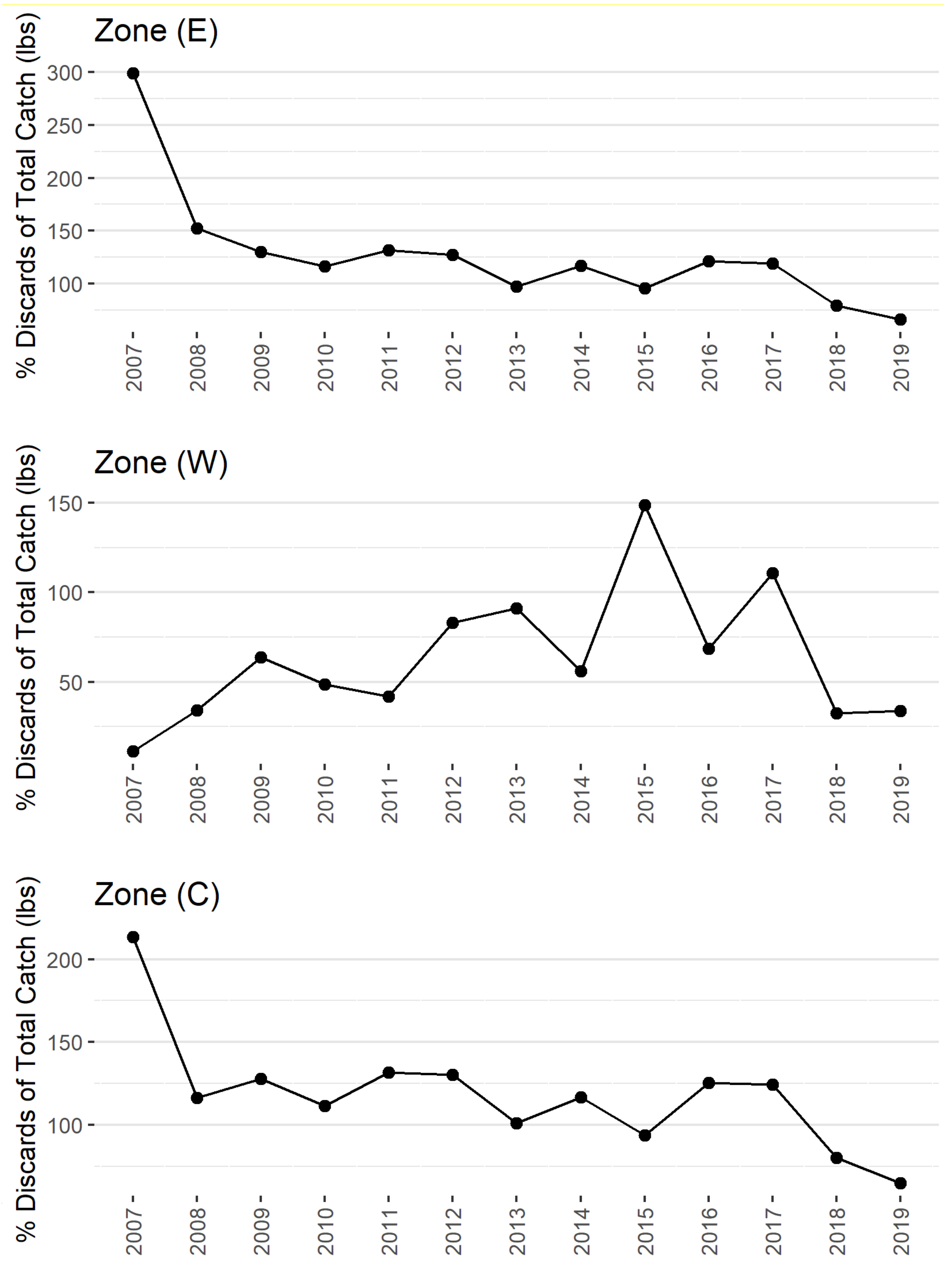
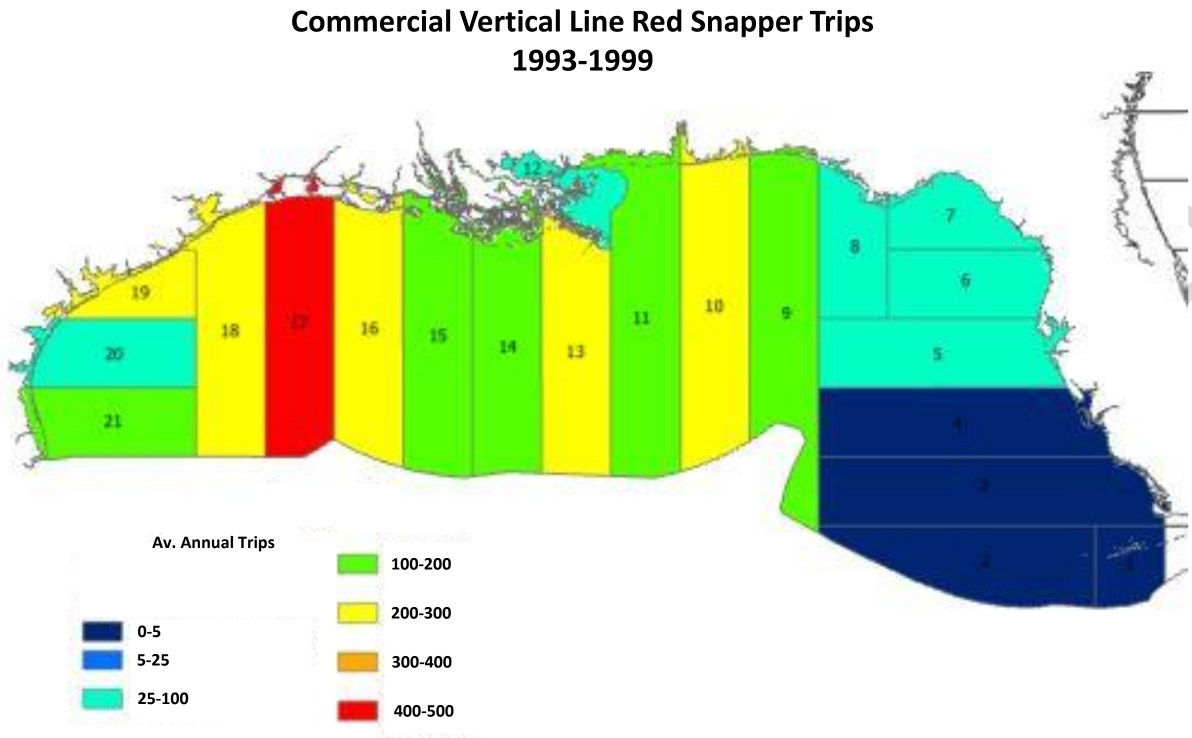
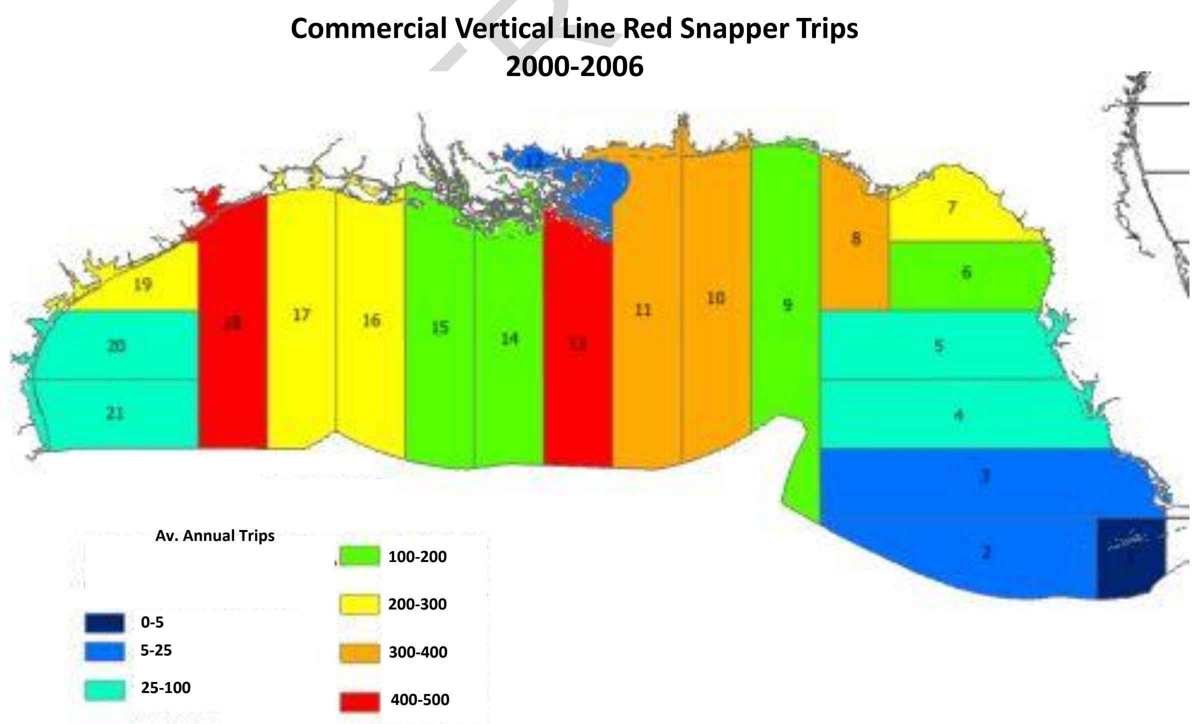


Figure 3.4.3.2 Observer CPUE expansion estimates of GOM Red Snapper bottom longline annual discards (+/-SE) in (A) number and (B) weight expressed as percentage of total catch (kept + discards) for 2007 - 2019**.**

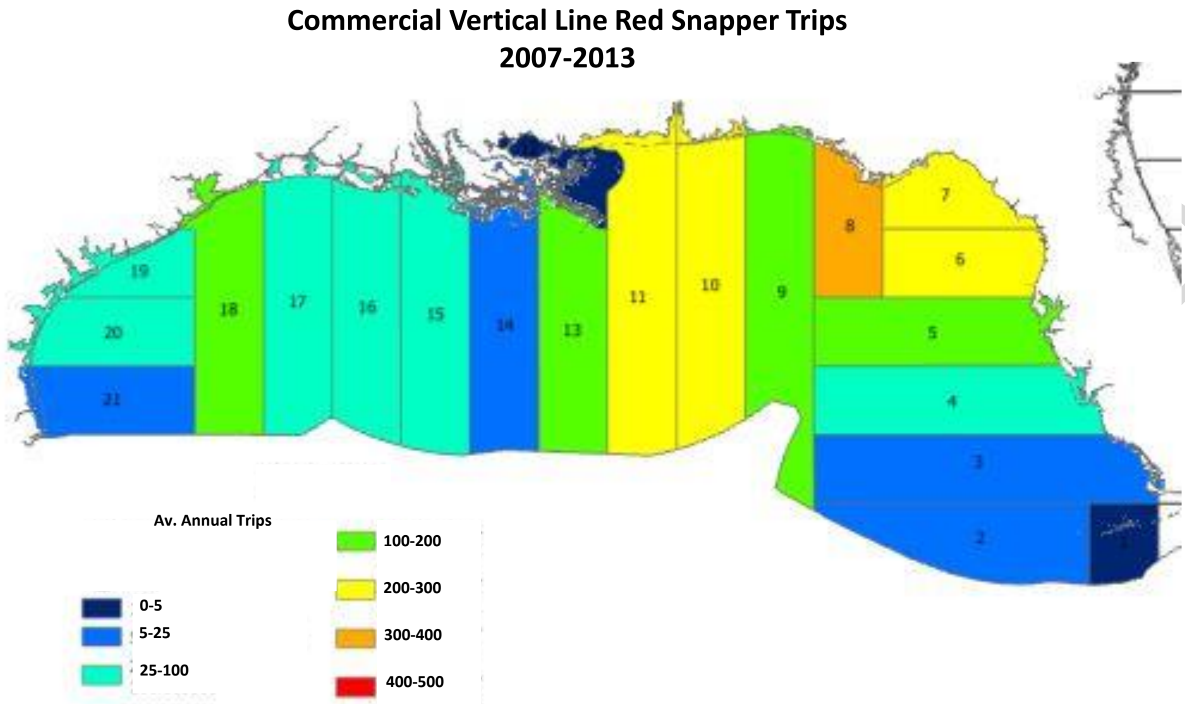
(A)


Commercial Vertical Line Red Snapper Trips
1993-1999
Av. Annual Trips
0-5
5-25
25-100
100-200
200-300
300-400
400-500

(B)


Commercial Vertical Line Red Snapper Trips
2000-2006
Av. Annual Trips
0-5
5-25
25-100
100-200
200-300
300-400
400-500

(C)



(D)

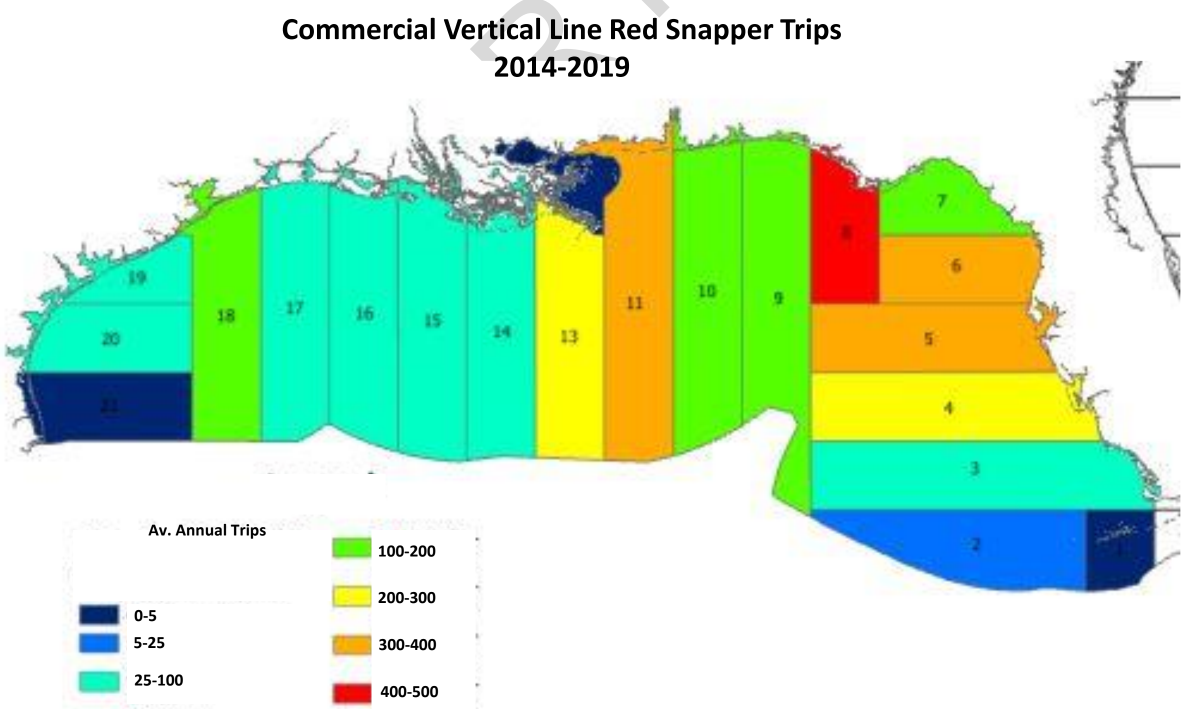
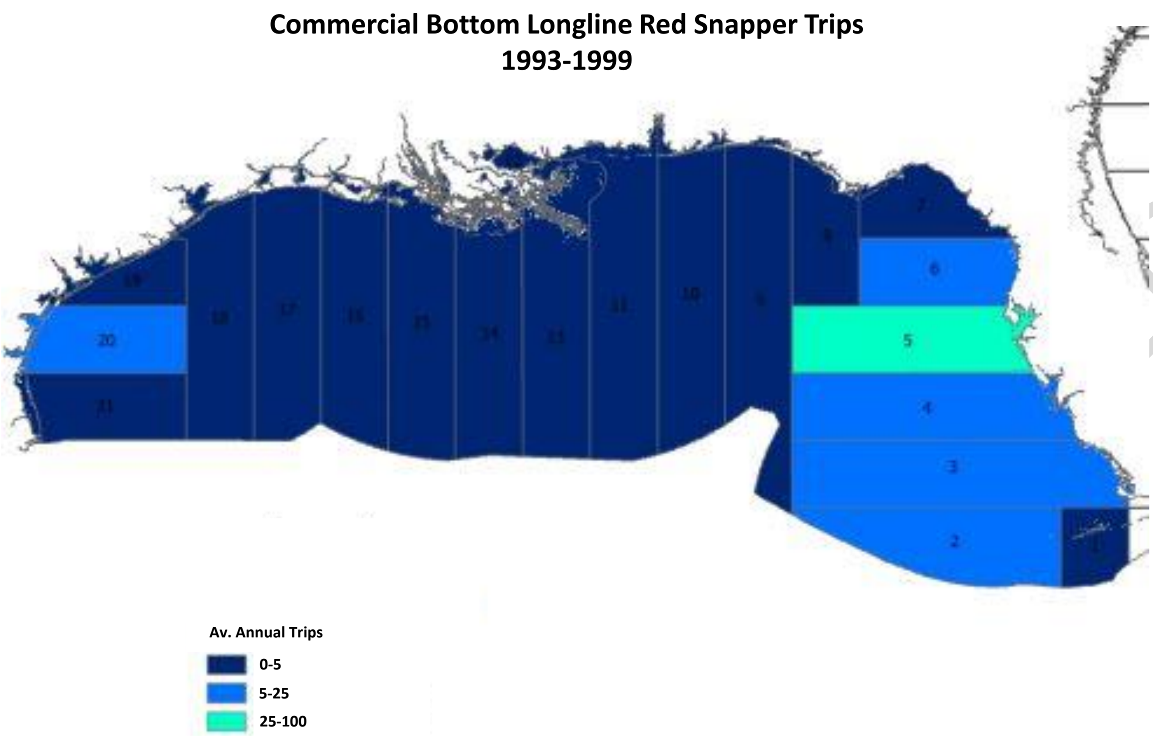
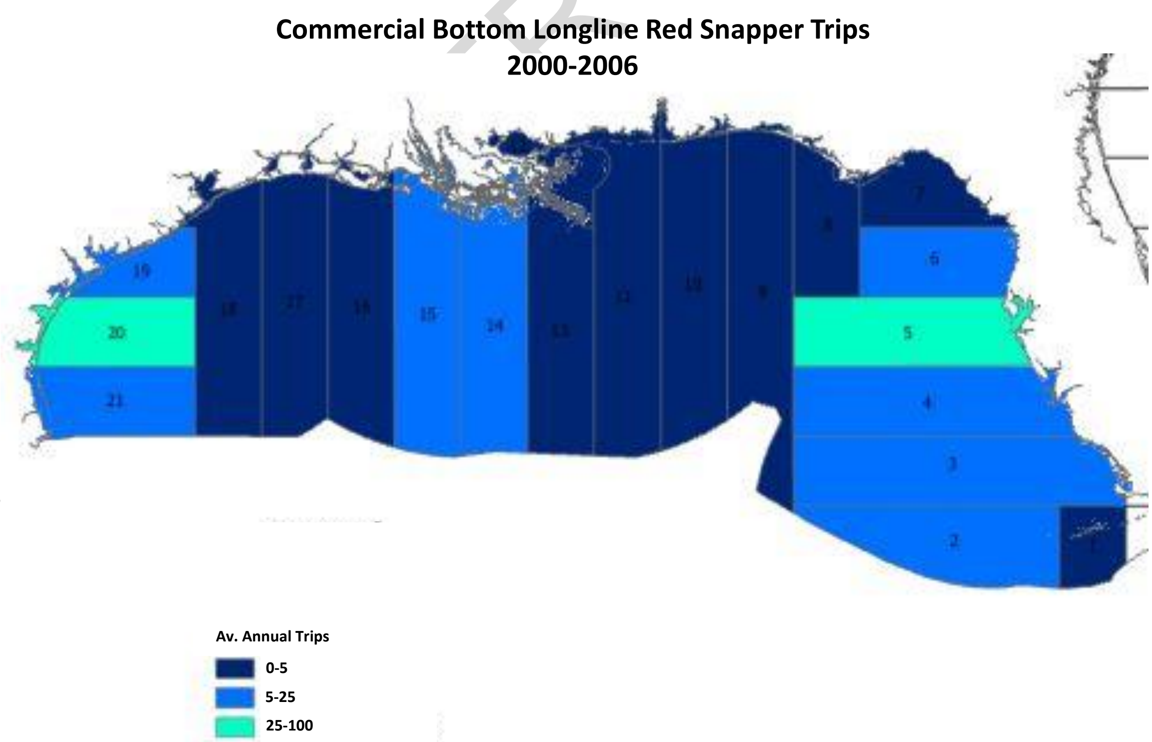


Figure 3.5.1: Average annual red snapper trips for commercial vertical lines for four time periods: **(A)** 1993-1999, **(B)** 2000-2006, **(C)** 2007-2013, and **(D)** 2014-2019.

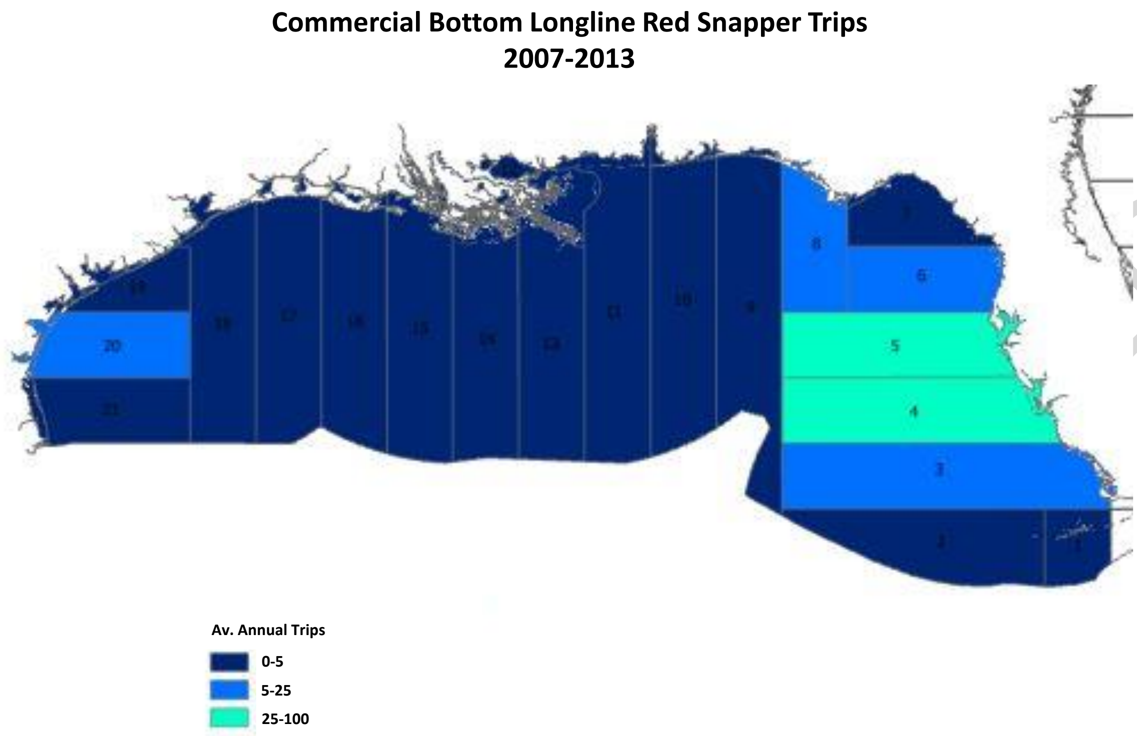
(A)


Commercial Bottom Longline Red Snapper Trips
1993-1999
Av. Annual Trips
0-5
5-25
25-100

(B)


Commercial Bottom Longline Red Snapper Trips
2000-2006
Av. Annual Trips
0-5
5-25
25-100

(C)



(D)

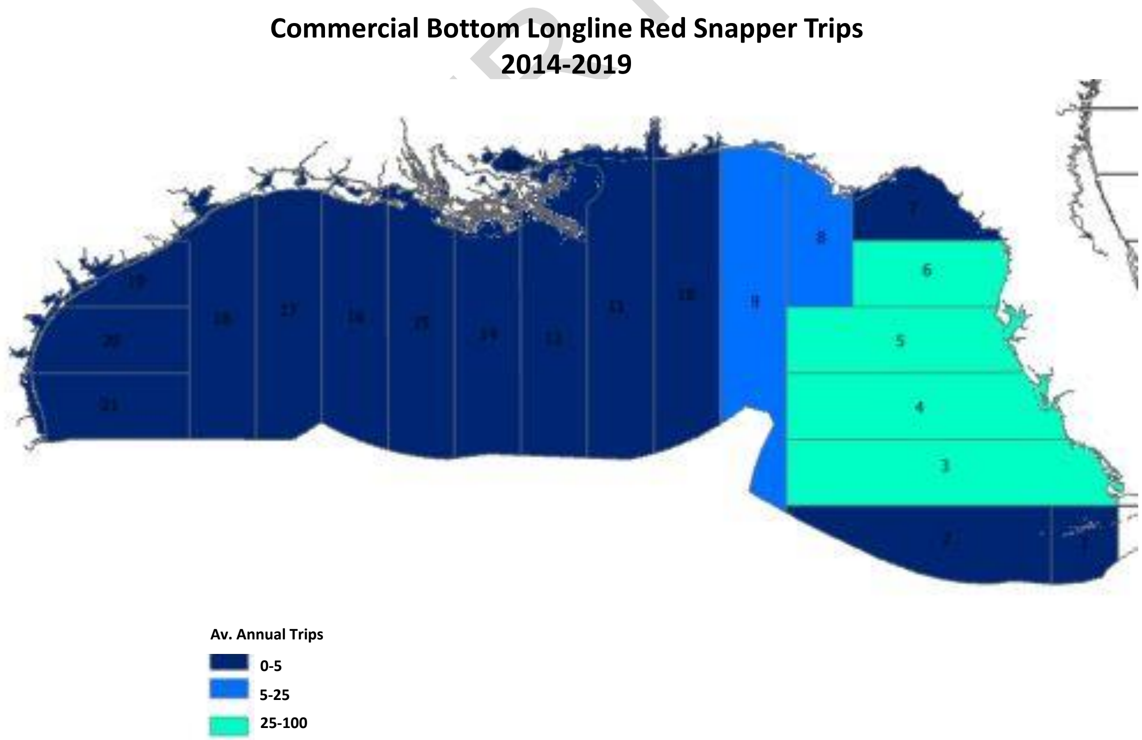


Figure 3.5.2: Average annual red snapper trips for commercial bottom longlines for four time periods: **(A)** 1993-1999, **(B)** 2000-2006, **(C)** 2007-2013, and **(D)** 2014-2019

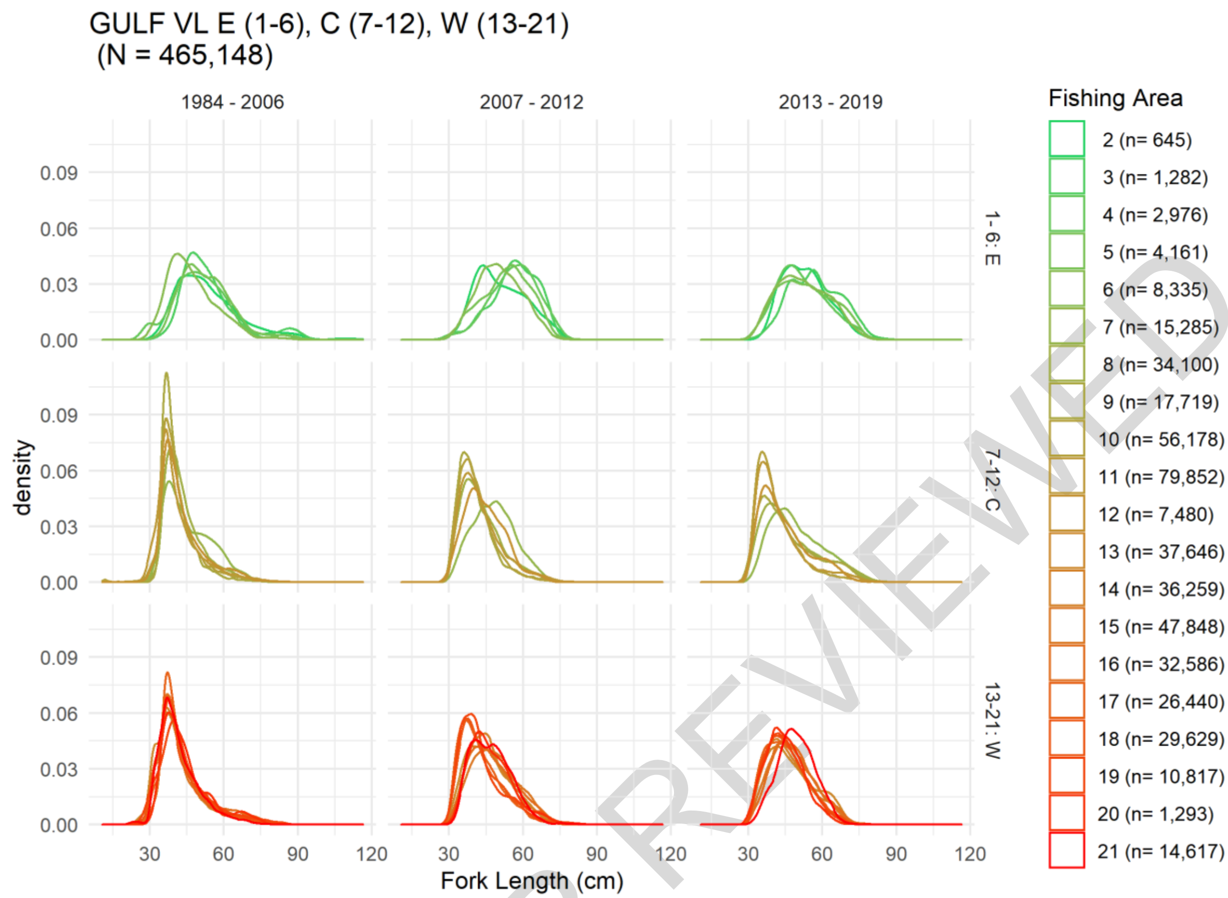


Figure 3.6.1, Red snapper vertical line TIP length distributions in the finest spatial resolution possible for each stock (rows) and time period (columns) where green represents the easternmost fishing area and transitions to red in the west. 2007-2012 represents a time of rebuilding and is expected to have shifting compositions during the stock recovery.

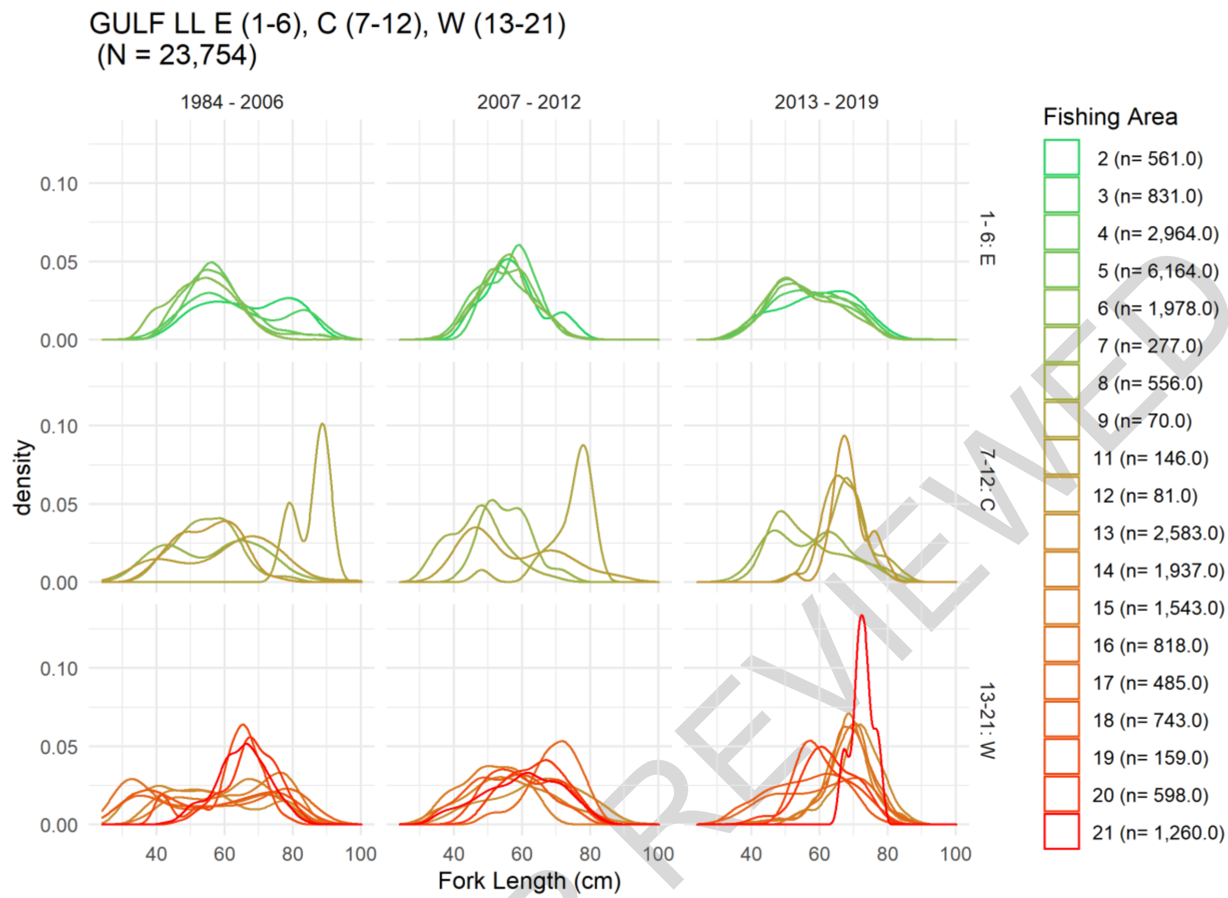


Figure 3.6.2, Red snapper longline TIP length distributions in the finest spatial resolution possible for each stock (rows) and time period (columns) where green represents the easternmost fishing area and transitions to red in the west. Lower sample sizes for longline gear results in more sporadic length distributions.

4 RECREATIONAL FISHERY STATISTICS

4.1 OVERVIEW

4.1.1 Group Membership

Leads

Ken Brennan- National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Fisheries Statistics Division (FSD)

Vivian Matter- NMFS SEFSC Sustainable Fisheries Division (SFD)

Members

Jason Adriance- Louisiana Department of Wildlife and Fisheries (LDWF)

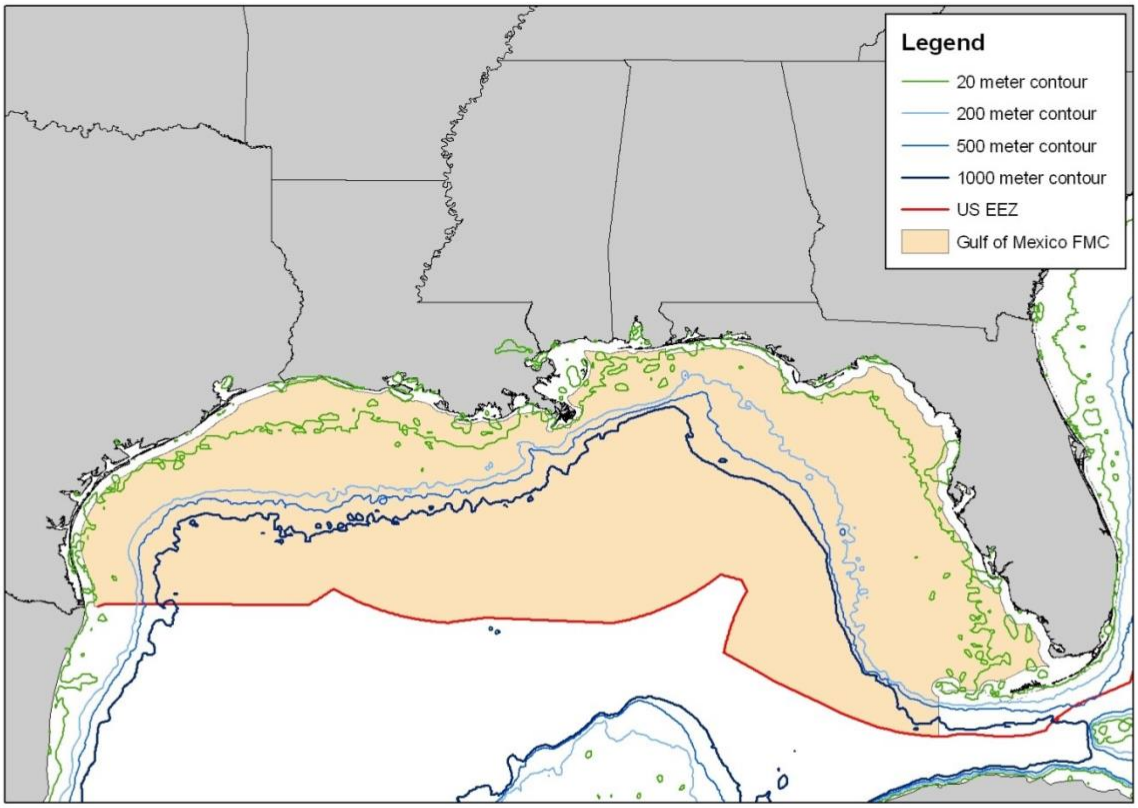
Donna Bellais- Gulf States Marine Fisheries Commission (GSMFC)

Susan Boggs- Gulf of Mexico Fisheries Management Council (GMFMC)
Rob Cheshire- NMFS SEFSC FSD
Troy Frady- GMFMC Appointee, Industry, AL
Michael Larkin- NMFS Southeast Regional Office (SERO)
Dominique Lazarre- Florida Fish and Wildlife Conservation Commission (FWCC)
John Marquez, Jr.- GMFMC Appointee, MS
Trevor Moncrief- Mississippi Department of Marine Resources (MDMR)
Craig Newton- Alabama Department of Conservation and Natural Resources (ADCNR)
Matthew Nuttall- NMFS SEFSC SFD
Beverly Sauls- FWCC
Eric Schmidt- Industry, FL
Steven Scyphers- Northeastern University (NEU)
Molly Stevens- NMFS SEFSC SFD
Jim Tolan- Texas Parks and Wildlife Department (TPWD)
Johnny Williams- Industry, TX

4.1.2 Tasks

1. Summarize stock identification parameters
2. Review fully calibrated MRIP FES/APAIS/FHS landings and discard estimates
3. Allocate MRIP catch estimates from Monroe County to the Gulf of Mexico or South Atlantic
4. Evaluate MRIP catch estimates by mode of fishing to determine appropriate modes for inclusion in the Red Snapper assessment
5. Review calibrations of state survey estimates (TPWD and LA Creel) into MRIP-FES units
6. Evaluate usefulness of historical data sources such as the Fishing, Hunting, and Wildlife-Associated Recreation Survey (FHWAR) to generate estimates of landings prior to 1981
7. Provide estimates of uncertainty around each set of landings and discard estimates
8. Review whether SRHS discard estimates (2004+) are reliable for use and determine if there are other sources of data prior to the first reliable year that could be used as a proxy to estimate headboat discards back in time
9. Provide nominal length distributions for both landings and discards if feasible
10. Evaluate adequacy of available data
11. Provide research recommendations to improve recreational data

4.1.3 Gulf of Mexico Fishery Management Council Scamp Group Management Boundaries



4.1.4 Stock ID Recommendations

Task 1:

Geographic Boundaries

The SEDAR 74 Stock ID Workshop recommended three stock ID regions for Red Snapper. The Western region includes Texas and Louisiana. The Central region includes Mississippi, Alabama, and Northwest Florida, through SRHS area 23 and MRIP Florida sub-region 1 (Dixie County). The Eastern region includes Central and Southwest Florida (SRHS area 21 and MRIP Florida sub-regions 2 and 3 (Levy to Monroe Counties) (SEDAR 74 SID Report).

Species Identification

There were no species misidentification issues for SEDAR 74.

4.2 REVIEW OF WORKING PAPERS

General Recreational Survey Data for Red Snapper in the Gulf of Mexico (SEDAR 74-DW-01)

General recreational survey data for Red Snapper from the Marine Recreational Information Program (MRIP), Texas Parks and Wildlife Department (TPWD), and Louisiana Creel Survey (LA Creel) are summarized from 1981 to 2019 for Gulf of Mexico states from Texas to western Florida. Charter, Headboat, Private fishing modes are presented. These fully calibrated MRIP estimates take into account the change in the Fishing Effort Survey, the redesigned Access Point Angler Intercept Survey, and the For Hire Survey. Tables and figures presented include calibration comparisons, landing and discard estimates, associated CVs, sample sizes, fish sizes, and effort estimates.

LA Creel/MRIP Red Snapper Private Mode Landings and Discards Calibration Procedure (SEDAR 74-DW-04)

Beginning in 2014, the Louisiana Department of Wildlife and Fisheries (LDWF) implemented its own creel survey (LA Creel) to provide recreational catch estimates for Louisiana-specific fishery management and stock assessment purposes. Prior to 2014, recreational catch estimates were taken from the National Marine Fisheries Service's Marine Recreational Intercept Program and the earlier Marine Recreational Fisheries Statistical Survey (NMFS MRIP/MRFSS). TheMRIP and LA Creel surveys were conducted simultaneously in 2015 for benchmarking purposes. Methods were needed to calibrate Red Snapper landings and discards estimates to provide a time series of estimates for SEDAR 74 in common currencies from 1981-2020. A ratio estimator approach is used to hind cast LA Creel recreational landings and discards estimates to 1981 and the MRIP recreational landings and discards estimates to 2020. Tables and figures presented include calibration comparisons, landing and discard estimates in numbers of fish, and associated CVs for LA Creel estimates 2014+.

Florida State Reef Fish Survey Metadata (S74-DW-05)

This paper briefly summarizes Florida's State Reef Fish Survey and the calibration of MRIP estimates to State Reef Fish Survey units from 1981 to 2015.

A description of Florida's Gulf Coast recreational fishery and release mortality estimates for the central and eastern sub-regions (Mississippi, Alabama, and Florida) (S74-DW-06)

Sampling protocol specifics for each data collection are described below. All data are divided by fleet (charter, headboat, private) and region. Florida regions throughout this document are NWFL [Escambia to Levy counties (Federal SAC 7-10: contained within Central Gulf of Mexico stock)] and SWFL [Citrus to Monroe Counties (Federal SAC 1-6: encompassing the entire Eastern Gulf of Mexico stock)]. Alabama (AL) and Mississippi (MS) are each considered individually. This document contains data summaries describing the structure of the Florida recreational fishery (private and for-hire) along with estimates of proportional mortality by depth in each for-hire sector (headboats and charter boats) in four sub-regions (MS, AL, NWFL, SWFL). Projection estimates describing release mortality reductions possible in each fleet with several levels of descender device usage as a barotrauma mitigation method are also presented.

Size and age information for Red Snapper, Lutjanus campechanus, collected in association with fishery-dependent projects along Florida's Gulf of Mexico coast (S74-DW-07)

The Fishery Dependent Monitoring subsection (FDM) of the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) monitors commercial and recreational fishing in marine environments along the Florida coast in association with several fishery-dependent research and monitoring projects. FDM administers two federal surveys, the Marine Recreational Information Program (MRIP) for the recreational sector and the Trip Interview Program (TIP) for the commercial sector. Additionally, FDM conducts several unique surveys of recreational anglers that allow for the collection of supplemental biological data. Each fishery-dependent research or monitoring project that contributed to the age and length data provided to the Life History Group is described below. Because fish must be returned to anglers quickly during fishery-dependent surveys, priority was given to collecting the left otolith if both otoliths could not be removed.

Methodology Description for a Simple Ratio Calibration of Texas Private Boat Red Snapper Annual Landings Estimates (S74-DW-10)

Annual estimates of private boat effort and Red Snapper landings are available from the Texas Parks and Wildlife Department (TPWD) Coastal Creel Surveys (CCS) program from 1983 to the present. The CCS design uses a fishing access site creel survey to estimate both catch and effort for the recreational private boat sector. This design differs from the multi-component complemented designs used by MRIP and other state surveys in the Gulf of Mexico Region. In 2016, the Marine Recreational Information Program (MRIP) conducted its Fishing Effort Survey (FES) in Texas (Papacostas and Foster, 2018; NOAA Fisheries, 2019) to produce effort estimates of private boat angler trips for comparison purposes. The difference between the TPWD and MRIP private boat effort estimates was large and significant (an order of magnitude), which is likely due at least in part by the exclusion of fishing from private access sites in the total effort estimates. A calibration ratio was proposed that could be used to create catch and effort estimates for Texas that would be more comparable to the corresponding MRIP estimates provided for the other Gulf States. Methods used to estimate variance for the ratio with a single year of benchmarking are also described.

Evaluating Uncertainty in Gulf Red Snapper Estimates: A Preliminary Sensitivity Analysis of Non-Sampling Errors in the Region's Recreational Fishing Surveys (S74-DW-11)

There are six different survey programs currently operating in the Gulf of Mexico to monitor the private boat recreational Red Snapper fishery: NOAA Fisheries' Marine Recreational Information Program (MRIP), which administers the Access Point Angler Intercept Survey (APAIS) and Fishing Effort Survey (FES; which replaced the Coastal Household Telephone Survey, or CHTS) in Mississippi, Alabama, and Florida; the Texas Coastal Creel Survey (CCS); Louisiana's LA Creel; Mississippi's Tails n' Scales; Alabama's Snapper Check; and Florida's State Reef Fish Survey (SRFS). Where programs overlap, systematic differences exist among estimates of Red Snapper catch. To date, we cannot definitively state why the estimates are different, other than they likely all suffer from differential levels of non-sampling error, or error that causes estimates to differ from the "true" removals (in this case, "true" Red Snapper landings and discards). The direction and magnitude of these non-sampling errors are currently unknown. With this study, we begin investigating how non-sampling errors may influence the magnitude of the estimates derived from the different recreational Red Snapper monitoring programs in the region. This study also motivates and supports a collaborative research initiative in response to the Congressional directive from the 2021 House Committee on Appropriations to conduct an independent assessment of the surveys operating in the Gulf of Mexico and make recommendations for their improvement.

SEFSC Computation of Uncertainty for General Recreational Landings-in-Weight Estimates, with Application to SEDAR 74 Gulf of Mexico Red Snapper (S74-DW-12)

The Southeast Fisheries Science Center (SEFSC) routinely provides stock assessment analysts with estimates of recreational catch and associated measures of uncertainty. Such provision has traditionally focused on estimates of catch-in-number because numbers are the native units of recreational monitoring surveys and the traditional inputs into stock assessment models for the southeast region (SFD 2021a). However, additional inputs for the relative size of landed fish may also be needed to properly constrain assessment model predictions of landings-in-weight, as required by fishery managers to set annual catch limits (SFD 2021b). This working paper introduces two possible approaches by which uncertainty may be represented for landings-in-weight estimates in SEDAR stock assessments.

Gulf of Mexico Red Snapper (Lutjanus campechanus) Commercial and Recreational Landings Length and Age Compositions (S74-DW-15)

This document outlines the data and methodologies used to estimate nominal length and age compositions of commercial and recreational landings for the SEDAR 74 Gulf of Mexico Red Snapper Assessment. These compositions were estimated using data sources approved in SEDAR 52 and additional data sources will be considered at the Data Workshop. Following the SEDAR 74 Stock Identification workshop, the eastern stock was split near the previous boundary used to weight the length compositions (e.g. Big Bend region of Florida). Under this new structure, data are sparser in the Eastern and Central stocks (previously combined as Eastern). Therefore, this working paper outlines data availability and provides nominal compositions. At the Data Workshop, final methodologies for tracking cohorts in the assessment model will be determined.

A Summary of Observer Data from the Size Distribution and Release Condition of Red Snapper Discards from Recreational Fishery Surveys in the Eastern Gulf of Mexico (SEDAR 74-DW-18)

Detailed information on the size and release condition of discarded fish is not collected in traditional dockside surveys of recreational fisheries. At-sea observer surveys provide valuable information on the size and condition of discarded fish, and such surveys have been conducted on for-hire vessels in Florida since 2005. For-hire observer surveys have not been consistently funded in Florida, which has led to short breaks in the time series in some regions. In the first three years observer trips were only conducted on headboat vessels, and surveys were expanded after 2008 to include both headboats and charter vessels across a larger geographic area. This report provides a summary of available information on the size composition, release condition, and disposition of Red Snapper collected by trained observers since 2005 during at-sea surveys on for-hire vessels in the eastern Gulf of Mexico.

Gulf State Recreational Catch and Effort Surveys Transition Workshop Summary Report (S74-DW-29)

This draft report summarizes the results of a virtual meeting, held Feb. 23-25, 2022, to address critical short and long-term needs necessary to move towards full transition of the use of data from various certified recreational fishing surveys in regional stock assessments in the Gulf of Mexico. It represents the latest in a series of meetings that have addressed the issue of comparability of alternative estimates. Upcoming assessments for Gag Grouper and Red Snapper in the Gulf create additional urgency for this task. This report is the proceedings of that meeting, summarizes presentations and the ensuing discussions and recommendations. More than 100 individuals attended the meeting and 50 participated directly in the discussions. Notably, five expert statistical consultants provided recommendations in response to presentations, questions, and discussions during the meeting. In addition, the Consultants met after the meeting to craft more synthetic responses to the suite of meeting topics. Their findings are included as an appendix to clearly distinguish topics that were addressed in plenary session from those that were addressed outside the meeting.

4.3 RECREATIONAL DATA SOURCES

4.3.1 Marine Recreational Information Program (MRIP)

Introduction

The Marine Recreational Information Program (MRIP), formerly the Marine Recreational Fisheries Statistics Survey, conducted by NOAA Fisheries (NMFS) provides estimates of catch per unit effort, total effort, landings, and discards for six two-month periods (waves) each year. MRIP provides estimates for three main recreational fishing modes: shore-based fishing (Shore), private and rental boat fishing (Priv), and for-hire charter and guide fishing (Cbt). MRIP also provides estimates for headboat mode (Hbt) in the mid and north Atlantic regions. MRIP covers all Gulf of Mexico states from western Florida to Mississippi. Louisiana was covered by the survey until 2014 and Texas is not covered to avoid overlap with the TPWD survey (discussed below in 4.3.2). When the survey first began in Wave 2 (Mar/Apr) of 1981, headboats were included in the for-hire mode, but were excluded after 1985 to avoid overlap with the Southeast Region Headboat Survey (SRHS), conducted by the NMFS Beaufort laboratory.

Recreational catch, effort, and participation were estimated through a suite of independent but complementary surveys that are described in SEDAR 68-DW-13. Over the years, effort data have been collected from three different surveys: (1) the Coastal Household Telephone Survey

(CHTS) which used random digit dialing of coastal households to obtain information about recreational fishing trips, (2) the weekly For-Hire Survey which interviews charterboat operators (captains or owners) to obtain trip information and replaced the CHTS for the charter mode (in 2000 for the Gulf of Mexico and East Florida and 2004 for the Atlantic coast north of Georgia), and (3) the Fishing Effort Survey which is a mail based survey whose sample frame consists of anglers from the National Saltwater Angler Registry and replaced the CHTS for the private and shore modes in 2018. Catch data are collected through dockside angler interviews in the Access Point Angler Intercept Survey (APAIS), which samples recreational fishing trips after they have been completed. In 2013, MRIP implemented a new APAIS to remove sources of potential bias from the sampling process. Catch rates from dockside intercept surveys are combined with estimates of effort to estimate total landings and discards by wave, mode, and area fished (inland, state, and federal waters).

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

Task 2: In order to maintain a consistent time series, charter estimates were calibrated on the Gulf coast prior to 2000 (SEDAR64-RD-12). CHTS and calibrated FHS charter catch estimates for Gulf of Mexico Red Snapper from 1981 to 1999 are shown in Figure 1 of SEDAR 74-DW-01. Calibrated APAIS and FES estimates for Gulf of Mexico Red Snapper from 1981 to 2019 are shown in Figure 2 of SEDAR 74-DW-01.

Monroe County

Monroe County MRIP landings are included in the official West Florida estimates. However, they can be estimated separately using domain estimation. The Monroe County domain includes only intercepted trips returning to that county as identified in the intercept survey data. Estimates are then calculated within this domain using standard design-based estimation which incorporates the MRIP design stratification, clustering, and sample weights (SEDAR68-DW-13). Although Monroe County estimates can be separated using this process, they cannot be partitioned into those from the Atlantic Ocean and those from the Gulf of Mexico (SEDAR-PW-07).

Task 3: For SEDAR 74, MRIP Red Snapper landings from Monroe County were allocated to the Gulf of Mexico because Red Snapper are less common on the extreme south Atlantic coast of Florida. This recommendation is in agreement with previous Gulf of Mexico (SEDAR 31 and 52) and South Atlantic (SEDAR 24 and 41) Red Snapper assessments.

Adjustment to Fishing Modes

Task 4a: Between 1981 and 1985, MRIP charter and headboat modes were combined into a single mode for estimation purposes. Since the NMFS Southeast Region Headboat Survey (SRHS) began in the Gulf in 1986, the MRIP combined charter/headboat mode must be split in order to provide estimates of headboat landings in these early years. The MRIP charter/headboat mode (1981-1985) was split by using a ratio of SRHS headboat angler trip estimates to MRIP charterboat angler trip estimates for 1986-1990. In accordance with SEDAR Best Practices, the mean ratio was calculated by state (or state equivalent to match SRHS areas to MRIP states) and then applied to the 1981-1985 estimates to split out the headboat component when needed (SEDAR-PW-07). The MRIP headboat component from this split was used to represent headboat fishing in the Gulf (Louisiana to western Florida) from 1981-1985 and SRHS headboat estimates for all years after 1985.

Task 4b: The Recreational Working Group also discussed the validity of the MRIP shore mode estimates for Gulf of Mexico Red Snapper. The Group recommended that all shore mode estimates be excluded because Red Snapper is an offshore species with a strong association with reefs and hard bottoms, and unlikely to be caught from shore (SEDAR 31-DW-04). This recommendation is in agreement with decisions made during SEDAR 31 and 52.

Uncertainty

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

4.3.2 Louisiana Creel Survey (LA Creel)

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

Task 5a:

Calibration to MRIP FES units

The MRIP and LA Creel surveys were conducted simultaneously in 2015 for benchmarking purposes. A ratio estimator is used to calibrate private mode LA Creel landings and discards in numbers of fish to MRIP FES units. Because the charter fishing frame used by the LA Creel and MRIP surveys are functionally equivalent, charter fishing estimates of the two surveys are assumed equivalent and are not adjusted. The ratio of the 2015 private mode landings estimates from the LA Creel and MRIP FES surveys is used to calibrate private LA Creel landings (2014, 2016-2020) to MRIP FES units as the product of the 2015 MRIP/LA Creel landings ratio and the annual LA Creel landings estimates. Discard estimates between surveys are calibrated using the same methodology as landings (SEDAR 74-DW-04). Effort calibrations were provided by using a ratio estimator of annual 2015 effort estimates from each survey for the private fishing mode.

Uncertainty

Coefficients of variation for annual LA Creel landings and discards estimates are provided by the LDWF. Variances are calculated from the survey data for each week of year, area, and fishing mode and are summed to estimate annual CV's of landings and discards. These variances, in LA Creel units, are then scaled into MRIP-FES units using a Taylor Series expansion that assumes the MRIP and LA Creel point estimates are independent (i.e., correlation = 0). This is the same approach used to calibrate the TPWD time series into MRIP-FES units, and is outlined in SEDAR 74-DW-10.

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

The TPWD Sport-Boat Angling Survey samples fishing trips made by sport-boat anglers fishing in Texas marine waters. All sampling takes place at recreational boat access sites. The raw data include information on catch, effort, and length composition of the catch for sampled boat-trips. These data are used by TPWD to generate recreational catch and effort estimates starting in May

1983 (SEDAR 70-WP-03). The survey is designed to estimate landings and effort by high-use (May 15-November 20) and low-use seasons (November 21-May 14). Since SEDAR 16 in 2008, SEFSC personnel have disaggregated the TPWD seasonal estimates into waves (2-month periods) using the TPWD intercept data. This was done to make the TPWD time series compatible with the MRIP time series. TPWD surveys private and charter boat fishing trips. While TPWD samples all trips (private, charter boat, ocean, bay/pass), most of the sampled trips are associated with private boats fishing in bay/pass areas as these trips represent most of the fishing effort. Charter boat trips in ocean waters are the least encountered by the survey. Additional information on the TPWD survey can be found in SEDAR 70-WP-03.

Task 5b:

Calibration to MRIP FES units

The MRIP-FES survey was implemented in Texas in 2016 (S74-RD-110) to compare MRIP-FES effort estimates with the associated estimates from the TPWD survey. A ratio estimator was calculated from these two sets of estimates and reviewed during the data workshop for SEDAR 74. This calibration is described in SEDAR 74-DW-10 and may be applied to landings, discards, and effort estimates to calibrate private TPWD estimates into MRIP-FES units. The MRIP-FHS has never been conducted in Texas and so an appropriate TPWD-MRIP calibration for the Texas charter mode is not available.

The Recreational Working Group evaluated the proposed calibration and considered two options for Texas estimates.

- Option 1: Use uncalibrated Texas estimates in TPWD units
  - Pros:
    - Consistent with how TPWD was used in previous assessments
  - Cons:
    - TPWD estimates as reported by the survey are not comparable in scale to the estimates generated by the other Gulf States.
    - Texas estimates would not be in the same units as the other Gulf States, leading to geographically disparate stock assessment inputs.
    - Does not address evidence from other sources (angler input, SRHS, USFWS 2011 Texas FHWAR) that suggest the Texas landings are underestimated.
- Option 2: Use calibrated Texas estimates to MRIP-FES units
  - Pros:
    - Generates estimates comparable in units as the other Gulf states
  - Cons:
    - Based on one year of overlap in effort data between the FES and TPWD.
    - Effort estimates by wave in the 2016 study did not reflect the expected effort distribution.

- Only available for private mode effort. No APAIS intercept survey conducted.
- Large variance associated with calibration ratio.

Given the two less than optimal options provided, the group recommended adjusting the private TPWD estimates to MRIP FES (SEDAR 74-DW-10). This comes with a strong recommendation to also prioritize the following three research recommendations:

- SSC to add TOR to operational assessment to include a topical working group to review and evaluate the results of the Gulf of Mexico transition plan to optimize the use of state and federal data.
- Integrate TPWD into the Gulf Transition Team in order to further evaluate the proposed calibration between TPWD and MRIP units and identify alternative methods that may be implemented, including increased benchmarking (e.g. 3-year benchmark period).
- Gulf Transition Team should investigate the drivers of high MRIP wave specific effort estimates for recreational modes during traditionally low effort waves (e.g. winter waves, particularly in MS).

Uncertainty

Standard errors of landings are provided by TPWD. The variances, in TPWD units, are then scaled into MRIP-FES units using a Taylor Series expansion that assumes the MRIP and TPWD point estimates are independent (i.e., correlation = 0). This approach is described in SEDAR 74-DW-10.

4.3.4 Southeast Region Headboat Survey (SRHS)

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

The SRHS was started in 1972 but only included vessels from North Carolina and South Carolina. In 1975, the survey was expanded to northeast Florida (Nassau-Indian River counties), followed by Georgia in 1976 and southeast Florida (St. Lucie-Monroe counties) in 1978. In

1986, the survey expanded to include west Florida, Alabama, Louisiana, and Texas. Mississippi was added to the survey in 2010. For SEDAR 74, only data from West Florida through Texas were included. Due to headboat area stock ID boundaries and confidentiality issues, estimates of SRHS catch are combined for Louisiana and Texas for the West Region, Mississippi with Alabama and Northwest Florida for the Central Region, and Southwest Florida for the East Region. The portion of the SRHS covering the Gulf States generally includes 65-70 vessels participating annually.

Texas Headboat Landings (1981-1985)

Landings estimates for Gulf of Mexico headboats between 1981 and 1985 come from the MRIP survey for all states except Texas. As in previous SEDARs, Texas headboat landings for 1981 to 1985 were estimated as a three-year average (1986-1988) from SRHS Texas headboat landings.

Uncertainty

The SRHS is designed to be a census and so reporting compliance and accuracy are the primary components of the uncertainty in landings and discard estimates over time. Headboat activity is monitored by port agents to validate trips. A quantitative method to describe the uncertainty in estimates from the SRHS was developed in SEDAR 68 (SEDAR68-DW-31). This method estimates uncertainty from the variance in industry-reported (logbook) catch data at the vessel, area, and month strata and applies a finite population correction factor to account for non-reporting of headboat fishing activity, the calculation of which is a function of the reported and estimated number of compliant vessels. The resulting CV estimates for scamp in SEDAR 68 averaged 0.03 over the entire time series, including those early years wherein only approximately 60% of the vessels submitted logbooks. In recent years, the CV for scamp was estimated to be 0 due to full compliance in reporting vessels and does not account for any potential errors in reporting, even though these are likely to be small. Additionally, the method applied in SEDAR 68 does not consider the duration of the trip in the variance estimates for catch. It is possible that outliers from multi-day trips could inflate the variance for more common species.

Given these concerns, two other options were considered in this assessment to describe uncertainty that are not based on variance in catch and include a buffer of 0.05 to the CV across all years to account for uncertainty in the reported values (i.e., misreporting). The first of these approaches used annual proportions of reported to estimated counts of active vessels reporting catch (fully or partially) by year, area, and month, which is equivalent to the compliance rate metric in the SEDAR 68 method. The second approach applies the annual proportions of reported to estimated trips by region as a proxy for CV.

The second method was chosen to be applied in SEDAR 74 because it is based on the number of fishing trips missing an associated logbook submission (i.e., unreported). The first method, conversely, applies a correction based on a fraction of non-compliant vessels, and so is believed to provide a less accurate correction to trip-level catch. The associated CV from the chosen approach (#2) is estimated from:

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

where n is the number of reported trips and N is the number of estimated trips. This method balances conflicting biases in uncertainty. Methodologies to account for catch from unreported trips leverage information from similar vessels, months, areas, and trip types and are likely to decrease our estimate of uncertainty. However, the quality of reporting from compliant vessels is likely to have improved over time which would suggest these uncertainty estimates are low.

4.3.5 Headboat At-Sea Observer Survey

An observer survey of the recreational headboat fishery was launched in AL in 2004 and in FL in 2005 to collect more detailed information on recreational headboat catch, particularly for discarded fish. Sampling in both states was discontinued in 2008, but was started again along western FL in June 2009, with coverage expanded to also include the charterboat fleet. Since 2009, spatial and temporal coverage along the west coast of FL has been variable (Table 1, SEDAR 74-DW-18); however, this will improve in the future as stable state funding was recently secured. Cooperative headboat and charterboat vessels were randomly selected each month throughout the year. Biologists board selected vessels with permission from the captain and observe anglers as they fish on the recreational trip. Data collected include the species, number, final disposition, and size of landed and discarded fish. Data are also collected on the length of the trip and area fished (inland, state, and federal waters) (SEDAR 74-DW-18).

4.4 RECREATIONAL LANDINGS

4.4.1 MRIP Landings

Weight Estimation

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

Two approaches for calculating the uncertainty around the landings-in-weight are presented in SEDAR 74-DW-12. The first approach is a modification to the method used to calculate catch-in-number CVs and assumes average weights are constants adding no additional uncertainty. The second approach adds the variability of the raw size data used to calculate recreational landings-in-weight estimates. Briefly, all observations of fish weight are averaged at the trip level, from which the mean and standard error of these trip-level summaries are calculated at the same strata used in SEFSC weight estimation (e.g., *syrsmwa*), combined to the year/mode level (e.g., year and mode), and converted to coefficients of variation (CV). These uncertainty estimates for SEFSC average weights are then combined with those for landings-in-number (Goodman 1960) as an uncertainty estimate for landings-in-weight. The Recreational Working Group recommended using the second approach for calculating uncertainty around average (fish) weight and landings-in-weight estimates.

Catch Estimates

Final MRIP landings estimates and associated coefficients of variation, in numbers of fish, are shown by year and mode in Table 3 of SEDAR 74-DW-01 and by year in Table 5 of SEDAR 74-DW-01. Estimates are provided for all Gulf of Mexico states from Louisiana to western Florida. Final MRIP landings estimates in pounds whole weight are shown by year and state in Table 6 of SEDAR 74-DW-01.

4.4.2 LA Creel Landings

Starting in 2014, recreational data for Louisiana are only available from the LA Creel survey. LA Creel landings estimates, calibrated to MRIP FES units for Louisiana Red Snapper (2014-2019) are provided in Table 1 of SEDAR 74-DW-04. These landings-in-number estimates are then multiplied by the corresponding SEFSC average weights to estimate landings-in-weight. Uncertainties for average weight and landings-in-weight are calculated using the same approach described above for MRIP (approach 2 in SEDAR 74-DW-12).

4.4.3 TPWD Landings

TPWD average estimates from 1983 to 1985 (by wave and mode) were used to fill in the missing estimates for Texas charter and private boat fishing from 1981 until the survey started in May 1983. TPWD Red Snapper landings-in-number estimates, calibrated to MRIP FES units for the private mode, from 1981 to 2019 are provided in Table 4.12.1. These landings-in-number estimates are then multiplied by the corresponding SEFSC average weights to estimate landings-in-weight. Uncertainties for average weight and landings-in-weight are calculated using the same approach described above for MRIP (approach 2 in SEDAR 74-DW-12).

4.4.4 SRHS Headboat Logbook Landings

Final SRHS landings estimates (in number and weight) by stock ID region are shown in Table 4.12.2. CVs are provided for landings estimates in number of fish and can be used as a proxy for uncertainty of estimates in weight. This would assume there is no additional uncertainty from the average weights calculated from the SRHS dockside biological sampling. CVs average 0.33, 0.45, and 0.56 across the first 5 years of the SRHS (1986-1990) for the West, Central, and East regions respectively and all decrease to near 0.05 in recent years.

4.4.5 Historic Recreational Landings

Introduction

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

FHWAR Census Method

The 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) presents summary tables of U.S. population estimates, along with estimates of hunting and fishing participation and effort from surveys conducted by the US Fish and Wildlife Service every 5 years from 1955 to 1985 (SEDAR 68-DW-11). This information was used to develop an alternative method for estimating recreational landings prior to 1981. The two key components from these FHWAR surveys that were used in this census method were the estimates of U.S. saltwater anglers and U.S. saltwater days. These estimates are used to calculate the historical effort of Gulf of Mexico saltwater anglers. The mean CPUE from the recreational estimates available beginning in 1981 can then be applied to the historical effort estimates for Gulf of Mexico anglers to provide estimates of recreational Red Snapper landings prior to 1981.

Task 6: Estimate historical Red Snapper landings prior to 1981

- Option 1: Calculate historical Red Snapper landings from the FHWAR method using mean CPUE from the recreational estimates from **1981-1985** MRIP, SRHS, TPWD, and LA Creel surveys.
- Option 2: Calculate historical Red Snapper landings from the FHWAR method using mean CPUE from the recreational estimates from **1981-1989** MRIP, SRHS, TPWD, and LA Creel surveys (Figure 4.13.1).
- Option 3: Do not estimate historical Red Snapper landings estimates prior to 1981.

The SEDAR 74 Recreational Working Group recommended calculating historical landings estimates from the FHWAR method using the mean CPUE from 1981 to 1989 (Option 2). This longer time period mitigates the higher variability in the MRIP catch estimates from early years of the survey described in section 4.3.1. Further, this time period represents a generally unregulated fishery characteristic of the Red Snapper fishery prior to 1981, during which there were no bag limits. Additionally, size restrictions generally had little effect on recreational fishing. Although the 12” size limit was implemented in November of 1984, headboats were exempted from that size restriction until 1986 and recreational anglers could keep up to 5 fish below the size limit (SEDAR 74-DW-25). There was also generally low enforcement of regulations during this time period. For these reasons, the Recreational Working Group recommended the mean CPUE from 1981-1989.

The Recreational Working Group was asked by assessment analysts to partition historical landings back in time by fishing mode and stock region. This was accomplished by calculating the mean ratio of recreational landings by mode and stock region from 1981-1989. These mean ratios are then applied to the historical landings from 1980-1955. The RWG discussed the change in the recreational fishing fleet composition back in time. This included firsthand personal accounts by headboat and charter boat captains, who indicated a higher prevalence of charter and headboat fishing in the 1950s and 1960s. It was also noted that there was an increase in the availability and affordability of boats for private anglers to fish offshore from 1955 to 1980 and an increase in population on the coast which led to an increase in potential private boat owners and anglers.

Based on these accounts and the lack of navigational and technological aids available to private recreational anglers fishing for Red Snapper in the past, it was agreed that the relative proportion of private landings would decrease back in time, while the relative proportion of for-hire landings would have increased. The RWG discussed how to adjust for this change, and recommended the following proposed method for partitioning the historical landings estimates back in time by region and stock:

- Assume the same geographic proportions of West, Central, and East Gulf as there was no evidence presented during discussions contradicting these ratios back to 1955.
- Apply mean ratio of recreational landings by mode and stock region from 1981-1989 to the time period 1975 to 1980 (Table 4.12.3). During this time period Loran C became more prevalent and affordable to private anglers.
- Approximate the relative proportion of landings by mode within each stock ID region prior to 1975 taking into account technological changes that influenced the prevalence of private and for-hire fishing (Table 4.12.3 and Figure 4.13.2).
    - 1965 -1974 - Loran A is mostly used by commercial and for-hire vessels; advent of Loran C
    - 1955 - 1964 - Limited availability of Loran A (military surplus) some being used as means for navigation by commercial and for-hire fishing vessels. Very limited for private anglers.

Historical Red Snapper estimates in number of fish are shown in Table 4.12.4 by stock ID and mode. Historical landings estimates in pounds whole weight were calculated by using the average weight from 1981-1989 by mode and stock ID region for the same time periods. These average weights were applied to the landings in number by mode, stock ID region and time periods. Historical Red Snapper landings estimates in pounds are shown in Table 4.12.5.

Uncertainty

CVs calculated using the FHWAR method for total recreational landings is 0.86. Since these estimates were further partitioned into stock ID and mode, the Recreational Working Group recommended increasing the uncertainty for the historical estimates (in number and weight) by stock region and mode to 1.0. These regional and mode specific estimates are highly uncertain given the limited information available to describe the fisheries back in time.

4.4.6 Total Recreational Landings

Combined landings estimates (MRIP, SRHS, TPWD, and LA Creel) by year, mode, and stock ID for 1981-2019 are shown in Tables 4.12.6- 4.12.8, Figure 4.13.3, and mapped in Figure 4.13.4.

4.5 RECREATIONAL DISCARDS

4.5.1 MRIP Discards

Fish reported to have been discarded alive are not seen by MRIP interviewers and so neither the identity nor the quantities of discarded fish can be verified. The size and weight of discarded fish are also unknown for all modes of fishing. MRIP discard estimates and associated coefficients of variation, in numbers of fish, are shown by year and mode in Table 4 of SEDAR 74-DW-01 and by year in Table 5 of SEDAR 74-DW-01. Estimates are provided for all Gulf of Mexico states from Louisiana to western Florida.

4.5.2 LA Creel Discards

Red Snapper are a target species of the LA Creel survey and discard estimates are available starting in 2016. LA Creel discard estimates of Red Snapper in 2014 and 2015 are imputed as the product of the ratio of annual discards to harvest in the 2016 LA Creel survey (Table 2, SEDAR 74-DW-04) and the 2014 and 2015 LA Creel harvest estimates. The 2016 LA Creel estimates were chosen to form the ratio of discards to harvest to calculate the 2014 and 2015 LA Creel discards estimates due to the similarity between the 2014-2016 Louisiana Red Snapper fishing seasons (i.e., similar federal and state season lengths) prior to fishery management changes implemented in 2017. Private mode LA Creel discard estimates, calibrated to MRIP FES units for Louisiana Red Snapper (2014-2019) are provided in Table 3 of SEDAR 74-DW-04.

4.5.3 TPWD Discards

Self-reported catch is not monitored by the TPWD survey and so discards of Red Snapper from Texas are not estimable from this survey (SEDAR 70-WP-03). As a proxy for recreational discards from Texas private and charter boat anglers, discard: landings ratios (B2:AB1) are calculated (by year and mode) from Louisiana catch estimates and multiplied by TPWD landings estimates. TPWD estimates of Red Snapper discards, calibrated to MRIP-FES units for the private mode, from Texas (1981-2019) are provided in Table 4.12.9. It should be noted that Red Snapper harvest is open year-round in Texas state waters and discarding in Louisiana is likely not representative of the entire western region. However, this is the only method currently available to estimate discards in Texas.

4.5.4 Headboat At-Sea Observer Survey Discards

Self-reported headboat discards (discussed in 4.5.5) are not currently validated within the SRHS. However, discard information from the At-Sea Observer Survey is used to validate the SRHS discard estimates and determine whether SRHS discards should be used for the entire time series (2004-2019) or for a partial time series. In the Gulf of Mexico, the At-Sea Observer Survey operates mainly in western Florida, with limited coverage in Alabama in certain years. No trips were sampled in the At-Sea Observer Survey in 2008. During SEDAR 52 the SRHS discard proportions were compared to the MRIP At-Sea Observer program discard proportions for validation purposes and to determine whether the SRHS discard estimates should be used for a full or partial time series (SEDAR 52- DW-21). Based on those findings and the updated discard estimates it was determined that the SRHS discard estimates should be used for a partial time series (2008-2019), while using the MRIP CH: SRHS discard ratio method to calculate headboat discards for 1981-2007 for SEDAR 74.

4.5.5 SRHS Logbook Discards

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

Task 8: Determine proxy for estimated headboat discards from 1981-2007 for the West Region and 1986 - 2007 for the Central and East Region. The ratio of the mean ratio of SRHS discard: landings (2008-2019) to the mean ratio of MRFSS CH discard: landings (2008-2019) was applied to the yearly MRIP charter boat discard: landings ratio (1986-2007, 1981-2007 in TX) in order to estimate the yearly SRHS discard: landings ratio (1986-2007, 1981-2007 in TX). This ratio was then applied to the SRHS landings (1986-2007, 1981-2007 in TX) in order to estimate headboat discards (1986-2007, 1981-2007 in TX).

The SEDAR 74 Recreational Working Group recommended using the MRIP CH: SRHS discard ratio proxy method 1981-2007 described above and the SRHS estimated discards 2008-2019.

The MRIP CH: SRHS discard ratio proxy method is the current SEDAR Best Practice method, and allows for changes in management and year class effects to be incorporated into the assessment (SEDAR-PW-07). Final estimated discards (1981-2019) are presented in Table 4.12.10 along with the proxy discard estimates. Uncertainty in SRHS discards for 2008-2019 use the same method described for the landings. Prior to 2008, MRIP CH CVs are used as a proxy for SRHS headboat CVs.

4.5.6 Total Recreational Discards

Combined discard estimates (MRIP, SRHS, TPWD, and LA Creel) are shown in Tables 4.12.11-4.12.13, Figure 4.13.5, and mapped in Figure 4.13.6.

4.6 BIOLOGICAL SAMPLING

4.6.1 Landed Fish

4.6.1.1 MRIP Biological Sampling

The MRIP angler intercept survey includes the collection of fish lengths from the harvested catch (landed, whole condition). Up to 15 of each landed species per angler interviewed are measured to the nearest mm along a centerline (defined as tip of snout to center of tail along a straight line, not curved over body). In those fish with a forked tail, this measure would typically be referred to as a fork length. In those fish that do not have a forked tail, it would typically be referred to as a total length, with the exception of some fish that have a single, or few, caudal fin rays that extend further. Weights are typically collected for the same fish measured, although weights are preferred when time is constrained. Ageing structures and other biological samples are not collected during MRIP assignments because of concerns over the introduction of bias to survey data collection. Discarded fish size is not collected by MRIP for any fishing mode.

Summaries of fish size for MRIP-sampled Red Snapper in the Gulf of Mexico by state (1981-2019) are provided in Table 4.12.14 (pounds whole weight) and Table 7 of SEDAR 74-DW-01 (millimeters fork length). Comparable summaries of fish size by mode are provided in Table 10 of SEDAR 74-DW-01 (pounds whole weight) and Table 9 of SEDAR 74-DW-01 (millimeters fork length). These summaries include the number of measured Red Snapper, number of angler trips from which Red Snapper were measured, and the minimum, average, and maximum size of all measured Red Snapper.

4.6.1.2 LA Creel Biological Sampling

Size, weight, and age composition of recreationally landed Red Snapper have been collected from the LDWF Biological Sampling Program starting in 2014. During open Red Snapper season, size measurement targets are 30 fish sampled per area per mode (charter and private) per week. Size measurements are maximum total lengths. Weight measurements are collected as time permits. Otolith sampling targets are obtained from the federal GulfFIN grants. Summaries of fish size, in millimeters total length and pounds whole weight, for LDWF-sampled Red Snapper in the Gulf of Mexico by mode (2014-2019) are provided in Tables 14 and 15, respectively of SEDAR 74-DW-01. These summaries include the number of Red Snapper sampled, number of angler trips from which Red Snapper were sampled, and the minimum, average, and maximum size of all sampled Red Snapper.

4.6.1.3 TPWD Biological Sampling

Length composition of the catch of Texas sport-boat anglers has been sampled by the TPWD since the high-use season of 1983 (mid-May). Total length is measured by compressing the caudal fin lobes dorsoventrally to obtain the maximum possible total length. Weights of sampled fish are not recorded, but lengths can be converted to weights using length-weight equations (SEDAR 70-WP-03).

Summaries of fish size, in millimeters total length, for TPWD-sampled Red Snapper in the Gulf of Mexico by mode (1983-2019) are provided in Table 13 of SEDAR 74-DW-01. These summaries include the number of measured Red Snapper, number of angler trips from which Red Snapper were measured, and the minimum, average, and maximum size of all measured Red Snapper.

4.6.1.4 SRHS Biological Sampling

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

Summaries of fish size, in kilograms whole weight, for SRHS-sampled Red Snapper in the Gulf of Mexico (1986-2019) are provided in Table 4.12.15. These summaries include the annual number of measured Red Snapper, the number of trips from which Red Snapper were measured, and the minimum, average, and maximum size of Red Snapper measured by SRHS dockside samplers.

4.6.1.5 MDMR Biological Sampling

The Mississippi Department of Marine Resources (MDMR) conducts numerous fishery dependent surveys that gather length and age data from both the commercial and recreational fleet. Biosampling, funded through GSMFC, is the project that collects Red Snapper commercial lengths and ages from brick and mortar federal dealers in coastal Mississippi. MRIP and Tails N' Scales (TNS) have dockside surveys with a PPS-based design where lengths and ages are collected from the recreational fleet. Since 2016, MDMR has expanded its efforts to collect biological data on the Red Snapper recreational fishery through the TNS program. All age data is entered through the GulfFIN Oracle database for both recreationally and commercially sampled Red Snapper.

4.6.1.6 AMRD Biological Sampling

The Alabama Marine Resources Division (AMRD) of the Alabama Department of Conservation and Natural Resources (ADCNR) collects biological data from commercial and recreational fisheries through a variety of projects. The data used in SEDAR 74 analyses was derived from state-federal cooperative projects such as the Gulf States Marine Fisheries Commission's Biological Sampling activity (as part of GulfFin) and MRIP (APAIS) for the recreational sector and NOAA Fisheries' TIP for the commercial sector. The recreational sector includes private and for-hire (federal and state) anglers. Fish length (fork length) was collected in each project and individual fish weights were collected as part of the GulfFin Biological Sampling and MRIP. The APAIS uses a probability-based sampling methodology while the Biological Sampling and TIP activities use opportunistic sampling. The Biological Sampling program also collects otoliths which were used in the ageing section. The data programs representing Alabama length and age data are described in more detail in SEDAR 74-DW-15.

4.6.1.7 FWRI Biological Sampling

The Fishery Dependent Monitoring subsection (FDM) of the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) monitors recreational fishing in marine environments along the Florida coast in association with several fishery-dependent research and monitoring projects. FDM administers the Marine Recreational Information Program (MRIP) for the recreational sector. Additionally, FDM conducts several unique surveys of recreational anglers that allow for the collection of supplemental biological data. The state surveys that provide information from harvested fish include: the At-Sea Observer sampling of for-hire vessels (headboat and charter boat; 2005-present, sampling stoppages described in SEDAR 74-DW-18), the State Reef Fish Survey of offshore private recreational fishers (2015-present), and supplemental biological sampling of recreational anglers (shore and private boat mode) via opportunistic biological sampling (2000-2018) and a formalized biological sampling survey based on a randomized draw (2018-present, the State Representative Biological Survey). Each fishery-dependent research or monitoring project that contributed to the age and length data provided to the Life History Group is described in SEDAR

74-DW-07, including a description of the ageing protocols used by the Fish and Wildlife Research Institute (FWRI) Age and Growth Lab.

Age data are summarized for a total of 61,211 individuals. The majority of age samples were obtained from surveys of the recreational sector, including 3,338 samples from private recreational boat trips, 23,453 from charter trips, and 6,622 from headboats. In addition, 296 aged fish were from an unknown source (primarily fishing tournaments; Table 1 - SEDAR 74-DW-07). Over 95% of fish aged from the private boat fishery were collected between 2009 and 2019 with total otolith collections being above 100 per year every year since 2014 (Tables 2 & 3 - SEDAR 74-DW-07). Over 58% of otoliths collected from charter vessels were collected from before 2009 with fish collected in NWFL representing the bulk of collections each year (Table 2 & 3 - SEDAR 74-DW-07). Headboat samples were heavily concentrated in the later period as well, with large collections in 2014 and 2015 in NWFL (Table 2 & 3 - SEDAR 74-DW-07).

4.6.1.8 Nominal Length Frequency Distributions of Landings

Length data from the recreational fisheries of the Gulf of Mexico are collected by federal and state agencies including TPWD, LDWF, MDMR, AMRD, and FWRI. Sources utilized include data collected in each state (described above) and warehoused by Gulf States Marine Fisheries Commission (GSMFC) in the GulfFIN database (2001-2019), MRIP (1981-2019), and SRHS (1986-2019). Sample sizes were more limited prior to 2007, particularly in the Eastern Gulf as defined in the Stock ID Workshop due to low Red Snapper abundance in this region. Any existing total length measurements without an associated fork length measurement were converted using the morphometric equation derived by the Life History Working Group for the Gulf of Mexico stock at the SEDAR 74 Data Workshop.

Task 9a: Nominal length frequencies were generated for recreational data by mode and stock ID region. Length compositions within regions defined in the Stock ID Workshop were investigated using the finest spatial scale allowed by SRHS survey domains for headboat mode (Figure 4.13.7) and by MRIP survey domains for charter boat mode (Figure 4.13.8). Private mode samples did not support viewing the data at this resolution. These figures indicate approximately similar length compositions within stock ID regions allowing for spatial aggregation of samples into nominal length compositions (e.g. not requiring a weighting procedure). Length compositions by recreational fishing mode (CB, HB, PR) were shown by stock ID region in time blocks (Figure 4.13.9) alongside associated sample sizes (Table 4.13.16) to compare length composition by mode and provide context for reliability based on data availability. This figure also shows potential stock recovery through time as the length compositions were the largest in recent years for all modes and stocks. These length frequency distributions indicate that headboat and charter boat modes are sufficiently dissimilar to model separately in this assessment, as was done in SEDAR 51.

Data were sufficient to provide nominal length compositions for all fleets except in the Eastern Stock, where temporal aggregations were recommended for all modes to meet minimum sample size thresholds, as was approved at panel (Table 4.12.17). Sampling prior to 2007 was sparse, but increases in recent years have allowed for the estimation of annual compositions since 2018. Sample sizes between 2008 and 2017 have allowed for temporal aggregations of two to three years.

4.6.1.9 Aging Data

Age samples are collected as part of the SRHS sampling protocol. Age samples collected from the private/rental boat, charter boat, and shore modes come from a number of sources including state fishery-dependent sampling programs (described above) and special projects. The number of Red Snapper aged from the recreational fishery by year and stock is summarized in Table 4.12.18. The number of trips these ages were collected from are summarized in Table 4.12.19. Nominal age frequencies were generated for recreational data by mode and stock ID region (SEDAR74-DW-15). The final recreational age composition inputs will be determined in the assessment phase.

4.6.2 Discarded Fish

4.6.2.1 Headboat At-Sea Observer Survey Biological Sampling

At-sea sampling of headboat (2005 to present) and charterboat (2009 to present) discards were initiated as part of the improved for-hire surveys to characterize the size distribution of live discarded fish. Headboat observer data was collected in both Florida and Alabama from 2005 to 2007 but continued in Florida after 2009 to the present. A summary of the live discard length data from Florida and Alabama from 2005-2007 was provided to analysts and described in SEDAR 74-DW-18. Data collections in Florida are conducted year-round. During the data workshop discussions, additional data from at-sea observer sampling conducted in Mississippi from 2016-2020 and Alabama from 2017-2019 were identified. In both states, new initiatives have allowed for the collection of additional discard length data from both the headboat (MS=470) and charter (MS=554, AL=293) fleets. Data collection in Mississippi and Alabama only occurs during the open Red Snapper season. Summary statistics for data collected in each state is represented in Table 4.12.20.

4.6.2.2 Weighted and Nominal Length Frequency Distributions of Discards

Task 9b:

Eastern stock ID region

Length measurements from 4,642 fish were used to generate headboat and charterboat discard length frequency distributions from the eastern stock ID region.

- <u>Headboat</u> lengths in this stock ID region (n=3,258) are available from 2005 to 2019 and are summarized in Table 4.12.20. The procedure for weighting headboat data to account for uneven sampling of different trip durations in each Florida region was discussed. This is particularly necessary to address oversampling of multi-day trips in Florida, in comparison to the proportion of multi-day trips reported by the headboat fleet (SEDAR 74-DW-18). Annual headboat discard length compositions are presented in the right panel (SWFL) of Figure 1 of SEDAR 74-DW-18 in blue. These discard length compositions were reviewed and recommended by the Recreational Working Group.

- <u>Charterboat</u> lengths in this stock ID region (n=1,384) are available from 2005 to 2020 and are summarized in Table 4.12.20. Charter discard length frequency data has not been weighted in past SEDAR assessments, with only nominal discard length compositions generated. Annual charterboat discard length compositions are presented in the right panel (SWFL) of Figure 2 of SEDAR 74-DW-18 in blue. These discard length compositions were reviewed and recommended by the Recreational Working Group.

Central stock ID region

Length measurements from 26,568 fish were used to generate headboat and charterboat discard length frequency distributions from the central stock ID region. The introduction of data from Mississippi and Alabama during this assessment led to additional data investigations to determine how to incorporate the Mississippi and Alabama data with northwest Florida data to provide a more complete representation of discard length data in the central stock assessment region.

- <u>Headboat</u> lengths in this stock ID region (n=17,223) are available from 2005 to 2020 in Florida, 2005 to 2007 in Alabama, and 2016 to 2020 in Mississippi (Table 4.12.20). NWFL data is weighted by trip type as described in SEDAR 74-DW-18 to correct for sampling of different trip lengths. Similar information to weight lengths in Alabama and Mississippi was not available. Nominal headboat compositions from Alabama were compared to both weighted and unweighted NWFL length compositions (Figure 4.13.10) and found to overlap closely for the 2005-2007 time period when data were collected in both states, regardless of weighting. Nominal headboat compositions from Mississippi were also compared to both weighted and unweighted NWFL length compositions (Figure 4.13.11) and found to have similar central tendencies for the 2016-2020 time period when data were collected in both states, regardless of weighting. NWFL does show some additional discarding of legal sized fish as compared to Alabama and Mississippi, whose data is only collected during the open season. Florida data is collected year round, and many discards are observed in the closed season, in addition to the open season. Based on these findings the Recreational Working Group considered three options for the headboat discard length compositions in the central stock ID region:

- Option 1 – Use only the FL length data and AL 2005-2007 headboat data, weighted to correct for trip type
  - Pro: consistent with how data has been treated in the past assessments
  - Con: excludes the new data available from Mississippi
- Option 2 – Use unweighted Alabama and Mississippi data combined with weighted Florida data.
  - Pro: uses all available data from the central stock ID region to inform discard length distributions
  - Con: does not weight distributions between states to account for differences in the magnitude of discards
- Option 3 – Determine a way to weight the state discard data between states, to appropriately account for the magnitude of discard contributions for each state
  - Pro: uses all the new data
  - Con: requires the analysts to develop a method for weighting the data between states to account for the magnitude of the contribution for each state.

The Recreational Working Group recommended option 2 of combining the unweighted Alabama and Mississippi data with the weighted NWFL data to create the headboat discard length composition for the central stock assessment region (Figure 4.13.12) in order to use all available data to from the central stock ID region to characterize its discard length distributions. Option 3 was put forward as a research recommendation in section 4.10.2.

- <u>Charterboat</u> lengths in this stock ID region (n=9,345) are available from 2009 to 2020 in Florida, 2017 to 2019 in Alabama, and 2016 to 2020 in Mississippi (Table 4.12.20). Charter discard length frequency data has not been weighted in past SEDAR assessments, with only nominal discard length compositions generated. Annual charterboat compositions from Alabama, Mississippi, and NWFL were compared for the 2017-2019 time period when data were collected in all three states (Figure 4.13.13). Charterboat data show a similar trend to headboat data, where generally the central tendencies of the length frequencies overlap, but Florida data shows a broader range of lengths associated with discarded Red Snapper. The Recreational Working Group recommended combining all Mississippi, Alabama, and NWFL data to create the charterboat discard length composition for the central stock assessment region (Figure 4.13.14).

Western stock ID region

There are no discard length information available from the Western region.

4.7 RECREATIONAL EFFORT

4.7.1 MRIP Effort

MRIP effort estimates are produced via the Fishing Effort Survey (FES) for private/rental boats and shore mode and the For-Hire Survey (FHS) for charter boat mode. MRIP effort is calculated in units of angler trips, which represents a single day of fishing in the specified mode that does not exceed 24 hours and is provided by year and state in Table 17 of SEDAR 74-DW-01. This table includes MRIP effort estimates for West Florida, Alabama, and Mississippi for all years and Louisiana from 1981 to 2013.

4.7.2 LA Creel Effort

LA Creel effort estimates (in angler trips) are provided for Louisiana for years 2014-2019 in Table 17 of SEDAR 74-DW-01 for all modes combined. LA Creel effort estimates are provided by mode in Table 4.12.21, where private effort estimates are calibrated to MRIP-FES units.

4.7.3 TPWD Effort

Texas effort estimates (in angler trips) from TPWD are provided in Table 17 of SEDAR 74-DW-01 for years 1983-2019 for all modes combined. TPWD effort estimates are provided by mode in Table 4.12.21, where private effort estimates are calibrated to MRIP-FES units.

4.7.4 SRHS Effort

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

SRHS effort estimates (in angler days) are provided in Table 4.12.22. Estimated headboat angler days have remained relatively stable in the Gulf of Mexico in recent years. The most obvious factor which impacted the headboat fishery in both the Atlantic and Gulf of Mexico was the effect of COVID in 2020. Reports from industry staff, captains/owners, and port agents indicated health concerns and restrictions most affected the number of trips and number of passengers reducing overall fishing effort.

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

4.7.5 Total Recreational Fishing Effort

Combined effort estimates in angler trips (MRIP, SRHS, TPWD, and LA Creel) are shown by year, mode, and stock ID in Table 4.12.23, Figure 4.13.15, and mapped in Figure 4.13.16. These effort estimates depict all recreational fishing activity in the Gulf of Mexico and are not specific to Red Snapper.

4.8 COMMENTS OD ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

Task 10: Regarding the adequacy of the available recreational data for assessment analyses, the Recreational Working Group discussed the following:

- Calibrations to MRIP-FES units for TPWD (1981-2019) and LA Creel (2014-2019) were presented and recommended for use during the Data Workshop. Several research recommendations (#1-3) are critical to address prior to the Operational Assessment for Red Snapper to further refine these landings estimates. Landings, as adjusted, appear to be adequate for the time period covered (1955-2019).
- Since there are no discard estimates from Texas, a proxy discard rate from Louisiana was used to fill in this data gap. Similarly, headboat mode discards prior to 2008 used a proxy discard rate from the charter mode. Discards are self-reported from all data sources. Discards, as adjusted, appear to be adequate for the time period covered (1981-2019).
- Size data appear to adequately represent the landed catch for all modes.
- Discard size data from the headboat and charterboat fleets appear to be (1) regulatory discards and/or (2) adequate for describing the size composition of discarded Red Snapper.

4.9 Itemized List of Tasks for Completion following Workshop

- The following tasks were completed by the Recreational Working Group during one internal working group webinar (May 31st) and two post workshop webinars with the full panel (May 23rd and July 5th):
    - SRHS uncertainty
    - Historical landings
    - Discard length comps

  The methods for these analyses are fully described in this report.
- Weighted length and age compositions will be completed for the Assessment Workshop and described in that report.

4.10 RESEARCH RECOMMENDATIONS

4.10.1 Evaluation and Progress of Research Recommendations from Previous Assessments

Research recommendations from SEDAR 31 in 2013 were evaluated and progress on each item is outlined below:

1. Evaluate the technique used to apply sample weights to landings. Investigate the SEFSC method by analyzing the order of variables in the hierarchy and the minimum number of fish used. Furthermore, evaluate alternative methods, including a meta-analysis of the existing information from different sources, areas, states, surveys, etc. that could be performed.

   Evaluation of Progress

   - Clarity has been requested regarding the first line of this research recommendation. The sample weights here are referring to the weight of the fish sampled in APAIS and how those are used to calculate average weights for landings estimates in pounds whole weight. They do not refer to survey design sample weights used by MRIP to estimate catch.
   - The minimum number of fish used was evaluated in 2019 and an adjusted minimum sample size of 15 fish per strata was recommended and has been used since (SEDAR 67-WP-06).
   - Additional size information from LA BIO has been incorporated into the SEFSC weight estimation method since 2021.

2. Develop methods to identify angler preference and targeted effort. Require a reef fish stamp for anglers targeting reef fish, pelagic stamp for migratory species, and deep-water complex stamp for deep-water species. The program would be similar to the federal duck stamp required of hunters and could help managers identify what anglers were fishing for.

   Evaluation of Progress

   - Florida requires private boat anglers to possess a State Reef Fish designation to legally possess a suite of reef fishes, including Red Snapper. This serves as a directory that is used to directly survey participants and estimate reef fish effort in Florida.

3. Continue and expand fishery-dependent at-sea observer surveys to collect discard information. This would help to validate self-reported headboat discard rates.

   Evaluation of Progress

   - Additional at-sea sampling programs for for-hire vessels have begun in Mississippi and Alabama and are described above in 4.6.2.1.
   - The State of Florida dedicated recurring funds starting in 2020 to support this work long-term and provide stability. Data are available upon request for NOAA Fisheries to validate headboat discard rates.

4. Track Texas commercial and recreational discards.

   Evaluation of Progress

- No progress noted

5. Estimate variances associated with the headboat program.
   Evaluation of Progress
   - Method developed in SEDAR 68 Research Track assessment for Scamp and described in SEDAR 68-DW-31.
   - Alternative method described above in section 4.3.4 and recommended for use in SEDAR 74.
6. Evaluate existing and new methods to estimate historical landings. Hind-casting of Red Snapper landings is complicated by a lack of reliable historical effort data. To get at estimating historical effort, analysts could track consumables (gas, ice, bait) to develop price indices.
   Evaluation of Progress
   - No progress noted
7. Investigate how CPUE changes over time due to technological advances and changes in fishing practices.
   Evaluation of Progress
   - Adjusted ratios to account for technological advances from 1955 to 1980. These are described above in 4.4.5.
   - Expanded years used in CPUE calculation to include 1981 to 1989, a period of time when the Red Snapper fishery was generally unregulated.

4.10.2 Research Recommendations for SEDAR 74

Task 11:

1. SSC to add TOR to operational assessment to include topical working group to review and evaluate the results of the Gulf of Mexico transition plan to optimize the use of state and federal data.
2. Integrate TPWD into the Gulf Transition Team in order to further evaluate the proposed calibration between TPWD and MRIP units and identify alternative methods that may be implemented, including increased benchmarking (e.g. 3-year benchmark period).
3. Gulf Transition Team should investigate the drivers of high MRIP wave specific effort estimates for recreational modes during traditionally low effort waves (e.g. winter waves, particularly in MS).
4. Develop and implement methods in the western Gulf region to collect vital statistics on the size distribution of recreational discards and directly estimate the magnitude of recreational discards in Texas.
5. Investigate the need for weighting headboat discard length composition data from new data streams. Determine if data need to be weighted due to over or under sampling of any

particular trip types. If so, provide total number of trips sampled by state (or headboat region) and year, dock to dock hours for each trip, fleet (charter vs headboat), and catch type (harvest vs discard).

6. Investigate methods for weighting charter discard length composition data (to account for uneven sampling of trip types), or determine if weighting by trip type is necessary for that fleet.
7. Develop methods to properly weight discard length composition data from different states relative to the proportional magnitude of discards.
8. Develop statistically valid methods to identify outlier estimates (e.g. extremely high catches) and adjust sample weights for records that have a disproportionately high influence on total catch estimates, and establish new SEDAR best practice methods.
9. Provide working paper or presentations during the data workshop group meeting documenting collection methods and caveats for new data streams being evaluated / used.
10. Develop a list of qualitative information about the snapper-grouper fishery from stakeholders and methods to evaluate validity.
11. Research of additional reference points for historical landings.
12. Estimate and publish historical landings for major species (or species groups) in a single initiative to ensure a consistent methodology.
13. General evaluation of start year of existing models and value of historical data.
14. Evaluate how changes in fishing outcomes (fish for freezer vs. offshore experience with a few filets for dinner) have impacted fishing behavior over time. Important for determining validity of some historical landings assumptions.

4.11 LITERATURE CITED

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

Cross, R. 2022. Florida State Reef Fish Survey Metadata. SEDAR 74-DW-05. Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL. 2 pp.

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

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

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

Lazarre, D. 2022. SEDAR 74-DW-18. A Summary of Observer Data from the Size Distribution of Red Snapper Discards from Recreational Fishery Surveys in the Eastern Gulf of Mexico. Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL.

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

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

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

NMFS Office of Science and Technology. 2019. SEDAR 74-RD-110. Texas Fishing Effort Survey – Final Project Report. National Marine Fisheries Service (NMFS) Office of Science and Technology (OST) Fisheries Statistics Division. Silver Spring, MD.

NMFS Office of Science and Technology. 2022. SEDAR 74-DW-10. Methodology Description for a Calibration of Texas Private Boat Red Snapper Annual Landings Estimates. National Marine Fisheries Service (NMFS) Office of Science and Technology (OST) Fisheries Statistics Division. Silver Spring, MD.

NMFS Office of Science and Technology. 2022. SEDAR 74-DW-11. Evaluating Uncertainty in Gulf Red Snapper Estimates: A Preliminary Sensitivity Analysis of Non-Sampling Errors in the Region's Recreational Fishing Surveys. National Marine Fisheries Service (NMFS)

Office of Science and Technology (OST) Fisheries Statistics Division. Silver Spring, MD.

Nuttall, M and V Matter. 2020. SEDAR 70-WP-03. Texas Parks and Wildlife Department's Marine Sport-Harvest Monitoring Program Metadata. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Fisheries Statistics Division. Miami, FL.

Nuttall, M. 2022. SEDAR 74-DW-01. General Recreational Survey Data for Red Snapper in the Gulf of Mexico. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Sustainable Fisheries Division. Miami, FL.

Nuttall, M and K Dettloff. 2022. SEDAR 74-DW-12. SEFSC Computation of Uncertainty for General Recreational Landings-in-Weight Estimates, with Application to SEDAR 74 Gulf of Mexico Red Snapper. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Sustainable Fisheries Division. Miami, FL.

Rago, P. 2022. SEDAR 74-DW-29. Draft of the Summary Report from the Gulf State Recreational Catch and Effort Surveys Transition Feb 2022 Workshop. Gulf MRIP Transition Team.

SEDAR Procedural Workshop 7. 2015. SEDAR-PW-07. Data Best Practices. SEDAR, North Charleston, SC. 151 pp.

SEDAR. 2021. SEDAR 74 Gulf of Mexico Red Snapper Stock ID Process: Final Report. SEDAR, North Charleston, SC. 87 pp.

Stevens, M. 2022. SEDAR 74-DW-15. Gulf of Mexico Red Snapper (*Lutjanus campechanus*) Commercial and Recreational Landings Length and Age Compositions. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Sustainable Fisheries Division. Miami, FL. 21 pp.

Vecchio, J, D Lazarre, B Sauls, M Head, and T Moncrief. 2022. SEDAR 74-DW-06. A description of Florida's Gulf Coast recreational fishery and release mortality estimates for the central and eastern sub-regions (Mississippi, Alabama, and Florida) with varying levels of descender use. SEDAR, North Charleston, SC. 27 pp.

Vecchio, J, J Carroll, D Lazarre, and B Sauls. 2022. SEDAR 74-DW-07. Size and Age Information for Red Snapper, *Lutjanus campechanus*, collected in association with fishery-dependent projects along Florida's Gulf of Mexico coast. Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL. 24 pp.

Zhang, X, J West, and J Adriance. 2022. SEDAR 74-DW-04. LA Creel/MRIP Red Snapper Private Mode Landings and Discards Calibration Procedure. Louisiana Department of Wildlife and Fisheries (LDWF) Office of Fisheries. Baton Rouge, LA.

4.12 TABLES

Table 4.12.1. Annual landings estimates of Texas Red Snapper from the TPWD survey. Landings are provided in number of fish and pounds whole weight. Estimates for the private mode are calibrated into MRIP-FES units (SEDAR 74-DW-10).

	AB1				LBS			
Year	Priv	CV	Cbt	CV	Priv	CV	Cbt	CV
1981	691,216	0.536	6,107	0.317	964,882	0.560	8,584	0.453
1982	691,216	0.536	6,107	0.317	964,882	0.685	8,584	0.348
1983	665,988	0.241	10,663	0.424	860,015	0.620	12,377	0.489
1984	386,998	0.292	617	1.000	793,485	0.652	1,081	1.000
1985	1,020,660	1.051	7,042	0.509	1,241,145	1.047	12,294	0.642
1986	1,391,561	0.892	5,131	1.000	1,941,752	0.907	7,441	1.000
1987	409,581	0.381	9,858	0.688	671,000	0.436	25,172	0.702
1988	575,887	0.414	737	0.575	907,992	0.537	2,610	0.575
1989	252,179	0.292	1,108	0.786	388,568	0.404	1,609	0.786
1990	271,611	0.310	11	1.000	445,023	0.443	18	1.000
1991	440,828	0.287	674	0.700	853,469	0.406	1,300	0.722
1992	373,451	0.206	369	1.001	878,931	0.329	923	1.001
1993	429,438	0.215	6,974	1.000	1,156,866	0.270	35,762	1.000
1994	836,610	0.215	10,427	0.482	2,283,231	0.293	40,960	0.551
1995	978,013	0.184	7,637	0.625	3,162,183	0.241	28,800	0.662
1996	858,354	0.206	6,983	0.542	3,126,608	0.248	28,067	0.571
1997	800,066	0.195	6,774	0.436	2,861,526	0.234	25,209	0.469
1998	595,592	0.220	11,464	0.490	2,449,531	0.254	43,807	0.506
1999	489,698	0.221	9,110	0.376	1,698,134	0.296	43,799	0.473
2000	484,304	0.226	8,278	0.396	1,595,688	0.290	28,127	0.476
2001	386,115	0.208	13,179	0.391	1,244,578	0.247	38,387	0.431
2002	401,941	0.189	16,018	0.382	1,491,961	0.240	53,611	0.398
2003	351,838	0.195	6,068	0.308	1,185,037	0.225	20,752	0.325
2004	342,040	0.199	9,387	0.322	1,059,382	0.236	31,821	0.376
2005	503,911	0.193	9,860	0.571	1,815,866	0.253	37,353	0.586
2006	572,127	0.198	10,222	0.266	1,967,777	0.225	26,527	0.299
2007	387,565	0.201	11,610	0.264	1,419,224	0.227	42,566	0.289
2008	336,689	0.251	6,428	0.506	1,598,673	0.275	32,046	0.522
2009	312,689	0.200	5,699	0.271	1,767,540	0.220	34,614	0.297
2010	244,081	0.227	7,674	0.423	1,411,158	0.245	51,635	0.501
2011	321,245	0.219	6,113	0.538	1,693,875	0.240	40,816	0.572
2012	318,444	0.198	4,975	0.244	1,540,916	0.233	39,449	0.263
2013	480,031	0.210	5,105	0.372	2,450,765	0.242	32,243	0.401
2014	364,045	0.236	6,570	0.312	1,890,259	0.275	35,449	0.344
2015	438,408	0.183	9,723	0.214	2,221,805	0.210	53,274	0.234
2016	243,263	0.213	6,849	0.242	1,341,975	0.246	39,842	0.263
2017	399,804	0.195	9,344	0.236	2,306,511	0.223	71,266	0.257
2018	479,475	0.186	10,429	0.317	2,891,976	0.211	77,151	0.325
2019	750,411	0.206	11,521	0.300	4,249,764	0.228	83,228	0.321

Table 4.12.2. Estimated SRHS headboat landings of Gulf of Mexico Red Snapper. Landings are provided in number of fish and pounds whole weight. CVs are provided for landings estimates in number of fish and can be used as a proxy for uncertainty of estimates in weight. CVs for headboat mode (1981-1985) do not include uncertainty around the estimated TX headboat landings and are calculated from MRIP LA data.

	Number						Pounds		
Year	West	CV	Central	CV	East	CV	West	Central	East
1981	335,366	0.570					416,169		
1982	335,366	0.970					416,169		
1983	335,366	0.300					416,169		
1984	335,366	0.430					416,169		
1985	335,366	0.610					416,169		
1986	316,090	0.399	14,903	0.888	1,461	0.594	372,643	34,204	3,644
1987	319,348	0.387	9,256	0.710	429	0.759	384,748	25,022	1,274
1988	423,024	0.344	12,881	0.218	951	0.668	581,361	30,605	2,195
1989	372,473	0.233	10,357	0.241	440	0.573	962,620	22,824	1,004
1990	187,006	0.300	15,393	0.191	146	0.215	342,555	35,331	429
1991	264,686	0.314	15,349	0.265	231	0.081	448,516	34,585	576
1992	413,056	0.209	33,832	0.190	41	0.115	872,859	77,060	152
1993	458,772	0.239	36,735	0.153	540	0.095	1,300,057	82,788	1,557
1994	497,738	0.215	28,771	0.192	227	0.241	1,441,644	83,204	615
1995	354,550	0.185	22,980	0.144	98	0.491	1,282,724	74,562	350
1996	349,266	0.320	28,314	0.086	74	0.428	1,324,394	84,173	225
1997	347,424	0.243	48,398	0.135	41	0.334	1,183,785	120,501	137
1998	244,738	0.138	76,455	0.140	304	0.586	940,659	183,412	685
1999	98,699	0.221	64,725	0.175	2,707	0.552	503,005	187,746	8,222
2000	111,410	0.193	56,399	0.108	1,241	0.608	585,453	173,964	3,877
2001	116,358	0.211	50,343	0.128	946	0.610	405,872	164,165	3,454
2002	138,475	0.088	74,945	0.156	176	0.482	607,223	217,093	493
2003	157,905	0.408	70,539	0.250	482	0.413	569,760	220,615	1,529
2004	110,329	0.119	62,020	0.246	1,462	0.327	503,163	185,771	4,348
2005	99,988	0.208	41,612	0.249	5,179	0.257	379,858	128,016	18,468
2006	121,177	0.206	46,744	0.385	1,138	0.264	450,708	122,689	2,845
2007	110,314	0.571	62,842	0.427	761	0.250	313,255	171,338	2,416
2008	57,569	0.244	60,630	0.087	1,356	0.066	222,711	180,280	4,965
2009	75,998	0.092	78,421	0.055	3,169	0.055	491,339	300,227	14,334
2010	51,514	0.055	33,932	0.063	2,011	0.098	284,081	136,540	8,909
2011	50,656	0.051	66,156	0.051	3,031	0.065	309,919	306,287	14,362
2012	54,283	0.092	51,710	0.081	2,468	0.054	440,874	265,255	17,955
2013	43,743	0.050	41,303	0.050	2,682	0.050	240,316	192,471	12,493
2014	35,511	0.050	40,547	0.050	2,210	0.050	195,438	176,566	10,289
2015	63,033	0.051	42,346	0.052	3,116	0.050	356,570	204,629	19,032
2016	61,137	0.052	35,553	0.051	2,896	0.050	352,210	162,091	12,278
2017	60,068	0.073	50,271	0.051	8,339	0.054	344,966	211,776	27,176
2018	62,595	0.052	56,764	0.051	8,690	0.052	371,114	244,814	36,716
2019	67,126	0.059	41,097	0.053	8,645	0.051	417,573	163,298	48,405

Table 4.12.3. Adjusted ratios used in FWHAR method for estimating historical Red Snapper recreational landings from 1955 to 1980 by stock ID region and mode.

1975-1980	West-Cbt	West-Priv	West-Hbt	West-Total	Central-Cbt	Central-Priv	Central-Hbt	Central - Total	East-Cbt	East-Priv	East-Hbt	East - Total
	0.07	0.44	0.10	0.61	0.10	0.17	0.06	0.33	0.01	0.06	0.00	0.065
1965-1974	West-Cbt	West-Priv	West-Hbt	West-Total	Central-Cbt	Central-Priv	Central-Hbt	Central - Total	East-Cbt	East-Priv	East-Hbt	East - Total
	0.17	0.27	0.17	0.61	0.13	0.12	0.08	0.33	0.03	0.04	0.00	0.065
1955-1964	West-Cbt	West-Priv	West-Hbt	West-Total	Central-Cbt	Central-Priv	Central-Hbt	Central - Total	East-Cbt	East-Priv	East-Hbt	East - Total
	0.28	0.10	0.23	0.61	0.16	0.08	0.09	0.33	0.05	0.02	0.00	0.065

Table 4.12.4. Estimated historical recreational landings in **number of fish** estimated for Red Snapper in the Gulf of Mexico 1955-1980. CV=1.0.

	West			Central			East			GOM
Year	Cbt	Hbt	Priv	Cbt	Hbt	Priv	Cbt	Hbt	Priv	Total
1955	386,180	317,219	137,921	220,674	124,129	110,337	62,065	2,936	24,826	1,386,287
1956	427,415	351,091	152,648	244,237	137,383	122,118	68,692	3,249	27,477	1,534,310
1957	468,650	384,962	167,375	267,800	150,637	133,900	75,319	3,563	30,127	1,682,332
1958	509,884	418,834	182,102	291,362	163,891	145,681	81,946	3,876	32,778	1,830,355
1959	551,119	452,705	196,828	314,925	177,145	157,463	88,573	4,190	35,429	1,978,377
1960	592,354	486,577	211,555	338,488	190,400	169,244	95,200	4,503	38,080	2,126,400
1961	612,128	502,819	218,617	349,787	196,755	174,894	98,378	4,653	39,351	2,197,383
1962	631,902	519,062	225,679	361,087	203,111	180,543	101,556	4,804	40,622	2,268,365
1963	651,675	535,305	232,741	372,386	209,467	186,193	104,734	4,954	41,893	2,339,348
1964	671,449	551,547	239,803	383,685	215,823	191,843	107,911	5,104	43,165	2,410,331
1965	427,552	409,552	666,533	321,070	185,240	304,961	62,785	5,255	92,037	2,474,983
1966	440,647	422,095	686,947	330,904	190,913	314,301	64,708	5,416	94,856	2,550,786
1967	453,741	434,639	707,361	340,738	196,586	323,641	66,631	5,576	97,674	2,626,589
1968	466,836	447,183	727,776	350,571	202,260	332,982	68,554	5,737	100,493	2,702,392
1969	479,931	459,726	748,190	360,405	207,933	342,322	70,477	5,898	103,312	2,778,195
1970	493,026	472,270	768,604	370,238	213,607	351,662	72,400	6,059	106,131	2,853,998
1971	538,766	516,084	839,910	404,587	233,424	384,287	79,116	6,621	115,977	3,118,772
1972	584,505	559,898	911,216	438,935	253,241	416,912	85,833	7,184	125,823	3,383,547
1973	630,245	603,712	982,522	473,283	273,058	449,537	92,550	7,746	135,669	3,648,321
1974	675,985	647,526	1,053,828	507,631	292,875	482,161	99,267	8,308	145,515	3,913,096
1975	276,637	424,227	1,833,549	417,209	250,337	696,198	24,444	8,870	235,714	4,167,184
1976	277,758	425,946	1,840,979	418,900	251,351	699,019	24,543	8,906	236,669	4,184,071
1977	278,879	427,665	1,848,409	420,591	252,366	701,840	24,642	8,942	237,624	4,200,958
1978	280,000	429,384	1,855,839	422,281	253,380	704,661	24,741	8,978	238,579	4,217,845
1979	281,121	431,104	1,863,270	423,972	254,395	707,482	24,840	9,014	239,535	4,234,731
1980	282,242	432,823	1,870,700	425,663	255,409	710,304	24,939	9,050	240,490	4,251,618

Table 4.12.5. Estimated historical recreational landings in **pounds whole weight** estimated for Red Snapper in the Gulf of Mexico 1955-1980. CV=1.0.

	West			Central			East			GOM
Year	**Cbt**	**Hbt**	**Priv**	**Cbt**	**Hbt**	**Priv**	**Cbt**	**Hbt**	**Priv**	**Total**
1955	1,462,722	454,965	252,651	541,436	244,822	239,518	188,210	8,195	55,735	3,448,254
1956	1,618,907	503,546	279,628	599,249	270,964	265,092	208,306	9,068	61,687	3,816,447
1957	1,775,092	552,124	306,606	657,063	297,105	290,668	228,402	9,945	67,636	4,184,640
1958	1,931,272	600,705	333,584	714,873	323,246	316,242	248,498	10,818	73,588	4,552,826
1959	2,087,457	649,284	360,560	772,686	349,387	341,818	268,594	11,695	79,539	4,921,020
1960	2,243,641	697,864	387,537	830,500	375,530	367,392	288,690	12,568	85,491	5,289,214
1961	2,318,539	721,159	400,474	858,222	388,064	379,657	298,328	12,987	88,344	5,465,774
1962	2,393,436	744,455	413,410	885,948	400,600	391,919	307,965	13,408	91,198	5,642,340
1963	2,468,330	767,751	426,347	913,670	413,137	404,184	317,602	13,827	94,051	5,818,899
1964	2,543,227	791,046	439,283	941,393	425,673	416,449	327,236	14,246	96,907	5,995,460
1965	1,619,426	587,392	1,220,989	787,764	365,353	662,004	190,393	14,667	206,627	5,654,615
1966	1,669,025	605,382	1,258,385	811,892	376,542	682,279	196,225	15,116	212,955	5,827,801
1967	1,718,621	623,373	1,295,780	836,020	387,731	702,554	202,056	15,563	219,282	6,000,980
1968	1,768,221	641,364	1,333,177	860,146	398,922	722,831	207,887	16,012	225,611	6,174,171
1969	1,817,820	659,353	1,370,573	884,274	410,111	743,106	213,719	16,462	231,939	6,347,358
1970	1,867,420	677,344	1,407,968	908,400	421,302	763,382	219,550	16,911	238,268	6,520,545
1971	2,040,668	740,184	1,538,590	992,677	460,388	834,203	239,916	18,480	260,373	7,125,478
1972	2,213,912	803,023	1,669,212	1,076,952	499,473	905,025	260,285	20,051	282,477	7,730,411
1973	2,387,160	865,862	1,799,834	1,161,227	538,559	975,847	280,654	21,620	304,582	8,335,345
1974	2,560,408	928,702	1,930,456	1,245,502	577,644	1,046,666	301,024	23,188	326,687	8,940,276
1975	1,047,810	608,440	3,358,789	1,023,646	493,745	1,511,294	74,126	24,757	529,187	8,671,793
1976	1,052,056	610,905	3,372,399	1,027,795	495,745	1,517,418	74,426	24,857	531,331	8,706,932
1977	1,056,302	613,370	3,386,010	1,031,944	497,747	1,523,542	74,726	24,958	533,475	8,742,073
1978	1,060,548	615,836	3,399,621	1,036,091	499,747	1,529,665	75,026	25,058	535,619	8,777,210
1979	1,064,794	618,303	3,413,233	1,040,239	501,749	1,535,789	75,326	25,159	537,765	8,812,357
1980	1,069,040	620,768	3,426,844	1,044,388	503,749	1,541,915	75,627	25,259	539,909	8,847,499

Table 4.12.6. Total recreational landings estimates (AB1) for Gulf of Mexico Red Snapper combined across all surveys (MRIP, TPWD, LA Creel, and SRHS) by year and mode for the **West region**. Estimates and their associated coefficients of variation (CV) are provided for recreational landings in numbers of fish (AB1) and in pounds whole weight (LBS). CVs for headboat mode (1981-1985) do not include uncertainty around the estimated TX headboat landings and are calculated from MRIP LA data. CVs are not available in weight units for headboat mode starting in 1986.

Year	Hbt_AB1	Hbt_CV	Cbt_AB1	Cbt_CV	Priv_AB1	Priv_CV	Hbt_LBS	Hbt_CV	Cbt_LBS	Cbt_CV	Priv_LBS	Priv_CV
1981	354,536	0.570	225,895	0.555	3,075,407	0.647	507,923	0.620	740,490	0.623	6,823,347	0.663
1982	358,850	0.970	274,792	0.948	1,863,327	0.388	439,374	0.970	449,503	0.950	3,794,947	0.606
1983	371,323	0.300	422,065	0.293	3,553,822	0.329	479,291	0.329	973,056	0.390	5,445,431	0.641
1984	368,374	0.430	378,268	0.429	789,515	0.266	467,064	0.430	1,745,872	0.450	1,661,525	0.645
1985	388,339	0.610	613,132	0.603	1,272,721	0.852	498,293	0.619	3,726,195	0.704	1,654,596	0.865
1986	316,090	0.399	77,146	0.207	1,730,541	0.721	372,643		143,087	0.446	2,823,515	0.765
1987	319,348	0.387	64,283	0.259	520,875	0.340	384,748		147,827	0.319	813,776	0.402
1988	423,024	0.344	15,018	0.809	805,754	0.326	581,361		32,384	0.809	1,387,250	0.482
1989	372,473	0.233	63,291	0.708	531,468	0.270	962,620		124,057	0.708	1,504,265	0.390
1990	187,006	0.300	28,440	0.580	395,835	0.312	342,555		82,345	0.587	597,948	0.445
1991	264,686	0.314	115,403	0.278	470,728	0.272	448,516		443,086	0.365	973,515	0.396
1992	413,056	0.209	123,052	0.309	625,422	0.178	872,859		438,313	0.372	1,642,224	0.313
1993	458,772	0.239	81,765	0.296	1,043,435	0.246	1,300,057		289,947	0.420	3,843,594	0.295
1994	497,738	0.215	57,285	0.261	1,205,383	0.205	1,441,644		291,985	0.394	4,117,430	0.287
1995	354,550	0.185	73,649	0.497	1,528,465	0.227	1,282,724		374,258	0.553	6,180,941	0.275
1996	349,266	0.320	57,143	0.487	1,066,610	0.183	1,324,394		353,393	0.522	4,266,101	0.230
1997	347,424	0.243	68,148	0.291	1,047,979	0.174	1,183,785		403,789	0.345	4,045,191	0.217
1998	244,738	0.138	106,153	0.343	1,012,251	0.250	940,659		606,743	0.369	6,390,569	0.280
1999	98,699	0.221	56,808	0.432	657,069	0.184	503,005		358,131	0.514	2,899,063	0.271
2000	111,410	0.193	20,477	0.249	656,299	0.196	585,453		119,230	0.374	3,159,977	0.268
2001	116,358	0.211	19,278	0.302	467,863	0.187	405,872		95,356	0.355	1,714,137	0.231
2002	138,475	0.088	54,462	0.246	428,249	0.180	607,223		280,393	0.271	1,657,626	0.233
2003	157,905	0.408	56,438	0.261	382,113	0.185	569,760		328,286	0.281	1,302,727	0.217
2004	110,329	0.119	81,847	0.259	360,469	0.190	503,163		304,521	0.326	1,168,984	0.229
2005	99,988	0.208	74,152	0.271	557,898	0.181	379,858		379,636	0.310	1,997,565	0.244
2006	121,177	0.206	95,019	0.207	696,553	0.174	450,708		360,127	0.249	2,313,846	0.204

Year	Hbt_AB1	Hbt_CV	Cbt_AB1	Cbt_CV	Priv_AB1	Priv_CV	Hbt_LBS	Hbt_CV	Cbt_LBS	Cbt_CV	Priv_LBS	Priv_CV
2007	110,314	0.571	64,282	0.202	537,811	0.166	313,255		227,916	0.234	1,992,092	0.197
2008	57,569	0.244	25,413	0.388	418,097	0.221	222,711		154,118	0.412	1,955,043	0.248
2009	75,998	0.092	29,388	0.398	418,994	0.184	491,339		205,165	0.415	2,416,245	0.205
2010	51,514	0.055	7,674	0.423	256,270	0.219	284,081		51,635	0.501	1,478,530	0.238
2011	50,656	0.051	10,449	0.434	380,196	0.200	309,919		84,424	0.481	2,196,484	0.224
2012	54,283	0.092	27,758	0.429	448,726	0.186	440,874		273,939	0.439	2,373,024	0.223
2013	43,743	0.050	19,921	0.464	578,628	0.186	240,316		195,032	0.485	3,120,266	0.222
2014	35,511	0.050	11,271	0.207	587,008	0.177	195,438		83,080	0.255	3,845,957	0.227
2015	63,033	0.051	28,729	0.125	713,784	0.151	356,570		225,254	0.159	4,444,967	0.184
2016	61,137	0.052	33,720	0.097	456,092	0.168	352,210		291,691	0.144	3,145,450	0.209
2017	60,068	0.073	36,875	0.108	564,237	0.158	344,966		293,707	0.149	3,610,785	0.191
2018	62,595	0.052	25,772	0.153	634,352	0.154	371,114		226,640	0.170	4,289,647	0.184
2019	67,126	0.059	28,781	0.149	941,672	0.172	417,573		236,529	0.191	5,800,148	0.199

Table 4.12.7. Total recreational landings estimates (AB1) for Gulf of Mexico Red Snapper combined across all surveys (MRIP and SRHS) by year and mode for the **Central region**. Estimates and their associated coefficients of variation (CV) are provided for recreational landings in numbers of fish (AB1) and in pounds whole weight (LBS). CVs are not available in weight units for headboat mode starting in 1986.

Year	Hbt_AB1	Hbt_CV	Cbt_AB1	Cbt_CV	Priv_AB1	Priv_CV	Hbt_LBS	Hbt_CV	Cbt_LBS	Cbt_CV	Priv_LBS	Priv_CV
1981	44,131	0.820	72,175	0.820	1,814,671	0.550	104,900	0.830	152,779	0.823	3,171,304	0.593
1982	247,419	0.430	409,279	0.420	211,587	0.430	310,332	0.431	721,369	0.589	481,274	0.559
1983	475,424	0.320	760,147	0.320	751,639	0.560	948,069	0.362	1,175,692	0.357	1,035,353	0.618
1984	132,091	0.370	211,197	0.370	272,732	0.600	343,976	0.473	378,253	0.408	312,352	0.632
1985	149,394	0.380	238,864	0.380	612,117	0.550	341,450	0.397	565,477	0.469	1,552,825	0.640
1986	14,903	0.888	507,401	0.210	261,562	0.680	34,204		1,821,590	0.261	1,030,043	0.719
1987	9,256	0.710	457,049	0.240	491,587	0.260	25,022		1,383,726	0.280	1,226,559	0.357
1988	12,881	0.218	358,245	0.320	365,960	0.480	30,605		1,110,397	0.367	1,013,440	0.513
1989	10,357	0.241	203,867	0.270	588,397	0.750	22,824		586,813	0.449	1,834,497	0.810
1990	15,393	0.191	143,525	0.330	348,726	0.370	35,331		759,517	0.428	826,123	0.418
1991	15,349	0.265	189,578	0.210	806,726	0.250	34,585		556,070	0.300	2,405,285	0.345
1992	33,832	0.190	352,497	0.180	1,422,294	0.200	77,060		1,069,803	0.329	4,193,230	0.234
1993	36,735	0.153	835,952	0.340	1,434,811	0.190	82,788		2,853,069	0.360	5,615,766	0.275
1994	28,771	0.192	373,415	0.210	1,002,018	0.240	83,204		1,488,624	0.243	4,356,660	0.298
1995	22,980	0.144	297,069	0.270	646,795	0.260	74,562		948,406	0.303	2,609,813	0.352
1996	28,314	0.086	423,073	0.310	506,756	0.200	84,173		1,833,650	0.348	1,867,540	0.325
1997	48,398	0.135	543,756	0.150	817,821	0.200	120,501		2,690,301	0.221	3,823,800	0.279
1998	76,455	0.140	871,474	0.100	563,447	0.210	183,412		3,544,826	0.118	2,345,196	0.316
1999	64,725	0.175	632,460	0.100	1,301,022	0.230	187,746		2,856,854	0.117	6,801,667	0.311
2000	56,399	0.108	376,376	0.080	864,523	0.210	173,964		1,744,329	0.094	3,864,135	0.251
2001	50,343	0.128	396,042	0.090	1,392,687	0.220	164,165		1,815,952	0.106	8,187,188	0.281
2002	74,945	0.156	556,133	0.090	1,871,975	0.200	217,093		2,571,420	0.112	9,070,895	0.253
2003	70,539	0.250	526,142	0.090	1,288,415	0.190	220,615		2,504,005	0.174	6,016,086	0.257
2004	62,020	0.246	531,741	0.090	1,633,282	0.270	185,771		1,862,784	0.097	6,125,700	0.297
2005	41,612	0.249	385,562	0.100	899,696	0.240	128,016		1,300,106	0.109	3,938,056	0.310
2006	46,744	0.385	388,459	0.110	985,369	0.200	122,689		1,239,569	0.117	3,421,054	0.253
2007	62,842	0.427	475,791	0.110	1,526,397	0.220	171,338		1,515,067	0.120	4,952,465	0.283
2008	60,630	0.087	265,441	0.120	898,069	0.170	180,280		1,024,999	0.134	4,043,048	0.199

Year	Hbt_AB1	Hbt_CV	Cbt_AB1	Cbt_CV	Priv_AB1	Priv_CV	Hbt_LBS	Hbt_CV	Cbt_LBS	Cbt_CV	Priv_LBS	Priv_CV
2009	78,421	0.055	205,255	0.160	1,079,273	0.210	300,227		1,102,839	0.179	4,596,019	0.231
2010	33,932	0.063	68,837	0.170	1,032,623	0.310	136,540		374,822	0.191	5,326,288	0.325
2011	66,156	0.051	153,432	0.190	1,242,753	0.200	306,287		954,409	0.202	7,971,276	0.225
2012	51,710	0.081	150,032	0.170	1,160,659	0.210	265,255		1,012,090	0.187	9,099,821	0.228
2013	41,303	0.050	165,648	0.350	2,091,560	0.310	192,471		1,132,367	0.367	14,466,985	0.320
2014	40,547	0.050	35,280	0.270	893,063	0.210	176,566		225,564	0.286	6,119,131	0.228
2015	42,346	0.052	204,965	0.230	1,023,321	0.230	204,629		1,331,390	0.250	6,711,504	0.250
2016	35,553	0.051	217,938	0.220	1,281,042	0.140	162,091		1,653,817	0.233	7,849,149	0.172
2017	50,271	0.051	239,362	0.260	2,568,119	0.190	211,776		1,486,665	0.274	15,859,962	0.217
2018	56,764	0.051	229,198	0.230	1,751,099	0.240	244,814		1,450,586	0.243	10,520,171	0.253
2019	41,097	0.053	282,023	0.270	1,946,996	0.200	163,298		1,672,666	0.286	10,841,563	0.231

Table 4.12.8. Total recreational landings estimates (AB1) for Gulf of Mexico Red Snapper combined across all surveys (MRIP and SRHS) by year and mode for the **East region**. Estimates and their associated coefficients of variation (CV) are provided for recreational landings in numbers of fish (AB1) and in pounds whole weight (LBS). CVs are not available in weight units for headboat mode starting in 1986.

Year	Hbt_AB1	Hbt_CV	Cbt_AB1	Cbt_CV	Priv_AB1	Priv_CV	Hbt_LBS	Hbt_CV	Cbt_LBS	Cbt_CV	Priv_LBS	Priv_CV
1981	13,529	0.830	21,631	0.830	568,244	0.640	34,985	0.840	51,606	0.893	968,168	0.641
1982	2,538	1.000	4,058	1.000	11,959	0.800	3,596	1.000	9,178	1.000	29,420	0.845
1983	23,342	0.410	37,321	0.410	580,760	1.000	65,432	0.512	56,543	0.410	1,294,876	1.000
1984	18,865	0.680	31,915	0.640	21,342	0.720	53,916	0.695	63,097	0.642	45,675	0.766
1985	6,866	0.780	11,182	0.770	157,060	0.710	24,922	0.808	28,496	0.773	445,067	0.722
1986	1,461	0.594	61,607	0.510	181,242	0.500	3,644		287,385	0.549	494,520	0.516
1987	429	0.759	3,429	0.900	106,125	0.530	1,274		7,350	0.919	314,634	0.531
1988	951	0.668	5,934	0.660	49,105	0.490	2,195		19,082	0.663	167,438	0.491
1989	440	0.573	11,474	1.000	142,386	0.690	1,004		49,037	1.000	322,181	0.690
1990	146	0.215	0	0.000	42,071	0.530	429		0		148,042	0.530
1991	231	0.081	75	1.000	17,216	0.610	576		187	1.000	67,366	0.610
1992	41	0.115	2,627	0.640	3,580	0.710	152		6,860	0.767	10,015	0.710
1993	540	0.095	0	0.000	0	0.000	1,557		0		0	
1994	227	0.241	57	1.000	0	0.000	615		202	1.000	0	
1995	98	0.491	0	0.000	3,298	1.000	350		0		15,433	1.000
1996	74	0.428	387	1.000	36,610	0.640	225		1,632	1.000	96,980	0.644
1997	41	0.334	1,729	0.750	0	0.000	137		8,657	0.756	0	
1998	304	0.586	8,037	0.690	0	0.000	685		22,864	0.697	0	
1999	2,707	0.552	802	0.460	11,548	0.520	8,222		2,776	0.509	39,730	0.554
2000	1,241	0.608	397	0.750	2,321	1.000	3,877		1,446	0.750	8,914	1.000
2001	946	0.610	1,516	0.530	0	0.000	3,454		5,369	0.613	0	
2002	176	0.482	523	0.530	7,709	0.720	493		1,729	0.530	30,192	0.721
2003	482	0.413	1,599	0.390	2,828	0.800	1,529		5,289	0.397	10,343	0.801
2004	1,462	0.327	440	0.470	7,039	0.920	4,348		1,576	0.479	22,213	0.920
2005	5,179	0.257	1,743	0.450	81,014	0.600	18,468		5,732	0.459	390,336	0.643
2006	1,138	0.264	10,948	0.860	18,542	0.790	2,845		35,052	0.863	59,250	0.791
2007	761	0.250	840	0.740	41,336	0.820	2,416		2,550	0.740	142,701	0.830
2008	1,356	0.066	3,285	0.610	5,624	1.000	4,965		12,472	0.615	28,942	1.000

Year	Hbt_AB1	Hbt_CV	Cbt_AB1	Cbt_CV	Priv_AB1	Priv_CV	Hbt_LBS	Hbt_CV	Cbt_LBS	Cbt_CV	Priv_LBS	Priv_CV
2009	3,169	0.055	1,893	0.620	18,935	0.600	14,334		10,482	0.649	61,133	0.600
2010	2,011	0.098	4,390	0.760	3,200	0.720	8,909		27,534	0.771	19,788	0.720
2011	3,031	0.065	0	0.000	16,390	0.660	14,362		0		81,478	0.661
2012	2,468	0.054	3,002	0.820	14,641	0.720	17,955		18,651	0.820	94,788	0.746
2013	2,682	0.050	487	0.760	3,574	0.790	12,493		2,987	0.768	21,457	0.790
2014	2,210	0.050	3,890	0.660	5,175	0.750	10,289		28,612	0.664	35,204	0.767
2015	3,116	0.050	8,019	0.680	1,901	1.000	19,032		48,168	0.689	14,097	1.000
2016	2,896	0.050	8,143	0.540	27,199	0.620	12,278		58,200	0.550	138,378	0.730
2017	8,339	0.054	19,437	0.510	77,403	0.420	27,176		103,256	0.522	348,975	0.439
2018	8,690	0.052	23,394	0.620	101,256	0.460	36,716		133,770	0.637	479,172	0.465
2019	8,645	0.051	18,048	0.310	106,202	0.530	48,405		102,888	0.328	638,478	0.538

Table 4.12.9. Annual discard estimates of Texas Red Snapper from the TPWD survey. Discards are provided in number of fish. Estimates for the private mode are calibrated into MRIP-FES units (SEDAR 74-DW-10).

Year	Priv_B2	Priv_CV	Cbt_B2	Cbt_CV
1981	39,958	0.990	2	0.987
1982	2,408	1.097	296	1.121
1983	695	0.133	13	0.000
1984	43,561	0.133	7	0.000
1985	118,165	0.983	27	1.112
1986	38,582	0.133	213	0.000
1987	94,389	1.215	276	1.137
1988	378,281	0.714	60	0.777
1989	176,096	0.846	81	0.939
1990	289,742	0.882	25	1.000
1991	384,542	1.041	821	1.023
1992	269,080	0.488	336	1.001
1993	217,646	0.556	5,732	1.000
1994	842,027	0.708	19,619	0.774
1995	1,243,035	0.702	9,231	0.825
1996	332,408	0.597	11,099	0.725
1997	372,886	0.639	6,105	0.709
1998	465,805	0.792	5,186	0.838
1999	1,518,422	0.524	2,065	0.588
2000	535,711	0.530	4,037	0.601
2001	424,690	0.577	10,324	0.640
2002	739,226	0.788	11,094	0.815
2003	1,613,358	0.690	6,389	0.712
2004	3,023,997	0.907	20,476	0.914
2005	1,828,615	0.650	26,180	0.772
2006	1,840,180	0.501	21,767	0.525
2007	771,231	0.488	22,688	0.511
2008	1,294,597	0.604	17,249	0.704
2009	839,889	0.583	6,424	0.602
2010	1,041,368	1.113	21,966	1.098
2011	1,128,201	0.685	4,321	0.777
2012	489,650	0.642	3,434	0.652
2013	1,523,352	0.548	7,100	0.608
2014	625,385	0.344	4,066	0.396
2015	753,132	0.311	6,018	0.329
2016	118,857	0.289	2,652	0.310
2017	320,400	0.274	2,514	0.303
2018	380,821	0.302	2,810	0.391
2019	844,184	0.266	13,594	0.342

Table 4.12.10. Estimated SRHS headboat discards of Gulf of Mexico Red Snapper. Discards are provided in number of fish. CVs for headboat mode (1981-2007) do not include uncertainty around the estimated TX headboat discards and are calculated from MRIP LA data.

Year	West	West_CV	Central	Central_CV	East	East_CV
1981	0	0.000				
1982	16,950	0.986				
1983	0	0.724				
1984	19,583	1.000				
1985	15,659	0.911				
1986	2,854	0.403	137	0.630	119	0.450
1987	2,431	0.844	549	0.400	60	1.000
1988	9,278	0.858	1,485	0.860	0	0.000
1989	7,356	0.983	1,135	0.450	0	0.000
1990	114,389	0.670	5,508	0.400	0	0.000
1991	87,510	0.328	10,101	0.290	0	0.000
1992	102,003	0.369	19,402	0.200	5	0.680
1993	102,382	0.322	7,273	0.450	0	0.000
1994	254,274	0.316	13,405	0.240	66	1.000
1995	116,361	0.492	19,777	0.430	0	0.000
1996	150,719	0.468	20,721	0.290	0	0.000
1997	85,010	0.330	48,054	0.250	4	1.000
1998	30,061	0.489	37,799	0.110	34	0.530
1999	6,075	0.537	55,915	0.090	1,889	0.780
2000	14,753	0.344	48,138	0.080	236	0.740
2001	24,748	0.561	46,240	0.100	503	0.730
2002	26,039	0.361	47,613	0.090	0	0.000
2003	45,140	0.282	48,924	0.090	253	0.900
2004	65,341	0.307	45,552	0.090	672	0.530
2005	72,082	0.317	39,288	0.090	1,359	0.600
2006	70,060	0.263	61,514	0.110	537	0.530
2007	58,531	0.227	57,591	0.110	591	0.630
2008	41,534	0.240	94,052	0.090	3,919	0.066
2009	30,974	0.090	94,201	0.050	5,841	0.055
2010	18,411	0.060	52,800	0.060	1,530	0.098
2011	23,092	0.050	82,104	0.050	6,295	0.065
2012	15,908	0.090	71,576	0.080	2,099	0.054
2013	9,849	0.050	80,013	0.050	1,575	0.050
2014	8,567	0.050	59,827	0.050	1,820	0.050
2015	9,714	0.050	53,346	0.050	1,489	0.050
2016	9,782	0.050	81,816	0.050	11,350	0.050
2017	10,278	0.070	115,406	0.050	15,268	0.054
2018	9,502	0.050	95,229	0.050	14,257	0.052
2019	11,312	0.060	77,428	0.050	12,680	0.051

Table 4.12.11. Total recreational discard estimates (B2) for Gulf of Mexico Red Snapper combined across all surveys (MRIP, TPWD, LA Creel, and SRHS) by year and mode for the **West region**. Associated coefficients of variation (CV) are also provided.

Year	Hbt	Hbt_CV	Cbt	Cbt_CV	Priv	Priv_CV
1981	0	0.000	2	0.000	63,443	0.587
1982	18,086	0.986	13,299	0.986	6,491	0.636
1983	132	0.724	1,526	0.724	695	1.047
1984	19,583	1.000	7	1.000	43,561	0.876
1985	15,659	0.911	27	0.911	204,990	0.721
1986	2,854	0.403	2,566	0.403	38,582	0.938
1987	2,431	0.844	1,802	0.844	120,038	0.980
1988	9,278	0.858	1,213	0.858	529,273	0.549
1989	7,356	0.983	4,604	0.983	371,122	0.550
1990	114,389	0.670	64,074	0.670	422,258	0.707
1991	87,510	0.328	140,526	0.328	410,625	0.973
1992	102,003	0.369	111,920	0.369	450,630	0.334
1993	102,382	0.322	67,206	0.322	528,829	0.319
1994	254,274	0.316	107,784	0.316	1,213,187	0.530
1995	116,361	0.492	89,025	0.492	1,942,650	0.480
1996	150,719	0.468	90,822	0.468	413,058	0.493
1997	85,010	0.330	61,416	0.330	488,430	0.507
1998	30,061	0.489	48,023	0.489	791,668	0.529
1999	6,075	0.537	12,877	0.537	2,037,391	0.403
2000	14,753	0.344	9,987	0.344	725,964	0.403
2001	24,748	0.561	15,101	0.561	514,604	0.498
2002	26,039	0.361	37,719	0.361	787,611	0.739
2003	45,140	0.282	59,423	0.282	1,752,181	0.676
2004	65,341	0.307	178,530	0.307	3,186,929	0.863
2005	72,082	0.317	196,889	0.317	2,024,526	0.594
2006	70,060	0.263	202,335	0.263	2,240,383	0.419
2007	58,531	0.227	125,620	0.227	1,070,212	0.371
2008	41,534	0.240	68,196	0.474	1,607,619	0.508
2009	30,974	0.090	33,124	0.508	1,125,424	0.451
2010	18,411	0.060	22,836	1.000	1,052,869	1.060
2011	23,092	0.050	7,385	0.759	1,335,234	0.594
2012	15,908	0.090	19,160	0.423	689,976	0.491
2013	9,849	0.050	27,707	0.536	1,836,243	0.474
2014	8,567	0.050	6,976	0.344	1,054,684	0.329
2015	9,714	0.050	17,781	0.264	1,283,348	0.328
2016	9,782	0.050	13,055	0.238	528,696	0.328
2017	10,278	0.070	9,921	0.178	839,758	0.278
2018	9,502	0.050	6,944	0.213	865,636	0.278
2019	11,312	0.060	33,960	0.229	1,692,191	0.243

Table 4.12.12. Total recreational discard estimates (B2) for Gulf of Mexico Red Snapper combined across all surveys (MRIP and SRHS) by year and mode for the **Central region**. Associated coefficients of variation (CV) are also provided.

Year	Hbt	Hbt_CV	Cbt	Cbt_CV	Priv	Priv_CV
1981	305	0.710	488	0.710	179,403	0.730
1982	4,839	1.000	7,736	1.000	13,169	0.660
1983	0	0.000	0	0.000	4,470	1.000
1984	2,367	1.000	3,784	1.000	0	0.000
1985	1,429	1.000	2,285	1.000	925	1.000
1986	137	0.630	7,325	0.630	13,528	0.850
1987	549	0.400	42,598	0.400	113,799	0.370
1988	1,485	0.860	64,906	0.860	9,133	0.470
1989	1,135	0.450	35,092	0.450	323,028	0.590
1990	5,508	0.400	80,687	0.400	772,205	0.590
1991	10,101	0.290	196,019	0.290	1,587,532	0.290
1992	19,402	0.200	317,612	0.200	1,315,577	0.170
1993	7,273	0.450	260,033	0.450	1,657,182	0.230
1994	13,405	0.240	273,364	0.240	940,422	0.240
1995	19,777	0.430	401,693	0.430	226,084	0.320
1996	20,721	0.290	486,469	0.290	1,014,854	0.260
1997	48,054	0.250	848,272	0.250	2,268,032	0.250
1998	37,799	0.110	676,954	0.110	1,112,842	0.220
1999	55,915	0.090	858,452	0.090	2,683,990	0.220
2000	48,138	0.080	504,744	0.080	2,562,346	0.230
2001	46,240	0.100	571,539	0.100	4,372,757	0.190
2002	47,613	0.090	555,125	0.090	6,425,866	0.220
2003	48,924	0.090	573,352	0.090	4,349,158	0.200
2004	45,552	0.090	613,631	0.090	4,505,055	0.190
2005	39,288	0.090	571,953	0.090	4,028,055	0.180
2006	61,514	0.110	803,201	0.110	4,173,109	0.160
2007	57,591	0.110	685,094	0.110	5,695,976	0.160
2008	94,052	0.090	486,489	0.110	4,356,132	0.210
2009	94,201	0.050	475,856	0.120	3,836,628	0.170
2010	52,800	0.060	226,653	0.150	4,425,910	0.190
2011	82,104	0.050	375,945	0.120	3,729,516	0.170
2012	71,576	0.080	258,458	0.120	3,971,312	0.160
2013	80,013	0.050	402,950	0.210	4,871,390	0.300
2014	59,827	0.050	281,548	0.170	3,864,994	0.220
2015	53,346	0.050	258,410	0.150	3,157,763	0.190
2016	81,816	0.050	416,808	0.190	5,482,595	0.170
2017	115,406	0.050	537,942	0.200	8,266,634	0.170
2018	95,229	0.050	422,031	0.150	5,025,444	0.190
2019	77,428	0.050	497,158	0.250	5,764,684	0.170

Table 4.12.13. Total recreational discard estimates (B2) for Gulf of Mexico Red Snapper combined across all surveys (MRIP and SRHS) by year and mode for the **East region**. Associated coefficients of variation (CV) are also provided.

Year	Hbt	Hbt_CV	Cbt	Cbt_CV	Priv	Priv_CV
1981	0	0.000	0	0.000	76,357	0.710
1982	247	1.000	396	1.000	0	0.000
1983	0	0.000	0	0.000	0	0.000
1984	2,248	1.000	3,594	1.000	82,405	0.790
1985	630	1.000	1,007	1.000	41,324	0.810
1986	119	0.450	17,128	0.450	11,688	0.710
1987	60	1.000	1,642	1.000	3,103	0.710
1988	0	0.000	0	0.000	35,687	0.480
1989	0	0.000	0	0.000	7,022	0.710
1990	0	0.000	0	0.000	21,540	1.000
1991	0	0.000	0	0.000	78,277	0.420
1992	5	0.680	1,018	0.680	80,073	0.440
1993	0	0.000	0	0.000	29,726	0.470
1994	66	1.000	57	1.000	38,864	0.590
1995	0	0.000	0	0.000	13,967	0.780
1996	0	0.000	0	0.000	35,811	0.490
1997	4	1.000	543	1.000	25,990	1.000
1998	34	0.530	3,075	0.530	65,605	0.590
1999	1,889	0.780	1,918	0.780	49,859	0.460
2000	236	0.740	259	0.740	67,724	0.690
2001	503	0.730	2,759	0.730	5,729	1.000
2002	0	0.000	0	0.000	6,874	1.000
2003	253	0.900	2,878	0.900	4,989	0.720
2004	672	0.530	693	0.530	92,594	0.750
2005	1,359	0.600	1,566	0.600	129,180	0.480
2006	537	0.530	17,678	0.530	55,316	0.540
2007	591	0.630	2,232	0.630	43,270	0.520
2008	3,919	0.066	16,106	0.760	40,481	0.620
2009	5,841	0.055	17,656	0.650	102,835	0.670
2010	1,530	0.098	4,049	0.770	129,468	0.560
2011	6,295	0.065	1,948	0.950	1,500,578	0.980
2012	2,099	0.054	1,344	0.890	14,288	1.000
2013	1,575	0.050	11,196	0.920	8,516	0.490
2014	1,820	0.050	9,079	0.540	49,385	0.590
2015	1,489	0.050	15,142	0.660	24,001	0.630
2016	11,350	0.050	42,282	0.430	708,161	0.660
2017	15,268	0.054	160,004	0.710	260,727	0.340
2018	14,257	0.052	59,027	0.370	647,039	0.400
2019	12,680	0.051	25,160	0.380	395,152	0.360

Table 4.12.14. Summary of weight measurements (pounds whole weight) from MRIP-intercepted Red Snapper by state and year. Summaries include the number of fish weighed by MRIP (Fish), the number of angler trips from which those fish were weighed (Trp), and the minimum (Min), geometric mean (Avg), and maximum (Max) size of fish weights. LA weights are available from MRIP only until 2013.

	West					Central					East				
Year	Fish	Trp	Min	Avg	Max	Fish	Trp	Min	Avg	Max	Fish	Trp	Min	Avg	Max
1981	208	35	0.4	3.1	15.4	299	49	0.2	2.7	22.0	54	13	0.2	1.7	11.0
1982	329	52	0.2	1.6	15.7	557	126	0.2	2.1	10.8	6	3	0.9	3.4	11.5
1983	1,640	255	0.2	1.8	51.6	906	178	0.2	1.7	12.9	106	66	0.7	3.9	27.4
1984	986	191	0.0	3.5	50.0	304	73	0.2	1.9	9.5	61	28	0.2	2.3	8.0
1985	878	136	0.1	1.6	19.7	426	111	0.2	2.3	16.6	39	22	0.2	2.7	9.8
1986	1,075	167	0.1	1.8	27.9	904	257	0.4	3.4	22.2	99	43	1.5	4.5	19.4
1987	820	132	0.2	1.8	22.9	1,155	214	0.2	2.8	26.1	32	12	0.7	4.6	19.2
1988	453	122	0.1	1.7	25.5	194	158	0.3	2.9	10.8	19	15	2.5	3.9	7.1
1989	389	96	0.2	2.1	17.3	558	119	0.5	3.0	22.7	24	5	0.9	1.9	4.0
1990	482	123	0.2	1.9	12.9	453	93	0.7	3.0	25.5	5	4	1.6	7.1	11.4
1991	944	160	0.2	3.0	35.2	1,364	198	0.8	3.1	30.6	5	4	2.0	4.7	8.3
1992	1,221	242	0.6	3.0	29.9	2,743	395	0.4	3.3	38.0	11	7	1.5	4.7	17.7
1993	1,093	221	0.3	3.1	22.1	1,629	266	0.6	3.7	27.0	0	0	0.0	0.0	0.0
1994	1,439	292	0.1	3.3	29.0	1,275	232	0.6	3.9	27.7	1	1	4.0	4.0	4.0
1995	2,194	451	0.0	3.4	23.8	760	159	1.0	3.6	21.8	1	1	15.2	15.2	15.2
1996	1,723	371	0.2	3.8	29.0	873	185	0.3	4.6	31.2	13	7	1.9	5.1	15.0
1997	1,653	364	0.8	3.9	23.8	2,501	363	1.1	5.3	43.9	21	6	0.9	4.9	26.7
1998	1,591	322	0.2	4.4	26.3	4,515	466	0.3	4.0	32.0	32	11	0.8	2.4	4.9
1999	960	225	0.4	4.4	34.3	9,717	849	0.2	5.7	52.5	36	13	1.3	4.4	25.9
2000	1,279	281	0.3	4.0	26.3	10,058	886	0.6	4.6	50.3	5	4	2.2	4.5	8.9
2001	1,015	236	0.3	3.4	22.3	8,102	680	0.7	4.8	36.1	22	8	1.9	6.2	14.9
2002	1,361	273	0.5	4.2	20.2	9,560	719	1.0	4.6	40.6	19	7	2.0	4.2	13.6
2003	1,453	275	0.3	4.2	29.2	8,507	775	1.1	4.7	41.1	59	12	1.5	3.4	8.2
2004	1,429	268	0.2	3.3	21.5	8,361	947	1.1	3.5	30.4	21	9	2.4	4.5	9.0
2005	1,598	327	0.3	3.8	25.5	6,975	765	1.3	3.3	23.8	77	23	1.8	3.7	10.8
2006	2,271	426	0.6	3.5	28.1	5,776	631	0.6	3.1	25.9	38	10	1.8	3.6	13.9
2007	1,879	322	0.5	3.6	19.1	6,453	700	0.7	3.1	25.9	31	10	2.2	3.6	8.5
2008	1,052	232	0.2	4.6	31.5	3,262	482	1.5	3.9	21.1	34	11	1.7	5.1	16.6
2009	1,243	254	0.1	5.7	23.8	1,904	330	1.9	5.2	24.3	16	9	2.8	5.3	8.4
2010	645	131	0.3	5.9	21.1	1,884	290	1.1	5.4	27.0	34	8	2.3	6.7	13.3
2011	943	197	0.3	5.8	19.5	1,918	303	1.1	6.1	27.3	15	5	4.1	6.1	12.5
2012	947	203	0.6	6.4	26.5	2,135	348	0.6	7.0	25.4	26	5	1.9	6.3	13.2
2013	1,287	264	0.4	5.8	29.3	1,579	351	1.2	7.6	24.4	31	6	2.4	7.3	13.4
2014	1,685	293	0.4	7.2	28.1	1,585	346	1.6	6.9	22.0	47	13	2.2	6.8	13.1
2015	2,499	432	0.3	6.6	22.8	2,242	497	0.4	6.7	25.8	45	7	3.2	6.3	17.0
2016	1,818	310	0.4	7.0	24.3	2,873	660	0.9	7.0	31.9	66	24	1.3	4.7	15.0
2017	2,682	473	0.6	6.9	28.2	2,766	694	0.4	6.5	25.4	176	43	0.7	4.1	22.0
2018	3,110	580	0.2	7.3	25.6	2,664	555	1.1	6.7	25.4	164	28	1.8	5.5	19.4
2019	2,858	541	0.3	6.5	25.9	3,363	678	1.2	6.3	25.4	193	42	1.6	5.5	15.0

Table 4.12.15. Summary of weight measurements (pounds whole weight) from SRHS-intercepted Red Snapper by state and year. Summaries include the number of fish weighed by SRHS (Fish), the number of angler trips from which those fish were weighed (Trips), and the minimum (Min), geometric mean (Mean), and maximum (Max) size of fish weights.

	West					Central					East				
Year	Fish	Min	Mean	SD	Max	Fish	Min	Mean	SD	Max	Fish	Min	Mean	SD	Max
1986	6,252	0.02	1.32	1.674	24.91	141	0.40	2.26	2.378	17.42	23	1.04	4.00	3.994	15.21
1987	5,978	0.18	1.35	1.513	30.75	191	0.40	2.97	5.027	39.68	1	3.31	3.31		3.31
1988	4,607	0.06	1.88	2.633	27.56	195	0.66	2.40	2.373	19.84	1	1.87	1.87		1.87
1989	6,320	0.22	1.64	1.935	22.38	280	0.33	2.24	2.097	15.06	6	2.65	6.30	3.312	11.35
1990	4,263	0.33	1.87	1.802	27.14	330	0.49	2.12	1.532	14.24	3	11.11	16.15	5.683	22.31
1991	3,422	0.02	1.96	1.706	29.63	496	0.62	2.25	1.649	12.74	1	3.57	3.57		3.57
1992	7,877	0.49	2.29	2.048	30.05	682	0.49	2.16	1.446	12.37	1	5.25	5.25		5.25
1993	7,056	0.73	2.67	2.600	33.16	385	0.66	2.25	1.617	10.80					
1994	6,645	0.68	2.92	2.717	23.55	806	0.29	3.00	2.481	21.34	510	0.35	2.92	2.562	14.75
1995	8,327	0.57	3.60	3.345	28.15	441	1.06	3.18	2.856	24.65					
1996	5,261	0.04	3.40	2.770	24.63	496	0.53	2.98	2.150	19.09					
1997	3,999	0.82	4.08	2.997	25.51	1,142	0.51	2.44	1.661	20.70					
1998	6,557	0.09	3.94	3.447	32.61	2,158	0.79	2.44	1.289	19.22					
1999	3,285	1.10	4.79	3.592	30.23	839	0.60	2.88	1.500	15.01	45	1.54	3.17	1.191	7.08
2000	3,196	0.07	3.73	2.597	29.37	1,131	0.44	3.04	1.837	15.17	5	2.98	3.61	0.529	4.21
2001	2,535	0.22	3.83	2.694	24.80	649	0.95	3.29	2.138	17.72	5	5.78	9.06	2.635	11.68
2002	2,385	0.15	4.06	2.791	24.76	1,250	1.17	2.91	1.583	25.35					
2003	2,008	0.02	3.83	3.083	22.22	1,086	1.41	3.13	1.809	21.52	3	2.84	3.51	0.577	3.90
2004	808	1.43	3.44	2.752	25.22	543	1.72	3.11	1.627	18.89	1	2.78	2.78		2.78
2005	1,016	1.54	3.50	2.692	23.74	301	1.57	3.09	1.847	18.08	2	2.16	2.25	0.125	2.34
2006	767	0.04	3.70	3.613	40.39	464	1.15	2.58	1.146	13.32	17	1.87	2.35	0.703	4.67
2007	768	0.62	3.23	1.814	16.29	1,264	0.64	2.66	0.971	11.62	16	1.72	2.95	0.791	5.25
2008	401	1.10	4.40	2.487	24.03	1,221	0.49	2.95	1.108	10.49	2	8.02	8.92	1.263	9.81
2009	866	0.99	6.26	3.281	23.59	911	0.60	3.78	2.006	14.73	36	2.05	4.22	1.708	7.89
2010	796	1.81	5.43	2.614	16.25	687	1.85	3.94	2.024	16.05	21	2.18	6.29	3.863	16.95
2011	978	1.92	6.79	3.094	17.33	722	0.40	4.63	2.580	20.88	15	3.09	5.95	1.705	8.86
2012	456	1.03	8.34	3.380	25.88	575	0.60	5.61	4.904	44.84	32	2.01	7.69	3.759	18.98
2013	2,299	0.11	5.68	2.441	23.46	1,057	0.46	4.80	3.063	20.85	19	2.27	5.08	3.367	13.29
2014	4,773	0.49	5.88	2.376	20.24	2,101	0.09	5.20	3.494	23.77	49	2.07	7.87	4.535	17.84
2015	4,013	0.33	6.00	2.382	22.49	2,138	0.46	5.27	3.529	25.35	126	1.96	6.01	4.304	18.01
2016	3,793	0.46	5.88	2.346	26.30	674	1.41	5.42	3.942	36.73	32	1.87	4.24	3.264	14.00
2017	2,887	0.60	5.94	2.352	25.02	754	1.26	4.48	2.867	24.78	78	1.98	3.36	2.427	16.62
2018	3,936	0.49	6.41	2.847	29.01	650	1.61	4.62	3.200	21.89	94	1.76	4.23	1.948	10.87
2019	3,788	0.42	6.12	2.612	22.75	1,413	0.62	4.06	2.726	23.77	96	2.25	5.73	2.645	14.22

Table 4.12.16. Associated sample sizes by stock and mode for length compositions in the three time periods shown in Figure 4.13.8.

	West			Central			East		
	CB	**HB**	**PR**	**CB**	**HB**	**PR**	**CB**	**HB**	**PR**
1981 - 2006	8,180	92,512	24,060	83,159	13,998	6,882	228	624	130
2007 - 2012	4,735	4,265	6,884	15,833	5,380	2,007	347	122	71
2013 - 2019	6,101	25,489	12,910	13,101	8,787	8,963	1,267	494	597

Table 4.12.17. Temporal aggregation of modes within the Eastern Stock to meet minimum sample size thresholds for estimating length and age compositions.

	Length Samples			Age Samples		
Time Period	**E_HB**	**E_CB**	**E_PR**	**E_HB**	**E_CB**	**E_PR**
1981-2006	812	228	130	211	141	5
2007-2009	423	105	30	371	73	13
2010-2012	883	242	41	627	209	26
2013-2015	482	356	30	461	243	19
2016-2017	416	261	428	197	90	277
2018	328	304	73	236	207	40
2019	294	346	66	189	207	14

Table 4.12.18. Annual number of recreational headboat (HB), charter boat (CB), and private (PR) age samples by stock.

Year	W_HB	W_CB	W_PR	C_HB	C_CB	C_PR	E_HB	E_CB	E_PR
1986	348	0	0	1	0	0	1	0	0
1987	146	0	0	0	0	0	0	0	0
1988	350	0	0	1	0	0	0	0	0
1989	82	0	0	0	0	0	1	0	0
1990	36	0	0	0	0	0	0	0	0
1991	102	526	0	20	237	0	0	2	0
1992	26	485	0	70	347	2	5	0	0
1993	910	189	24	254	370	0	0	62	0
1994	385	0	0	170	423	0	53	0	0
1995	10	0	0	11	360	0	0	0	0
1996	0	0	0	95	100	0	0	0	0
1997	0	0	0	95	56	0	1	0	0
1998	957	135	212	669	945	237	1	1	0
1999	263	97	75	351	658	581	14	0	0
2000	250	2	3	139	504	0	1	2	0
2001	74	0	0	217	377	1	1	11	0
2002	205	245	322	219	2,506	309	0	15	0
2003	139	229	600	70	6,022	353	2	35	3
2004	168	400	627	63	3,815	197	1	3	0
2005	205	422	815	48	5,089	194	52	5	0
2006	205	238	1,081	109	3,383	251	78	5	2
2007	67	475	530	185	402	64	7	14	1
2008	133	467	340	146	366	30	46	7	10
2009	428	427	323	367	520	73	318	52	2
2010	393	49	434	236	1,269	58	240	122	13
2011	660	413	130	185	1,138	80	260	73	13
2012	361	401	380	227	1,670	157	127	14	0
2013	1,471	615	313	665	1,987	113	155	21	7
2014	1,230	241	515	2,890	835	314	103	81	12
2015	998	455	381	2,337	1,807	650	203	141	0
2016	723	341	568	321	1,307	858	39	24	10
2017	1,070	529	433	385	899	581	158	66	267
2018	1,062	601	515	709	1,232	815	236	207	40
2019	1,059	382	540	770	1,331	649	189	207	14

Table 4.12.19. Annual number of recreational headboat (HB), charter boat (CB), and private (PR) trips sampled for ages by stock.

Year	W_HB	W_CB	W_PR	C_HB	C_CB	C_PR	E_HB	E_CB	E_PR
1986	58	0	0	1	0	0	1	0	0
1987	47	0	0	0	0	0	0	0	0
1988	69	0	0	0	0	0	0	0	0
1989	27	0	0	0	0	0	1	0	0
1990	11	0	0	0	0	0	0	0	0
1991	5	29	0	10	43	0	0	1	0
1992	6	27	0	23	62	1	1	0	0
1993	107	9	1	90	69	0	0	2	0
1994	57	0	0	68	73	0	13	0	0
1995	2	0	0	8	52	0	0	0	0
1996	0	0	0	31	29	0	0	0	0
1997	0	0	0	46	11	0	1	0	0
1998	87	6	10	144	42	19	1	1	0
1999	33	1	10	74	41	12	3	0	0
2000	54	1	0	29	60	0	1	0	0
2001	19	0	0	34	52	1	1	3	0
2002	42	23	33	41	134	39	0	5	0
2003	23	32	55	24	3,973	63	2	15	3
2004	31	35	68	37	2,970	84	1	3	0
2005	28	44	106	12	4,290	55	52	5	0
2006	27	25	84	44	2,497	76	78	5	2
2007	13	51	49	46	137	22	7	14	1
2008	11	41	43	146	165	10	46	6	10
2009	50	52	50	219	242	23	318	52	2
2010	31	4	26	141	1,123	20	240	122	13
2011	44	30	20	113	674	64	260	73	13
2012	30	32	29	113	1,202	73	127	14	0
2013	119	46	34	243	1,617	58	151	20	7
2014	135	26	56	1,567	678	263	67	29	12
2015	153	41	51	280	286	134	24	22	0
2016	87	34	58	52	168	232	13	9	6
2017	80	56	53	62	129	144	24	16	63
2018	130	79	67	102	197	172	40	39	14
2019	139	44	61	125	232	150	30	45	9

Table 4.12.20. Summary statistics for discard length frequency data provided by Mississippi, Alabama, and Florida. Data from Mississippi, Alabama and northwest Florida (NWFL) correspond with the central stock assessment region, and southwest Florida (SWFL) corresponds with the eastern stock assessment region.

HEADBOAT FLEET																
	MISSISSIPPI				**ALABAMA**				**NWFL**				**SWFL**			
YEAR	*N*	*Min*	*Mean*	*Max*	*N*	*Min*	*Mean*	*Max*	*N*	*Min*	*Mean*	*Max*	*N*	*Min*	*Mean*	*Max*
2005					1197	180	306	491	1672	157	316.4	552	133	190	418.5	657
2006					1411	182	292.2	800	2038	191	317.3	634	260	207	364.3	622
2007					1165	204	314.2	459	2788	127	326.2	655	112	300	433.8	635
2009									423	214	349	684	208	241	461.1	760
2010									406	236	357.7	725	283	287	501	752
2011									578	255	410.6	750	527	304	481.1	790
2012									796	196	389.1	751	96	325	495.3	708
2013									555	240	376.1	704	84	270	457.1	720
2015									516	171	376.5	690	21	290	394.9	560
2016	21	283	366.3	510					867	190	353.1	747	358	180	358.6	675
2017	189	208	341.1	522					797	208	355.2	787	244	250	396.8	686
2018	95	284	341.2	385					636	200	360.2	870	416	215	409.4	742
2019	87	260	338.8	528					801	209	366.9	660	516	164	430.5	727
2020	78	228	322.7	371					107	248	388.2	580				
CHARTER FLEET																
	MISSISSIPPI				**ALABAMA**				**NWFL**				**SWFL**			
YEAR	*N*	*Min*	*Mean*	*Max*	*N*	*Min*	*Mean*	*Max*	*N*	*Min*	*Mean*	*Max*	*N*	*Min*	*Mean*	*Max*
2009									529	245	379.7	780	18	345	429.2	580
2010									1174	236	417.2	813	28	349	489.6	662
2011									1289	143	426	940	3	515	570	640
2012									885	221	431.3	954	16	300	388.8	474
2013									944	213	379.8	825	9	320	426.6	602
2015									436	205	382.9	770	123	290	457.7	630
2016	139	232	354.1	542					841	189	365.3	852	191	250	347.5	450
2017	160	204	369.4	613	42	230	403.6	800	804	159	365.9	818	239	290	404.6	724
2018	100	283	334.6	400	3	423	453	509	760	167	354.8	724	420	259	445.7	766
2019	98	258	362	636	248	149	386.2	735	781	204	372.7	819	276	230	439.7	719
2020	47	232	362.6	545					65	266	364.9	620	61	225	372.5	566

Table 4.12.21. Annual effort estimates for Texas and Louisiana anglers from MRIP (LA 1981-2013), LACR (LA 2014+), and TPWD (TX 1983+). All estimates for the private mode are calibrated into MRIP-FES units, the methods of which are described in SEDAR 74-DW-04 (LACR) and SEDAR 74-DW-10 (TPWD).

	TX		LA		
Year	Cbt	Priv	Cbt	Hbt	Priv
1981			82,560	7,216	2,795,268
1982			78,798	6,887	3,448,692
1983	31,110	5,717,248	91,690	8,014	3,637,251
1984	24,175	6,753,183	96,331	8,419	3,378,932
1985	30,753	7,410,952	92,596	8,093	3,420,068
1986	26,520	7,392,606	68,898		3,299,210
1987	31,108	9,354,116	86,823		3,182,763
1988	27,877	9,043,534	97,770		3,090,098
1989	43,233	8,156,959	111,340		3,279,304
1990	34,753	7,912,144	102,374		3,519,980
1991	49,848	7,910,706	112,035		3,594,434
1992	48,351	8,903,857	106,907		3,813,484
1993	54,519	9,187,859	112,686		3,930,692
1994	90,792	9,877,312	113,883		3,874,700
1995	74,051	9,902,718	115,195		3,946,252
1996	75,535	9,850,042	114,007		4,145,783
1997	95,031	8,711,458	116,288		4,330,619
1998	109,561	8,883,670	116,717		4,412,813
1999	115,950	10,706,000	118,518		4,848,823
2000	156,167	10,500,486	85,432		5,333,517
2001	140,795	8,746,968	126,340		5,447,482
2002	136,952	8,698,453	96,617		5,099,412
2003	118,479	9,264,535	129,492		5,138,240
2004	122,918	9,428,899	141,868		4,827,449
2005	101,456	8,691,226	122,463		4,326,928
2006	151,309	9,305,355	179,262		4,378,135
2007	148,673	8,054,536	142,508		4,756,911
2008	144,307	7,944,532	151,643		5,236,730
2009	118,940	8,790,021	168,141		5,730,837
2010	126,061	8,114,013	76,240		6,098,096
2011	158,261	9,064,548	96,787		5,944,122
2012	217,675	8,529,423	108,457		5,730,292
2013	146,500	9,278,528	121,871		5,476,618
2014	139,144	8,980,071	130,622		4,478,621
2015	144,344	8,455,671	159,794		4,840,531
2016	157,318	9,962,788	179,238		4,406,514
2017	187,850	8,883,595	178,723		4,549,944
2018	304,925	8,890,396	183,313		4,470,872
2019	366,757	8,478,839	168,571		4,144,552

Table 4.12.22. Estimated SRHS headboat effort (in angler days) for Gulf of Mexico.

Year	West	Central	East
1986	62,459	101,336	138,741
1987	69,725	76,111	140,938
1988	78,087	67,648	128,300
1989	66,256	57,233	151,092
1990	65,042	60,758	153,148
1991	66,342	62,392	111,920
1992	86,129	66,180	118,622
1993	92,160	73,703	134,195
1994	113,429	69,110	135,452
1995	100,962	67,798	114,612
1996	102,840	64,336	90,577
1997	91,215	65,599	83,843
1998	85,504	66,664	118,667
1999	66,261	60,959	115,158
2000	63,347	57,106	102,225
2001	61,583	55,748	101,495
2002	73,173	55,554	86,277
2003	81,068	62,555	81,656
2004	64,990	63,494	94,936
2005	59,857	52,797	77,436
2006	75,794	66,346	57,703
2007	66,286	67,997	68,883
2008	44,133	62,118	68,058
2009	54,005	65,623	76,815
2010	47,371	41,092	70,424
2011	49,170	79,074	79,722
2012	53,615	79,611	84,205
2013	57,328	67,352	109,206
2014	52,865	73,381	119,607
2015	56,799	70,388	125,918
2016	55,368	75,716	125,932
2017	53,131	72,764	125,526
2018	53,698	73,673	119,871
2019	53,714	66,877	120,271

Table 4.12.23. Total recreational fishing effort (in angler trips) for Gulf of Mexico by mode and year (MRIP, SRHS, TPWD, and LA Creel). The combined private-shore mode in the LA Creel survey is allocated as private fishing. MRIP headboat estimates are used from 1981-1985 and SRHS from 1986+.

West				Central				East		
Cbt	Hbt	Priv	Total	Cbt	Hbt	Priv	Total	Cbt	Hbt	Priv
82,560	7,216	2,795,268	2,885,044	92,371	40,577	2,722,546	2,855,494	179,341	94,998	6,669,133
78,798	6,887	3,448,692	3,534,377	258,200	137,252	2,837,465	3,232,917	291,431	116,772	7,673,280
122,800	8,014	9,354,499	9,485,312	193,924	85,454	2,371,474	2,650,852	320,524	163,025	9,567,170
120,507	8,419	10,132,114	10,261,040	200,779	97,182	3,634,221	3,932,183	280,455	136,610	10,368,065
123,349	8,093	10,831,019	10,962,461	169,617	83,937	5,626,228	5,879,782	358,028	185,486	6,675,184
95,418	70,752	10,691,816	10,857,986	233,049	109,501	4,881,068	5,223,618	306,934	149,920	6,971,520
117,932	81,749	12,536,880	12,736,560	354,826	94,606	4,549,524	4,998,956	221,501	175,186	8,263,928
125,647	83,764	12,133,632	12,343,043	269,988	95,117	4,375,597	4,740,702	165,651	180,397	9,950,151
154,572	75,876	11,436,264	11,666,712	298,724	77,740	4,342,397	4,718,861	262,506	205,230	10,559,047
137,127	76,780	11,432,124	11,646,032	203,569	84,679	2,736,932	3,025,180	329,791	213,445	12,548,217
161,884	81,337	11,505,140	11,748,360	311,368	84,919	2,929,846	3,326,133	264,410	152,329	13,535,909
155,258	96,090	12,717,341	12,968,689	248,411	88,649	2,717,482	3,054,542	280,064	158,896	13,197,651
167,205	100,043	13,118,550	13,385,798	278,841	92,904	3,904,041	4,275,787	338,681	169,155	13,049,759
204,675	118,160	13,752,012	14,074,847	291,234	91,884	4,175,935	4,559,053	330,960	180,088	12,616,507
189,246	105,772	13,848,971	14,143,989	321,550	96,121	3,531,534	3,949,205	430,644	162,491	13,961,044
189,542	107,764	13,995,824	14,293,131	355,761	95,265	4,106,273	4,557,299	337,673	134,122	13,329,241
211,319	94,157	13,042,077	13,347,553	266,302	90,340	3,911,918	4,268,560	390,600	115,464	14,809,162
226,278	90,553	13,296,483	13,613,313	271,509	84,811	4,076,075	4,432,394	412,702	150,970	15,053,774
234,467	48,435	15,554,823	15,837,725	297,159	59,167	5,622,320	5,978,646	344,852	111,772	14,986,982
241,598	72,056	15,834,002	16,147,656	249,153	81,259	5,999,721	6,330,133	383,788	145,461	13,800,980
267,136	64,516	14,194,451	14,526,102	237,119	73,549	7,111,168	7,421,836	414,969	133,904	14,842,138
233,569	69,614	13,797,866	14,101,048	253,721	74,590	6,535,509	6,863,820	438,705	115,841	14,559,599
247,971	82,703	14,402,775	14,733,449	253,435	84,091	7,359,201	7,696,727	359,193	109,768	14,904,967
264,785	65,024	14,256,348	14,586,158	275,823	84,474	8,659,644	9,019,942	415,559	126,306	17,729,380
223,918	62,093	13,018,155	13,304,166	234,442	72,310	8,049,871	8,356,623	360,612	106,056	16,748,668
330,571	77,265	13,683,490	14,091,326	250,705	91,581	9,100,702	9,442,987	376,844	79,650	14,120,517
291,181	144,368	12,811,447	13,246,997	280,888	92,156	9,690,632	10,063,676	442,659	93,357	14,052,639
295,950	29,253	13,181,262	13,506,465	239,033	88,627	9,293,163	9,620,824	428,988	97,102	16,866,891
287,082	58,088	14,520,858	14,866,028	230,831	95,052	8,713,701	9,039,584	411,350	111,263	15,025,847
202,300	49,354	14,212,109	14,463,764	125,729	58,778	8,715,899	8,900,407	405,290	100,979	15,750,729
255,048	52,086	15,008,670	15,315,804	262,264	113,677	9,482,632	9,858,573	385,671	115,375	15,094,221
326,132	61,588	14,259,715	14,647,436	275,000	116,010	10,735,788	11,126,798	510,293	123,479	16,327,654
268,371	60,222	14,755,146	15,083,739	279,468	107,828	9,025,293	9,412,589	507,462	125,369	16,280,391
269,766	56,390	13,458,692	13,784,848	284,955	119,593	7,535,770	7,940,318	512,429	136,898	14,846,796
304,138	60,863	13,296,202	13,661,203	370,346	116,572	7,877,969	8,364,887	536,523	142,852	12,545,628
336,556	58,404	14,369,303	14,764,262	333,618	122,944	8,764,593	9,221,155	599,637	145,467	12,861,680
366,573	56,345	13,433,539	13,856,458	336,785	120,773	10,137,744	10,595,303	545,357	144,133	12,033,494
488,238	55,932	13,361,269	13,905,438	341,321	125,490	9,120,022	9,586,833	597,816	134,783	11,566,078
535,328	54,967	12,623,392	13,213,686	378,050	113,422	8,194,723	8,686,194	762,322	135,341	10,222,218

4.13 FIGURES

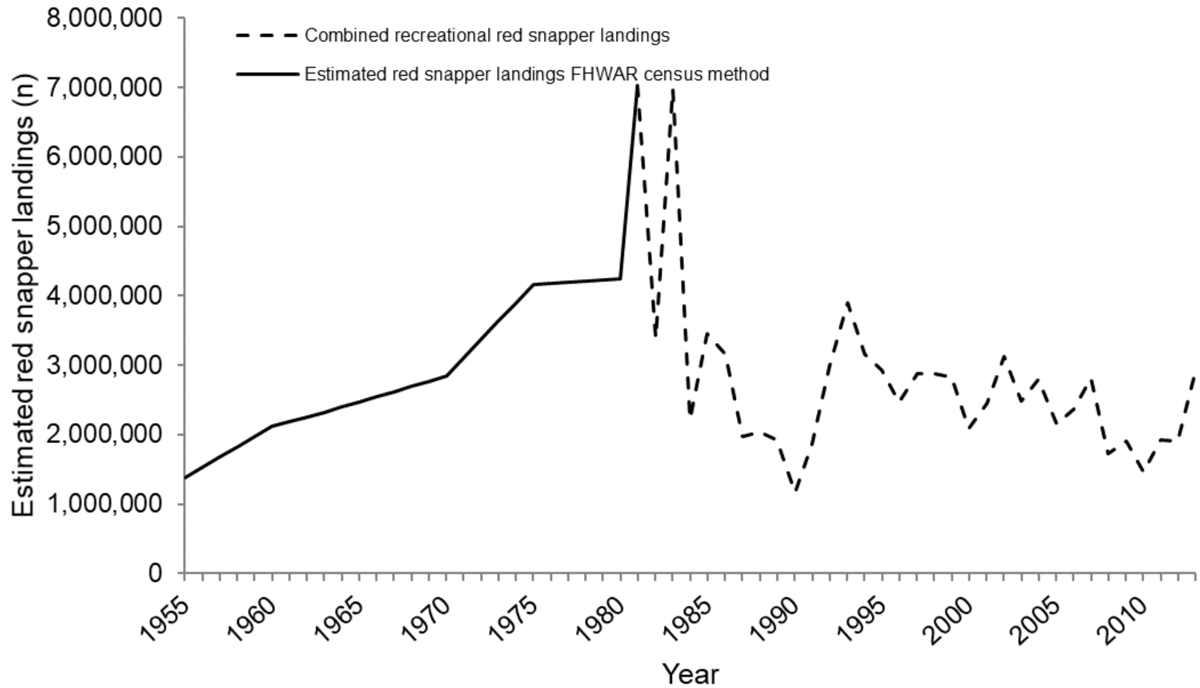


Figure 4.13.1. Historical landings in number of fish (FHWAR method using 9-year average CPUE 1981-1989).

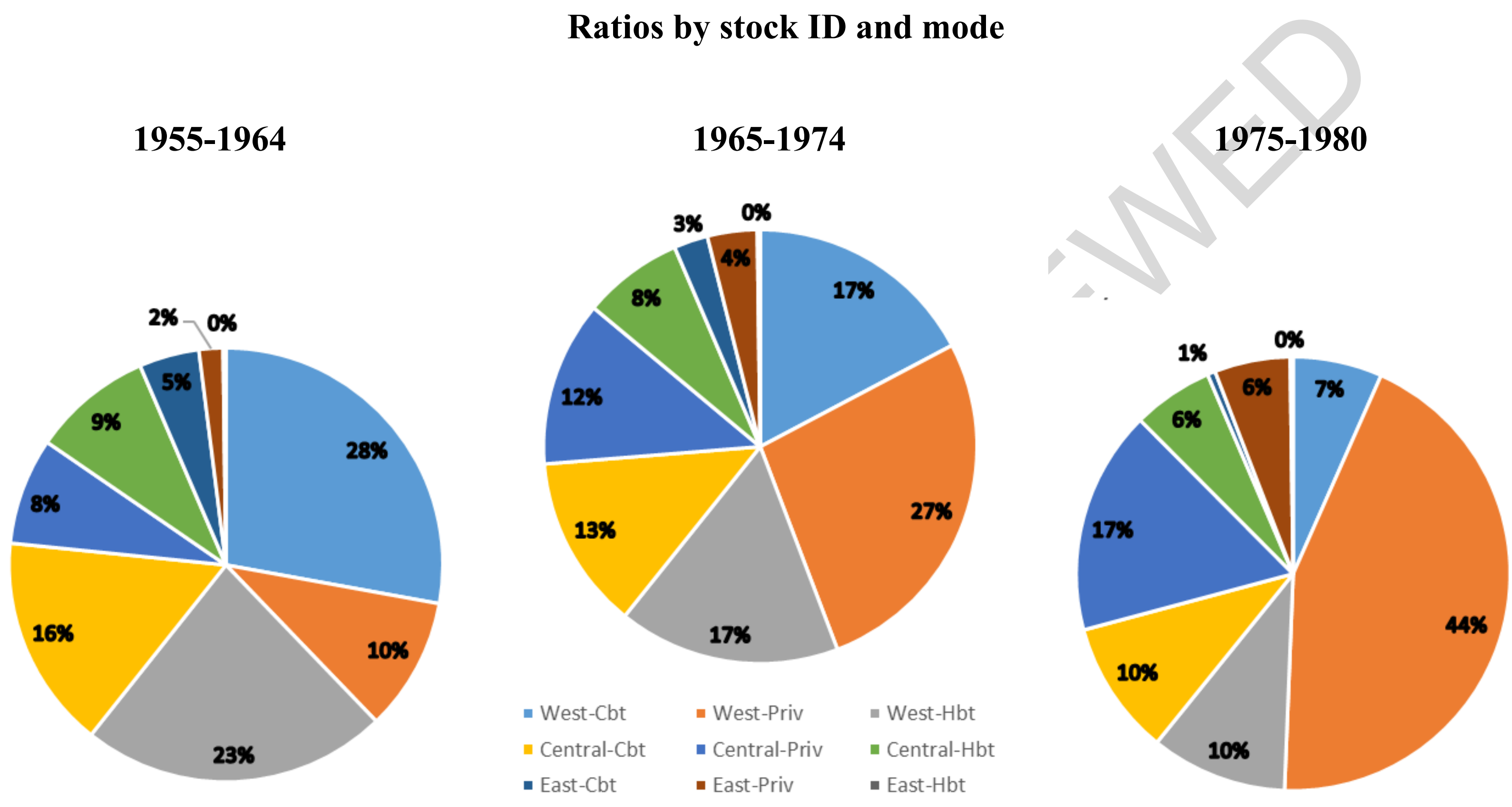


Figure 4.13.2. Adjusted ratios used in FWHAR method for estimating historical Red Snapper recreational landings from 1955 to 1980 by stock ID region, mode, and time period.

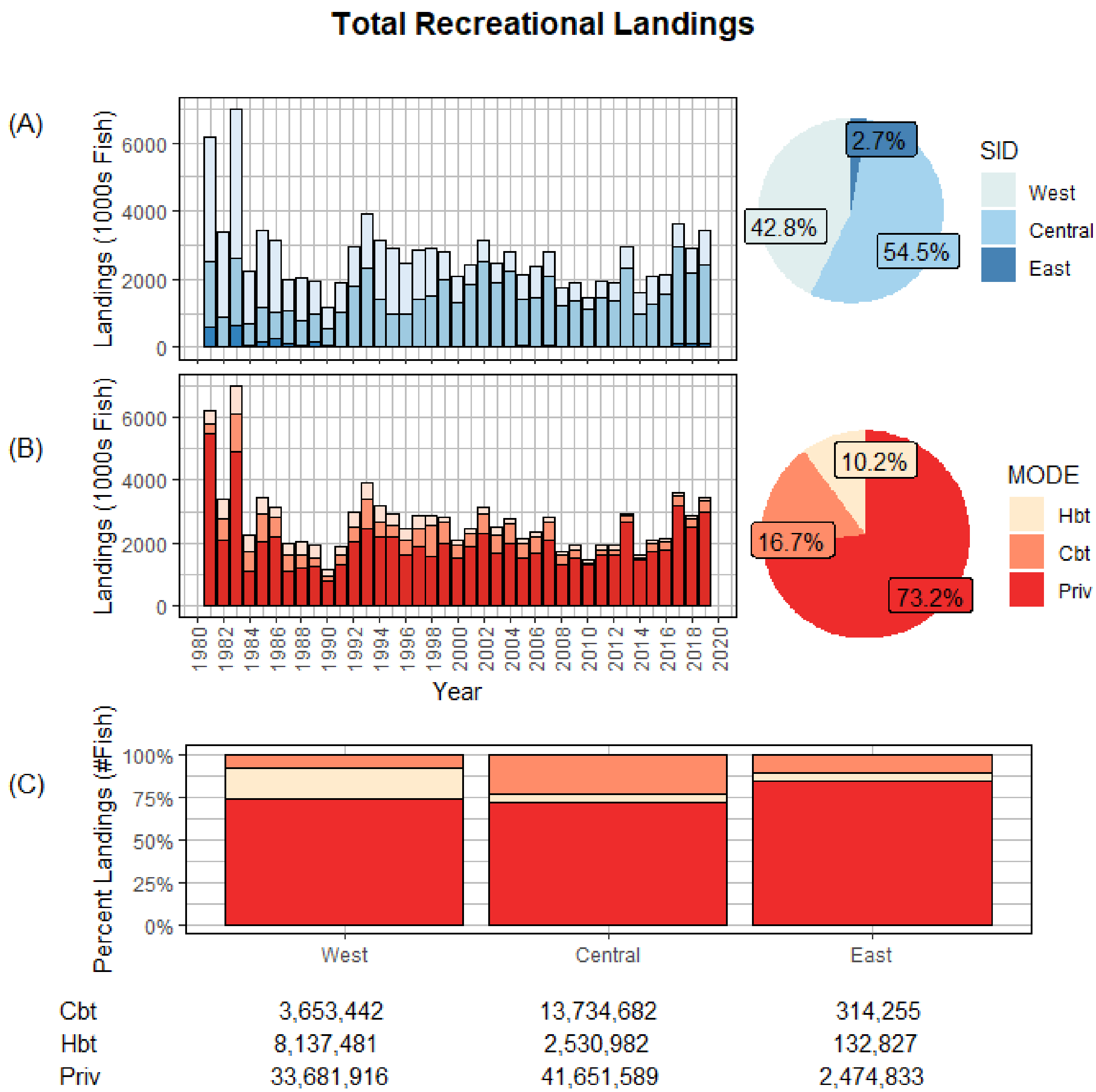


Figure 4.13.3. Total recreational landings (AB1) for Gulf of Mexico Red Snapper across all surveys (MRIP, SRHS, TPWD, and LA Creel). Landings are provided (A) by state and year (1981-2019) in thousands of fish, (B) by mode and year in thousands of fish, and (C) by mode and state in numbers of fish (as a percentage). The combined private-shore mode in the LA Creel survey is allocated as private fishing. MRIP headboat estimates are used from 1981-1985 and SRHS from 1986+.

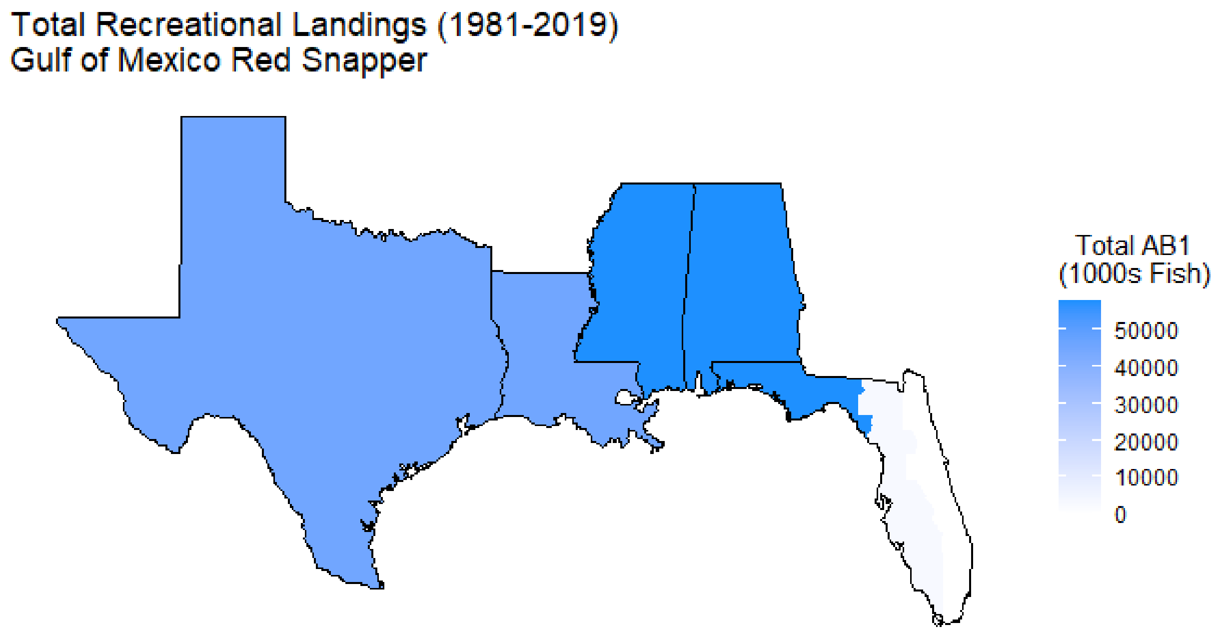
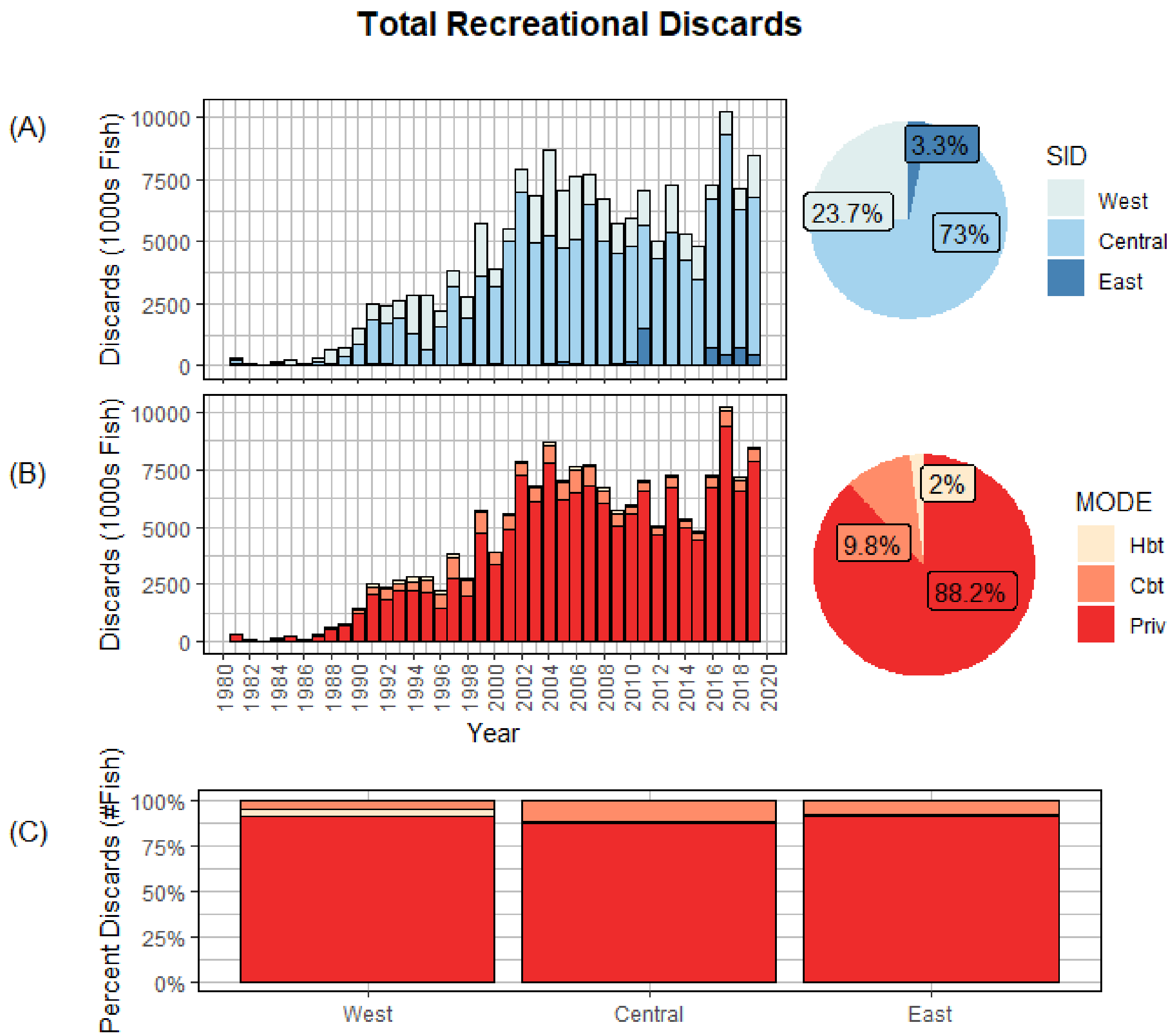


Figure 4.13.4. Distribution of total recreational landings (AB1), in thousands of fish, for Red Snapper across the Gulf of Mexico. Estimates are combined across all surveys (MRIP, SRHS, TPWD, and LA Creel) and years (1981-2019).



	West	Central	East
Cbt	1,911,367	14,082,655	421,434
Hbt	1,699,781	1,602,857	87,574
Priv	36,291,010	107,101,497	4,983,608

Figure 4.13.5. Total recreational discards (B2) for Gulf of Mexico Red Snapper across all surveys (MRIP, SRHS, TPWD, and LA Creel). Discards are provided (A) by state and year (1981-2019) in thousands of fish, (B) by mode and year in thousands of fish, and (C) by mode and state in numbers of fish (as a percentage). The combined private-shore mode in the LA Creel survey is allocated as private fishing. MRIP headboat estimates are used from 1981-1985 and SRHS from 1986+.

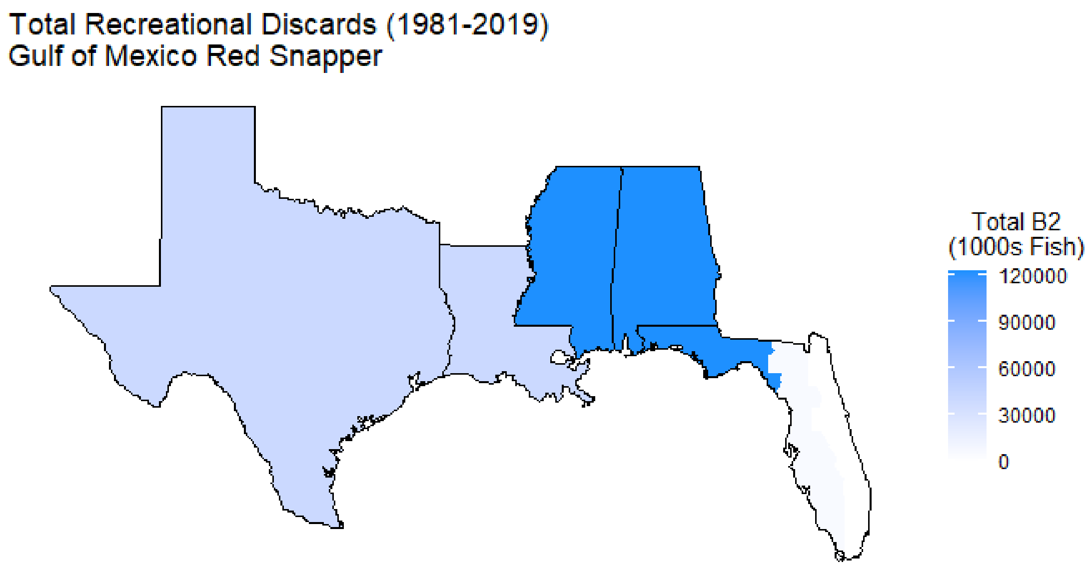


Figure 4.13.6. Distribution of total recreational discards (B2), in thousands of fish, for Red Snapper across the Gulf of Mexico. Estimates are combined across all surveys (MRIP, SRHS, TPWD, and LA Creel) and years (1981-2019).

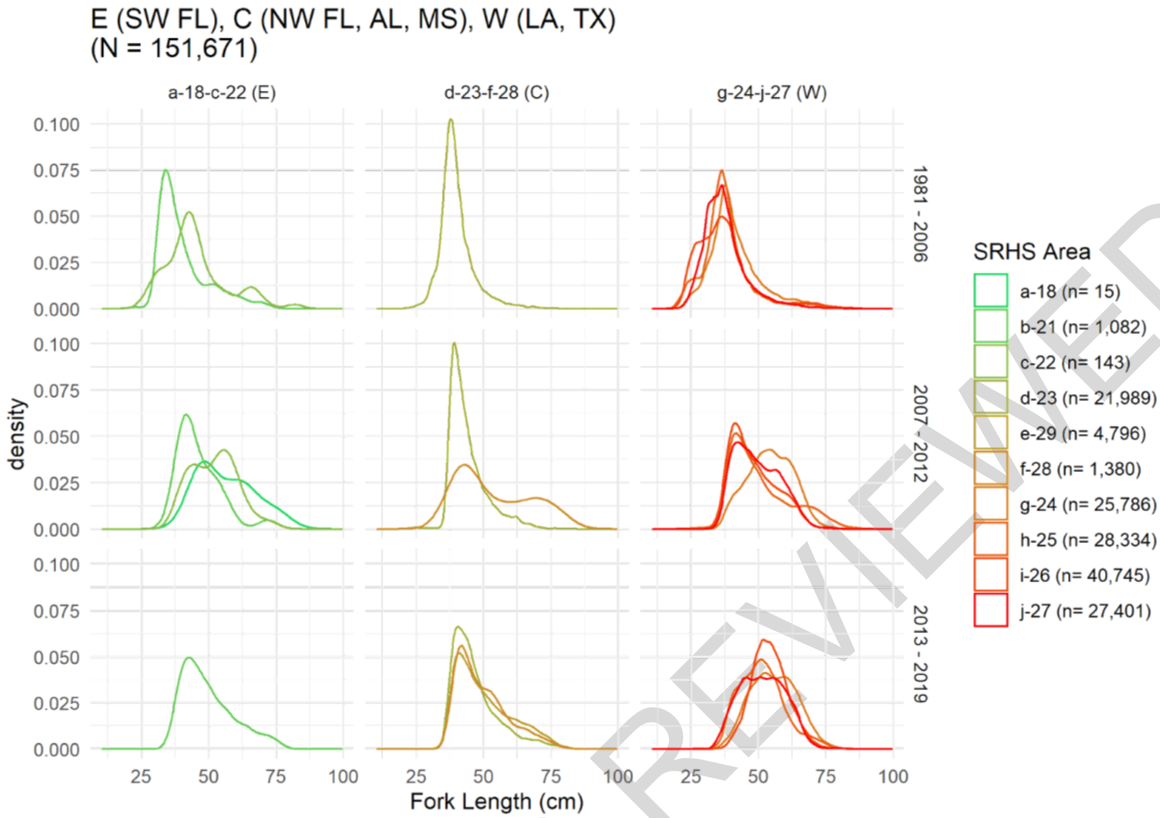


Figure 4.13.7. Red snapper headboat length compositions at the finest spatial resolution by SRHS area where color gradients are shown from east (green) to west (red) and paneled by stock (columns) and time periods (rows).

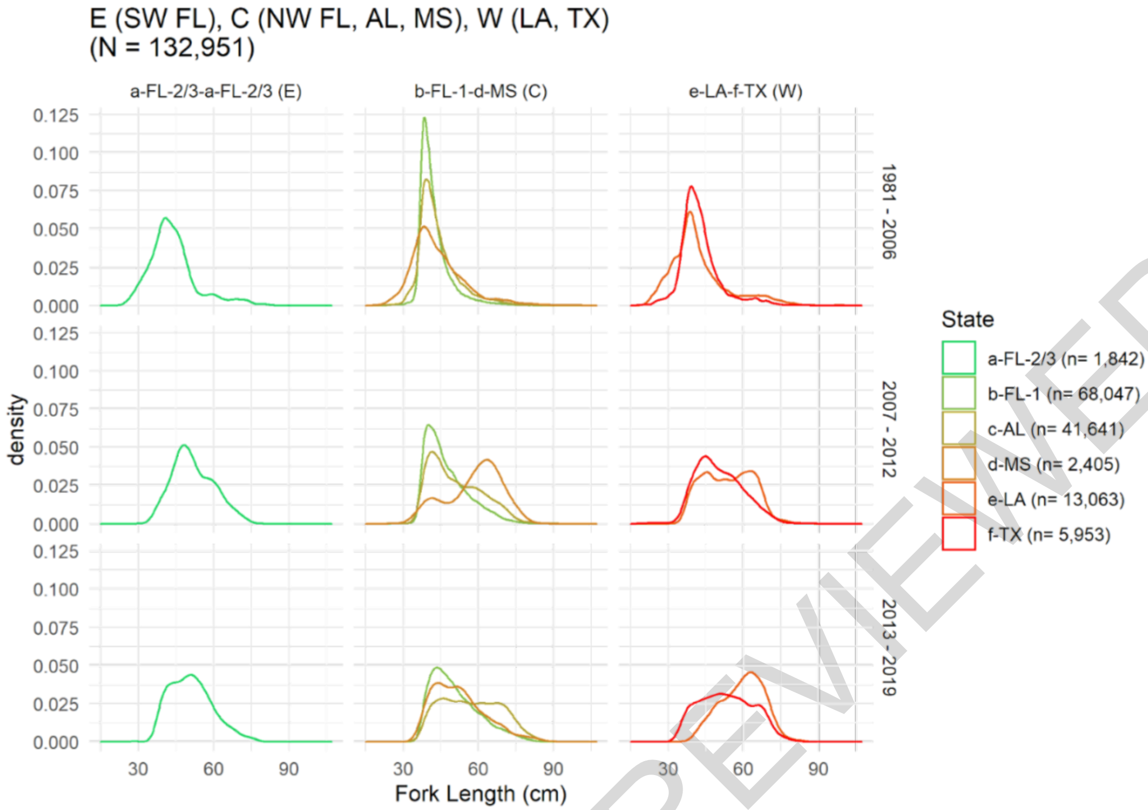


Figure 4.13.8. Red snapper charter boat length compositions at the finest spatial resolution by MRIP sampling domains where color gradients are shown from east (green) to west (red) and paneled by stock (columns) and time periods (rows).

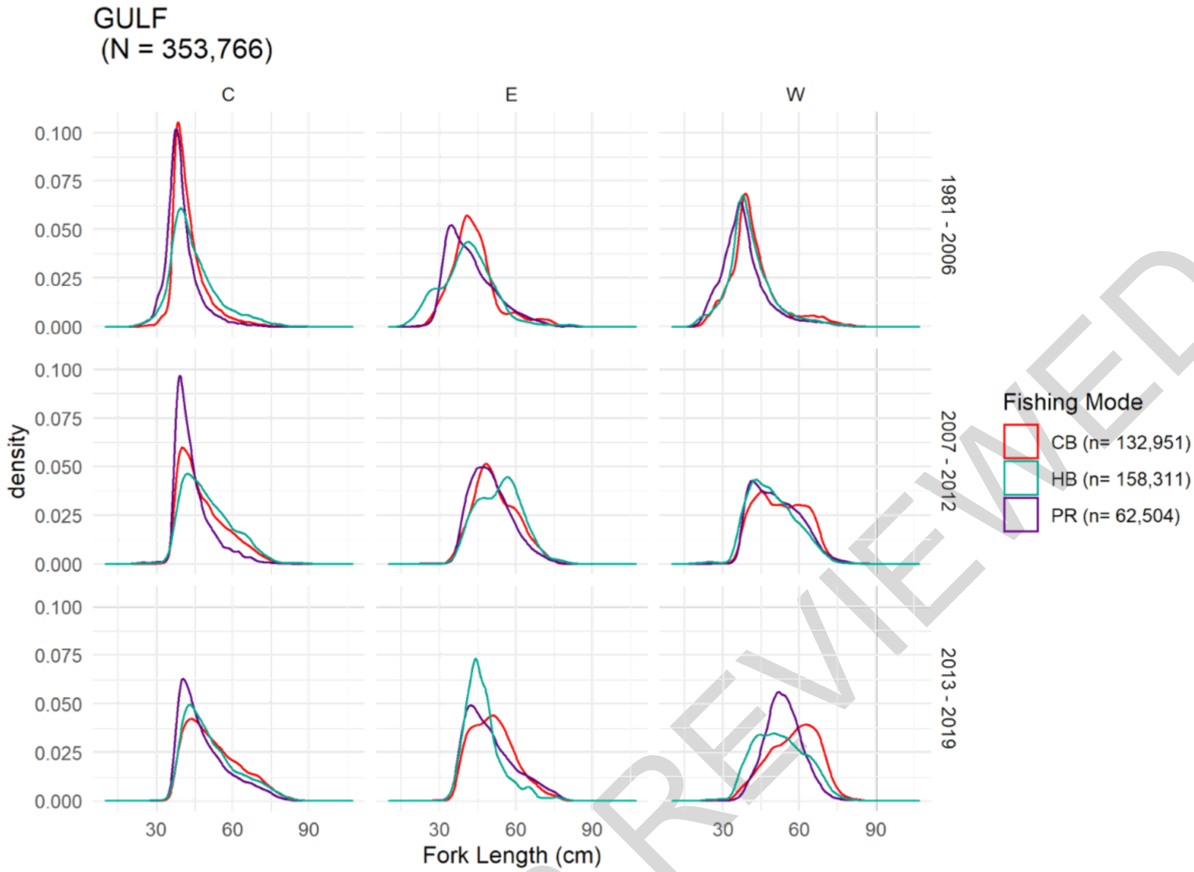


Figure 4.13.9. Red snapper charter boat, headboat, and private length compositions paneled by stock (columns) and time periods (rows).

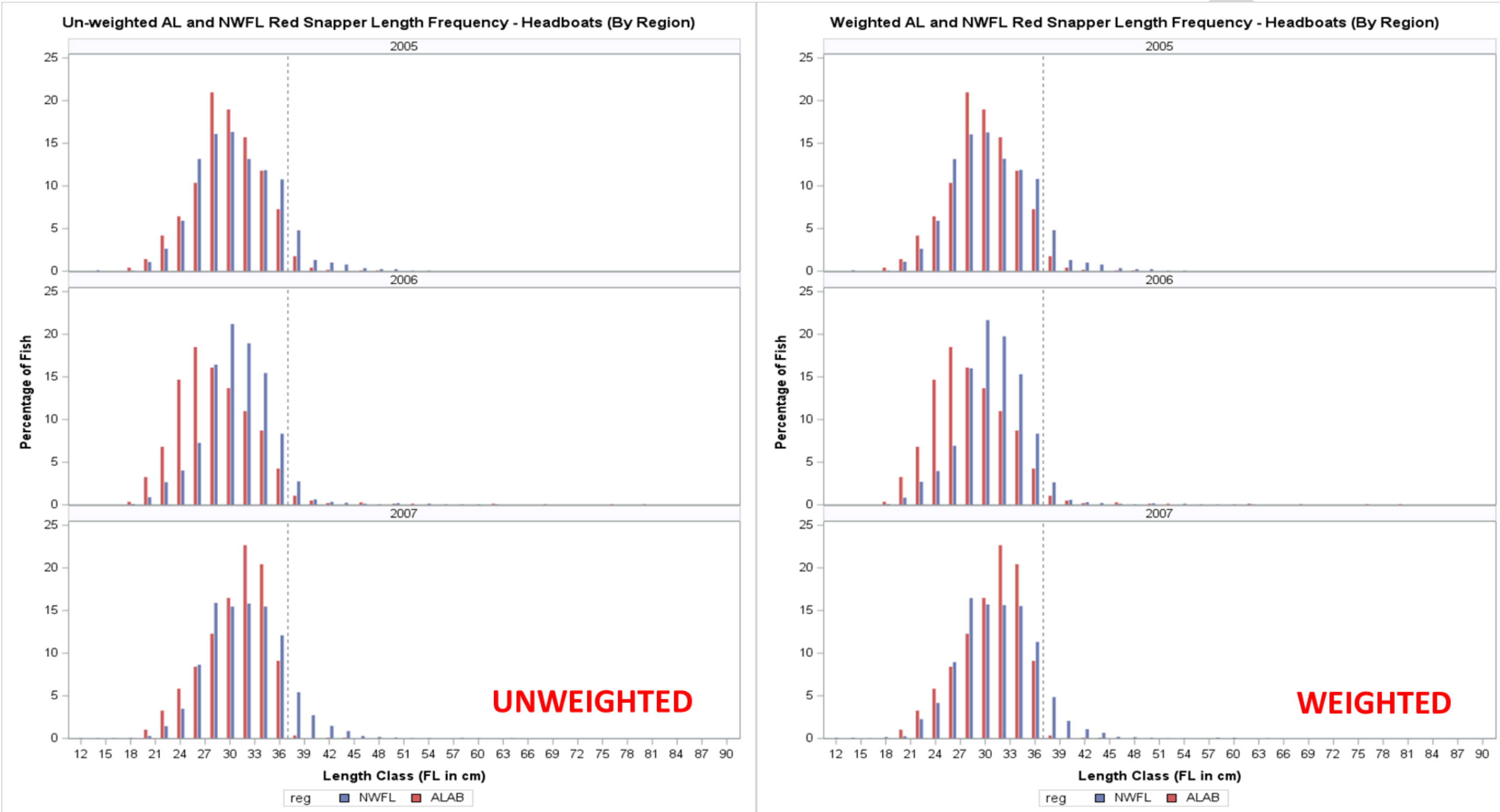


Figure 4.13.10. Comparison of Alabama and northwest Florida headboat discard length composition data from 2005-2007. The left pane corresponds with unweighted data, and right pane shows compares nominal Alabama and weighted northwest Florida data

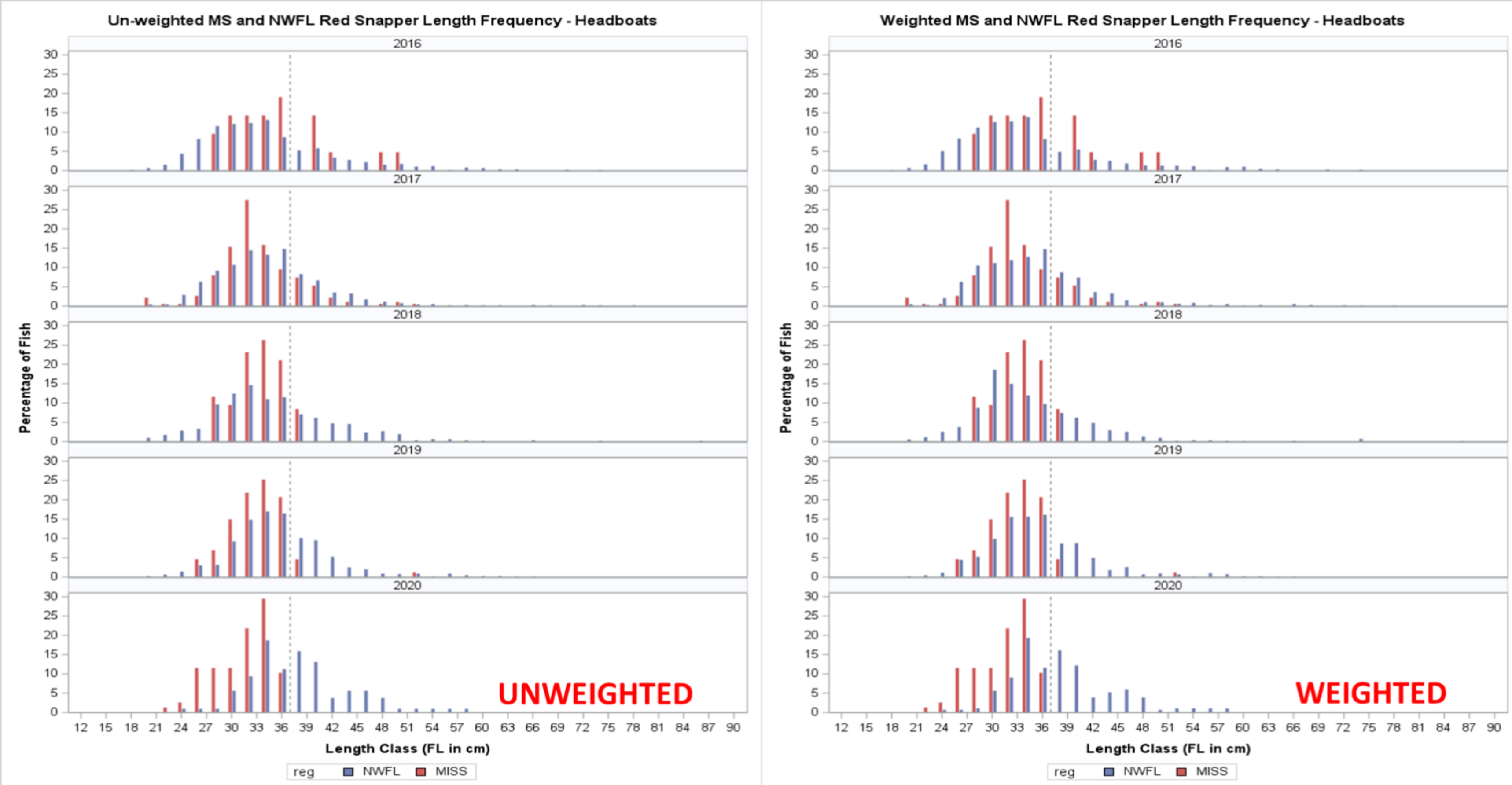


Figure 4.13.11. Comparison of Mississippi and northwest Florida headboat discard length composition data from 2016-2020. The left pane corresponds with unweighted data, and the right pane shows compares nominal Mississippi and weighted northwest Florida data.

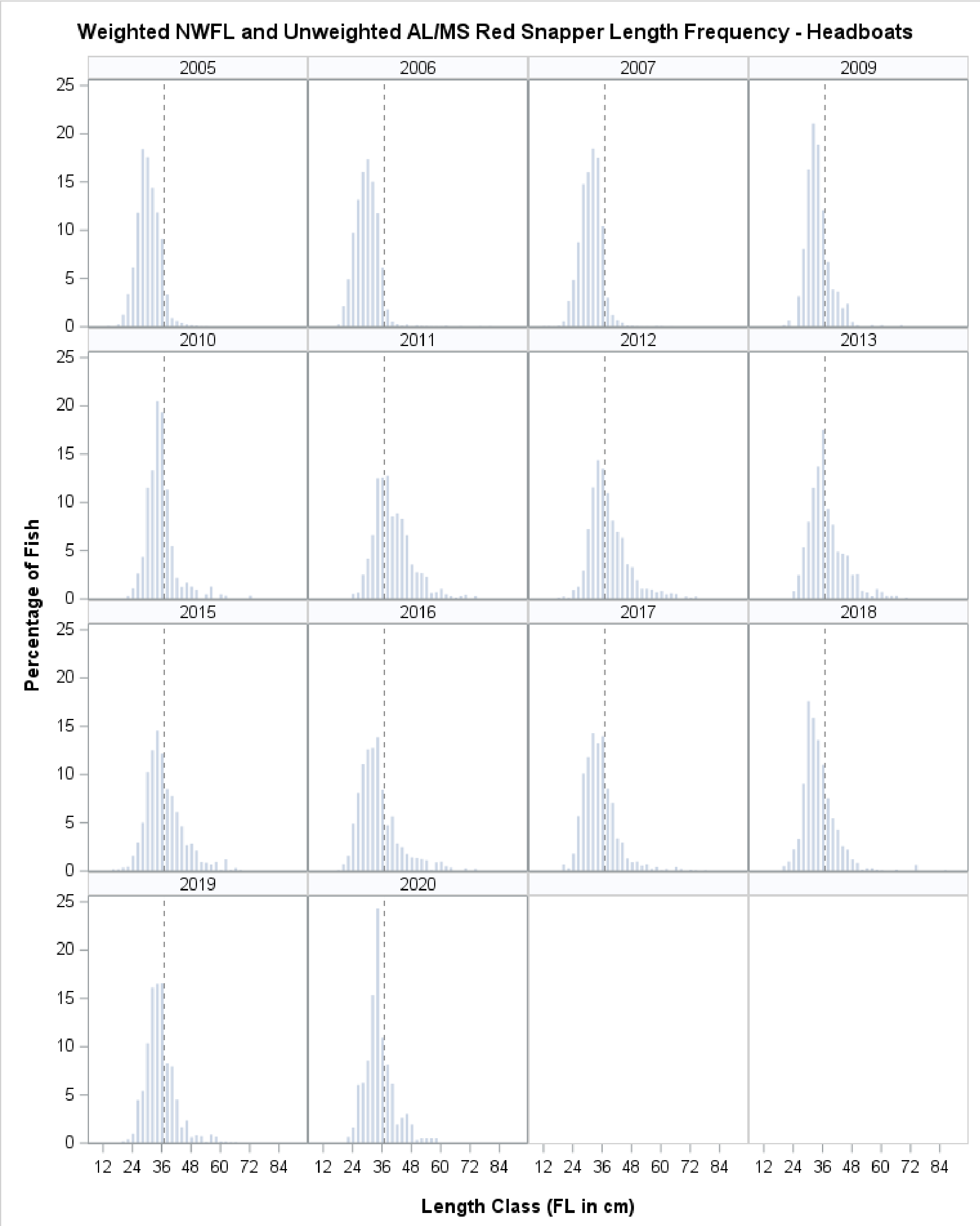


Figure 4.13.12. Combined discard length composition data from 2005 to 2020, for the central stock assessment region. Northwest Florida data is weighted to correct for under/over sampling. Data from Mississippi and Alabama are unweighted.

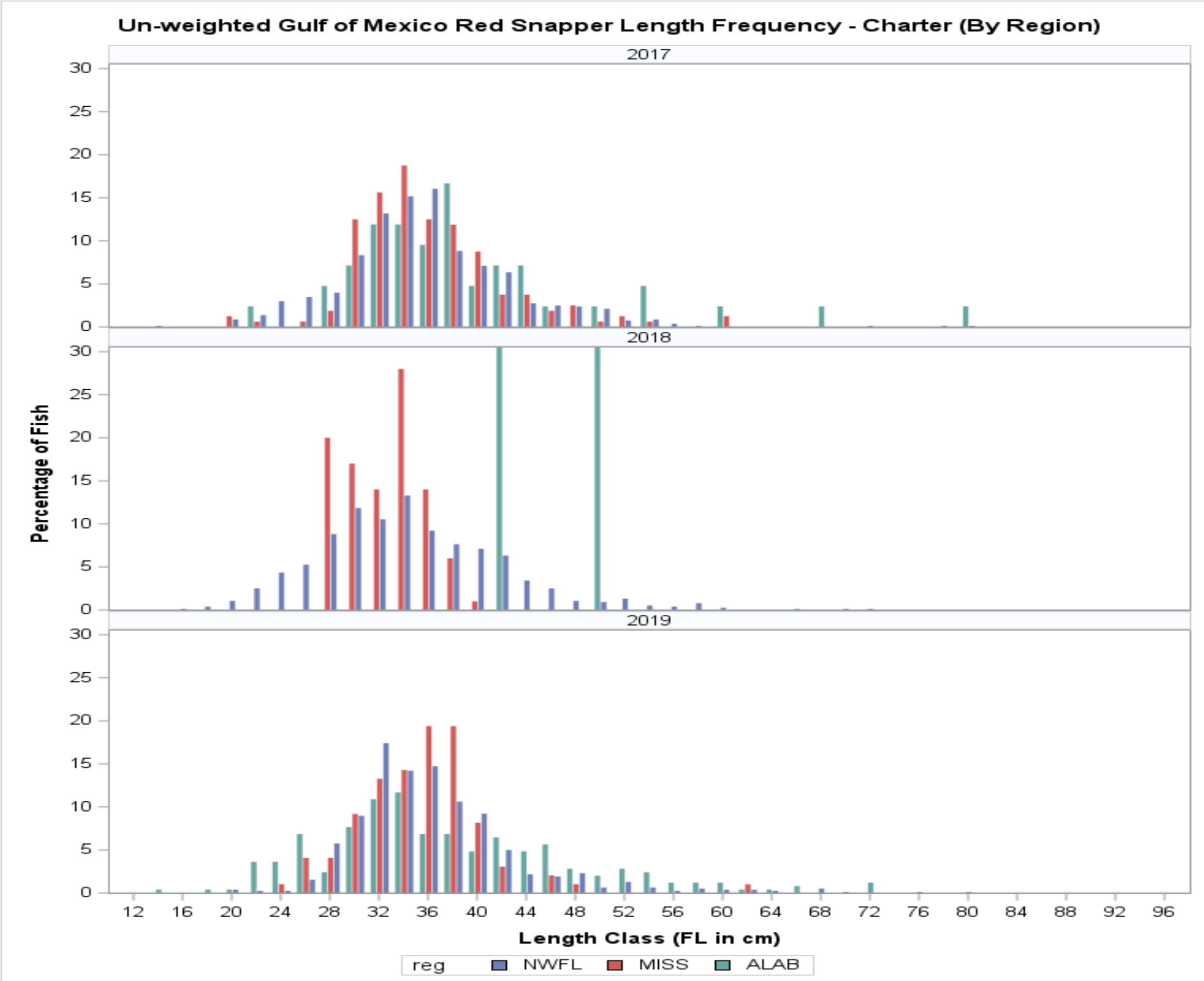


Figure 4.13.13. Comparison of unweighted charter discard length composition data from 2017 to 2019, the years where charter sampling overlaps between Mississippi, Alabama, and northwest Florida (the central stock assessment region).

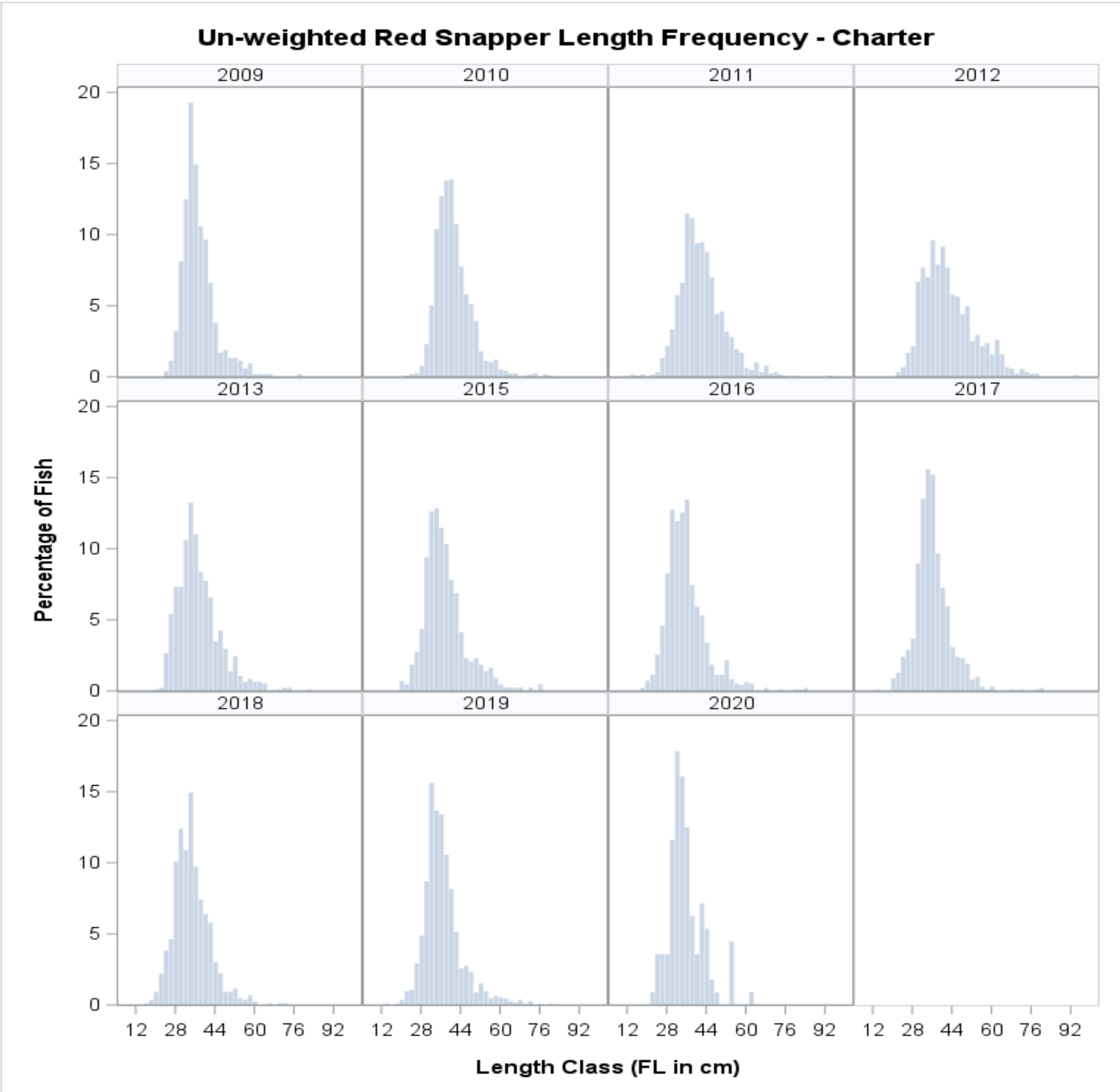
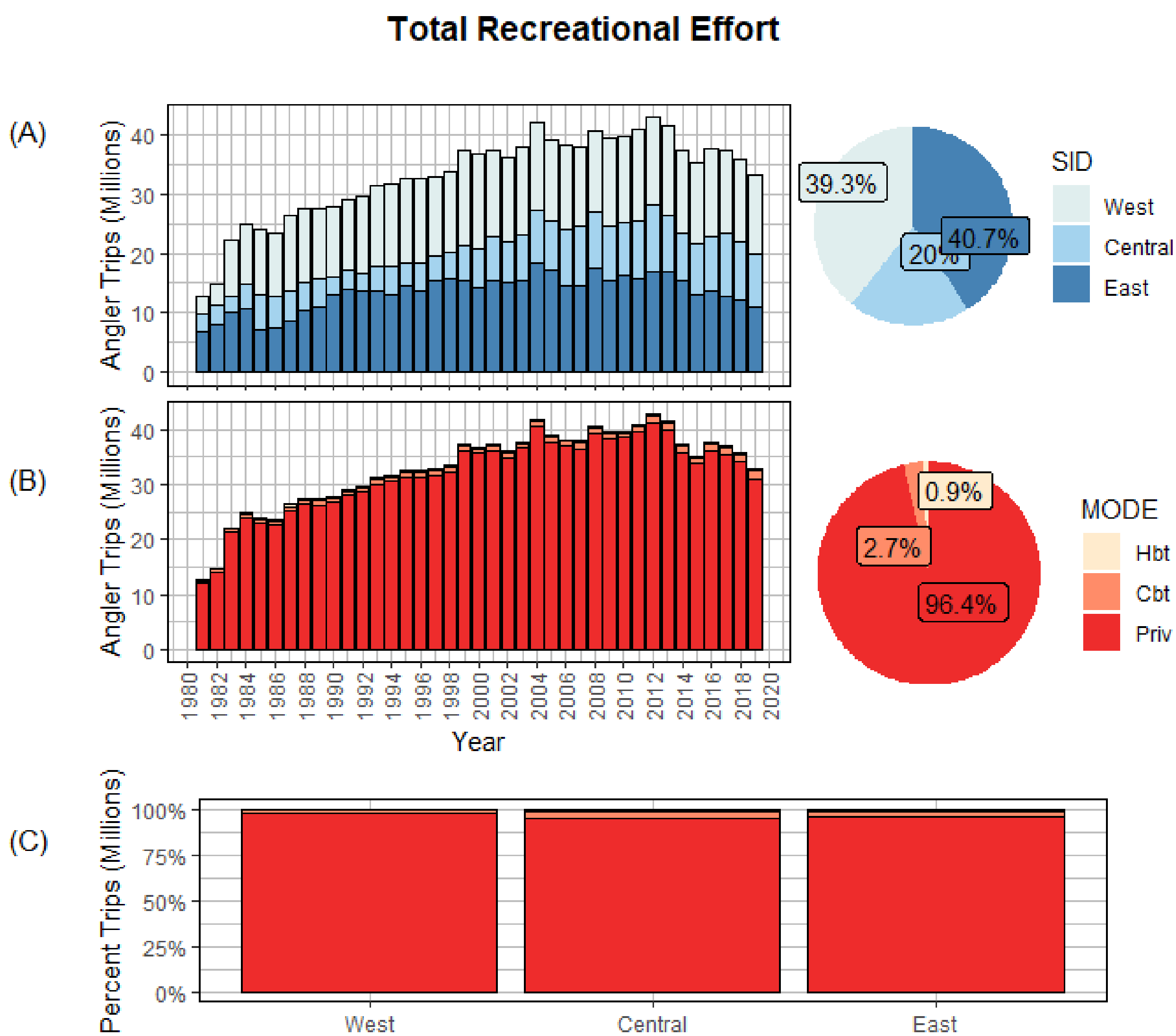


Figure 4.13.14. Combined charter discard length composition data from 2009 to 2020, for the central stock assessment region. All data is unweighted.



	West	Central	East
Cbt	9	10	15
Hbt	3	4	5
Priv	494	243	504

Figure 4.13.15. Total recreational fishing effort for Gulf of Mexico anglers in millions of angler trips (MRIP, SRHS, TPWD, and LA Creel). Effort is provided (A) by state and year (1981-2019), (B) by mode and year, and (C) by mode and state (as a percentage). The combined private-shore mode in the LA Creel survey is allocated as private fishing. MRIP headboat estimates are used from 1981-1985 and SRHS from 1986+.

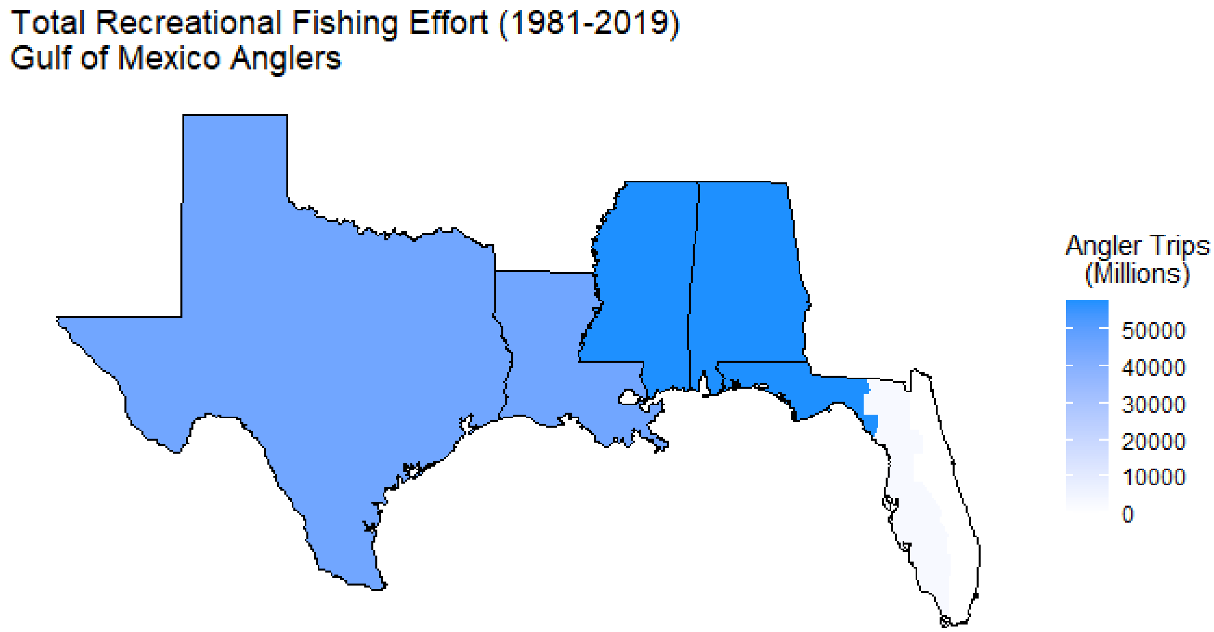


Figure 4.13.16. Distribution of total recreational fishing effort by Gulf of Mexico anglers. Estimates are combined across all surveys (MRIP, SRHS, TPWD, and LA Creel) and years (1981-2019).

5 INDICES OF POPULATION ABUNDANCE

5.1 OVERVIEW

The Index Working Group (IWG) reviewed indices and accompanying analyses from 28 fishery-independent and 12 fishery-dependent datasets that represented regional relative abundance trends in the west, central, or east Gulf of Mexico (GOM) as defined by the SEDAR 74 Stock ID Workshop (SEDAR 74 Stock ID 2021). Section 5.2 lists all the working papers, which contain the full descriptions of the datasets, analytical methods and model diagnostics, reviewed by the IWG. The IWG reviewed and evaluated indices independently for each of the three regions in the GOM following the criteria listed in Section 5.3. Relative spatial coverage of "Suitable" and "Suitable and Recommended" indices are included in Figure 5.10.1 and 5.10.2, respectively. Rationalizations for the recommendation or exclusion of an index are given in the 'Comments on Adequacy for Assessment' in Sections 5.4 (fishery-independent) and 5.5 (fishery-dependent).

In the west GOM, seven fishery-independent and one fishery-dependent indices of abundance are recommended for use in the assessment by the IWG, while two fishery-independent and three fishery-dependent indices were not recommended. Sampling effort, relative abundance and coefficient of variation on the mean (CV, standard error/mean) for recommended indices in the west region are show in Table 5.9.1, and overall trends in Figure 5.10.3.

Recommended	Not Recommended
SEFSC Bottom Longline	Fall Groundfish (1972-1986)
SEAMAP Summer Groundfish Old (1982-2008)	SEAMAP Vertical Line
SEAMAP Summer Groundfish New (2009-2019)	Recreational (Charter and Private)
SEAMAP Fall Groundfish Old (1988-2007)	Commercial VL Logbook (Pre IFQ)
SEAMAP Fall Groundfish New (2008-2019)	Commercial VL Observer (Post IFQ)
SEAMAP Fall Plankton	
SEAMAP Reef Fish Video	
Southeast Region Headboat Survey	

In the central GOM, five fishery-independent and one fishery-dependent indices of abundance are recommended for use in the assessment by the IWG, while seven fishery-independent and three fishery-dependent indices were not recommended. Sampling effort, relative abundance and CV for the recommended indices in the central region are shown in Table 5.9.2, and overall trends in Figure 5.10.4.

Recommended	Not Recommended
SEFSC Bottom Longline	Combined Bottom Longline (SEFSC / DISL)
SEAMAP Summer Groundfish New (2009-2019)	DISL Bottom Longline
SEAMAP Fall Groundfish New (2008-2019)	Fall Groundfish (1972-1986)
SEAMAP Fall Plankton	SEAMAP Summer Groundfish Old (1982-2008)
Combined Reef Fish Video	SEAMAP Fall Groundfish Old (1988-2007)
Southeast Region Headboat Survey	FWRI Artificial Reef Video
	SEAMAP Vertical Line
	Recreational (Charter and Private)
	Commercial VL Logbook (Pre IFQ)
	Commercial VL Observer (Post IFQ)

In the east GOM, four fishery-independent and two fishery-dependent indices of abundance are recommended for use in the assessment by the IWG, while three fishery-independent and two fishery-dependent indices were not recommended. Sampling effort, relative abundance and CV for recommended indices in the east region are shown in Table 5.9.3, and overall trends in Figure 5.10.5.

Recommended	Not Recommended
SEFSC Bottom Longline	SEAMAP Fall Plankton
SEAMAP Summer Groundfish New (2009-2019)	FWRI Artificial Reef Video
SEAMAP Fall Groundfish New (2008-2019)	SEAMAP Vertical Line
Combined Reef Fish Video	Southeast Region Headboat Survey
Commercial VL Logbook (Pre IFQ)	Recreational (Charter and Private)
Commercial VL Observer (Post IFQ)	

5.1.1 Terms of reference

The IWG was tasked with completing objectives associated with the following Terms of Reference (note that the numbering follows to the original Terms of Reference):

3. Provide measures of population abundance that are appropriate for stock assessment.
   - Consider all available and relevant fishery-dependent and -independent data sources
   - Document all programs evaluated; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics.
   - Provide maps of fishery and independent survey coverage.
   - Develop fishery and survey CPUE indices by appropriate strata (e.g., age, size, area, and fishery).
   - Provide appropriate measures of uncertainty for the abundance indices to be used in stock assessment models.
   - Document pros and cons of available indices regarding their ability to represent abundance.
   - Categorize the available indices into one of three tiers: Suitable and Recommended, Suitable and Not Recommended, or Not Suitable; provide each categorization.
   - For recommended indices, document any known or suspected temporal patterns in catchability not accounted for by standardization.

11. Develop an updated Connectivity Modeling Simulation recruitment index for recruitment forecasting.
   - Explore potential hypotheses to link the ecosystem and climatic events identified to population and fishery parameters.

5.1.2 Group membership

Members of the IWG included: Adam Pollack (co-workgroup lead), David Hanisko (co-workgroup lead), Matthew Campbell, Dave Chagaris, LaTreese Denson, Francesca Forrestal, Chris Gardner, Carissa Gervasi, Eric Gigli, John Mareska, Paul Mickle, James Nance, Craig

Newton, Will Patterson, Ryan Rindone, Katie Siegfried, Matthew Smith, Ted Switzer, and Kevin Thompson.

The following people also provided data products to the group but were not included in discussions/recommendations outside of their data product: Mark Albins, Crystal Hightower, Kevin McCarthy, Kate Overly, and Steven Smith.

5.2 REVIEW OF WORKING PAPERS

The IWG reviewed the following working papers:

SEDAR74-DW-13	-	Standardized Catch Rate Indices for Red Snapper (*Lutjanus campechanus*) during 1981-2019 by the U.S. Gulf of Mexico Charterboat and Private Boat Recreational Fishery
SEDAR74-DW-17	-	Standardized Catch Rate Indices for Red Snapper (*Lutjanus campechanus*) during 1993-2006 by the U.S. Gulf of Mexico Vertical Line Fishery
SEDAR74-DW-21	-	Using a Censored Regression Modeling Approach to Standardized Catch Per Unit Effort for Red Snapper *(Lutjanus campechanus*) during 1986-2019 from the Southeast Region Headboat Survey in the U.S. Gulf of Mexico
SEDAR74-DW-23	-	Indices of abundance for Red Snapper (*Lutjanus campechanus*) on natural reefs in the eastern Gulf of Mexico using combined data from three independent video surveys
SEDAR74-DW-24	-	Develop an updated Connectivity Modeling Simulation recruitment index for recruitment forecasting
SEDAR74-DW-26	-	Red Snapper Abundance Indices from Bottom Longline Surveys in the Northern Gulf of Mexico
SEDAR74-DW-27	-	Indices of abundance for Red Snapper (*Lutjanus campechanus*) on artificial reefs on the West Florida Shelf from stationary video surveys
SEDAR74-DW-28	-	SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Red Snapper
SEDAR74-DW-30	-	Red Snapper Abundance Indices from Groundfish Surveys in the Northern Gulf of Mexico
SEDAR74-DW-31	-	Red Snapper (*Lutjanus campechanus*) larval indices of relative abundance from SEAMAP Fall Plankton Surveys, 1986 to 2019
SEDAR74-DW-38	-	Estimation of vertical line commercial indices for Western, Central, and Eastern Gulf of Mexico red snapper using reef fish observer data

SEDAR74-DW-39 - SEAMAP Vertical Longline Survey (2012-2021): Indices of Abundance of Gulf of Mexico Red Snapper, *Lutjanus campechanus*

5.3 CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATION

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

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

After the index was evaluated, it was deemed either Suitable or Not Suitable, following the guidance in the Terms of Reference (see section 5.1.1). Once all the indices were evaluated on their own merits and determined to be Suitable / Not Suitable, suitable indices then entered the second stage of review that determined whether they would be recommended for use in the assessment. Indices were then assigned one of the following categories.

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

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

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

5.4 FISHERY-INDEPENDENT INDICES

5.4.1 NOAA Fisheries SEFSC Bottom Longline Survey

The NOAA Fisheries Southeast Fisheries Science Center (SEFSC) Population and Ecosystem Monitoring (PEM) Division has conducted standardized bottom longline surveys in the Gulf of Mexico (GOM), Caribbean, and Western North Atlantic Ocean (Atlantic) since 1995. The objective of these surveys is to provide fisheries independent data for stock assessment purposes for as many species as possible. The survey fishes a one nautical mile bottom longline, with 100 baited hooks for one hour.

5.4.1.1 Methods of Estimation

Working Paper Number: SEDAR74-DW-26
Data Type: Fishery Independent
Time Series: 2001 – 2019
Sampling Intensity: Tables 5 (west), 7 (central) and 9 (east) in working paper.
Size/Age Data: Primarily age-2+ adult fish.
Data Filtering Techniques: Standard filtering protocols to remove problematic stations.
Standardization: Delta-lognormal
Submodel Variables

West:
Binomial: Year + Zone + Depth
Positive Observations: Year

Central:
Binomial: Year + Zone
Positive: Year

East:
Binomial: Year + Zone
Positive: Year + Zone

Abundance Indices: Tables 5 (west), 7 (central) and 9 (east) in working paper.

5.4.1.2 Comments on Adequacy for Assessment

Indices from the SEFSC Bottom Longline Survey were presented for the west, central, and east regions. Overall, the IWG deemed all of the regional indices were suitable for further examination based on the spatial and temporal coverages, fishery independent, and the statistical design. In the east region, concerns were raised about the lack of positive occurrences over several years and single positive occurrences in other years. However, since this survey primarily indexes larger adults, it was suggested that the east index be recommended for the assessment to help show the presence of these larger adults as the stock recovers/expands. In addition, both the indices for the west and central regions were deemed suitable. After reviewing all of the indices for all three regions, the indices were deemed “Suitable and Recommended”.

5.4.2 NOAA Fisheries SEFSC Fall Groundfish Survey

The NOAA Fisheries SEFSC Fall Groundfish Survey (henceforth, Fall Groundfish Survey) was conducted from 1972 to 1984 and primarily covered an area within the north central Gulf of Mexico (GOM) between 88° W and 91°30′ W, with some additional sampling to the east and west. The survey was conducted primarily during October and November with up to three 10-

minute tows at stations randomly selected from a block-grid system. Sampling occurred between 5 and 50 fathoms. During 1985 and 1986, the survey was moved under SEAMAP; however, the block-grid survey design was retained. Therefore, those years were retained for analysis with the Fall Groundfish Survey, as opposed to being included with the SEAMAP Fall Groundfish Survey (Old Design).

5.4.2.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-30
Data Type: Fishery Independent
Time Series: 1972-1986
Sampling Intensity: Tables 4 (west) and 10 (central) in working paper.
Size/Age Data: No length data available, but assumed to be similar to SEAMAP Fall Groundfish Survey lengths, primarily age-0 red snapper
Data Filtering Techniques: Standard filtering protocols to remove problematic stations.
Standardization: Delta-lognormal

Submodel Variables

West:
Binomial: Year + Depth
Positive Observations: Year + Depth

Central:
Binomial: Year + Depth + Time of Day
Positive: Year + Depth + Time of Day

Abundance Indices: Tables 4 (west) and 10 (central) in working paper.

5.4.2.2. Comments on Adequacy for Assessment

Upon review of the Fall Groundfish Survey and the SEAMAP Groundfish Survey, the IWG agreed that it was appropriate to split the time series because of the differences in survey design and survey area. In addition, there were no issues with the survey design, nor the temporal coverage. However, the IWG did have concerns about the limited coverage in both the west and central regions and did not feel that the area covered by the Fall Groundfish Survey would be representative of the entire west and central regions. Based on those concerns, the Fall Groundfish Survey was deemed "Suitable and Not Recommended".

5.4.3 SEAMAP Summer Groundfish Survey (Old Design)

While the NMFS Fall Groundfish Survey was being conducted in the fall, a summer (primarily sampling during June and July) groundfish survey was added in 1982 under the Southeast Area Monitoring and Assessment Program (SEAMAP) to address the effectiveness of the Texas Closure. SEAMAP is a collaborative effort between federal, state and university programs, designed to collect, manage and distribute fishery independent data throughout the region. Sampling during the summer survey was conducted during the night using a stratified random design with strata defined by area and depth zone (see presentation for strata definition). This survey covered an area between Brownville, TX and Mobile Bay, AL. It should be noted that shrimp statistical zone (SSZ) 10 was dropped from the survey universe in 1989 because of the increased number of hangs in the area as Alabama expanded their artificial reef permit area. In addition, the years 1982 and 1983 were dropped from the analysis in the west region due to poor spatial coverage.

Beginning in 1987, the SEAMAP summer and fall groundfish surveys adopted a unified sample design. Strata were still defined by area and depth zone, but with an additional stratum based on time of day (day and night) incorporated into the design. Towing time was variable during the survey, ranging from 10 (min) to 55 (max) minutes, and was dependent on the time required to completely tow through a depth zone. If the depth zone could not be covered in 55 minutes, multiple tows were made at the station. The survey gear consists of a 12.8-m (42 ft) semi-balloon shrimp trawl with a 12.8-m headrope and does not contain a turtle excluder device (TED) or any bycatch reduction devices (BRD).

5.4.3.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-30
Data Type: Fishery Independent
Time Series: 1982-2008
Sampling Intensity: Tables 18 (west) and 22 (central) in working paper.
Size/Age Data: Primarily age-1 red snapper
Data Filtering Techniques: Standard filtering protocols to remove problematic stations.
Standardization: Delta-lognormal

Submodel Variables

West:
Binomial: Year + Depth Zone + Paired SSZ + Time of Day
Positive Observations: Year + Depth Zone

Central:
Binomial: Year + Depth Zone
Positive: Year + Time of Day

Abundance Indices: Tables 18 (west) and 22 (central) in working paper.

5.4.3.2. Comments on Adequacy for Assessment

After a review of the changes in survey methodology between the SEAMAP Summer Groundfish Survey (Old Design) and the SEAMAP Summer Groundfish Survey (New Design), the IWG agreed that the time series should be split when the survey design change was implemented. For the SEAMAP Summer Groundfish Survey (Old Design), the survey design was deemed acceptable as it was a long time series and the only time series that surveys subadult (primarily age-1) red snapper. The survey coverage across the West Region was robust, with the entire area covered in most years. Therefore, the IWG deemed the index for the west region "Suitable and Recommended". However, spatial coverage in the central region was not as robust, with only the areas off Mississippi and Alabama sampled. Therefore, the IWG deemed the index for the central region "Suitable and Not Recommended".

5.4.4 SEAMAP Summer Groundfish Survey (New Design)

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

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

5.4.4.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-30
Data Type: Fishery Independent
Time Series: 2009-2019
Sampling Intensity: Tables 20 (west), 24 (central) and 26 (east) in working paper.
Size/Age Data: Primarily age-1 red snapper
Data Filtering Techniques: Standard filtering protocols to remove problematic stations.
Standardization: Delta-lognormal

Submodel Variables

West:
Binomial: Year + Depth + SSZ
Positive Observations: Year + Depth + SSZ

Central:
Binomial: Year + SSZ
Positive: Year + SSZ

East:
Binomial: Year + SSZ
Positive: Year + Time of Day

Abundance Indices: Tables 20 (west), 24 (central) and 26 (east) in working paper.

5.4.4.2. Comments on Adequacy for Assessment

As noted in Section 5.3.3.2, the SEAMAP time series was split when the survey design was changed in 2008. For the SEAMAP Summer Groundfish Survey (New Design), the survey design was deemed acceptable as it was a long time series and was the only time series that surveys subadult (primarily age-1) red snapper. The survey coverage across the all the regions were robust, with the entire area being covered in most year. Therefore, the IWG deemed the indices for all of the regions "Suitable and Recommended".

5.4.5 SEAMAP Fall Groundfish Survey (Old Design)

Starting in 1985, the NMFS Shrimp/Bottomfish Trawl Survey was brought under the SEAMAP umbrella. The survey retained the block-grid survey design, but expanded the depth coverage out to 100 fathoms. Sampling intensity was reduced to a single 15-minute tow per grid to accommodate a westward expansion to include the Texas shelf. Sampling occurred during day and night. Even though this is officially a SEAMAP survey, it is typically treated as part of the Shrimp/Bottomfish Trawl Survey due to the use of the block-grid design. For a full description of all the surveys, additional background and time series rationale see Nichols 2004.

Beginning in 1987, the SEAMAP summer and fall groundfish surveys adopted a unified sample design. Strata were still defined by area and depth zone, but with an additional stratum based on time of day (day and night) incorporated into the design. Towing time was variable during the survey, ranging from 10 (min) to 55 (max) minutes, and was dependent on the time required to complete tow through a depth zone. If the depth zone could not be covered in 55 minutes, multiple tows were made at the station. The survey gear consists of a 12.8-m (42 ft) semi-balloon shrimp trawl with a 12.8-m headrope and does not contain a turtle excluder device (TED) or any bycatch reduction devices (BRD).

5.4.5.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-30
Data Type: Fishery Independent
Time Series: 1987-2007
Sampling Intensity: Tables 6 (west) and 12 (central) in working paper.
Size/Age Data: Primarily age-0 red snapper
Data Filtering Techniques: Standard filtering protocols to remove problematic stations.
Standardization: Delta-lognormal
Submodel Variables

West:
Binomial: Year + Depth Zone + Paired SSZ + Time of Day

Positive Observations: Year + Depth Zone + Paired SSZ + Time of Day

Central:
Binomial: Year + Depth Zone + Time of Day
Positive: Year + Depth Zone + Time of Day

Abundance Indices: Tables 6 (west) and 12 (central) in working paper.

5.4.5.2. Comments on Adequacy for Assessment

As discussed in Section 5.3.3.2, the SEAMAP Fall Groundfish Survey was split between the old and new survey designs was deemed acceptable. For the SEAMAP Fall Groundfish Survey (Old Design), the survey design was deemed acceptable as it was a long time series and was the only time series that surveys subadult (primarily age-0) red snapper. The survey coverage across the west region was robust, with the entire area being covered in most years. Therefore, the IWG deemed the index for the west region "Suitable and Recommended". However, spatial coverage in the central region was not as robust, with only the areas off Mississippi and Alabama sampled. Therefore, since the IWG did not think this area was representative of the entire central region, the index for the central region was deemed "Suitable and Not Recommended".

5.4.6 SEAMAP Fall Groundfish Survey (New Design)

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

In 2008, SEAMAP received supplemental funding that provided the opportunity to conduct experimental bottom trawl surveys on the West Florida Shelf. Based on the success of the experimental trawl surveys by the state of Florida, the surveys were expanded in 2010 to include the area from Mobile Bay, AL to Key West, FL.

5.4.6.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-30
Data Type: Fishery Independent
Time Series: 2008-2019
Sampling Intensity: Tables 8 (west), 14 (central) and 16 (east) in working paper.
Size/Age Data: Primarily age-0 red snapper
Data Filtering Techniques: Standard filtering protocols to remove problematic stations.
Standardization: Delta-lognormal
Submodel Variables

West:
Binomial: Year + SSZ
Positive Observations: Year + Depth + SSZ

Central:
Binomial: Year + Depth + SSZ
Positive: Year + Depth + SSZ

East:
Binomial: Year + Depth + SSZ
Positive: Year + SSZ

Abundance Indices: Tables 8 (west), 14 (central) and 16 (east) in working paper.

5.4.6.2. Comments on Adequacy for Assessment

As noted in Section 5.3.3.2, the SEAMAP time series was split when the survey design was changed in 2008. For the SEAMAP Fall Groundfish Survey (New Design), the survey design was deemed acceptable because it provided a long time series and was the only time series that surveys subadult (primarily age-0) red snapper. The survey coverage across the all the regions was robust, with the entire area covered in most years. Therefore, the IWG deemed the indices for all of the regions “Suitable and Recommended”.

5.4.7 SEAMAP Reef Fish Video Survey

The primary objective of the annual Southeast Area Monitoring and Assessment Program (SEAMAP) reef fish video survey is to provide an index of the relative abundances of fish species associated with topographic features (e.g., reefs, banks, and ledges) located on the continental shelf of the Gulf of Mexico (GOM) from Brownsville, TX to the Dry Tortugas, FL. Secondary objectives include quantification of habitat types sampled (video, multi-beam and side-scan), and collection of environmental data throughout the survey. Because the survey is conducted on topographic features the species assemblages targeted are typically classified as reef fish (e.g. red snapper, *Lutjanus campechanus*), but occasionally fish more commonly associated with pelagic environments are observed (e.g. Amberjack, *Seriola dumerili*). The survey has been executed from 1992-1997, 2001-2002, and 2004-present and historically takes place from April - May, however in limited years the survey was conducted through the end of August. The 2001 survey was abbreviated due to ship scheduling, during which, the only sites that were completed were located in the western Gulf of Mexico. Data was not collected in 2020 due to the COVID outbreak. Types of data collected on the survey include diversity, abundance (MinCount, i.e. MaxN), fish length, habitat type, habitat coverage, bottom topography and water quality. The size of fish sampled with the video gear is species specific; however, Red Snapper sampled over the history of the survey had fork lengths ranging from 116 – 1061 mm, and mean annual fork lengths ranging from 355 – 558 mm (Table 5, Figure 30). Age and reproductive data cannot be collected with the camera gear, but beginning with the 2012 survey, a vertical line component was coupled with the video drops to collect hard parts, fin clips, and gonads and was included in the life history information provided by the NMFS Panama City Laboratory.

5.4.7.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-28
Data Type: Fishery Independent
Time Series: 1993-2019
Sampling Intensity: Average number of stations / 128.9 (sd = 59.5).
Size/Age Data: Table 5 and Figure 30 in working paper.
Data Filtering Techniques: Manual filtration of low sample years (1998-2000, and 2003). Manual reduction of the dataset to the west Gulf only as prescribed in the red snapper stock ID process.
Standardization: Negative-binomial
Model Variables *[year, habitat complexity, depth]*

Annual Abundance Indices: Table 4 (west) in working paper.

5.4.7.2. Comments on Adequacy for Assessment

The index was recommended for use in the assessment model given the history of its continued use in benchmark and update assessments. In addition to the bottom longline survey, the SEAMAP RFV survey index is considered one of the more critical indices to include in the assessment. The survey frequently observes red snapper on the deployments given that the sampling design targets reef. Some discussion was raised concerning the large increase in the index between 2017 and 2018. The data appear to be real in that the high point coincides with a high number of positive sites in the west Gulf (coastal Texas in particular) that also showed high abundance. The point also corresponds with other indices showing similar increases in that time frame and discussion led to the conclusion that by definition sampling is inherently variable and this is only one representation of the status of the stock. The survey shows reasonable precision with CVs ranging from 15-25%. Importantly, this index is the only fisheries independent survey data that is collected on sensitive reef environments where trawl and longline gears cannot be deployed.

5.4.8 Combined Video Survey

Historically, three different stationary video surveys were conducted to assess trends in reef fish relative abundance in the northern Gulf of Mexico (GOM). The NMFS SEAMAP reef fish video survey (SFRV), carried out by NMFS Mississippi Laboratory, has the longest running time series (1993-1997, 2002, and 2004+), followed by the NMFS Panama City lab survey (PC; 2005+), with the most recent survey being the Florida Fish and Wildlife Research Institute video survey (FWRI, starting year 2010). Given the surveys use standardized deployment, camera field of view, and fish abundance methods to assess fish abundancies on reef or structured habitat, combining indices across datasets allows for the largest possible sample sizes in model fitting and encompassing a greater proportion of the distribution of the stock. As such, we used a habitat-based approach to combine relative abundance data for generating annual trends for Red Snapper (*Lutjanus campechanus*) throughout the east GOM (eGOM) for the central and east regions as defined in the Stock ID process for this assessment.

5.4.8.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-23
Data Type: Fishery Independent
Time Series: 1993-2020 (central); 2010-2020 (east)
Sampling Intensity: Table 5 (central) and Table 6 (east) in working paper.
Size/Age Data: represents juvenile through adult biomass; see figures 11-13 in working paper.

Data Filtering Techniques: For all surveys, video reads were excluded if they were unreadable due to turbidity or deployment errors. For the SFRV survey, data included in this index are from 1993 and on, due to different counting methods in 1992. The entire spatial extent of the Panama City data was used from 2006 on with 2005 excluded because of an incomplete survey. For the FWRI data from prior to 2010 was excluded due to the earlier year's not including side-scan geoform as a variable which was determined to be potentially important as an explanatory variable in the analyses. Following discussions at the data workshop, the decision was made to truncate the overall time series for the south region due to very low catch rates in the SFRV survey initially and the small footprint of the PC survey in that region. Therefore, the east index was limited to 2010-2020.

Standardization: Relative abundance indices were generated using a stepwise approach. First, a habitat variable was created that included each of the separate survey individual variables that could be applied to all the data. This was done so final index models can account for changing sampling effort and habitat allocation through time rather than limiting the model to be predicted only by year and survey. We first determined the percentage of sites that occurred on good, fair, or poor (G, F, P) habitats for each survey and region independently. For this, we used a categorical regression tree approach (CART). These subsequent variables were then used a negative-binomial GLM along with year and survey to predict annual abundances for each region independently.

Submodel Variables
Central CART variables by survey:
SFRV: presence/absence of seawhips, presence/absence of shell, maximum relief, latitude, longitude
PC: depth, presence/absence of soft corals, maximum relief
FWRI: geoform, longitude, maximum relief, depth

East CART variables by survey:
SFRV: longitude, latitude, depth

PC: depth, presence/absence of soft corals, presence/absence of sponge, presence/absence of algae
FWRI: longitude, latitude, depth, habitat strata

Annual Abundance Indices: Table 5 (central) and Table 6 (east) in working paper.

5.4.8.2. Comments on Adequacy for Assessment

This index was deemed both suitable and recommended for this assessment. This decision was due to the wide range of the stock being covered in terms of both spatial coverage and habitats sampled, the large sample sizes of video sets, and the large size range of this species being indexed. Following discussions within the IWG, initial analyses were re-run to exclude early years in the time series for the east given the low catches in the time series until the addition of the more inshore efforts by the FWRI survey began in 2010 and the final SFRV CART models and index values recommended and submitted reflect this.

5.4.9 SEAMAP Fall Plankton Survey

The Southeast Area Monitoring and Assessment Program (SEAMAP) has supported the collection and analysis of ichthyoplankton samples from fishery-independent resource surveys in the Gulf of Mexico since 1982 with the goal of producing a long-term database on the early life stages of fishes. Red Snapper (*Lutjanus campechanus*) larvae captured in bongo net samples during the SEAMAP Fall Plankton Surveys were used to develop indices of relative abundance from 1986 to 2019. The indices represent trends in the adult spawning stock biomass.

5.4.9.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-31
Data Type: Fishery Independent
Time Series: 1986-2019
Sampling Intensity: See Table 4 (west), Addendum Table 1 (northeast/central) and Table 7 (east) in working paper.
Size/Age Data: Represents the adult spawning stock

Data Filtering Techniques: Occurrence and age corrected catch per unit area (CPUA) used in the indices were based on larvae greater than 3.75 mm and less than 9.75 mm in body length to account for the identification uncertainty of smaller snapper larvae and the effects of gear avoidance by larger rarely caught larvae. Year to year variability in spatial coverage from Fall Plankton Survey data was addressed by limiting observations to samples taken at SEAMAP stations that were sampled during at least (~66%) of all years for which there was consistent spatial coverage respectively to the west, northeast/central and east Gulf of Mexico. Core data for the west index included all samples taken during at least 20 of the 30 years of available data, the core data for the updated northeast/central index included all samples taken during at least 22 of the 33 years of available data, and core data for the east index included all samples taken during at least 18 of 27 years of available data. Years in which Red Snapper were not observed, respective to the west, northeast/central and east Gulf of Mexico were removed prior to the generation of indices.

Standardization: Delta-lognormal generalized linear models were used to generate age corrected abundance indices for the west and northeast/central Gulf of Mexico, and a binomial generalized linear model was used to generate a relative index based on the proportion of positive occurrence in the east Gulf of Mexico.

Submodel Variables
West:
Binomial: *Year + Time of Day + Subregion*
Positive Observations: *Year + Time of Day + Subregion*
Updated Northeast/Central:
Binomial: *Year + Time of Day + Subregion*
Positive Observations: *Year + Subregion + Depth*
East:
Binomial: *Year*

Annual Abundance Indices: See Table 4 (west), Addendum Table 1 (northeast/central) and Table 7 (east) in working paper.

5.4.9.2. Comments on Adequacy for Assessment

Initial indices presented to the IWG included delta-lognormal standardized indices of age corrected larval abundance for the west and northeast/central regions, and a proportion of positive occurrence for the east region. The IWG raised concerns with the timing of the SEAMAP Fall Plankton Survey (late August and September) which is conducted towards the end of the Red Snapper spawning season and outside of peak spawning. Thus, raising the question as whether the indices were adequately capturing population trends. Particularly, in the east region where larvae were rarely taken. The IWG also requested discussions be held with the life history group in regard to the timing of the survey and the capturing of trend. Based on these discussions and the rare catch of larvae, the east index was not recommended by the IWG as suitable to move forward for the assessment phase. The IWG also requested a re-analysis of the northeast/central delta-lognormal index to include samples from the 2015 and 2017 SEAMAP Fall Plankton Surveys with partial spatial coverage in the MS/AL and FL subregions. The updated northeast/central index was presented, discussed during the Data Workshop and recommended by the IWG to replace the initial index. The west and updated northeast/central indices were recommended by the IWG as suitable to move forward to the assessment phase.

5.4.10 FWRI Artificial Reef Video Survey

The Fish and Wildlife Research Institute (FWRI) began using stereo-baited remote underwater video survey (S-BRUV) to assess trends in reef fish species in 2008 on the West Florida Shelf (WFS) to supplement ongoing NOAA surveys that focused on different habitats or were limited in geographic scope. These initial efforts were focused on natural reefs offshore of Tampa Bay and Charlotte Harbor but funding through the National Fish and Wildlife Fund (NFWF) expanded the survey to cover the entirety of the WFS region from zones 2-10. These data contribute to the natural reef combined video index. Part of this expansion was the inclusion of artificial reef habitats as a stratum within the mapping and sampling protocol. Efforts on these habitats began in 2014 in the Panhandle and in 2016 for the remainder of the state. These efforts have continued through funding from the NOAA Restore Science program starting in 2020. Given the time series of these surveys as well as ongoing interest in incorporation information from artificial reef habitats into the Red Snapper assessment, we developed an index for these habitats for the two regions identified in the stock ID process.

5.4.10.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-27
Data Type: Fishery Independent
Time Series: 2014-2020 (central); 2016-2020 (east)
Sampling Intensity: See Table 1 in working paper for both regions by survey.
Size/Age Data: Represents juvenile through adult biomass; see Figure 3 in working paper.

Data Filtering Techniques: For all surveys, video reads were excluded if they were unreadable due to turbidity or deployment errors. Sites included were targeted on artificial reefs identified to artificial structures during side-scan mapping before setting the camera only.

Standardization: Due to the general zero-inflated nature of these data, as with other indices using the video data, a negative binomial GLM was fit to predict annual MaxN. All potential habitat variables were initially used in the model which included spatial data such as latitude, longitude, depth as well as the landscape level habitat as side-scan geoform, and finally site-specific variables which were the amount of relief seen at a site on video and percent coverage and the presence/absence of sponge, rock, algae, hard corals, soft corals, unknown sessile organisms, and seagrass. Models for each region were backwards selected by sequentially removing non-significant variables to find the most parsimonious model using AIC as criteria. Final models for the two regions were (where per=percent cover, and pa=presence/absence):

Submodel Variables
Central: year + latitude + longitude + artificial habitat_pa + rock_per + algae_pa

East: year + depth + latitude + longitude + algae_per + scoral_per +sponge_per+ rock_per + artificial habitat_per

Annual Abundance Indices: see Table 2 in working paper.

5.4.10.2. Comments on Adequacy for Assessment

This index was not deemed suitable for the east region given the low sample sizes, very low proportion positive and the limited time series. The central region was suitable yet not recommended for the short time series, smaller spatial footprint, and relatively flat trend in abundance. However, continued data collection and exploration of generating time series from this survey was recommended by the IWG and overall panel.

5.4.11 DISL Bottom Longline

The Dauphin Island Sea Lab (DISL) has conducted fishery-independent shark bottom longline surveys in the north-central GOM off Alabama since 2010. The gear used during the survey is similar to that used by the SEFSC Bottom Longline Survey but utilizes a different sampling design.

5.4.11.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-26
Data Type: Fishery Independent
Time Series: 2010 – 2019
Sampling Intensity: Table 13 (central) in working paper.
Size/Age Data: Primarily age-2+ adult fish.
Data Filtering Techniques: Standard filtering protocols to remove problematic stations.
Standardization: Delta-lognormal
Submodel Variables
Binomial: Year
Positive: Year

Annual Abundance Indices: Table 13 (central) in working paper.

5.4.11.2. Comments on Adequacy for Assessment

The IWG found this survey to have an acceptable statistical design with good temporal coverage. However, this survey has limited spatial coverage, mainly off the coast of Alabama (Figure 5.10.1), that may not be representative of the entire central region for red snapper. This survey also catches the same size class of individuals that are captured in the SEFSC Bottom Longline Survey, which covers the entire central region. Therefore, the IWG determined that the DISL Bottom Longline Survey was 'Suitable and Not Recommended' for use in the stock assessment.

5.4.12 NOAA Fisheries SEFSC Bottom Longline Survey / DISL Bottom Longline Survey

This is a combination of the SEFSC Bottom Longline Survey (Section 5.3.1) and the DISL Bottom Longline Survey (Section 5.3.11) datasets for the Central Region.

5.4.12.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-26
Data Type: Fishery Independent
Time Series: 2001 – 2019
Sampling Intensity: Table 11 (central) in working paper.

Size/Age Data: Primarily age-2+ adult fish.
Data Filtering Techniques: Standard filtering protocols to remove problematic stations.
Standardization: Delta-lognormal, Conn Method

Submodel Variables
Binomial: Year + Zone
Positive: Year + Zone

Annual Abundance Indices: Table 11 (central) in working paper.

5.4.12.2. Comments on Adequacy for Assessment

Several analytical approaches were attempted on this dataset to try to combine the data from the SEFSC Bottom Longline Survey and the DISL Bottom Longline Survey. The main issue is that the DISL survey samples in a small spatial area with high abundance in the central region (off Alabama), whose abundance trends overweight the signal from the SEFSC Bottom Longline Survey, which samples across the entirety of the central region (Figure 5.10.1). When compared to the indices from solely the DISL Bottom Longline Survey, the combined index has almost an identical trend to lead to the discussion of how the DISL data was driving the entire index trend and overwhelming the data from the rest of the central region. The Conn Method was attempted as an alternative to the delta-lognormal model, but it appeared to just average the two indices. It is the recommendation of the IWG that this index needs more research on the proper way to combine the datasets, while properly accounting for the weighting of the different survey areas. Therefore, this index was deemed 'Suitable and Not Recommended' for the assessment.

5.4.13 SEAMAP Vertical Line Survey

We developed a set of fishery-independent indices of abundance for Gulf of Mexico Red Snapper based on SEAMAP vertical line catch data collected between 2012 and 2021. The indices were fit using type 1 negative binomial GLMs with zero-inflation mixture components. Indices were fit to different conditional models including, Year only, Year * Habitat, Year * Depth, and Year * Zone. We also fit three independent indices for each of the three spatial zones (west, central, and east) described in "Option C" of the SEDAR 74 Stock ID Report.

5.4.13.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-39
Data Type: Fishery Independent
Time Series: 2012-2021
Sampling Intensity: Tables 1 (west), 2 (central) and 3 (east) in working paper
Size/Age Data: Figure 1
Data Filtering Techniques: NA
Standardization: type 1 negative binomial with zero-inflation mixture component

Model Variables: year, zone, depth stratum, habitat type

Annual Abundance Indices: Table 12 (west, central and east) in working paper.

5.4.13.2. Comments on Adequacy for Assessment

The consensus of the workshop participants was that the index was unsuitable for use in the assessment for the following reasons: (1) lack of representative spatiotemporal sampling, particularly in early years of time series, (2) apparent habitat bias, particularly in early years of time series, (3) if early years of time series are censored due to reasons 1 & 2, the index covers too short a time period, and (4) there were concerns that the vertical line gear may be susceptible to saturation at locations with high abundance.

5.5 FISHERY-DEPENDENT INDICES

5.5.1 Recreational (Charterboat and Private)

A delta-lognormal index of abundance for the Gulf of Mexico Charterboat and Private combined recreational fishery was constructed for the SEDAR74 Operational Red Snapper stock assessment. The index uses recreational fishery data obtained from the Marine Recreational Information Program, LA Creel Survey and Texas Parks and Wildlife. Indices for the Gulf of Mexico east, central and west regions were developed following the trip selection approach and standardization methodology used for SEDAR52 and SEDAR31.

5.5.1.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-13
Data Type: Fishery Dependent
Time Series: 1981-2019
Sampling Intensity: Tables 10 (west), 8 (central) and 6 (east) in working paper.
Size/Age Data: NA
Data Filtering Techniques: Stevens-McCall
Standardization: Delta-censored lognormal

Submodel Variables
Binomial: Year, regulation season, anglers, area and wave (central region)
Binomial: Year, area, anglers and regulation season (west region)
Censored Lognormal: year, wave and mode (central region)
Censored Lognormal: year, wave and mode (west region)

Annual Abundance Indices: Tables 10 (west), 8 (central) and 6 (east) in working paper.

5.5.1.2. Comments on Adequacy for Assessment

During the Data Workshop IWG, several different approaches were attempted for the index standardization due to concerns surrounding changes in management. The nominal index on the full times series for the central region was outside the confidence interval of the standardized index beginning in 2007 (SEDAR74-DW-13 Figure 16). This corresponds to a shift in the red snapper bag limit from four to two fish as well as the reduction in open fishing days of red snapper in 2007. The three region indices were all based on type "A" catches, which does not fully reflect all the fish caught by the recreational fishery. A second set of indices were constructed during the Data Workshop, ones based off A, B1 and B2 type catches. This encompassed both observed caught red snapper (A), unobserved caught red snapper (B1) and unobserved released red snapper (B2). The east region still lacked sufficient data to construct an index and the west region index could not be attempted, as discards are not collected by Texas. A delta lognormal was used to standardize the AB1B2 catches, as the censored approach was not needed to account for bag limits on the landed and discarded catches. The central nominal index of AB1B2 catches remained outside the standardized confidence interval after management regulations went into effect and exhibited a flat trend in recent years (SEDAR74-DW-13 Figure 17).

Stakeholders attending the webinar noted that effort has been increasing in recent years in the forms of larger vessels and engines and that fishing behavior has changed due to the implementation of federal and state regulations. These changes in the types of effort metrics noted by the stakeholders are not recorded by MRIP and therefore cannot be accounted for through standardization methods. The IWG concluded that due to changes in management regulation, fisher behavior and effort, the Charterboat and Private indices do not reflect the underlying population of red snapper in the Gulf of Mexico and did not recommend them for use in the assessment.

5.5.2 Southeast Region Headboat Survey

The Southeast Region Headboat Survey (SRHS) collects data on the catch and effort for individual headboat trips. Reported information includes landing date and location, vessel identification, the number of anglers, a single fishing area for the entire trip, trip duration and/or type (half/three-quarter/full/multi-day, day/night, morning/afternoon), and catch by species in number and weight. Headboats operate based on the federal season and use hook and line gear. They generally target hard bottom reefs as the fishing grounds and multiple species in the snapper-grouper complex.

5.5.2.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-21
Data Type: Fishery Dependent
Time Series: 1986-2019
Sampling Intensity: See Table 1 in working paper for number of annual trips by Stock ID region and percent of trips positive for red snapper catch.
Size/Age Data: Age 2+

Data Filtering Techniques: Major data filtering included selecting only trips from April 21st to Nov 1st 1986 – 2007 and the Stephens and McCall (2004) trip selection approach to determine trips that occurred in red snapper habitat since no direct targeting information was available.

Standardization: Delta censored lognormal regression

Submodel Variables

West:
Binomial: Year + Area + Season + Anglers* + Trip Type*
Positive Observations: Year + Area + Season
Central:
Binomial: Year + Trip Type*
Positive: Year + Season
East:
Binomial: Year + Area + Season
Positive: Year + Season
***Only explored as factors for modeling success because these factors were confounded with effort for the CPUE response variable in the lognormal model.

Annual Abundance Indices: Table 6 (west), 7 (central) and 8 (east) in working paper.

5.5.2.2. Comments on Adequacy for Assessment

The indices presented at the data workshop for the IWG included the standardized indices for the central and west regions, and the nominal index for the east region (due to a lack of model convergence for the east index). All data used in the indices were filtered to dates between April 21st and Nov 1st, 1986 – 2007. The west and central indices were recommended by the IWG as suitable to move forward to the assessment phase but with some caveats.

In the west region, the SRHS index can be considered for investigation but may not be needed in favor of a fishery independent survey that covers the same temporal range. Considering all other presented indices, there was a 4-year gap in the available information in the west that the SRHS data could potentially inform. The assessment team can explore the usefulness of these additional data points to the model. If the west index is used in the assessment model, the assessment analysts should be aware of the potential conflict in relative abundance trends in the early time period between the SRHS data and the other indices for the west.

In the central region, the SRHS index is recommended for use in the assessment, as it was one of the only time series that extended back to 1986.

5.5.3 Commercial Vertical Line (Pre IFQ)

Standardized catch-per-unit-effort indices of relative abundance were derived from data collected on commercial vertical line fisheries operating in the Gulf of Mexico. East, central, and west stock ID area indices were developed using fishery dependent data collected from the Coastal Fisheries Logbook Program (CFLP). All main effects and first order interactions were tested during model development and the final models were selected using a forward stepwise regression approach and AIC. For all areas, indices were truncated at 2006 due to the commercial vertical line fishery shifting to an IFQ program in 2007.

5.5.3.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-17
Data Type: Fishery Dependent
Time Series: 1993 - 2006
Sampling Intensity: Average sample size
East – 162
Central – 975
West – 1,673
Size/Age Data: Dome-shaped selectivity with peak selection occurring at age 4-5.
Data Filtering Techniques: Stevens-McCall
Standardization: delta-lognormal
Submodel Variables
Year, Month, Shrimp Statistical Grid (Area), Crew Size (Crew), Days Fishing (Away), and Hook Hours (lines fished*hooks per line* hours fished).*
** Hook Hours only tested in the binomial model*

Annual Abundance Indices: Tables 3 (west), 2 (central) and 1 (east) in working paper.

5.5.3.2. Comments on Adequacy for Assessment

During the SEDAR 74 data workshop the IWG reviewed the commercial vertical line pre-IFQ (ComVL) indices with the goal of determining if the indices were both suitable and recommended for assessment. An index was classified as suitable for use if it was determined to have been constructed from data appropriate for index development using well-documented statistical methods that produced standardized indices of abundance and measures of uncertainty. If an index was deemed suitable for use in assessment, it was then evaluated alongside all other suitable indices within a given stock ID area. Recommended indices were those that used the highest quality data and/or covered a year-range or age/size-structure that was not represented by the other recommended indices.

Upon review by the SEDAR 74 IWG, the ComVL indices for the east, central, and west stock ID areas were determined to be suitable for use in assessment. While the indices for all stock ID areas were considered suitable for use, only the east and were recommended for use in the SEDAR 74 stock assessment. When recommended, the ComVL indices were included due to their historic temporal coverage. The indices were not recommended when the stock ID area had fishery independent indices of abundance that provided similar temporal coverage as the ComVL.

5.5.4 Commercial Vertical Line (Post IFQ)

There are concerns that catch-per-unit-effort (CPUE) abundance indices based on commercial fleet landings may not be valid after implementation of individual fishing quotas (IFQs) for selected grouper-snapper species in the Gulf of Mexico (GOM). To address these concerns, a novel CPUE index was developed in 2020-2021 for scamp and yellowmouth grouper for the commercial fleet using data from the reef fish observer program (Smith et al. 2021). Observer observations of catch include both kept and discarded fish, and are thus not directly impacted by changes in management regulations (e.g., minimum size, catch quotas, etc.). This methodology was applied to develop commercial fleet CPUE indices for red snapper for SEDAR 74.

5.5.4.1. Methods of Estimation

Working Paper Number: SEDAR74-DW-39
Data Type: Fishery Dependent
Time Series: 2007-2019
Sampling Intensity: Tables 1 (west), 2 (central) and 3 (east) in working paper.
Size/Age Data: Length composition was collected by observers; see abundance indices below.

Methods Overview: Reef fish observer data for vertical line gear have much in common with fishery-independent surveys utilizing fishing gears, including: latitude-longitude coordinates were recorded at each specific fishing location, catches were recorded for individual species, and lengths were recorded for individual fish (Scott-Denton et al. 2011). A probability survey approach was thus used for estimation of the reef fish observer CPUE index. The spatial sample frame was delineated as 500x500 m grid cells (i.e., sample units) encompassing the full range of red snapper observed depths in the west, central, and east GOM. Analysis techniques accounted for varying gear characteristics (e.g., hook types, hook sizes, etc.) and varying effort (e.g., number of lines, fishing time at a location, etc.) in the estimation procedure. Analysis and estimation methods were presented to the IWG, and are documented in an accompanying working paper (Smith 2022).

Data Filtering Techniques: Initial filtering steps restricted data to vertical line gears, and excluded observations with missing location information (i.e., latitude-longitude). This enabled assignment of observations at specific fishing locations to a unique 500x500 m grid cell with associated depth information, and subsequent restriction of observations to the observed red snapper depth range of 10-140 m.

Red snapper length frequency distributions were found to differ with respect to hook type (j-hooks vs. circle hooks) as well as hook size. Data were subsequently filtered to include circle hooks, which accounted for over 90% of observations, for two distinct hook size categories (small and large) based on hook shaft length measurements taken by observers.

Species co-occurrence analysis following methods of Mackenzie et al. (2006) was used to identify valid red snapper sample units, i.e., sample units with a non-zero probability of catching scamp: fishing samples were included if either red snapper or a positively-associated species were captured.

Previous analyses for scamp/yellowmouth grouper identified line-hours as the most appropriate effort variable for CPUE estimation. High values of line-hours exceeding the 99th percentile were excluded as outliers.

Effort Standardization: Line-hours were standardized for the two hook size categories and two reel types (hand, mechanical) using the fishing power approach (Robson 1966), which estimates the relative catchability (q) among gears, and then converts effort of each gear in terms of a designated standard gear. Estimation of fishing power was carried out using a compound pdf generalized linear model (GLIM), which analyzed presence-absence using a logistic regression model and catch-when-present using a gamma pdf GLIM. Small circle hooks with mechanical reels was designated as the standard gear. Effort for other gears was converted to that of the standard gear, and the data were pooled for estimating the CPUE index.

Annual Abundance Indices: Annual estimates of red snapper CPUE and associated variance were estimated using a Hurwitz-Thompson ratio-of-means estimator for a stratified sample frame (Lohr 2010). Estimation was carried out separately for the west, Central, and east subregions of the GOM. Depth stratification within each subregion was effective with respect to spatial partitioning of sample variance for CPUE. Spatial strata weighting controlled for potential bias of subregion CPUE estimates due to disproportionate sampling in relation to depth strata. Strata-weighted annual length compositions were computed following the procedures of Smith et al. (2022).

Estimates of the reef fish observer abundance index for GOM red snapper for 2007-2019 for the commercial vertical line fleet are provided in Tables 1, 2 and 3 for the respective west, central, and east subregions.

5.5.4.2. Comments on Adequacy for Assessment

During the SEDAR 74 data workshop, the IWG reviewed the observer post-IFQ commercial vertical line indices with the goal of determining if the indices were both suitable and recommended for assessment. An index was classified as suitable for use if it was determined to have been constructed from data appropriate for index development using well-documented statistical methods that produced standardized indices of abundance and measures of uncertainty. If an index was deemed suitable for use in assessment, it was then evaluated alongside all other suitable indices within a given stock ID area. Recommended indices were those that used the highest quality data and/or covered a year-range or age/size-structure that was not represented by the other recommended indices.

Upon review by the SEDAR 74 IWG, the ComVL indices for the east, central, and west stock ID areas were determined to be suitable for use in assessment. While the indices for all stock ID areas were considered suitable for use, only the east index was recommended for use in the

SEDAR 74 stock assessment. When recommended, the ComVL indices were included due to their historic temporal coverage. The indices were not recommended when the stock ID area had fishery independent indices of abundance that provided similar temporal coverage as the ComVL.

5.6 RECRUITMENT INDEX BASED ON THE CONNECTIVITY MODEILING SYSTEM

The Connectivity Modeling System (CMS) is a biophysical modeling system based on a Lagrangian framework and was developed to study complex larval migrations. The CMS uses outputs from hydrodynamic models and tracks the three-dimensional movements of advected particles through time, given a specified set of release points and particle behaviors, while simulating realistic larval behaviors such as ontogenetic vertical migration. Specifics on the hydrodynamic model forcing the simulation, and other details on how the simulation was parameterized specific to red snapper biology, are described in SEDAR 74-RD-71. The recruitment index is a measure of the proportion of larvae that are expected to successfully settle to suitable recruitment habitat within the given biological constraints, due to the effects of oceanographic currents. The index thus represents a scalar on the total larval supply expected each year, prior to any density-dependent processes that act on the larvae upon settlement. Variance estimates for the index are obtained by running a range of sensitivities to the assumed larval depth distribution, providing a mean and annual standard deviation for the index.

5.7 RESEARCH RECOMMENDATIONS

- Explore alternative methods for properly weighting the DISL BLL survey in order to incorporate it with the NOAA Fisheries BLL survey
- Explore utility of design based index estimator for Gulfwide video survey
- Calibration of optical and acoustic imaging systems to better sample low visibility environments
- Explore alternative trip selection protocols that can account for changing regulations and angler behavior
- Explore influence of interacting species on gear selectivity and catchability

5.8 LITERATURE CITED

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

Lohr, S.L. 2010. Sampling: design and analysis, 2nd ed. Boston: Brooks/Cole.

Mackenzie, D.I., Nichols, J.D., Royle, J.A. Pollock, K.H., Bailey, L., Hines, J.E. 2006.Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Academic Press.

Nichols, S. 2004. Derivation of red snapper time series from SEAMAP and groundfish trawl surveys. SEDAR7-DW01.

Robson, D.S. 1966. Estimation of the relative fishing power of individual ships. ICNAF. Res. Bull. 3:5-15.

SEDAR 74 Stock ID. 2021. Gulf of Mexico Red Snapper Stock ID Process Final Report. Available: http://sedarweb.org/docs/page/S74_Stock_ID_Report_FINAL_v4 _watermark.pdf

Scott-Denton, E., Cryer, P.F., Gocke, J.P., Harrelson, M.R., Kinsella, D.L., Pulver, J.R., Smith, R.C., Williams, J. 2011. Descriptions of the U.S. Gulf of Mexico reef fish bottom longline and vertical line fisheries based on observer data. Marine Fisheries Review 73(2):1-26.

Smith, S.G., S. Sagarese, S. Martinez-Rivera, K.J. McCarthy. 2021. Estimation of a commercial index for Gulf of Mexico scamp & yellowmouth grouper using reef fish observer data. SEDAR Working Paper SEDAR68-AW-04. SEDAR, North Charleston, SC. 34 pp.

Smith, S.G. 2022. Estimation of vertical line commercial indices for Western, Central, and Eastern Gulf of Mexico red snapper using reef fish observer data. SEDAR Working Paper SEDAR74-DW-38. SEDAR, North Charleston, SC.

Smith, S.G., S. F. Atkinson, and S. Martinez-Rivera. 2022. Estimation of length composition of commercial discards for Gulf of Mexico red snapper. SEDAR Working Paper SEDAR74-DW-37. SEDAR, North Charleston, SC.

5.9 TABLES

Table 5.9.1. Sampling effort (N), relative abundance (Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of west Gulf of Mexico indices recommended for consideration in the assessment.

	SEFSC Bottom Longline			SEAMAP SGF - Old 1982-2008			SEAMAP SGF - New 2009-2019			SEAMAP FGF - Old 1988-2007		
Year	**N**	**Index**	**CV**	**N**	**Index**	**CV**	**N**	**Index**	**CV**	**N**	**Index**	**CV**
1984				161	0.74713	0.28624						
1985				77	1.11016	0.3086						
1986				79	0.29356	0.43855						
1987				178	0.71006	0.22079						
1988				145	0.34651	0.24776				181	0.42781	0.14968
1989				141	0.25619	0.30539				180	0.85672	0.14082
1990				172	2.26208	0.16018				175	0.90854	0.12376
1991				185	1.02087	0.18827				179	1.02731	0.11777
1992				180	0.64442	0.1977				179	0.31611	0.15075
1993				178	0.70395	0.19391				177	0.57429	0.14108
1994				177	1.34549	0.17943				179	1.62501	0.12146
1995				176	1.17612	0.1702				177	1.74663	0.11071
1996				174	1.30854	0.17055				181	0.86993	0.12869
1997				163	0.99397	0.17211				178	1.29003	0.12559
1998				169	0.88587	0.1919				181	0.59505	0.14396
1999				179	0.75858	0.19287				182	1.37449	0.11653
2000				171	1.39109	0.15399				179	0.90717	0.1181
2001	124	0.32272	0.25898	116	0.78658	0.26337				184	0.68066	0.13467
2002	150	0.24739	0.2234	183	1.09421	0.17058				181	0.64987	0.13396
2003	100	0.28885	0.28409	137	0.61355	0.21065				183	1.15195	0.12107
2004	95	0.34471	0.28458	177	1.33104	0.16223				162	1.79825	0.1094
2005				148	1.50193	0.16631				186	1.27156	0.10272
2006	71	0.27649	0.35084	176	1.41881	0.14692				176	1.08383	0.12343
2007	70	0.29871	0.34949	155	1.16578	0.1824				173	0.84479	0.14374
2008				206	1.13354	0.15471						
2009	76	0.51429	0.26035				301	0.36643	0.15392			
2010	46	0.25183	0.46088				201	0.86976	0.14973			
2011	139	0.70517	0.19059				171	1.21008	0.14826			
2012	53	1.24024	0.27629				176	0.83538	0.14179			
2013	63	1.14287	0.25134				141	1.30822	0.16676			
2014	47	0.86446	0.30549				162	0.79263	0.16255			
2015	56	2.12482	0.22997				168	1.08551	0.15037			
2016	54	1.76134	0.22033				162	0.89431	0.15118			
2017	67	2.69753	0.16413				161	0.85424	0.16141			
2018	59	1.5612	0.22425				135	1.63878	0.13971			
2019	48	2.3574	0.2253				145	1.14466	0.15603			

Table 5.9.1 (continued). Sampling effort (N), relative abundance (Index) scaled to a mean of one for each time series, and the coefficient of variation on the mean (CV, standard error/mean) of west Gulf of Mexico indices recommended for consideration in the assessment.

	SEAMAP FGF - New 2008-2019			SEAMAP Fall Plankton			SEAMAP Reef Fish Video			Southeast Region Headboat Survey		
Year	**N**	**Index**	**CV**	**N**	**Index**	**CV**	**N**	**Index**	**CV**	**N**	**Index**	**CV**
1984												
1985												
1986				49	0.2823	0.6320				970	0.8600	0.2100
1987				55	0.4391	0.6333				970	0.8900	0.2000
1988										986	1.0700	0.2000
1989				28	0.5494	0.6198				1,023	0.9600	0.2000
1990				31	0.4452	0.5060				1,054	0.6700	0.2000
1991				31	0.2149	0.7220				1,115	1.2700	0.2100
1992				55	0.2536	0.4771				1,538	1.7800	0.2100
1993				55	0.2692	0.4772	45	0.1400	0.1543	1,671	1.6700	0.2000
1994				55	0.1973	0.6324	45	0.3400	0.1817	1,832	1.2300	0.1800
1995				55	0.7589	0.3384	44	0.3100	0.2134	1,687	1.4300	0.2000
1996				55	0.534	0.4148	165	0.7000	0.1967	1,494	1.5400	0.2300
1997				54	0.8922	0.3240	127	1.5500	0.2065	1,487	1.5800	0.2000
1998										1,301	1.1800	0.2000
1999				55	0.3805	0.4419				515	0.3900	0.3000
2000				55	1.2189	0.3169				1,199	0.6900	0.2000
2001				47	0.8468	0.4718				1,356	0.8100	0.2600
2002				54	0.6436	0.3517	93	1.0800	0.2163	1,417	0.7100	0.2400
2003				54	1.2069	0.2997				1,320	0.6200	0.2200
2004				54	0.6848	0.3575	51	0.9500	0.1647	1,457	0.4700	0.2200
2005							136	0.9600	0.2023	1,464	0.5300	0.2200
2006				52	1.1941	0.3548	139	0.3800	0.2140	1,384	0.5700	0.2400
2007				55	1.0471	0.2979	171	1.0200	0.1709	1,484	1.0900	0.2700
2008	286	0.44531	0.10027				131	0.7200	0.1899			
2009	273	1.47183	0.09172	55	1.2756	0.2903	167	1.0800	0.2343			
2010	176	0.69347	0.12964	53	0.5209	0.4415	106	2.2400	0.1963			
2011	177	0.81607	0.12176	53	2.1040	0.3357	103	1.7400	0.2397			
2012	132	1.57527	0.12207	55	1.9798	0.2910	200	1.8700	0.1961			
2013	91	0.66354	0.18001	54	1.0537	0.2992	136	2.6200	0.2058			
2014	146	0.90006	0.12683	52	1.5505	0.3214	113	3.4900	0.1726			
2015	144	1.64949	0.11665				48	2.1400	0.1980			
2016	118	1.10622	0.15101	55	3.1776	0.2682	168	2.6400	0.2268			
2017	143	0.765	0.14591	53	0.8388	0.3522	189	3.0400	0.2055			
2018	142	1.07697	0.12548	53	1.5928	0.2777	194	6.0400	0.1978			
2019	137	0.83676	0.14676	47	2.8477	0.2387	265	3.3400	0.1816			

Table 5.9.2. Sampling effort (N), relative abundance (Index) scaled to a mean of one for each time series, and the coefficient of variation on the mean (CV, standard error/mean) of central Gulf of Mexico indices recommended for consideration in the assessment.

	SEFSC Bottom Longline			**SEAMAP SGF – New 2009-2019**			**SEAMAP FGF – New 2008-2019**			**SEAMAP Fall Plankton**		
Year	**N**	**Index**	**CV**	**N**	**Index**	**CV**	**N**	**Index**	**CV**	**N**	**Index**	**CV**
1981												
1982												
1983												
1984												
1985												
1986												
1987												
1988												
1989												
1990												
1991										17	0.1200	1.2117
1992												
1993												
1994										33	0.0314	1.2239
1995										30	0.0603	1.2234
1996												
1997										32	0.0884	1.2196
1998												
1999										33	0.3690	0.7212
2000										33	0.8043	0.6277
2001	55	0.15237	0.88290							31	0.1530	0.7130
2002	48	0.10488	0.88624									
2003	55	0.24000	0.72815							32	0.3974	0.6220
2004										33	0.1586	1.2240
2005												
2006	14	0.14765	1.22517							33	0.6077	0.7167
2007										33	0.8912	0.5008
2008							50	0.60397	0.33950	25	0.0906	1.2148
2009	32	0.32922	0.73190	140	0.44691	0.27059	107	2.28064	0.18760	33	0.5059	0.7150
2010	32	1.12868	0.50307	71	1.01429	0.31763	85	0.69305	0.28053	32	2.7249	0.4142
2011	97	1.51067	0.29569	64	0.56773	0.37691	42	0.57036	0.34558	33	0.9057	0.7222
2012	22	1.03395	0.72472	80	1.07656	0.31270	51	1.36823	0.29081	27	0.7881	0.5416
2013	38	0.49373	0.74039	67	1.37233	0.34904	57	0.70064	0.33441	33	0.8545	0.5438
2014	24	1.85775	0.46027	91	0.68369	0.31524	55	0.97828	0.29420	31	1.4842	0.5494
2015	38	2.13419	0.41541	101	0.65342	0.34799	62	1.29191	0.27548	19	0.4687	1.2215
2016	42	2.28623	0.45247	81	0.95237	0.29861	36	0.98483	0.41426	33	1.0315	0.4485
2017	24	0.79160	0.56928	88	1.67192	0.22371	76	0.56256	0.27826	23	4.2551	0.2941
2018	33	1.07228	0.56710	66	1.14448	0.31295	56	1.27098	0.27251	32	1.8049	0.4214
2019	20	1.71680	0.61978	78	1.41630	0.29393	51	0.69456	0.32661	29	4.4050	0.3188

Table 5.9.2 (continued). Sampling effort (N), relative abundance (Index) scaled to a mean of one for each time series, and the coefficient of variation on the mean (CV, standard error/mean) of central Gulf of Mexico indices recommended for consideration in the assessment.

	Combined Reef Fish Video			Southeast Region Headboat Survey		
Year	**N**	**Index**	**CV**	**N**	**Index**	**CV**
1981						
1982						
1983						
1984						
1985						
1986				259	0.17000	0.38000
1987				436	0.15000	0.31000
1988				713	0.19000	0.25000
1989				726	0.22000	0.25000
1990				835	0.30000	0.24000
1991				971	0.35000	0.22000
1992				1,066	0.67000	0.22000
1993	26	0.09741	0.57081	1,179	0.71000	0.22000
1994	24	0.08574	0.70649	1,183	0.52000	0.21000
1995	13	0.04870	1.09378	1,392	0.58000	0.20000
1996	39	0.13690	0.44562	1,460	0.72000	0.22000
1997	41	0.25866	0.33672	1,566	1.28000	0.27000
1998				1,399	1.66000	0.33000
1999				834	1.12000	0.28000
2000				1,537	1.69000	0.26000
2001				1,451	1.62000	0.28000
2002	46	0.60902	0.26021	1,617	2.46000	0.34000
2003	64	1.18576	0.20357	1,721	1.95000	0.28000
2004	126	0.97289	0.17316	1,499	1.57000	0.29000
2005	203	0.96136	0.18208	1,303	1.35000	0.33000
2006	212	1.56115	0.19131	1,310	0.84000	0.32000
2007	141	1.38441	0.15066	1,238	1.90000	0.51000
2008	195	1.81834	0.14053			
2009	213	1.64643	0.12213			
2010	287	1.59289	0.10499			
2011	218	0.85330	0.13124			
2012	148	1.04232	0.15704			
2013	233	0.95279	0.18277			
2014	188	0.78473	0.13857			
2015	444	1.37161	0.09877			
2016	406	1.50448	0.11062			
2017	371	1.08306	0.15943			
2018	564	1.50381	0.10567			
2019	164	1.54425	0.13500			

Table 5.9.3. Sampling effort (N), relative abundance (Index) scaled to a mean of one for each time series, and the coefficient of variation on the mean (CV, standard error/mean) of east Gulf of Mexico indices recommended for consideration in the assessment.

	SEFSC Bottom Longline			SEAMAP SGF – New 2009-2019			SEAMAP FGF – New 2008-2019			Combined Reef Fish Video		
Year	**N**	**Index**	**CV**	**N**	**Index**	**CV**	**N**	**Index**	**CV**	**N**	**Index**	**CV**
1981												
1982												
1983												
1984												
1985												
1986												
1987												
1988												
1989												
1990												
1991												
1992												
1993												
1994												
1995												
1996												
1997												
1998												
1999												
2000												
2001	67	0.12015	1.15202									
2002												
2003	96	0.42597	0.81321									
2004	87	0.68704	0.66200									
2005	43	0.52529	1.14653									
2006	43	0.25678	1.14319									
2007	37	1.73555	0.79655									
2008							29	0.66509	0.78822			
2009	54	1.16084	0.57105	88	0.09735	0.91896	66	0.40885	0.53266			
2010	48	1.85093	0.49667	104	0.03350	1.26022	61	0.72140	0.43027	186	0.47611	0.33185
2011	140	1.77124	0.31908	106	1.17019	0.50238				413	0.62507	0.23062
2012	45	0.48289	0.80844	143	0.55628	0.44159	17	0.93305	0.77485	427	0.31771	0.23106
2013	37	2.85228	1.14085	106	0.17358	0.91565	49	0.17427	0.77531	285	0.71539	0.31198
2014	31	0.35960	1.13798	123	0.37885	0.44236	109	3.26184	0.34433	432	0.40242	0.22818
2015				119	3.35578	0.33977	109	1.25273	0.29908	370	1.55938	0.41883
2016	37	1.68080	0.65289	111	2.02925	0.29053	37	1.60227	0.42693	629	2.10454	0.15977
2017	38	0.64649	0.80277	99	1.49400	0.36124	92	0.86033	0.36111	585	1.50676	0.18838
2018	36	0.50953	0.81929	113	1.17880	0.33840	83	0.34283	0.55536	626	1.49763	0.20049
2019	34	0.93462	0.80558	101	0.53242	0.53561	88	0.77733	0.39848	727	1.13123	0.26553

Table 5.9.3 (continued). Sampling effort (N), relative abundance (Index) scaled to a mean of one for each time series, and the coefficient of variation on the mean (CV, standard error/mean) of east Gulf of Mexico indices recommended for consideration in the assessment.

	Commercial VL Logbook (Pre IFQ)			Commercial VL Observer (Post IFQ)		
Year	**N**	**Index**	**CV**	**N**	**Index**	**CV**
1981						
1982						
1983						
1984						
1985						
1986						
1987						
1988						
1989						
1990						
1991						
1992						
1993	53	0.30000	0.22900			
1994	44	0.11300	0.30900			
1995	72	0.25100	0.20700			
1996	79	0.24200	0.18900			
1997	161	0.38200	0.17700			
1998	120	0.26400	0.21300			
1999	147	1.01600	0.17900			
2000	173	1.58700	0.13900			
2001	166	1.10200	0.16700			
2002	233	0.95200	0.16300			
2003	251	1.22000	0.13500			
2004	282	2.07300	0.12700			
2005	243	1.85700	0.13100			
2006	239	2.64100	0.11500			
2007				287	0.39728	0.14602
2008				310	0.47711	0.13951
2009				219	0.82190	0.14229
2010				496	0.83540	0.09916
2011				750	0.85067	0.07327
2012				1532	0.70204	0.05315
2013				660	0.74750	0.08099
2014				490	0.83747	0.11095
2015				853	0.90985	0.19003
2016				871	2.02687	0.08491
2017				457	1.49261	0.27869
2018				158	1.75158	0.14050
2019				81	1.14973	0.20411

5.10 FIGURES

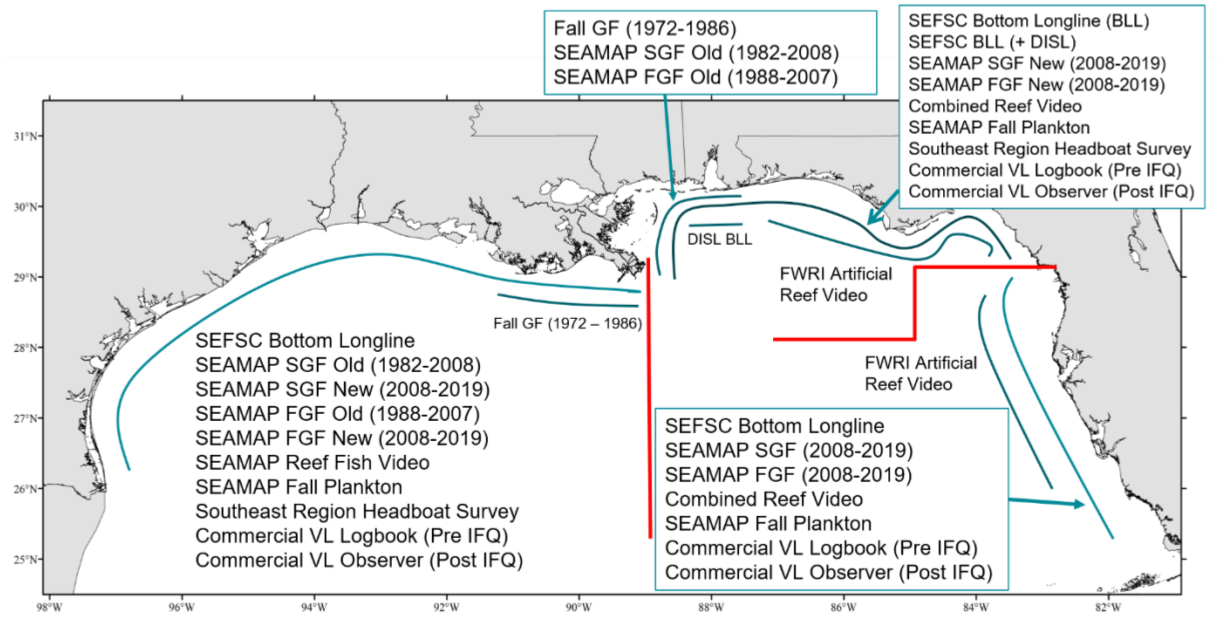


Figure 5.10.1. Relative spatial extent of indices found to be suitable for further review. Red lines represent the boundaries between the regions as defined at the SEDAR74 Stock ID Workshop.

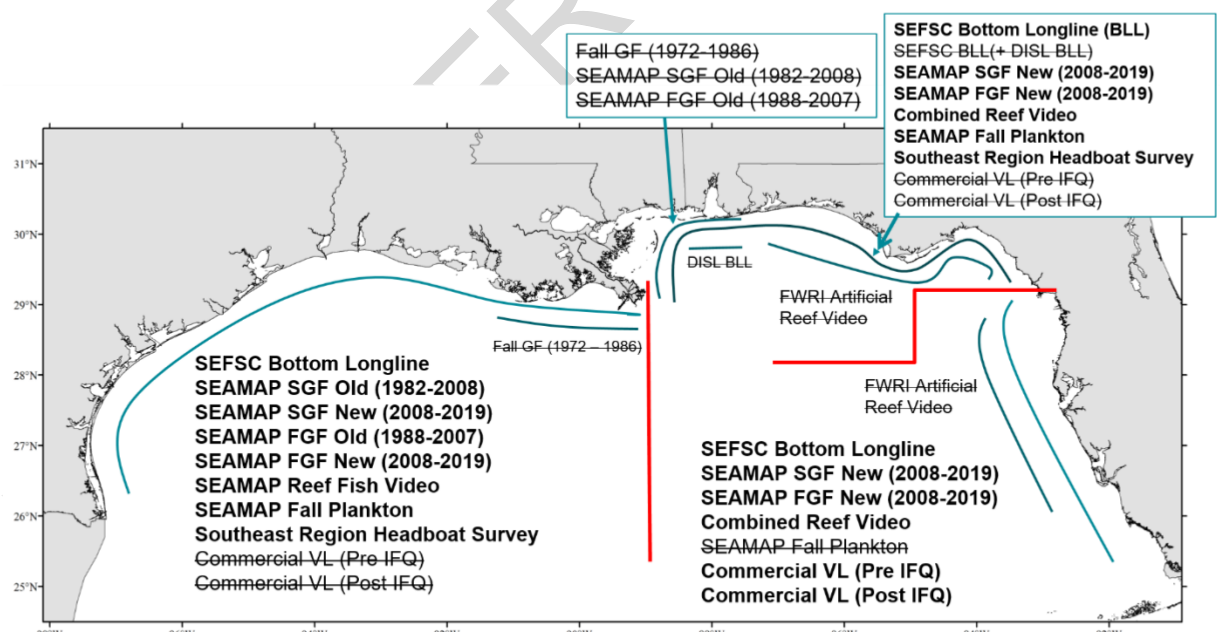


Figure 5.10.2. Relative spatial extent of indices found to be "Suitable and Recommended" for use in the assessment. Red lines represent the boundaries between the regions as defined at the SEDAR74 Stock ID Workshop.

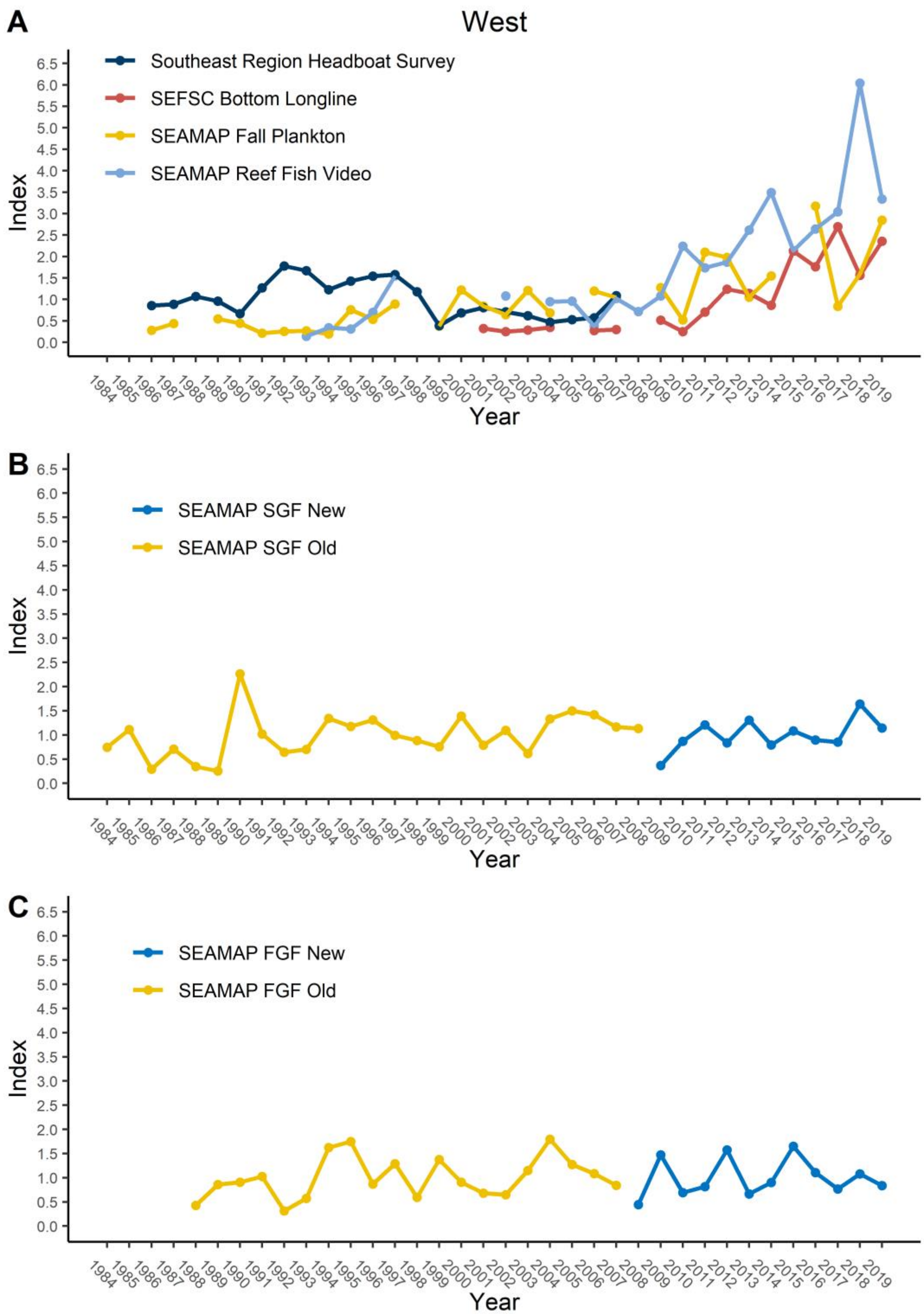


Figure 5.10.3. Recommended relative abundance indices for the west Gulf of Mexico, scaled to a mean of one for each time series. Panel A represents adult indices, panel B primarily age-1 recruits, and panel C primarily age-0 recruits.

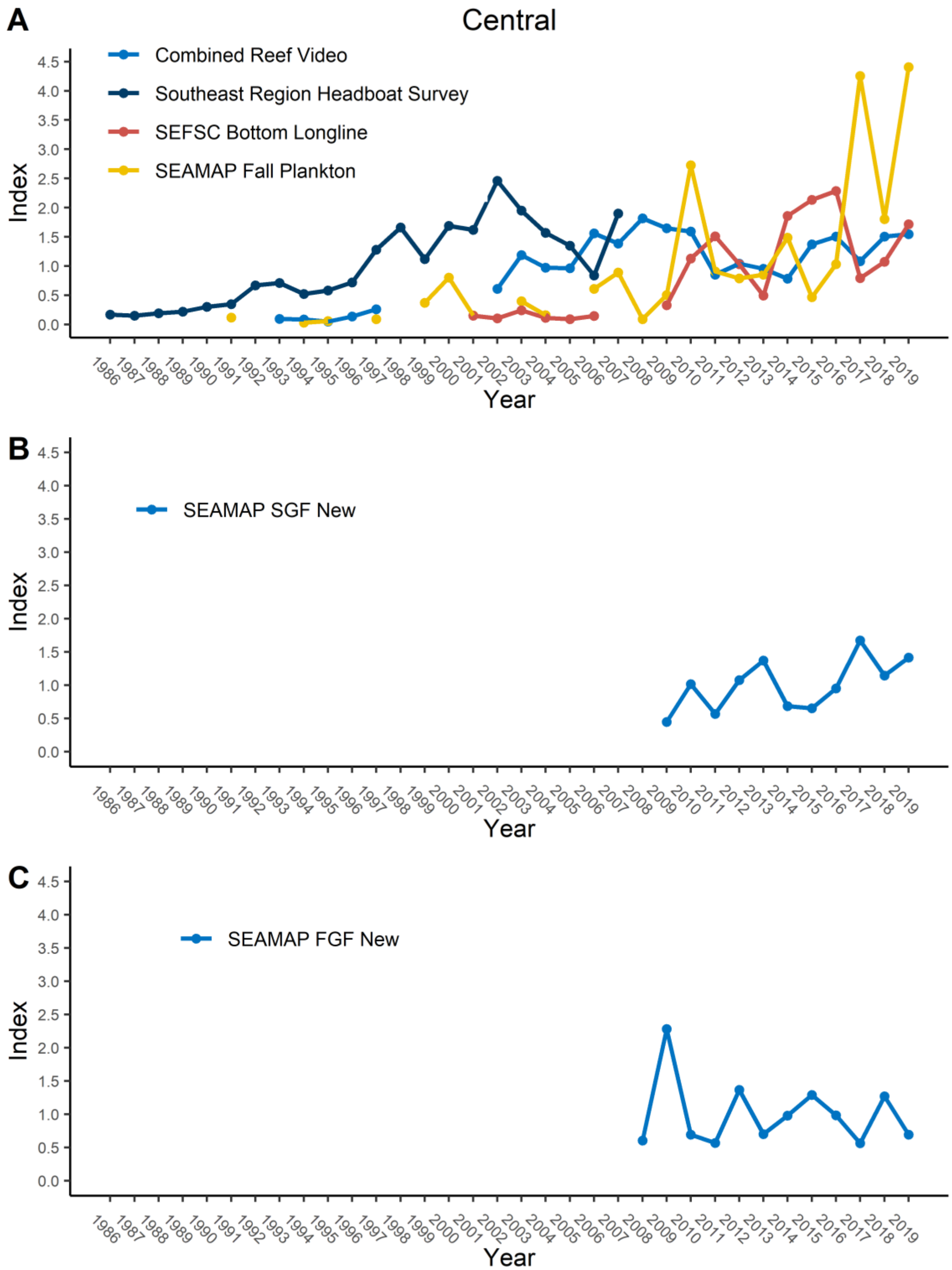


Figure 5.10.4. Recommended relative abundance indices for the central Gulf of Mexico, scaled to a mean of one for each time series. Panel A represents adult indices, panel B primarily age-1 recruits, and panel C primarily age-0 recruits.

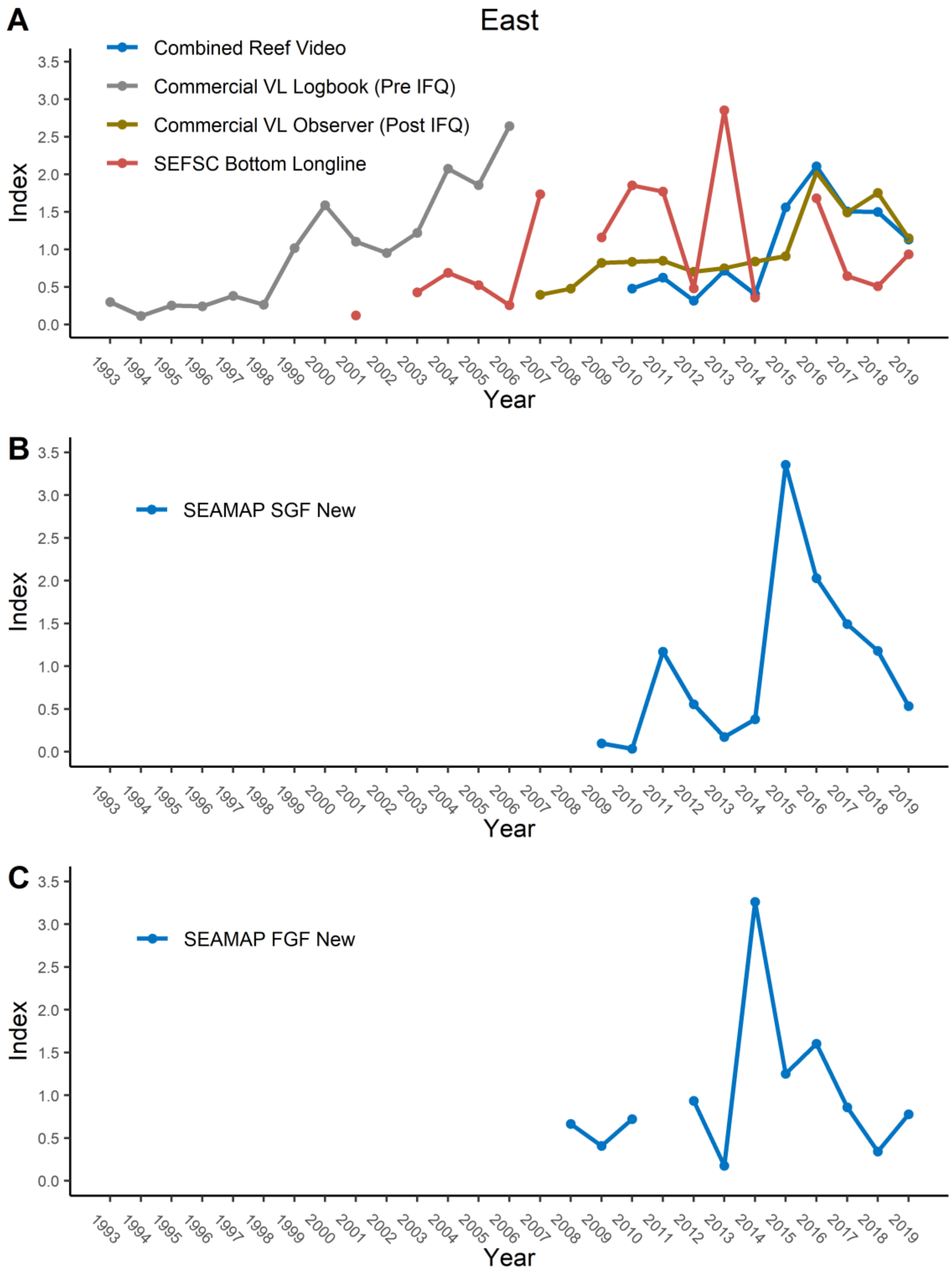


Figure 5.10.5. Recommended relative abundance indices for the east Gulf of Mexico scaled to a mean of one for each time series. Panel A represents adult indices, panel B primarily age-1 recruits, and panel C primarily age-0 recruits.