SEDAR

Southeast Data, Assessment, and Review

SEDAR 74

Gulf of Mexico Red Snapper Stock ID Process Final Report

Original Release: August 2021

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SEDAR
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North Charleston, SC 29405

Document History:

August 20, 2021 Original Release

October 28, 2021 Revision

The report was re-released with modified language to clarify the intent of the CPUE and Landings Working Group section.

In the executive summary

Stock Option Summaries
Option C
Text changed from

A three-unit stock that maintains the current boundary at the Mississippi river outflow (statistical zone 12/13) and adds an additional split east of Cape San Blas, FL and slightly north of Tampa (statistical zones 7/8). Option C was proposed as a proxy for the preferred split at Cape San Blas, FL. This option locates the boundary at the nearest point to the east of Cape San Blas, FL that the recreational data resolution would allow (See Appendix C for further details).

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A three-unit stock that maintains the current boundary at the Mississippi river outflow (statistical zone 12/13) and adds an additional split east of Cape San Blas, FL and slightly north of Tampa (statistical zones 7/6). Option C was proposed as a proxy for the preferred split at Cape San Blas, FL. This option locates the boundary at the nearest point to the east of Cape San Blas, FL that the recreational data resolution would allow (See Appendix C for further details).

This was done to correct an error in the statistical zones identifying the boundary location north of Tampa (highlighted above)

Correction 2

In the Landings and CPUE section of the executive summary

The following text was changed from

Given the above findings, the recommendation from the landings and CPUE working group was for a three-stock model with the primary boundary located at the Mississippi River (between statistical zones 12/13) and a secondary boundary at or near Cape San Blas, FL (statistical zones 7/8). The proposed boundaries allow for the separation and modeling of fisheries dynamics evident in the presented data. These boundaries also create problems for the assessment for two reasons: 1) small sample sizes for all size composition data, and 2) only able to reliably separate Alabama from NWFL in the SRHS data since 2013. Moving the 2nd boundary east to the Big Bend region (statistical zones 7/6) was a suggested compromise as it would not require the separation of AL from NWFL in the SRHS data but would still have sample size issues across all data sources.

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Given the above findings, the recommendation from the landings and CPUE working group were either a two-stock model with a boundary at statistical zones (9/10), or a three-stock model with the primary boundary located at the Mississippi River (between statistical zones 12/13) and a secondary boundary at or near Cape San Blas, FL (statistical zones 7/8). The proposed boundaries allow for the separation and modeling of fish biology and fisheries dynamics evident in the presented data. The suggested boundaries at 9/10 and/or 7/8 are likely to create issues for the assessment for two reasons: 1) small sample sizes for all size composition data, and 2) only able to reliably separate Alabama from NWFL in the SRHS data since 2013. Moving the secondary boundary at Cape San Blas, FL (7/8) east to the Big Bend region (statistical zones 7/6) was a suggested compromise as it would not require the separation of AL from NWFL in the SRHS data but would still have sample size issues across all data sources.

Changes were made to clarify the conclusion of the Landings and CPUE working group following additional discussions that occurred after the initial report was submitted.

November 2, 2021 Revision

Document History: Landings and CPUE Working Group

- The executive summary was changed to accurately reflect the workgroup's summary findings
- Any language referencing a consensus recommendation was removed from the report
- The report section was reorganized to improve flow and readability
    - Moved the "Length Compositions of Landings" section before the "Discussion" section (no changes to text within)
    - Moved Figure 11 to be the new Figure 3 (and updated subsequent figure references)
- Years 2012-2019 were added to Table 5, to ensure that all the data was presented
- Reference to Figure 4 in the "Reef Fish Video Surveys" section was updated to Figure 10 to correctly identify the relevant figure

Table of Contents

1 INTRODUCTION

1.1 *WORKSHOP TIME AND PLACE*

The SEDAR 74 Scamp Stock ID Process was conducted via a series of webinars between November 2020 and July 2021, including a data scoping webinar and three discussion webinars to review data and analysis.

1.2 *TERMS OF REFERENCE*

Process Goal: Review Gulf of Mexico stock structure and unit stock definitions and consider whether changes are required.

1. Review relevant information on population structure. Potential sources include genetic studies, growth patterns, movement and migration, existing stock definitions, otolith chemistry, oceanographic and habitat characteristics, and hotspot maps of landings or CPUE.

2. Make recommendations on biological stock structure and the assessment unit stock or stocks to be addressed through SEDAR 74 and document the rationale behind the recommendations. The default boundaries for assessments should be the current Council boundaries between the Gulf of Mexico and South Atlantic, and the boundary used in previous assessments to divide the eastern (shrimp grids 1-12) and western (shrimp grids 13-21) Gulf of Mexico. If there is reasonable evidence for deviating from these boundaries, an accompanying recommendation on spatial considerations for management should also be provided.

3. Discuss the strength of evidence in support of stock ID recommendations with particular attention paid to recommendations if they result in a mismatch of biological stock structure, assessment unit stock, and existing management boundaries.

4. Provide recommendations for future research on stock structure.

5. Prepare a report providing complete documentation of workshop recommendations and decisions.

1.3 *LIST OF PARTICIPANTS*

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1.4 *LIST OF STOCK ID PROCESS WORKSHOP WORKING PAPERS AND 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.	15 March 2021

		Thompson, Matt Campbell	
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
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 Artificial Reefs in the Northern Gulf of Mexico	Maria N. Piraino & Stephen T. Szedlmayer	
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	Sean P. Powers, J. Marcus Drymon,[1] Crystal L. Hightower,

	Continental Shelf of the North-Central Gulf of Mexico	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 Snapper in the Northern Gulf of Mexico	Dana K. Sackett and Matthew Catalano
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

2 STOCK ID PANEL REPORT

2.1 EXECUTIVE SUMMARY

Three working groups and their subgroups reviewed studies and provided data to support the delineation of the red snapper dynamics in the Gulf of Mexico (GOM). Given the breadth of information available the various working groups provided support for multiple stock boundaries, including the Mississippi river outflow (between statistical zones 12/13), Cape San Blas, FL (between statistical zones 7/8), the De Soto Canyon (between statistical zones 9/10), and the Big Bend area (statistical zones 7/6, Figure 1). Initially, the working groups were unable to come to a decision about the recommended biological stock boundaries, and instead provided information to support their individual working group recommendations. Due to the lack of agreement amongst the groups, three possible stock ID boundary options were proposed for the third and final workshop. All proposed stock ID options aimed to incorporate most working group recommendations and concerns. Based on the proposed stock ID options and in consideration of the spatial differences in red snapper biology and fishery dynamics presented by the working groups, an Assessment Unit Stock ID recommendation was made at the final workshop, Option C. There was general consensus among participants about the recommendation for the final Stock ID assessment units, though some apprehension was expressed by some individuals.

Below is a summary of the biological stock recommendations supported by the different working groups and their subgroups, along with the summaries of the stock ID options and the final assessment unit stock consensus recommendation. See pages 23-72 for the final working group reports from the Stock ID Workshop.

<u>Biological Stock Recommendations</u>

Genetics

A review of the research to date on red snapper genetics failed to produce a definitive recommendation for stock structure in the Gulf of Mexico (GOM). Despite the inconclusive results, several themes emerged during the stock ID deliberations. The information reviewed consistently indicated that the Gulf population is not a single, well-mixed unit and likely consists of metapopulations that experience periodic low level gene flow through adult migration and larval drift. Demographic analyses comparing the genetics of young-of-the-year fish and adults showed that recruitment predominantly occurs from distinct pools, highlighting the importance of maintaining healthy spawning populations throughout the Gulf. Analyses conducted during the most comprehensive study to date (Portnoy 2017) were inconclusive regarding the status of the area between Cape San Blas, FL and the Mississippi River; however, some models showed more affinity of samples from this region with the eastern GOM. Further analysis of this dataset also indicated a genetic discontinuity along the West Florida Shelf but could not define an exact boundary. The genetics workgroup did not make any specific stock structure recommendations.

Life History

The life history working group formed two subgroups, one focusing on age, growth & reproduction (AGR) and the other on movement. The AGR subgroup identified a number of trends in the data that lent support to the hypothesis that GOM red snapper are organized as metapopulations rather than biologically distinct or reproductively isolated sub-populations. Spatial differences in maximum age and age distribution were observed with older aged fish found in the western and central (MS, AL, and FL panhandle) GOM. Studies analyzing spatial differences in growth rates of red snapper showed a general decline from east to west. The review of available research on red snapper reproduction produced several conclusions. Red snapper have a similar spawning season across the northern GOM. Spawning occurs throughout the species range and occurs within an individual's home range rather than specific spawning habitats. In the western Gulf, red snapper had greater size and age at 50% maturity, greater spawning interval, and lower fecundity compared to the eastern GOM. However, data were insufficient to determine if these differences were the result of distinct biology or the difference in size and age composition between the eastern and western Gulf. Based on their review of the data the AGR subgroup recommended a three-unit model with boundaries at the Mississippi River (between statistical zones 12/13) and at Cape San Blas, FL (between statistical zones 7/8).

The movement subgroup reviewed studies of larval dispersal and connectivity, ontogenetic movement, and adult movement of red snapper. Studies of larval dispersal and connectivity showed that the vast majority of successful recruits settle in the region in which they are spawned. Some cross-region transport of larvae does occur; however, the Mississippi River outflow and to a lesser extent the Apalachicola Peninsula act as significant impediments to larval transport. Models of ontogenetic movement predicted that in the eastern GOM juvenile red snapper around Louisiana, Mississippi, and Alabama tend to move eastward through the Florida Panhandle and toward the west Florida shelf as they age. In the western GOM, red snapper were predicted to exhibit offshore movement rather than along shore movements with increasing age. Review of acoustic and conventional tagging studies for adult red snapper identified several pertinent conclusions. First, adult red snapper exhibit high site fidelity with periodic short range (1-10K) movements. Second, longer range movements (>100K) were observed infrequently and were very rarely recorded crossing known impediments like the Mississippi River and Apalachicola Peninsula. The movement sub-group recommended maintaining the status-quo model with the boundary located at the Mississippi River delta (between statistical zones 12/13), with some evidence for an additional boundary at or near Cape San Blas, FL (border of statistical zones 7-8).

Upon review of the subgroup reports, the overall recommendation from the life history working group was for a three-stock model with the primary boundary located at the Mississippi River (between statistical zones 12/13), and a secondary boundary at or near Cape San Blas, FL (between statistical zones 7/8). This recommendation reflects a majority consensus of those who participated in the life history working group discussions; however, additional recommendations were proposed. For example, a two-stock model with a division between statistical zones 10/11 was proposed yet not supported by the majority of the working group.

Landings and CPUE

The landings and CPUE working group reviewed data from fishery-dependent and fishery-independent sources, in order to understand differences in regional landings, CPUE, and in some cases length composition. The data reviewed included commercial data (longline and vertical line) from 1984-2019, general recreational data (private and charter modes) from 1986-2019, Southeast Regional Headboat Survey (SRHS) data within the same time frame, and reef fish video surveys from Panama City, Mississippi, and FWRI. Landings from the commercial sector data were made available but are not included in the working group report.

A large portion of the general recreational GOM landings were from the northeast, with the Florida panhandle currently contributing 36.7%, but has been increasing over time. Alabama contributes 32%, and Louisiana currently contributes 19.9% but has decreased over time. All other areas (Texas, Mississippi, and western Florida also referred to as Southwest Florida-SWFL) consistently contribute considerably less to the overall GOM landings. From the SRHS data, which is 9.04% of the overall recreational data, similar regional patterns were observed. These patterns include the importance of the Northwest Florida (NWFL)/AL region and its increase in landings over time as well as the lack of landings from SWFL. In contrast to the general recreational data the SRHS data indicated a relatively high contribution from Texas to the overall landings. The patterns in SRHS landings were also seen in its CPUE where Texas has the highest CPUE, while CPUE in the eastern GOM are slightly lower.

The various reef fish surveys had similar patterns in CPUE to one another, which included clear differences in trends on either side of Cape San Blas, FL (statistical zones 7/8) and a second boundary potentially around Tampa Bay (statistical zones 5/6). Reef fish video surveys also observed generally larger fish in the big bend and south Florida areas compared to the western GOM.

Given the above findings, the recommendation from the landings and CPUE working group were either a two-stock model with a boundary at statistical zones (9/10), or a three-stock model with the primary boundary located at the Mississippi River (between statistical zones 12/13) and a secondary boundary at or near Cape San Blas, FL (statistical zones 7/8). The proposed boundaries allow for the separation and modeling of fish biology and fisheries dynamics evident in the presented data. The suggested boundaries at 9/10 and/or 7/8 are likely to create issues for the assessment for two reasons: 1) small sample sizes for all size composition data, and 2) only able to reliably separate Alabama from NWFL in the SRHS data since 2013. Moving the secondary boundary at Cape San Blas, FL (7/8) east to the Big Bend region (statistical zones 7/6) was a suggested compromise as it would not require the separation of AL from NWFL in the SRHS data but would still have sample size issues across all data sources.

2.1.1 Stock Option Summaries

The large amount of information, and in some cases inconclusive or conflicting recommendations from the individual working groups, prevented the stock ID panel from reaching a consensus decision during the originally scheduled workshops. To facilitate consensus building during a follow up workshop, the analytical team compiled three options papers that summarized the available data and the pros and cons of each plausible stock delineation. The option papers were disseminated using google docs to facilitate collaboration and made available to the panel well ahead of the final meeting with all members encouraged to contribute. Summaries of the option papers are below with the final versions included as appendices to this document.

<u>Option A:</u>

A three-unit stock that maintains the current boundary at the Mississippi river outflow (statistical zone 12/13) and adds an additional boundary at the AL/FL border (statistical zone 9/10). Option A was proposed as a proxy for the preferred split at Cape San Blas, FL. This option locates the boundary at the nearest point to the west of Cape San Blas, FL that the recreational data resolution would allow; however, historical (pre-2013) separation of the SRHS data into the proposed regions in option A remained an issue (See Appendix A for further details).

<u>Option B:</u>

A two-unit stock that shifts the current boundary at the Mississippi River outflow eastward to the AL/FL border (in proximity to the De Soto Canyon, statistical zones 9/10). Option B was proposed by members of the landings and CPUE and life history groups. Proponents of option B think that it most appropriately separates differences in relative abundance, as inferred from CPUE, and more closely matches the ecological boundaries influencing northern Gulf red snapper. Historical (pre-2013) separation of the SRHS data into the proposed regions in option B could not be reliably accomplished as in option A (See Appendix B for further details).

Option C:

A three-unit stock that maintains the current boundary at the Mississippi river outflow (statistical zone 12/13) and adds an additional split east of Cape San Blas, FL and slightly north of Tampa (statistical zones 7/6). Option C was proposed as a proxy for the preferred split at Cape San Blas, FL. This option locates the boundary at the nearest point to the east of Cape San Blas, FL that the recreational data resolution would allow (See Appendix C for further details).

2.1.2 Assessment Unit Stock Recommendation

Following review of the working group reports, the panel identified two stock structures that could be supported by the data. One option, supported by the majority of the panel, proposed a three-unit stock structure with boundaries at the Mississippi River and Cape San Blas, FL. Unfortunately, the resolution at which the recreational fisheries were surveyed made it logistically impossible to subset the data at Cape San Blas, FL. Options A and C were presented as the closest alternatives to the Cape San Blas, FL boundary that could accommodate the data. Of these, Option C was eventually selected as the most appropriate alternate to the preferred boundary at Cape San Blas, FL, while also providing the data providers and analysts the ability to revert to the status quo boundary if models do not converge. Option C also did not require an ad hoc adjustment to Alabama SRHS landings prior to 2013. Option B, which created a two-stock model with a boundary between Florida and Alabama, was supported by the remainder of the panel.

The boundaries of Option C aim to take into account the biological recommendations of the various working groups. Although the Mississippi river boundary may not be fully supported by genetic information it does have some implications for differences in regional stock productivity as it strongly influences larval retention. Biological differences such as changes in length composition and maximum age exist on either side of the Mississippi River boundary supporting the argument for its retention. The biogeographic influence of the De Soto Canyon or Cape San Blas, FL may influence stock differences but the current data are inadequate at describing the mechanism for its influence on the populations dynamics and therefore difficult to model in the assessment. In addition, Option C allows for maintaining the integrity of the SRHS data for Alabama which cannot be reliably split from the Florida panhandle. Doing so would require ad hoc analyses that would likely violate statistical assumptions.

While Option C was ultimately selected as the stock structure for SEDAR 74, it was not without objection. Several members of the panel strongly supported Option B as the more appropriate stock structure and expressed concern with the stock ID process and the need to select a single stock structure for exploration during a research track assessment. From a strictly academic perspective, advancing multiple stock structures through the assessment process and comparing them via model diagnostics and simulation studies would be ideal. Unfortunately, the personnel time needed to provision red snapper data for multiple spatial structures and complete the subsequent assessments was not budgeted for SEDAR 74. Special consideration from the SEDAR steering committee would be needed well in advance of the assessment to accommodate such a request as it is essentially asking for the completion of two independent stock assessments.

Figures

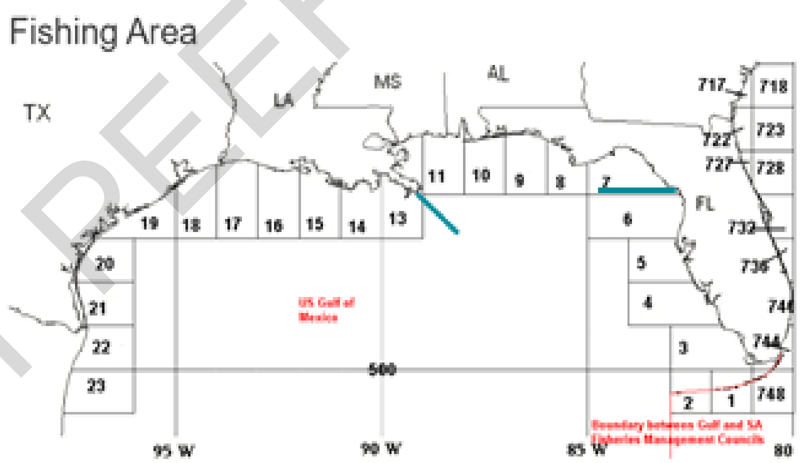


Figure 1. National Marine Fisheries Service (NMFS) fishing area, divided into 23 statistical fishing zones. Green lines indicate Option C, which was recommended by the Stock ID Panel: assessment stock boundariesbetween statistical zones 12/13- Mississippi River outflow, and zones 7/6 - Big Bend.

2.2 *LIFE HISTORY WORKING GROUP*

Names and affiliations of the SEDAR 74 Stock ID Life History Working Group. Participation in the first and second working group calls, and subsequent email discussions, are indicated.

Participants	**Affiliation**	**Call 1: 4/19/21**	**Call 2: 5/28/21**	**Email Discussions**
Jason Adriance	LDWF	●		
Robert Allman	NOAA SEFSC Panama City	●	●	●
Beverly Barnett	NOAA SEFSC Panama City	●	●	●
Kristan Blackhart	NOAA OST	●		
Steve Bortone	Osprey Aquatic Sciences	●		
Nancy Brown-Peterson	USM GCRL	●	●	●
Jessica Carroll	FWC	●		
Matt Catalano	Auburn University			
Judd Curtis	SAFMC	●	●	●
Michael Dance	LSU	●	●	●
LaTreese Denson	NOAA SEFSC Miami	●		
Marcus Drymon	MSU and MASGC (Group Lead)	●	●	●
Kerry Flaherty-Walia	FWC	●		
Benny Galloway	LGL Associates	●		●
Steve Garner	NOAA SEFSC Panama City	●	●	●
Jay Grove	NOAA SEFSC Miami	●		
Amanda Jefferson	MSU and MASGC	●	●	●
Mandy Karnauskas	NOAA SEFSC Miami	●		●
Matt Lauretta	NOAA SEFSC Miami			
Susan Lowerre-Barbieri	UF and FWC	●	●	●
Peter Mudrak	Auburn University	●		
Julie Neer	SAFMC	●		
Will Patterson	UF			
Sean Powers	USA and DISL			
Katie Siegfried	NOAA SEFSC Miami			
Matt Smith	NOAA SEFSC Miami	●		
Matt Streich	TAMU-CC	●		
Ted Switzer	FWC			
Steve Szedlmayer	Auburn University			
Ana Vaz	UM	●		

2.2.1 Life History Working Group Executive Summary

A life history working group was assembled to discuss potential changes to the stock ID boundary for red snapper, currently located between NOAA Fisheries statistical grids 12 and 13 (i.e., at the outflow of the Mississippi River) (Table 1). The group was further split into two sub-groups: one for age, growth, and reproduction, and one for movement. These two sub-groups met several times virtually with additional communication via phone and email.

The recommendation from the life history working group is for a three-stock model with the primary boundary located at the Mississippi River (between zones 12/13), and a secondary boundary at or near Cape San Blas, FL (zones 7/8). This recommendation reflects a majority consensus of those who participated in the life history working group discussions; however, additional recommendations were proposed. For example, a two-stock model with a division between zones 10/11 was proposed (Gallaway and Cole 1999 a,b and Gallaway et al. 2009), yet not supported by the majority of the working group. Summaries of the datasets and literature examined by the age/growth/reproduction sub-group and the movement subgroup are provided below.

2.2.2 Age, Growth and Reproduction

The age, growth and reproduction life history stock ID sub-group reviewed studies examining spatial differences in these life history parameters for Gulf of Mexico (GOM) red snapper. The group also analyzed fishery-independent length and age data submitted for the last red snapper assessment (SEDAR 52).

Age

Spatial differences in age distributions were noted from fishery-independent (Mitchell et al. 2002) and fishery-dependent (Allman et al. 2002; Allman and Fitzhugh 2005) datasets with older ages reported from the western GOM (west of MS river) compared to the eastern GOM. This trend was also noted for maximum calendar age estimates of fishery independent ages collected from 1986-2016; moreover, ages from the central GOM (off AL and the western FL panhandle) were also comprised of greater maximum ages compared to the eastern GOM (Fig 1). A comparison of these data from 3 time periods 1986-2004, 2005-2010 and 2011-2016 all indicated a similar spatial pattern in maximum ages.

Growth

Two GOM studies made direct spatial comparisons of red snapper growth parameters. Fischer et al. (2004) sampled recreational landings from AL, LA and south TX. Red snapper off TX were found to have significantly lower L_∞ and greater k compared to LA and AL, but these differences may have been due to the absence of larger fish from TX. Linear regressions of mean fork length at age for ages 2-10 found no significant difference among states. A later study by Saari et al. (2014) compared red snapper collected from the recreational fishery in 6 regions of the GOM (south TX, north TX, LA, AL, northwest FL and central FL). They found that red snapper collected off FL and south TX were on average smaller and grew at a faster rate compared to other regions. Saari et al. (2014) also reported that strong 2004, 2005 and 2006 year classes were detected across all 6 regions sampled. Similarly, Allman and Fitzhugh (2007) recorded strong 1989 and 1995 year-classes in both the eastern and western GOM. Saari et al. (2014) concluded that a combination of demographic differences and consistency in dominant year classes gulf wide, supported recent conclusions that red snapper form meta-populations of semi-isolated assemblages that are demographically distinct, but also influenced by mixing between assemblages.

Spatial differences were also observed in the size-at-age of red snapper collected on fishery-independent surveys. Observed mean size-at-age compared across 4 regions (TX, LA, AL/FL panhandle and west FL shelf) suggested fastest growth off the west FL shelf followed by AL/FL panhandle and the slowest growth in the western GOM (Fig. 2). Breaking down further into 6 regions (southwest FL, west FL shelf, AL/FL panhandle, LA, north TX and south TX) provided additional support for an overall decline in growth rate from east to west across the northern GOM (Fig. 3).

Reproduction

Several studies have examined spatial differences in reproductive parameters for GOM red snapper. Brown-Peterson et al. (2009) sampled the headboat and commercial fishery on the Florida east coast and Dry Tortugas (GOM) and found that relative fecundity estimates were lower for Dry Tortugas compared to east coast of Florida. Spawning frequency was also greater for east coast fish (2.2 days) compared to Dry Tortugas (4.3 days). Another study off FL by

Lowerre-Barbieri et al. (2012) used fishery-independent sampling and found that spawning red snapper off Tampa were smaller and younger than those off the FL panhandle. Kulaw et al. (2017) examined temporal (10 years apart) and spatial differences in sexual maturity and egg production. They found that mean GSI was generally greater in eastern GOM (AL) compared to western GOM (LA) and fish matured at smaller sizes and ages in the eastern GOM compared to the western GOM on artificial habitat for both time periods. Batch fecundity estimates were greater in the east than in the west during the early period with no difference for sampling period 2 and no difference in spawning frequency east or west by age class was noted. Porch et al. (2015) is the only study to-date which sampled Gulf-wide with standardized methodology. They evaluated the relationship between spawning fraction and female length and age, time of year, depth, gear type (vertical line or longline), or region (east or west of the MS River). They found that the effects of region and gear type were not significant once time of year and size or age were accounted for and suggested that regional difference may not be due to any intrinsic difference in the biology of the fish, but due to there being more large, old red snapper in the western GOM. Brown-Peterson et al. (2019) used meta-analysis models to analyze data collected from 1991-2017 in the eastern and western GOM. They found an increase in the spawning interval in northwest GOM over time and no notable change in northeast GOM. Relative batch fecundity decreased to a greater degree in the northwest GOM compared to the northeast GOM suggesting reproductive compensation in the northwest GOM. From these studies and other ongoing research, the life history group concluded that: 1. duration of the spawning season is similar across the northern GOM, 2. red snapper from the western GOM had a greater size and age at 50% maturity, greater spawning interval and lower fecundity compared to the eastern GOM. However, we do not have the needed data to determine if these observed differences are due to differences in the biology of red snapper, or to differences in size and age distributions between the eastern and western GOM, and 3. red snapper spawning is exhibited throughout their range (Fig. 4), with adults exhibiting high annual site fidelity and spawning at these sites rather than moving to specific spawning habitat. This reproductive strategy suggests reproductive isolation at much smaller spatial scales than any of the suggested stock boundaries. Overall, the reproductive sub-component of the Life History sub-group noted that existing data is not sufficient to definitively determine if there are any Gulf-wide differences in Red Snapper reproduction due to differing data collection/analyses methodologies across studies, and thus the entire Gulf of Mexico could be considered a single stock.

Age, Growth and Reproduction sub-group recommendation: The life history age, growth and reproduction sub-group recommends a 3 region model, keeping the original division at the MS river (between statistical grids 12-13) and adding a division at Cape San Blas (between statistical grids 7-8). These divisions are based on known faunal breaks, differences in age composition, growth rates and size-at-maturity of red snapper.

2.2.3 Movement

The movement sub-group of the life history working group reviewed and summarized the available literature pertaining to the movement and population connectivity of red snapper throughout the Gulf of Mexico (GOM) at various ontogenetic life stages. These studies included modeling of larval transport, mark-recapture conventional tagging studies, acoustic telemetry, and ontogenetic movement modeling.

<u>*Larval Connectivity*</u>

Studies modeling larval transport and connectivity showed that a barrier near the Mississippi River minimizes nearly all of the cross-subregion larval transport. A primary boundary at ~89W degrees (Mississippi River) restricted the larval transfer rate to <2% with 98% of successfully settling larvae being retained in regions in which they were spawned (Karnauskas & Paris, SEDAR74-SID-02; Figures 5-7). A secondary division at ~85W degrees (Cape San Blas) had between 2-3% larval transfer rate. However, the authors note that "setting a subpopulation boundary near the Mississippi River minimizes nearly all of the cross-subregion larval transport, and designation of a second barrier has little additional benefit in terms of separating out functionally different regions with respect to spawning and recruitment dynamics" (Karnauskas & Paris, SEDAR74-SID-02). There was a net eastward movement that occurred in June, July, and August under the influence of weaker shoreward wind stress. Topographic impediments to longshore larval transport in the northern GOM (the Mississippi River delta, DeSoto Canyon, and the Apalachicola peninsula) restricted the quantity of larvae crossing but did not eliminate it (Johnson et al. 2009). Lastly, larval abundance was found to be twice as great over the Louisiana–Texas shelf as over the Mississippi–Alabama shelf and four times as great over the

Mississippi–Alabama shelf as over the West Florida shelf (Hanisko et al. 2007). These results suggest that only a small fraction of the Louisiana–Texas larvae have a chance of being transported eastward across the Mississippi River delta and that the limited transport of larvae across these impediments suggests that separate management may be warranted for the eastern and western GOM.

Acoustic Telemetry

Several studies using acoustic telemetry tagging have determined that red snapper exhibit high site fidelity, localized movement, and high residency (see Table 1). The mean days detected in each of these studies ranged from 64-324 days with the maximum days detected ranging from 92-1096 days. Acoustic telemetry array designs are often restricted in spatial extent, which limits the utility of this technique for estimating greater movements and dispersal on both spatial and temporal scales. Friess et al. (2021) conducted a meta-analysis of many acoustic arrays along the Florida Gulf coast with many different species. Red snapper were considered to be a high-detection resident with no detections on neighboring arrays and very few gaps between detections on the 'home' array. In summary, although some movement of red snapper is detectable through acoustic telemetry occurs, this is primarily at local scales and this movement does not cross purported stock boundaries.

Mark-Recapture Conventional Tagging

Studies that examined movement using conventional tagging based on mark-recapture methods found mean days at liberty for red snapper to range from 112-404 days, with the maximum from 253-2049 days (Table 2). The mean and maximum distance these fish traveled ranged from 0.3-30.9 km and 5-558 km, respectively. In many studies, the majority (>74%) of fish were recaptured at or within 5 km of the release site. Recapture data from recent tagging studies showed only two fish were recaptured in a different region (Figure 8), and the absolute distance these fish traveled was between 5-23 km. The max distance estimates show that some of these fish do disperse broadly and show large scale movements of 100s of km. Most commonly, however, these movements were found to be within state boundaries. Movement across the Mississippi River boundary was found to be extremely rare, but there was some evidence of movement from Alabama to the Florida panhandle, and further east to the West Florida Shelf (1-

5% from conventional tagging studies) (Patterson et al. 2001, Patterson and Cowan 2003, Addis et al. 2016).

<u>*Ontogenetic Movement (Modeling)*</u>

The predicted distribution of juvenile, sub-adult, and adult red snapper abundance over unconsolidated substrates in the Gulf indicated a net eastward shift with age in the eastern Gulf (Dance and Rooker 2019). The center of juvenile abundance in the eastern Gulf was concentrated east of the MS River off of LA/MS/AL (Galloway et al. 1999, Dance and Rooker 2019) and expanded eastward with age to the WFL shelf. Results support connectivity between AL/FL panhandle and the WFL shelf, which was also documented in conventional tagging data. In contrast, a net offshore movement was predicted in the western Gulf. While it should be noted that predictions from this study were focused on fish over unconsolidated substrates rather than reef structures (Dance and Rooker 2019), recent findings suggest a significant proportion of the Gulf red snapper population occurs over unconsolidated bottom (Stunz et al. 2021).

The main conclusions drawn from the synopses of these movement studies are:

1. The primary barrier for larval transfer occurs near the Mississippi River (between stat zones 12/13). While there is evidence of a weaker secondary barrier near Cape San Blas, addition of a second barrier provides little additional benefit with respect to spawning and recruitment dynamics.
2. Acoustic telemetry shows that red snapper exhibit high site fidelity and residency times, though some movement does occur on local scales (1-10 km).
3. Mark and recapture conventional tagging reveals the occurrence of large scale movement (> 100 km) across potential boundaries; however, movements across the Mississippi River boundary are extremely rare, while movement from the AL/FL panhandle to the West Florida Shelf are relatively more common but still low (~1-5%).
4. Information on ontogenetic movement supports an east/west stock split, and there appears to be some exchange between AL/FL panhandle and WFL shelf.

Movement sub-group recommendation: The movement sub-group concludes that the data examined support the current 2-stock model with the boundary located at the Mississippi River delta (between stat zones 12/13), with some evidence for an additional boundary at or near Cape San Blas (border of statistical grids 7-8).

2.2.4 Additional Considerations

The SEFSC has initiated a participatory conceptual modeling process with experienced anglers in the Gulf of Mexico, to gather insights regarding the red snapper fishery. The process is designed to capture local knowledge on the important physical, biological, social, economic, and regulatory drivers of the red snapper population and its associated fisheries. Preliminary results from this initiative (based on conversations with anglers in the Alabama and Florida panhandle region) suggest that tropical storm activity is perceived as a major driver of adult red snapper movements, by influencing both the migration of red snapper off their normal habitats as well as the distribution of the habitats on which they depend (i.e., by physically moving artificial structures or burying natural reefs). Anglers have noted that movement of adult red snapper following storm activity is highly variable and not unidirectional, and is event-specific depending on the precise storm path and site of intersection with the coast. Further details from this work will be summarized in a Data Workshop working paper and may provide additional insights to the stock identification process.

2.2.5 Tables

Table 1. Summary table of results from acoustic telemetry studies

Study	Location	Habitat	Number Tagged	Mean / Max Days Detected	Residency Times
Szedlmayer 1997	Alabama	Artificial	23	150 / 597	-
Szedlmayer & Schroepfer 2005	Alabama	Artificial	54	212 / 595	-
Schroepfer & Szedlmayer 2006	Alabama	Artificial	77	179 / 597	-
Westmeyer et al 2007	Louisiana	Artificial	125	64 / 202	-
Piraino & Szedlmayer 2014	Alabama	Artificial	46	324 / 694	88% after 10mo.
Williams-Grove & Szedlmayer 2016	Alabama	Artificial	56	- / 1096	23 mo, 82% yr^{-1}
Froehlich et al 2019	Texas	Artificial	15	72 / 92	
Everett et al 2020	LA / AL	Artificial	59	-	7 mo, 70% at 1yr
Friess et al 2021	Florida	Natural	91	-	150 d

Table 2. Summary table of results from mark-recapture conventional tagging studies (modified from Patterson et al. 2007) and mean recapture rates by state.

Study	Location	Habitat	#	Recaps	Mean Days	Max Days	Mean Dist	Max Dist	Site fidelity
Beaumariage (1969)	West Florida	Natural	1126	384	113	2049		279	90% w/in 5 km
Fable (1980)	Texas	Both	299	17	112	253	0.3	5	94% at release site
Szedlmayer and Shipp (1994)	Alabama	Artificial	1155	146	137	430	4.6	3.2	74% w/in 2 km
Patterson and Cowan (2003)	Alabama	Artificial	2932	599	404	1501	30.9	558	25-27% per year
Strelcheck et al. (2007)	Alabama	Artificial	4317	629	401	1587	2.1	202	~50% per year
Diamond et al. (2007)	Texas	Both	5614	130	166	564	9.8	58.3	~52% at release site
Addis et al. (2013)	Florida	Artificial	2114	232	313		29.5	320	19% recaptured at release site

State	Tags	Recaps	Recap Rate
Texas	5913	147	2.50%
Alabama	8404	1374	16%
Florida	3240	616	19%

2.2.6 Figures

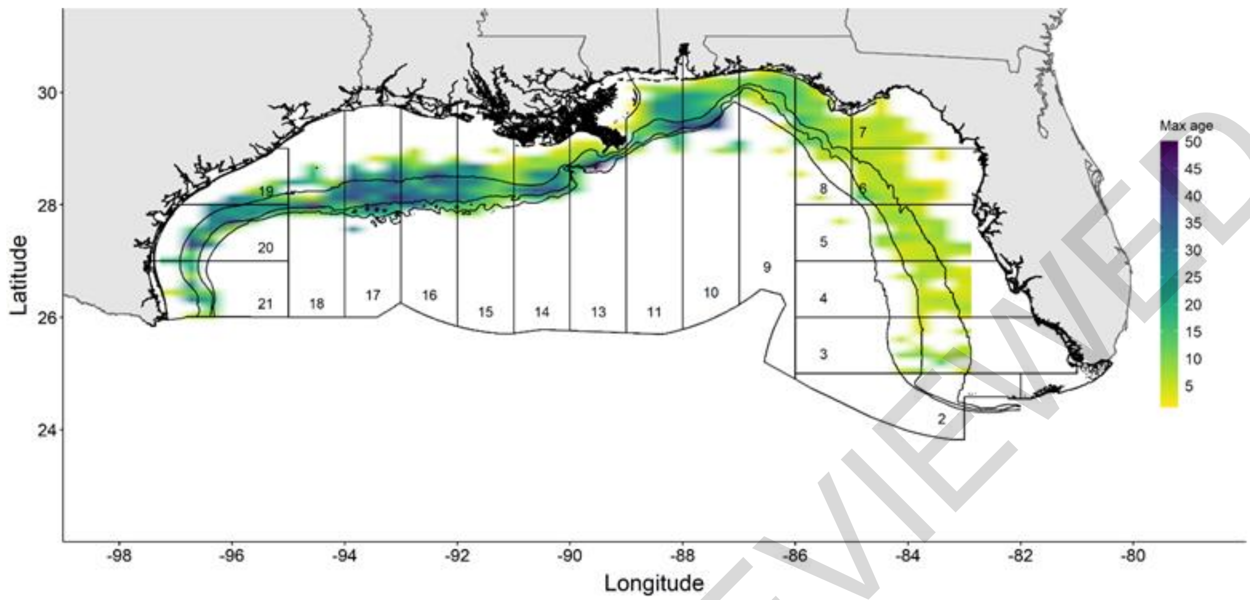


Figure 1. Maximum (calendar) age estimates (n = 20,348) for GOM red snapper collected from fishery independent surveys (handline, bottom longline, vertical longline, trap, or trawl) conducted in the nGOM from 1986-2016. Grids 1-12 correspond to the eastern GOM; grids 13-21 correspond to the western GOM. The 50, 100, and 200 m isobaths are shown.

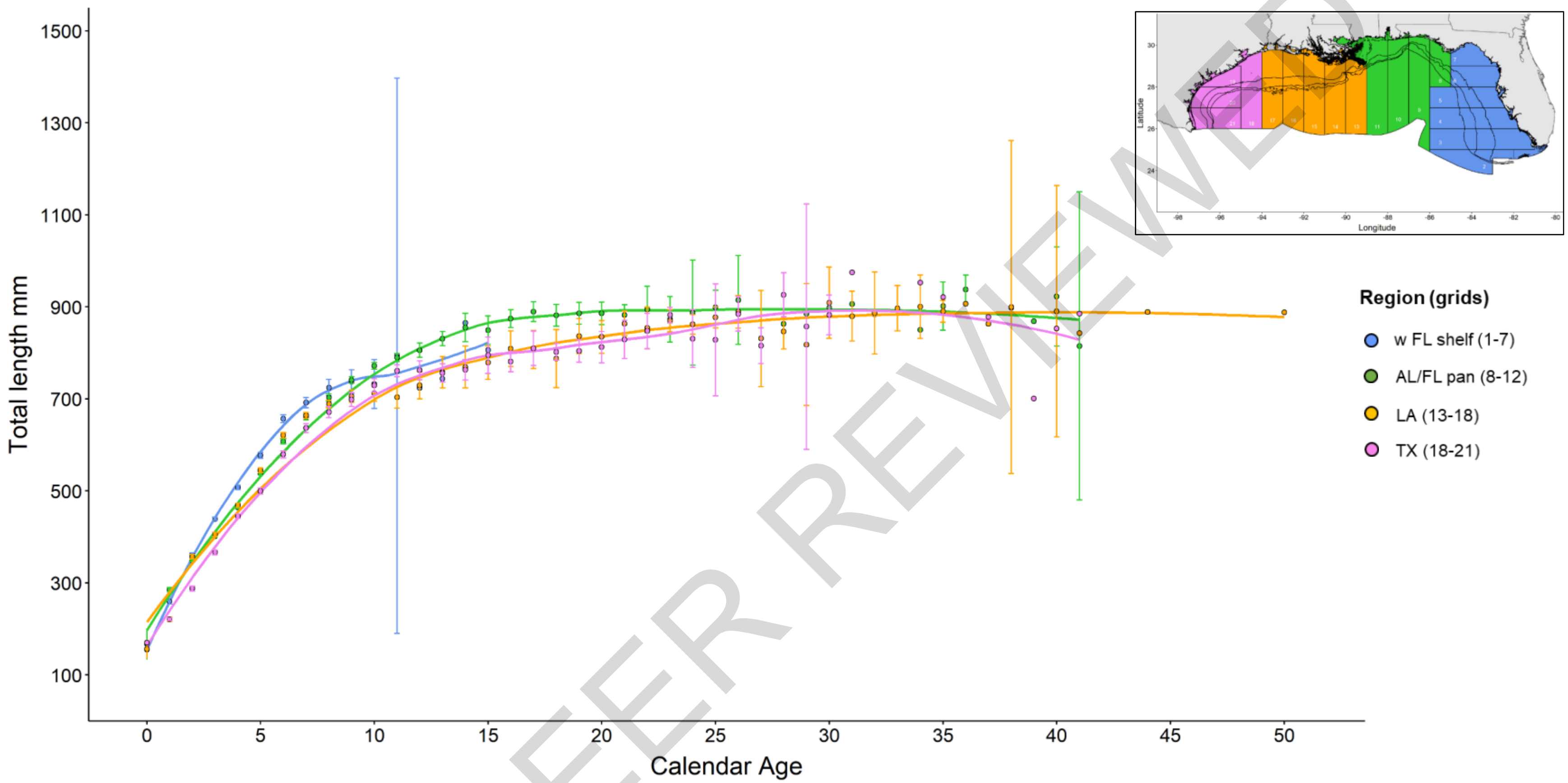


Figure 2. Mean size-at-age estimates (95% CI; N = 25,132) for GOM red snapper collected from fishery independent surveys from 1986-2016 based on hypothetical stock ID demarcation lines specified at Cape San Blas (85° longitude), MS river outflow (89° longitude), LA/TX border (94° longitude) resulting in four regions: 1) wFL shelf (n = 2,558), AL/FL pan (n = 11,375), LA (n = 6,852), and TX (n = 4,347).

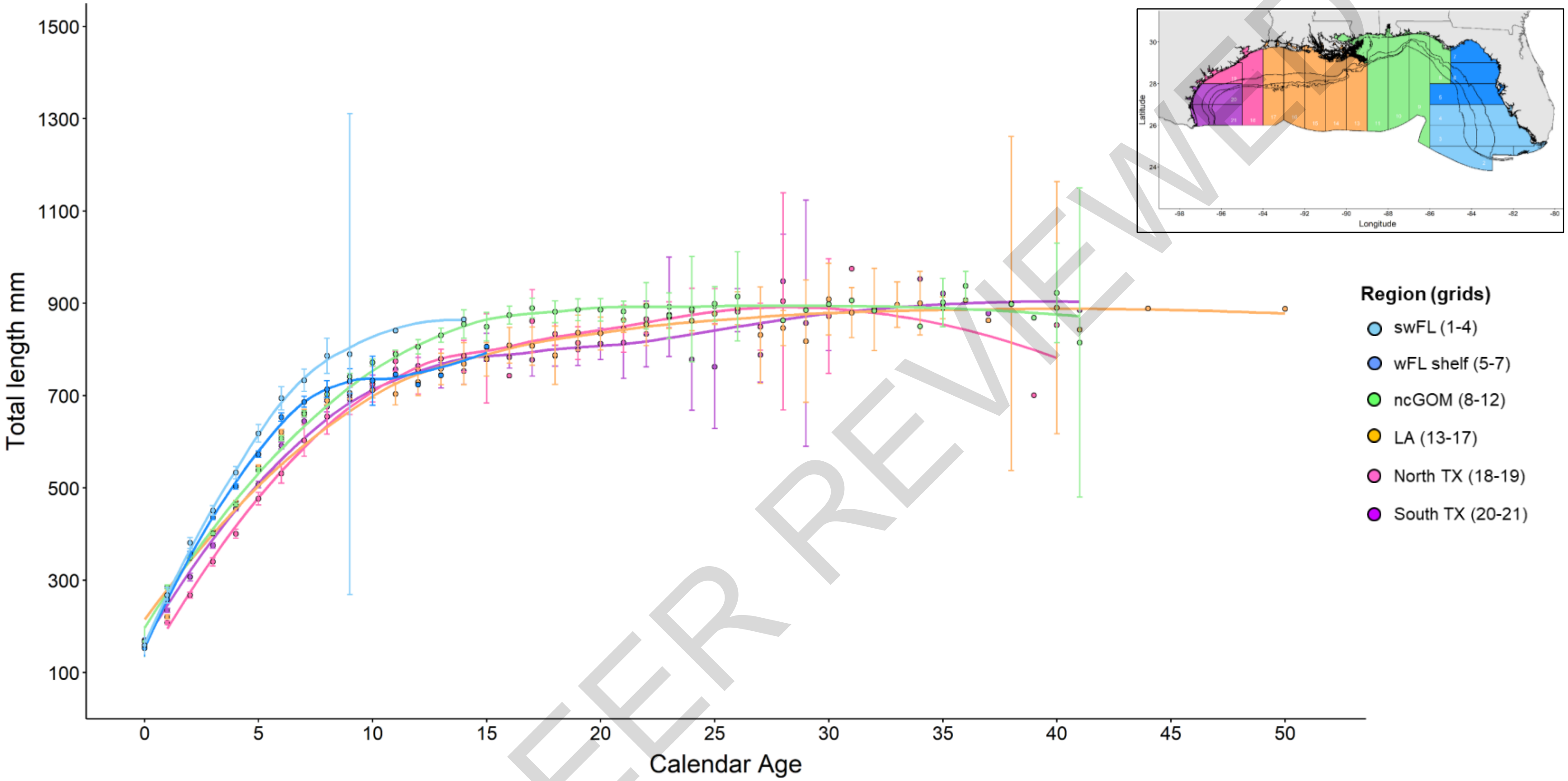


Figure 3. Mean size-at-age estimates (95% CI; N = 25,132) for GOM red snapper collected from fishery independent surveys from 1986-2016 based on six hypothetical stock ID regions: 1) south Texas (n = 3,035), 2) north Texas (n = 1,312), 3) Louisiana (n = 6,852), 4) northcentral GOM (n = 11,375), 5) west Florida shelf (n = 2,213), and 6) southwest Florida (n = 345).

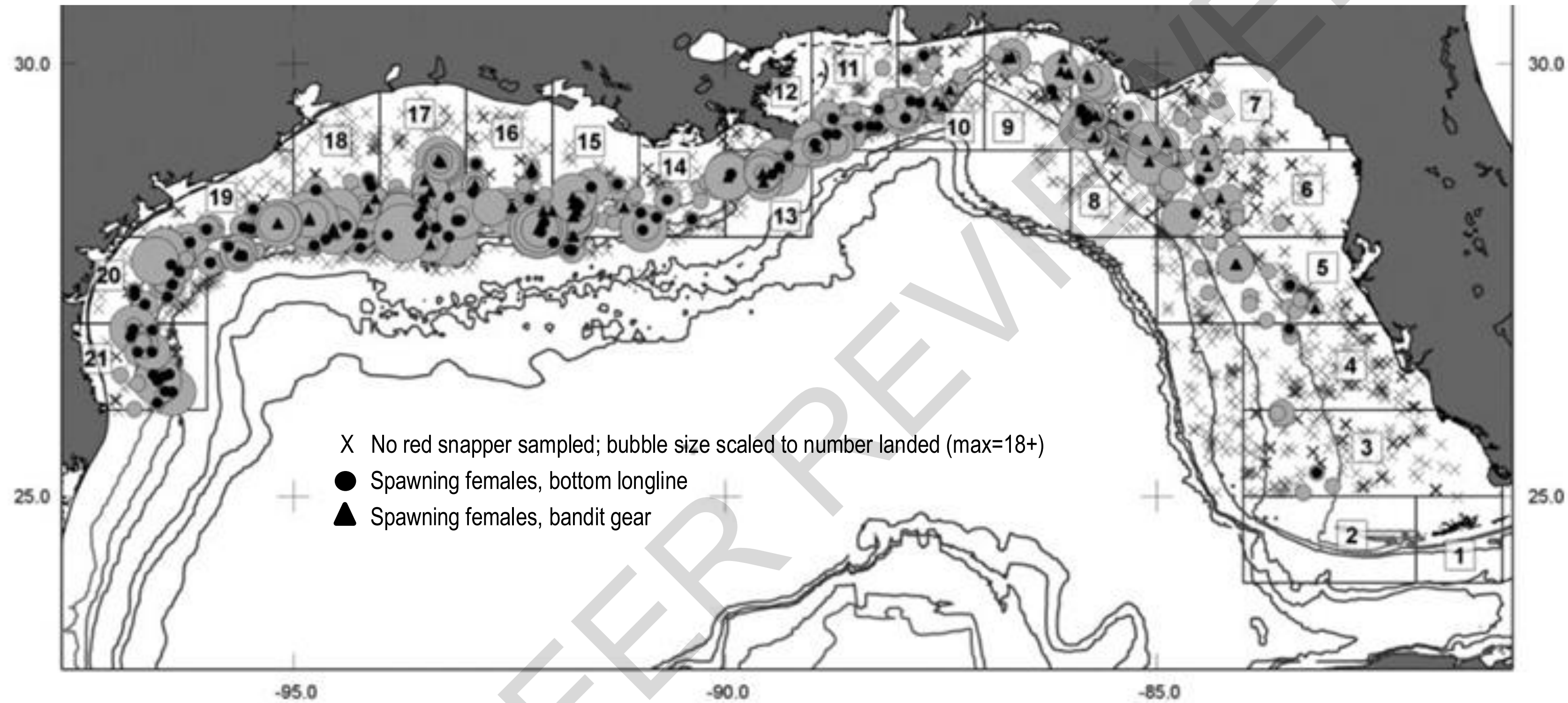


Figure 4. Red snapper spawning sites from Porch et al. (2015)

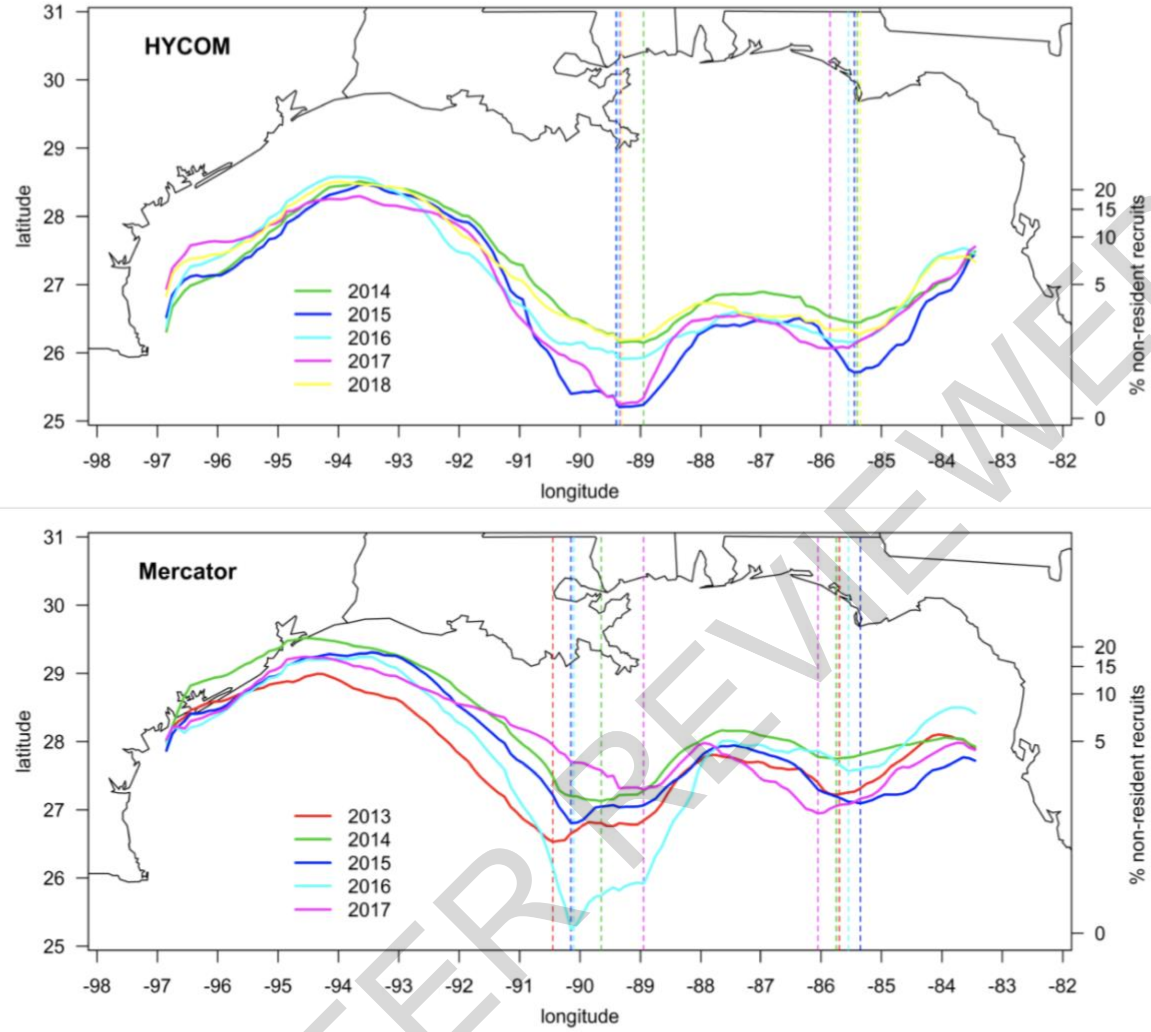


Figure 5: Karnauskas & Paris, SEDAR74-SID-02

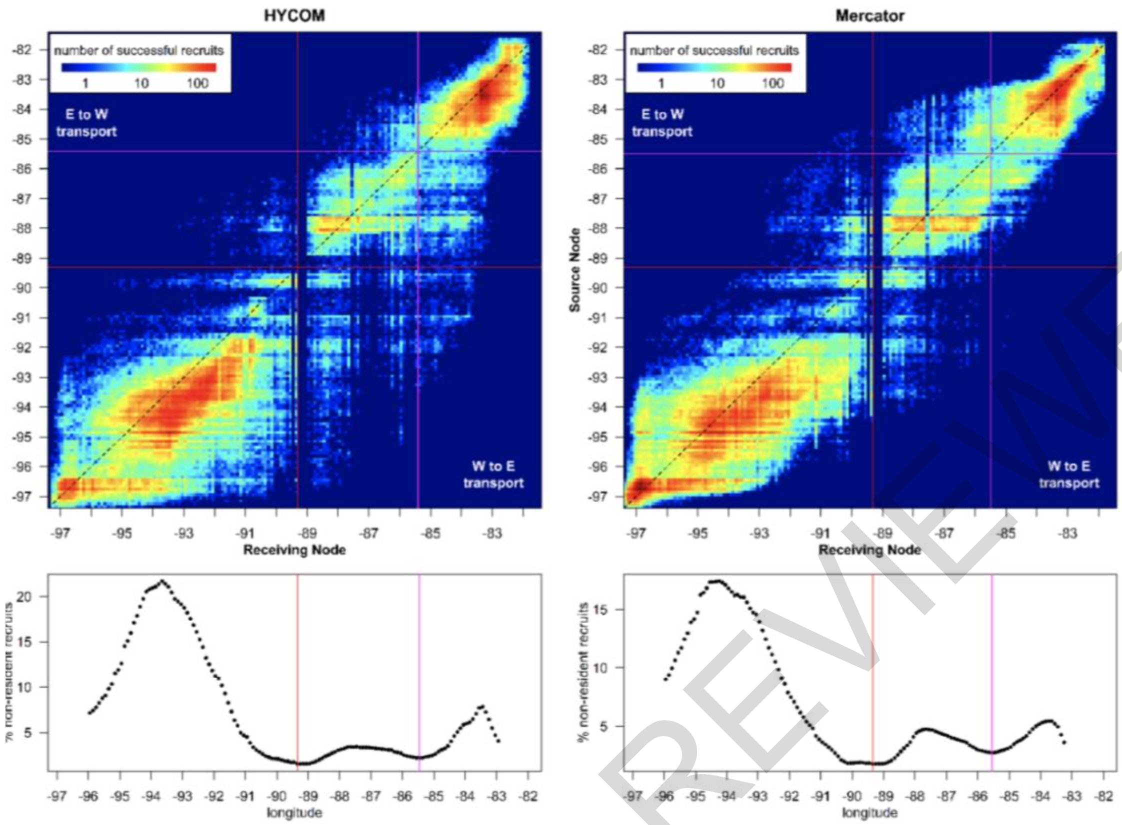


Figure 6: Karnauskas & Paris, SEDAR74-SID-02

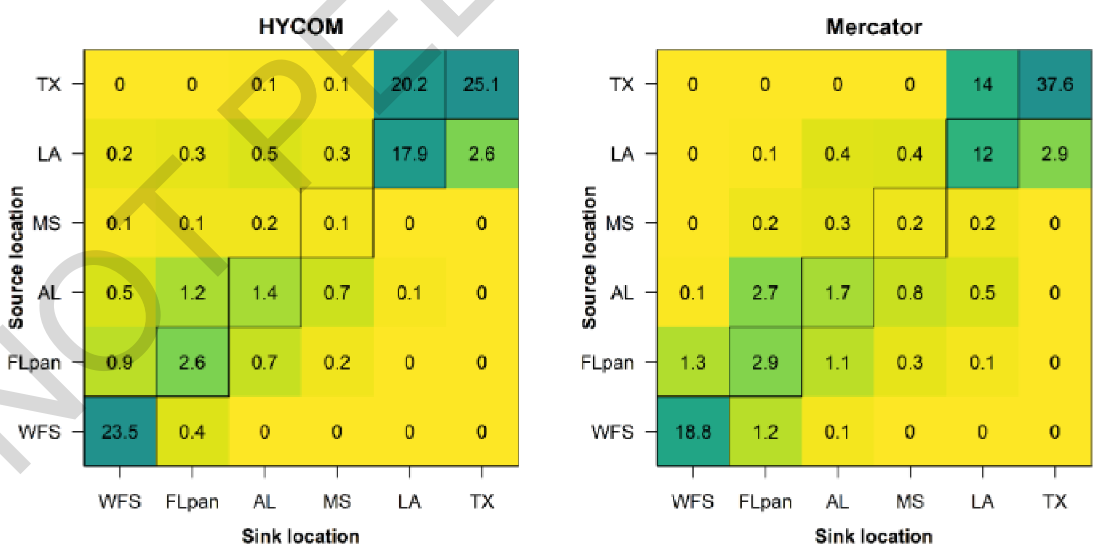


Figure 7: Karnauskas & Paris, SEDAR74-SID-02

Release Region	Recapture Region			
	FL	AL	TX East	TX West
FL	95	0	0	0
AL	2	86	0	0
TX_east	0	0	105	0
TX_west	0	0	0	83

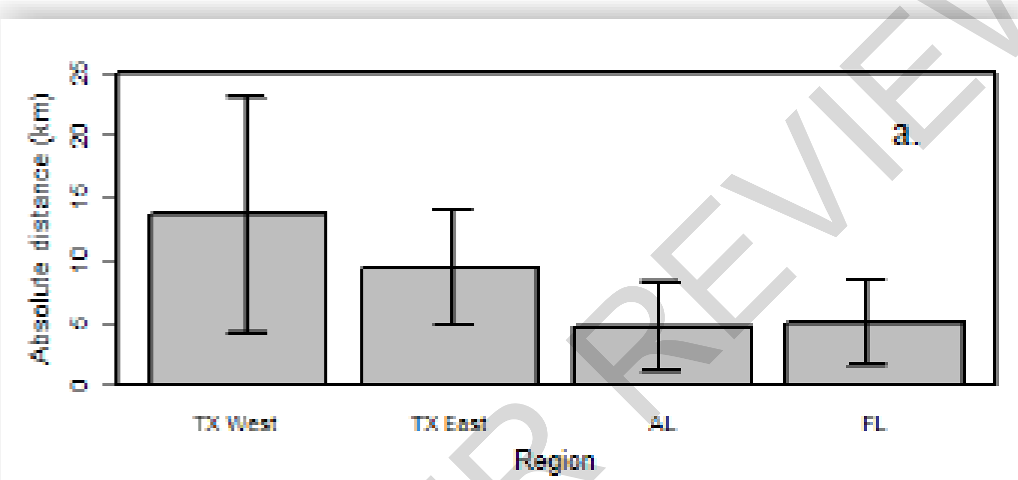


Figure 8: Recapture regions from The Great Red Snapper Count and mean absolute distance between tagging and recapture locations.

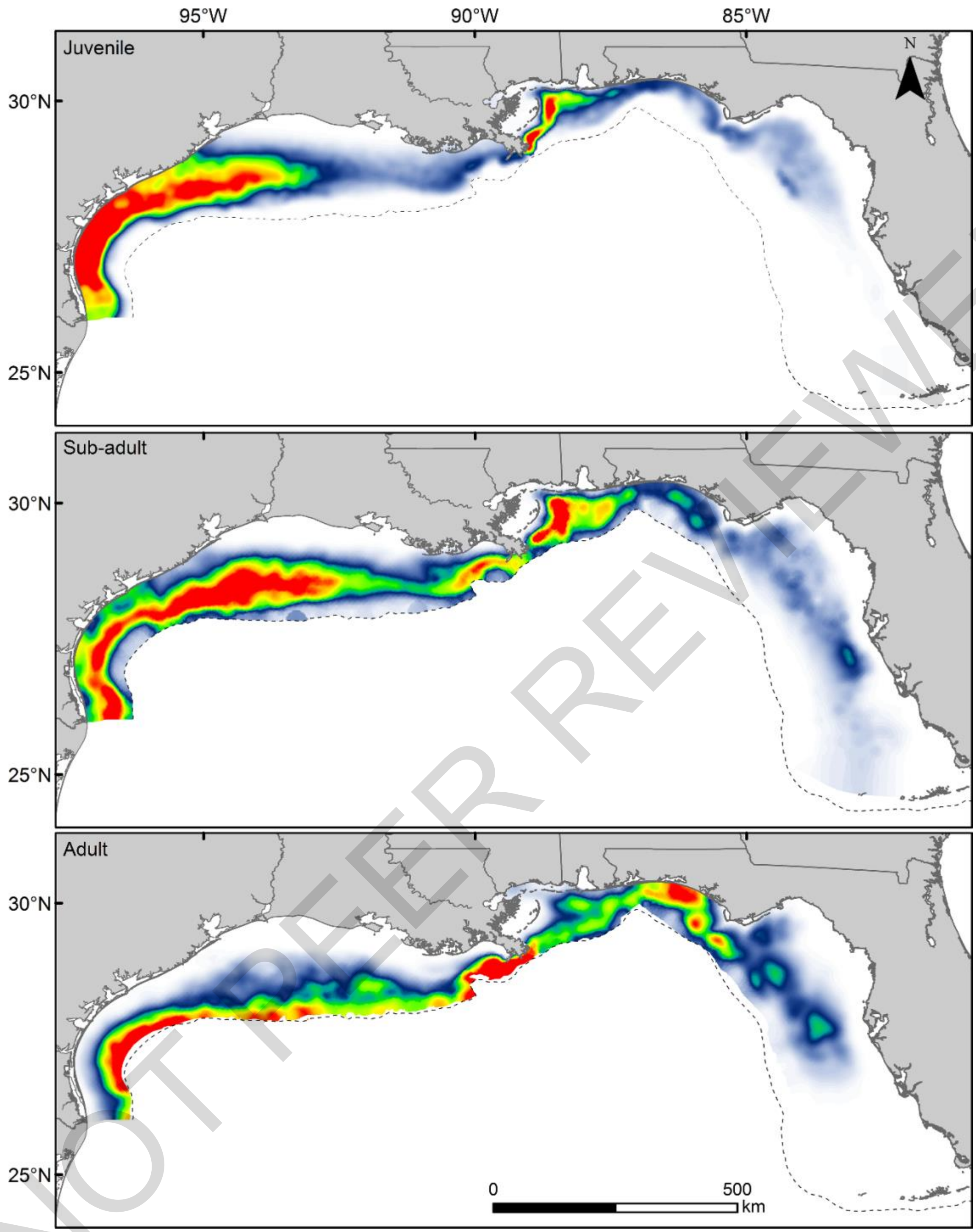


Figure 9: From Dance and Rooker 2019. Ontogenetic movement of red snapper juveniles (top), sub-adult (middle), and adult (bottom).

2.2.7 References

Addis, D. T., W. F. Patterson III, and M. A. Dance. 2016. The potential for unreported artificial reefs to serve as refuges from fishing mortality for reef fishes. North American Journal of Fisheries Management 36(1):131-139.

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.

Allman, R. J., L. A. Lombardi-Carlson, G. R. Fitzhugh, and W.A. Fable. 2002. Age structure of red snapper (*Lutjanus campechanus*) in the Gulf of Mexico by fishing mode and region. Proceedings of the Gulf and Caribbean Fisheries Institute 53:482–495.

Brown-Peterson, N. J., K. M. Burns, and R. M. Overstreet. 2009. Regional differences in Florida red snapper reproduction. Proceedings of the Gulf and Caribbean Fisheries Institute 61:149–155.

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.

Dance, M.A. and J. R. Rooker. 2019. Cross-shelf habitat shifts by red snapper (*Lutjanus campechanus*) in the Gulf of Mexico. PLoS ONE 14 (3): e0213506.

Fischer, A. J., M. S. Baker Jr., 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.

Friess, C. S. Lowerre-Barbieri, G.R. Poulakis, N. Hammerschlag, and others. 2021. Regional-scale variability in the movement ecology of marine fishes revealed by an integrative acoustic tracking network. Marine Ecology Progress Series 663:157-177.

Gallaway, B.J., and J.C. Cole. 1999a. Reduction of juvenile red snapper bycatch in the US Gulf of Mexico shrimp trawl fishery. North American Journal of Fisheries Management 19: 342-255. SEDAR74-RD-81. SEDAR, North Charleston, SC.

Gallaway, B.J., and J.C. Cole. 1999b. Delineation of essential habitat for juvenile red snapper in the northwestern Gulf of Mexico. Transactions of the American Fisheries Society 128: 713-726. SEDAR74-RD-83. SEDAR, North Charleston, SC.

Gallaway, B.J., S.T. Szedlmayer, and W. J. Gazey. 2009. 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. Reviews in Fisheries Science 17(1): 48-67. SEDAR74-RD-82. SEDAR, North Charleston, SC.

Hanisko, D.S., J. Lyczkowski-Shultz and G. W. Ingram. 2007. Indices of larval red snapper (*Lutjanus campechanus*) occurrence and abundance for use in stock assessment. Pages 285– 300. Edited by: W. F. Patterson, J. H. Cowan, G. R. Fitzhugh, D. L. Nieland. In Red snapper ecology and fisheries in the U.S. Gulf of Mexico, American Fisheries Society, Bethesda, Maryland, Symposium 60.

Johnson, D. R., H. M. Perry, J. Lyczkowski-Shultz, D. Hanisko. 2009. Red snapper larval transport in the Gulf of Mexico. Transactions of the American Fisheries Society 138:3, 458-470.

Karnauskas, M. and C. B. Paris. 2021. A Lagrangian biophysical modeling framework informs stock structure and spawning-recruitment of red snapper (*Lutjanus campechanus*) in the northern Gulf of Mexico. SEDAR74-SID-02. SEDAR, North Charleston, SC. 9 pp.

Kulaw, D. H., J. H. Cowan, 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(3):e0172360.

Lowerre-Barbieri, S., L. Crabtree, T.S. Switzer, and R.H. McMichael. 2012. Spatio-temporal dynamics in red snapper reproduction on the West Florida Shelf, 2008-2011. SEDAR31-DW15. SEDAR, North Charleston, SC. 12 pp.

Mitchell, K.M., T. Henwood, G.R. Fitzhugh and R.J. Allman. 2004. Distribution, abundance and age structure of red snapper (*Lutjanus campechanus*) caught on research longlines in the U.S. Gulf of Mexico. Gulf of Mexico Science, 22(2): 164-172.

Patterson, W. F. III and J. H. Cowan. 2003. Site Fidelity and Dispersion of Red Snapper. In American Fisheries Society Symposium (Vol. 36, pp. 181-193).

Patterson III, WF, J.C. Watterson, R. L. Shipp, and J. H. Cowan Jr. 2001. Movement of tagged red snapper in the northern Gulf of Mexico. Transactions of the American Fisheries Society 130(4): 533-545.

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: Dynamics, Management, and Ecosystem Science 7:233–2245.

Saari, C. R., J. H. Cowan Jr., and K.M. Boswell. 2014. Regional differences in the age and growth of Red Snapper (Lutjanus campechanus) in the U.S. Gulf of Mexico. U.S. National Marine Fisheries Service Fishery Bulletin 112:261–273.

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. 2021. Estimating the Absolute Abundance of Age-2+ Red Snapper (*Lutjanus campechanus)* in the U.S. Gulf of Mexico. Mississippi-Alabama Sea Grant Consortium, NOAA Sea Grant. 303 pages.

2.3 GENETICS WORKING GROUP

Genetics Workgroup Appointed Participants Eric Saillant (Chair, USM), David Portnoy (TAMU-CC), Steve Cadrin (UMASS Dartmouth), John Mareska (GMFMC SSC), Nathan Putman (LGL Ecological Associates)

Genetics Workgroup Observer: LaTreese Denson (NOAA)

2.3.1 Literature and Data Review and Evaluation

The genetics working group reviewed published literature and relevant to the genetic population structure of Red Snapper in the Gulf of Mexico during Teams Meetings and email communications.

Working documents that were reviewed by the workgroup included the following 6 papers (in publication date chronological order):

Pruett C.L., Saillant E., Gold J.R. 2005. Historical population demography of red snapper (Lutjanus campechanus) from the northern Gulf of Mexico based on analysis of sequences of mitochondrial DNA. Marine Biology 147: 593-602.

Gold J.R., Saillant E. 2007. Population structure of red snapper in the northern Gulf of Mexico. American Fisheries Symposium 60 ch. 13. 15pp.

Saillant E., Bradfield S.C., Gold J.R. 2010. Genetic variation and spatial autocorrelation among young-of-the-year red snapper (Kutjanus campechanus) in the northern Gulf of Mexico. ICES Journal of Marine Science 67: 1240-1250.

Hollenbeck C.M., Portnoy D.S., Saillant E., Gold J.R. 2015. Population structure of red snapper (Lutjanus campechanus) in U.S. waters of the western Atlantic Ocean and the northeastern Gulf of Mexico. Fisheries Research 172: 17-25.

Puritz J.B., Gold J.R., Portnoy D.S. 2016. Fine-scale partitioning of genomic variation aming recruits in anexploited fisery: causes and consequences. Scientific Reports 6:36095.

Portnoy D.S. 2017. Stock structure, connectivity, and effective population size of red snapper (Lutjanus Campechanus) in U.S. waters of the Gulf of Mexico. Final report Marfin award # NA12NMF4330093

Additional published genetic studies of red snapper in the Gulf of Mexico reviewed by the group did not bring additional information due to limitations of the datasets used in terms of sample sizes, numbers of sampling localities, or marker systems so the below report focuses primarily on these 6 papers.

Additional documents discussed by the panel included

SEDAR52-WP-20: Karnauskas, Walter and Paris, Use of the Connectivity Modeling System to estimate movements of red snapper (Lutjanus campechanus) recruits in the northern Gulf of Mexico

Document Review

Pruett et al. 2005. Historical population demography of red snapper (Lutjanus campechanus) from the northern Gulf of Mexico based on analysis of sequences of mitochondrial DNA

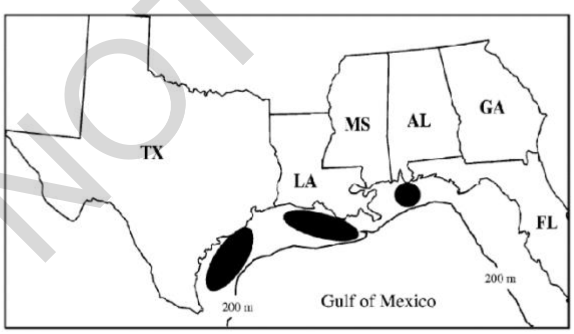
Approach:
Stock structure and demographic history of red snapper in the northern Gulf of Mexico (Gulf) was analyzed based on mitochondrial (mt) DNA sequences from 360 individuals sampled from four cohorts (year classes) at three localities across the northern Gulf (Alabama, Louisiana and Texas).

Findings:

- Exact tests of genetic homogeneity and analysis of molecular variance both among cohorts within localities and among localities were non-significant.
- Nested clade analysis provided evidence of different temporal episodes of both range expansion and restricted gene flow with isolation-by-distance.
- A mismatch distribution of pairwise differences among mtDNA haplotypes and a maximum-likelihood coalescence analysis indicated a population expansion phase that dated to the Pleistocene and probably represents (re)colonization of the continental shelf following glacial retreat.

Interpretations

- **The spatial distribution of red snapper in the northern Gulf appears to have a complex history that likely reflects glacial advance/retreat, habitat availability and suitability, and hydrology.**
- Habitat availability/suitability and hydrology may partially restrict gene flow among present-day red snapper in the northern Gulf and give rise to a metapopulation structure with variable demographic connectivity.
- This type of population structure may be difficult to detect with commonly used, selectively neutral genetic markers.

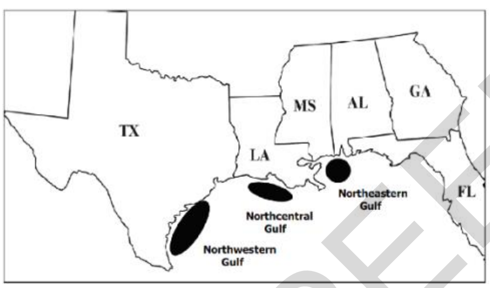


Gold and Saillant 2007. Population Structure of Red Snapper in the Northern Gulf of Mexico;

Approach
Genetic variation was inferred at 19 nuclear-encoded microsatellite loci and a 590 bp protein-coding fragment of mt DNA were assayed among Gulf red snapper sampled from four cohorts at each of three offshore localities (12 samples total, 576 to 758 samples per region for the microsatellite dataset, 90 samples per region for the mtDNA dataset) in the northern Gulf of Mexico.

Findings
- Significant heterogeneity in allele and genotype distributions among samples was detected at four microsatellites
- Six of seven 'significant' pairwise comparisons between samples revealed the heterogeneity to be temporal rather than spatial.
- Nested-clade analysis of mtDNA variants indicated different temporal episodes of range expansion and isolation by distance.

Interpretations
- **Collectively, the findings are consistent with the hypothesis that red snapper in the northern Gulf occur as a network (or metapopulation) of semi-isolated assemblages that may be demographically independent over the short term, yet over the long term can influence each other's demographics via gene flow.**
- This type of population structure may be difficult to detect with commonly used, selectively neutral genetic markers.



	TX 95	LA 95	AL 95	TX 97	LA 97	AL 97
TX 95	—	0.001	0.001	0.001	0.001	0.002
LA 95	0.001*	—	0.001	0.001	0.000	0.001
AL 95	0.000*	0.031	—	0.001	0.000	0.001
TX 97	0.000*	0.013	0.000*	—	0.000	0.000
LA 97	0.036	0.756	0.737	0.078	—	0.001
AL 97	0.000*	0.000*	0.000*	0.054	0.073	—

<u>Saillant, E., Bradfield, S. C., and Gold, J. R. 2010</u>. Genetic variation and spatial autocorrelation among young-of-the-year red snapper (Lutjanus campechanus) in the northern Gulf of Mexico. – ICES Journal of Marine Science, 67: 1240–1250.

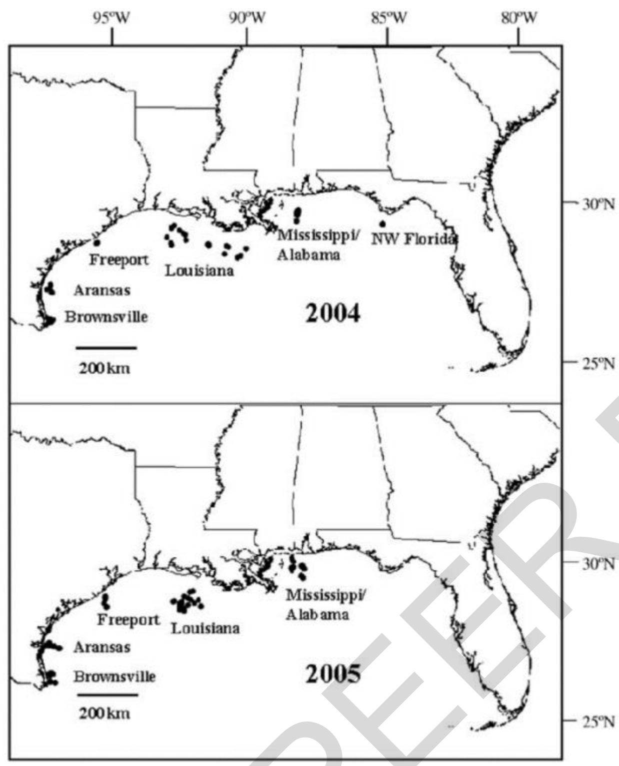
Approach
Temporal and spatial genetic variations at 18 nuclear-encoded microsatellites were assayed among age-0 red snapper, sampled from the 2004 and 2005 cohorts along the northcentral and western Gulf of Mexico during Seamap groundfish surveys and from a mixed-age group sampled off northwest Florida. Samples were grouped in five regions separated by un-sampled areas.

Findings
- Hierarchical analysis of molecular variance revealed genetic heterogeneity among habitat patches within regions, but not among regions.

- A significant, positive spatial autocorrelation of microsatellite genotypes among fish sampled within the geographic range 50–100 km was detected.

Interpretations

- **The results of the study demonstrate that spatial genetic structuring among young-of-the-year red snapper in the Gulf occurs at small geographic scales consistent with restricted larval dispersal and isolation by distance and is consistent with a metapopulation stock-structure model of partially connected populations**
- This accentuates the importance of maintaining healthy local spawning populations of red snapper in all regions across the northern Gulf.



Hierarchical model	Source of variation	d.f.	% molecular variance	*p*-value
Model 1	Among regions (Φ_{CT})	5	0.004	0.493
	Between cohorts within regions (Φ_{SC})	5	0.08	0.062
Model 2	2004 cohort			
	Among regions (Φ_{CT})	4	0.045	0.204
	Among sampling tows within regions (Φ_{SC})	36	0.314	0.188
	2005 cohort			
	Among regions (Φ_{CT})	4	−0.018	0.311
	Among sampling tows within regions (Φ_{SC})	56	0.489	0.009

Hollenbeck et al. 2015. Population structure of red snapper (Lutjanus campechanus) in U.S. waters of the western Atlantic Ocean and the northeastern Gulf of Mexico

Approach

Population structure of adult red snapper from 8 localities in the southeastern coast of the United States (Atlantic) and the northeastern Gulf of Mexico (Gulf) was assessed using genotypes at 16nuclear-encoded microsatellites (46 to 101 samples per locality) and mtDNA haplotypes of the NADH dehydrogenase4 (ND4) gene (20 samples per locality).

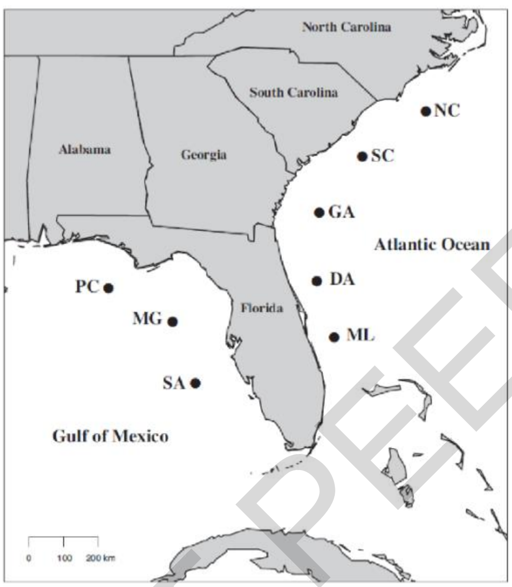
Findings

- Initial tests (FST-based, hierarchical AMOVA) of spatial genetic homogeneity within and between regions were non-significant, consistent with a single population or stock of red snapper in the Atlantic and Gulf.

- Inferences derived from other statistical approaches were consistent with genetic and/or demographic differences within and between the two regions.
- The estimated, average, long-term migration rate between the two regions (0.27%) was well less than the 10% rate below which populations can respond independently to environmental perturbation.
- Comparisons of global estimates of average, long-term effective size (NeLT) with estimates from individual sample localities indicated **genetic heterogeneity within both the Atlantic and Gulf**.

Interpretations

- These results **paralleled those of prior genetic studies of red snapper from the Gulf (a network of partially connected demographic assemblages homogenized by periodic gene flow, see above).**
- Future genetics studies and other work on red snapper in both the Atlantic and Gulf should include approaches to identify demographically independent units within each region and assess their size, patterns of connectivity, and contribution to the fishery.
- Monitoring global and/or local effective size also should be considered.



Puritz et al. 2016 Fine-scale partitioning of genomic variation among recruits in an exploited fishery: causes and consequences

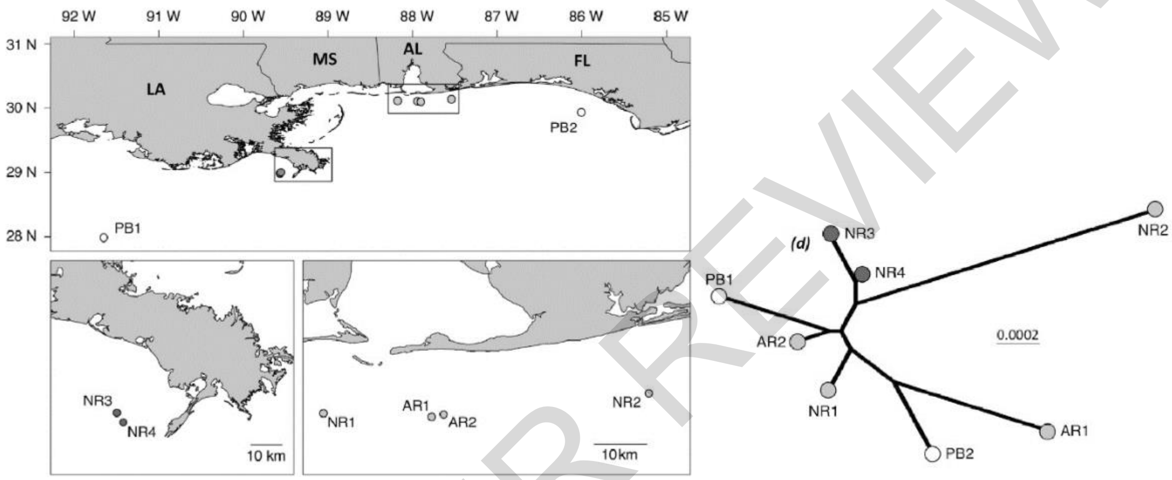
Approach
Surveyed variation in 7,382 SNPs in red snapper young-of-the-year sampled at six localities (sample sizes between 18 and 37 per locality, average 27) and in adults sampled at two localities in the northern Gulf of Mexico (sample sizes 31 and 35).

Findings

- Significant genetic heterogeneity was detected between the two adult samples, separated by ~600 km, and at spatial scales less than five kilometers among samples of YOY.

- **Genetic differences between YOY samples and between YOY samples and adult samples were not associated with geographic distance, and a genome scan revealed no evidence of loci under selection.**
- Estimates of the effective number of breeders, allelic richness, and relatedness within YOY samples were not consistent with sweepstakes recruitment.

Interpretations
- The data demonstrate, at least within one recruitment season, that multiple pulses of recruits originate from distinct groups of spawning adults, even at small spatial scales.
- For exploited species with this type of recruitment pattern, protection of spawning adults over wide geographic areas may be critical for ensuring productivity and stability of the fishery by maintaining larval supply and connectivity.



Adults no shading, YOY shaded by location

Portnoy. 2017. Stock Structure, Connectivity, and Effective Population Size of Red Snapper (Lutjanus Campechanus) In U.S. Waters of The Gulf Of Mexico.

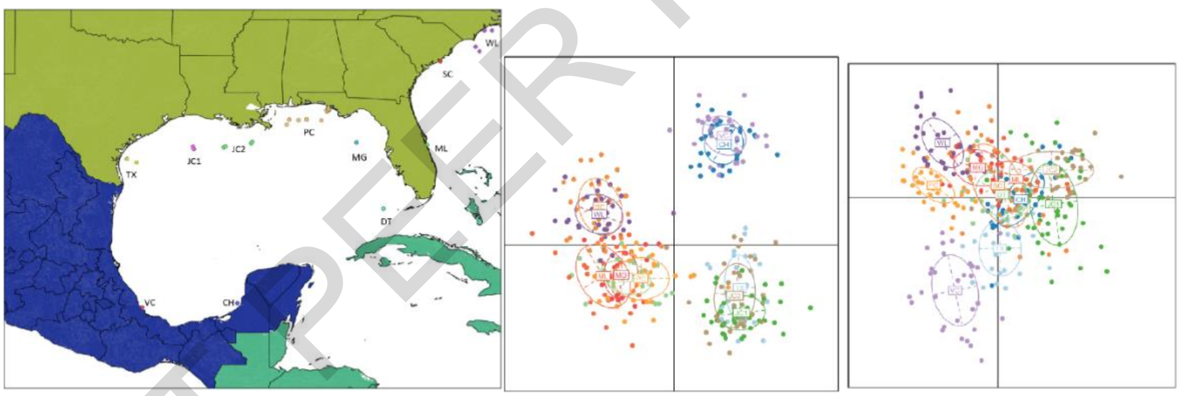
Three concurrent subprojects were completed with the common goal of providing information about stock structure and genetic demography of Gulf red snapper using a cutting-edge, next-generation sequencing approach. Subproject 1 aimed to develop a variant calling pipeline specifically for population genomic applications and used in the other project components. Subproject 2 was published and discussed above (Puritz et al. 2016). Subproject 3 focused on assessing Populations structure of red snapper in the U.S Atlantic and Gulf of Mexico

Approach (Subproject 3)
Diversity was assessed within and among 11 geographic samples of mixed-age red snapper including localities on the East coast, northeastern, central and western gulf and two localities in the southern Gulf (samples sizes between 20 and 38 per location, average 29).

Findings
- Within sample diversity was similar among samples
- Eighteen outlier loci, putatively under directional selection were identified.

- All tests of global heterogeneity were significant but estimates of pairwise FST for neutral and outlier data sets did not reveal interpretable patterns.
- **Spatial analysis of principal components (sPCA) indicated global structuring and suggested that samples were best grouped into four regions (Carolinas, Florida, western Gulf and southern Gulf) or two regions (Carolinas and Florida, western and southern Gulf) depending on the connection network used.**
- The four-region model was supported by discriminant analysis of principle components (DAPC) and estimates of pairwise FST between the four regions were significant for the outlier data set but not for the neutral data.
- Similarly, for the two-region model, estimates of pairwise FST were significant for the outlier dataset and not significant for the neutral data set.
- Estimates of migration using two methodologies suggested rates generally below 10% and favored movement into Florida.

Interpretations
- Red snapper are not genetically homogenous throughout U.S. waters.
- Gulf of Mexico may be comprised of two stocks but there was not a strong consensus across analyses based on the neutral data set.
- This may be due to non-equilibrium conditions in Gulf red snapper, i.e. recent range expansion associate with the end of the last glacial period, or high connectivity metapopulation structure.



2.3.2 Group conclusions

The group discussed that collectively, all available information consistently indicates that the Gulf of Mexico is not a single unit. The lack of clarity in stock structure in terms of number of units and their delineation is due to a number of factors including the large population size of red snapper which leads to slow divergence among regions coupled with periodic gene flow which contributes to erasing genetic differences.

The occurrence of two units in US Gulf waters was suggested by the most recent study but attempts to delineate regions using spatially explicit models have been unsuccessful (Portnoy et al. 2017).

Demographic analyses indicate that local recruitment results from distinct pools (Puritz et al. 2016). However, spatial autocorrelation of genotypes and isolation by distance were only detected in juveniles when sampling was continuous along the shelf (Saillant et al. 2010) suggesting adult movements are contributing to gene flow.

Overall, no clear recommendation on stock delineation can be made based on available data and the group recommended considering other sources of information including tagging and larval dispersal models (e.g. SEDAR52-WP20).

The group recognizes the limitation of sample sizes in a number of the older studies and the more recent ones (yet partially compensated by the large number of loci for the latter) and recommends taking advantage of the recent extensive genetic sampling across the Gulf on different habitat types to improve current assessments and delineation of stock units.

Finally, the group discussed whether available genetic data provided support in favor of moving of the geographic boundary separating the eastern and western Gulf stocks further East, to the area of Cape San Blas, for the purpose of assessment and management. Analyses conducted during the most comprehensive study to date (Portnoy 2017) were inconclusive regarding the status of the area between Cape San Blas and the Mississippi river with some models showing more affinity of samples from this region with the eastern Gulf (e.g. the 4-groups sPCA analysis in Portnoy 2017) A recent re-analysis of the dataset using a landscape genetics approach indicated a genetic discontinuity along the West Florida Shelf, but could not define an exact boundary (Portnoy, personal communication)

2.4 *LANDINGS AND CPUE WORKING GROUP*

Names and affiliations of the SEDAR 74 Stock ID Landings and CPUE Working Group.

Jim Tolan (TX Parks & Wildlife Dept.)
Darin Topping (TX Parks & Wildlife Dept.)
Steven Scyphers (Northeastern University)
Kevin Thompson (FL Fish & Wildlife Comm.)
Kevin Anson (AL DCNR)
Trevor Moncrief (MS DMR)
Jason Adriance (LA WLF)
Ted Switzer (FL Fish & Wildlife Comm.)
Matthew Nuttall (NOAA Federal)
Kelly Fitzpatrick (NOAA Federal)
Molly Stevens (NOAA Federal)
Matthew Campbell (NOAA Federal)
Adam Pollack (NOAA Federal)
Kenneth Brennan (NOAA Federal)

Kevin McCarthy (NOAA Federal)
Sarina Atkinson (NOAA Federal)
Vivian Matter (NOAA Federal)
David Hanisko (NOAA Federal)
Refik Orhun (NOAA Federal)
Katherine Overly (NOAA Federal)
Chris Gardner (NOAA Federal)
Jeff Pulver (NOAA Federal)
LaTreese Denson (NOAA Federal)

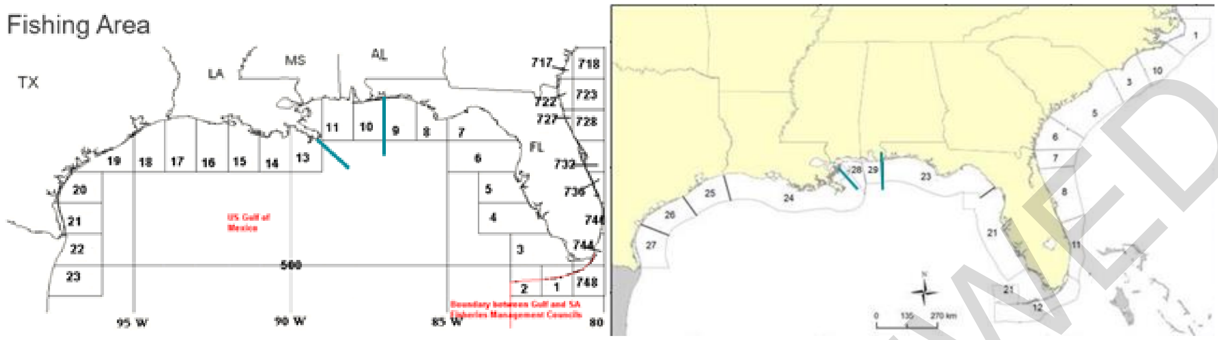
2.4.1 Landings and CPUE Working Group Executive Summary

The landings and catch per unit effort (CPUE) working group met remotely via webinars, phone calls, and email communications to determine if the current stock ID boundary for red snapper is still recommended for the upcoming SEDAR 74 Assessment. Currently the boundary for the East and West stocks within the Gulf of Mexico is located between NOAA statistical grids 12 and 13, or the outflow of the Mississippi River. Based on recreational and commercial landings, spatial differences in length frequency distributions, and reef fish video surveys, the members of the landings and CPUE working group felt there was sufficient evidence to warrant either moving the current boundary to the east (for a 2-stock model) or adding an additional stock boundary in the eastern Gulf (for a 3 stock model). While several of the Workgroup members exhibited a preference for Option B based on landings and length frequency differences, others felt Option C was more appropriate given an inability to partition SRHS data at the FL/AL boundary proposed in Option B and a desire to retain the primary LA/MS stock boundary, which was supported by the findings of the life history working group (e.g., larval connectivity; S74-SID-02). We provide the rationales put forward by members of the workgroup to support their preference for either a 2 or 3 stock model, as outlined below.

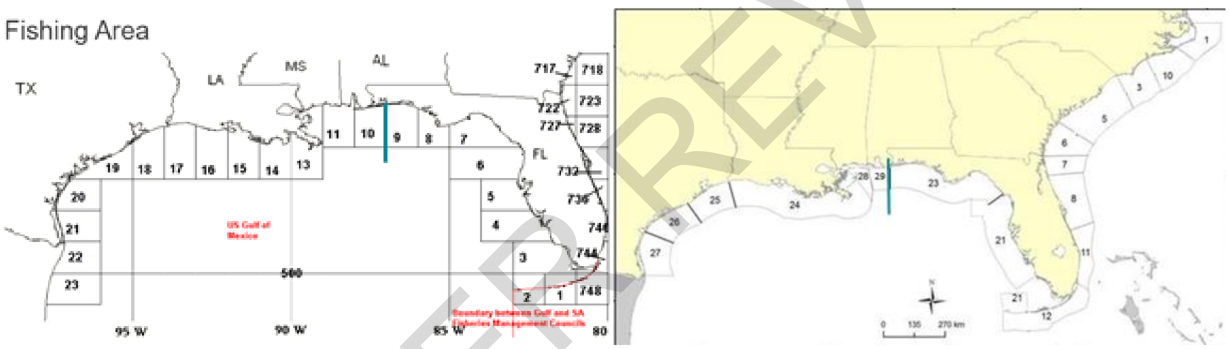
Stock Boundary Options

Three new stock boundary options were proposed during the Stock ID workshop in addition to the current boundary (split at the Mississippi River outflow) based on scientific evidence. These options are presented and discussed as they relate to fishery-dependent data, with survey design stratifications and possible stock delineations for various data sources detailed in Figures 1-3. Below, Stock ID options are summarized with the maps on the left representing NMFS Fishing Areas available in commercial data, and the maps on the right representing current SRHS

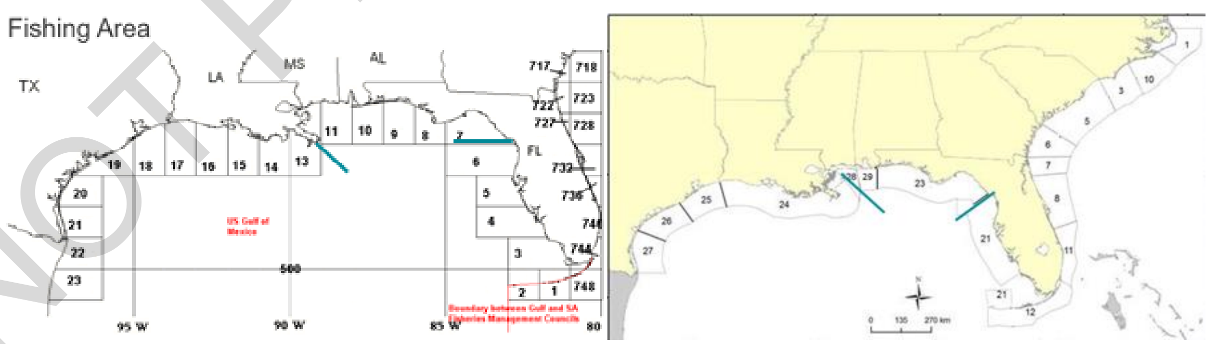
Headboat Areas (please note that SRHS Area 29, the separation of AL from the FL panhandle Area 23, was not incorporated until 2013).



Option A: Stock Boundary Option A maintains the current split at the Mississippi River outflow (as in SEDAR 52) and incorporates an additional split for MS/AL where there may be unique fishery dynamics and differing trends of abundance.



Option B: Stock Boundary Option B removes the split at the Mississippi and pools MS/AL with TX/LA which share similar trends in abundance.



Option C: Stock Boundary Option C maintains the current split at the Mississippi River outflow (as in SEDAR 52) and incorporates an additional split for MS/AL/FL panhandle where there are similar fishery dynamics.

2.4.2 General Recreational Landings

General recreational landings of Gulf of Mexico Red Snapper (SEDAR 74-SID-01) are largely concentrated in the northeast, with 32.7% of all private and charter landings between 1981-2019 coming from Alabama and 36.7% from the Florida panhandle (i.e., AL:FL border to the Dixie:Levy county border; see Figs 4 and 5). Louisiana also accounts for an appreciable portion of Red Snapper landings in the Gulf (19.9%). Texas, Mississippi, and other parts of western Florida contribute relatively little to the Gulf-wide recreational landings of Red Snapper (respectively, 2.5%, 4.6%, and 3.5% of Gulf-wide landings since 1981).

The current east-west boundary for Gulf Red Snapper (i.e., those used in SEDAR 52) separates this stock between NMFS stat zones 12 and 13. From the perspective of general recreational landings, this structure largely amounts to separating Louisiana Red Snapper from those in Alabama and the Florida panhandle, which may be necessary to model the general decline in Louisiana landings over time (31.9% of Gulf-wide landings in 1981-1999 and 6.4% since 2000). Shifting the current stock boundary east to include MS and AL (i.e., Option B; two-area model) may therefore inhibit the assessment model from detecting and explaining this trend in Louisiana landings if driven by something other than fishing effort (e.g., fishing behavior). Similarly, general recreational landings of Gulf Red Snapper have also changed in the Florida panhandle, increasing from 19.4% of historic Gulf-wide landings (1981-1999) to 56.2% since 2000. Like Louisiana, this trend may warrant consideration of separating the FL panhandle from AL, as is proposed in Option A (i.e., three-area model).

2.4.3 Southeast Region Headboat Survey (SRHS)

Red snapper landings in the SRHS are concentrated in TX (74.1% of Gulf-wide landings, 1986-2019), followed by NWFL/AL (18.8% of Gulf-wide landings, 1986-2019). LA, MS (added to the SRHS in 2010), and SWFL have consistently accounted for little of the Gulf-wide SRHS landings. SRHS red snapper landings have shifted through time. From 1986-1999 TX accounted for 83.7% of the Gulf-wide SRHS landings while NWFL/AL accounted for 8.2%. From 2000-2019 TX accounted for 56.4% of the Gulf wide SRHS red snapper landings while the NWFL/AL landings increased to 38.1%. The increase in landings in the NWFL/AL region in the SRHS is reflected in the increase in the general recreational fishery. SRHS landings are a relatively small component of the overall recreational fishery (9.04% of the overall recreational landings). It is also important to note that the SRHS area domains represent the area where the fish were landed, not the waterbody caught.

The spatial analysis of SRHS catch records utilizes the reported primary fishing location for each trip (Klibansky, 2020, Figure 6). This analysis shows the highest CPUEs off of TX and the western coast of LA. However, there are no SRHS selected headboats operating in western LA. Those catches are reported by TX vessels that run longer trips, rather than by vessels operating in eastern LA, and therefore are included in the TX estimated landings. CPUEs in eastern LA, MS, and NWFL/AL are slightly lower, with relatively few red snapper caught per angler hour in SWFL.

2.4.4 Reef Fish Video Surveys

Size composition data and mean CPUE were summarized for three fishery-independent reef fish video surveys to examine potential evidence of stock structure: the MS Labs reef fish survey (shelf-edge reef habitats Gulf-wide), the Panama City reef fish survey (shelf reef habitats of the northeastern Gulf of Mexico), and the FWRI reef fish survey (shelf and shelf-edge reef habitats off the Florida Gulf coast). Observed patterns in CPUE were generally similar among the three western Gulf regions (Texas, West Louisiana, and East Texas) and the North Central region that extended from the mouth of the Mississippi River east to Cape San Blas (Figure 7). In contrast, observed fish were generally larger overall in the Big Bend and South Florida (Cape San Blas to the Florida Keys) than they were in the western or north-central Gulf (Figure 8). In the eastern Gulf of Mexico, clear differences in CPUE trends were evident east and west of Cape San Blas in both the Panama City (Figure 9) and FWRI data (Figure 10). In the FWRI data, trends were similar in both the Mid Peninsula and South Florida regions (Figure 10). Based on summaries of reef fish video survey data, there is little evidence to suggest a clear boundary at the mouth of the Mississippi River. Instead, it appears that there is a distinct break at Cape San Blas (boundary between statistical zones 7 and 8), and potentially a second break at or around Tampa Bay (between statistical zones 5 and 6). However, understanding the difficulties in breaking some data sets at the Cape San Blas boundary, these results may support the exploration of a 3-stock model with one break between zones 10 and 11 and a second break between zones 6 and 7.

2.4.5 Length Compositions of Landings

Length compositions of Red Snapper landings were analyzed at the finest spatial scale possible throughout the Gulf of Mexico for commercial and recreational fleets. These compositions are provided as supplementary information to the Stock Identification Workshop and should not serve as the primary driver for stock structure decisions since these can be influenced by interacting factors other than stock structure, including but not limited to gear selectivity, gear distribution, and fishing behavior.

Commercial

Commercial size data were supplied through the Trip Interview Program (TIP, n=436,893) and the Fisheries Information Network housed at GSMFC (GulfFIN, n=13,629). These data were reported with one of 21 statistical areas divided along the US Gulf of Mexico coastline (Figure 1).

Commercial length samples were aggregated by fishing areas defined under each of the Stock Boundary Options within the fleet structure utilized in SEDAR52 to display available sample sizes. Vertical Line (VL) gear had sufficient samples in all Stock Boundary Options to estimate nominal length compositions (Table 1). Longline (LL) gear did not have consistent sampling in the Central region from the Stock Boundary Options A & C to support estimation of length compositions for either three-stock model (Table 2). VL was the primary gear type landing Red Snapper, accounting for nearly 95% of commercial length samples, and was used to visualize spatial shifts in length compositions throughout the Gulf. The annually aggregated VL length compositions display a continuous shift from the largest fish landed in the eastern Gulf of Mexico (GOM), the smallest fish in the central GOM, and intermediate sizes in the western GOM (Figure 11).

Recreational

Recreational data were supplied through the Southeast Regional Headboat Survey (SRHS), Marine Recreational Information Program (MRIP), and GSMFC Fisheries Information Network (GulfFIN). In 2013 SRHS landing areas were reevaluated in order to separate Alabama and Florida data and landings estimates. SRHS areas represent where the fish were landed, rather than the waterbody where the fish were caught (Figure 2). The finest resolution MRIP data can be compiled is by state, except for Florida, which is subdivided into five sampling domains, three of which are in the Gulf of Mexico (Figure 3).

Recreational length samples were aggregated under each definition of Stock Boundary Options within the same fleet structure utilized in SEDAR52 to display available sample sizes. SRHS headboat samples were truncated to 7 years of data (2013-2019) in Options A and B due to the inability to split AL from the panhandle of FL (i.e. addition of Area 29 in 2013 facilitated these stock boundaries). Stock Boundary Option C had insufficient samples in the eastern region, leaving the current boundary the most viable option for SRHS data (Table 3).

General recreational length data (MRIP and GulfFIN) also had insufficient samples in the eastern region under Stock Boundary Option C for both charterboat (Table 4) and private modes (Table 5), indicating an overall lack of a recreational Red Snapper fishery in this region. By the late 1990s, there are sufficient charterboat length samples to support Options A or B, but the current stock boundary has a more even distribution of sampling and fewer years that dip below the 30 sample size threshold (Table 4, Fig. 12). These issues are exacerbated in the private mode, where more years of data would be dropped under Options A and B due to fewer samples overall compared to charterboat (Table 5, Fig. 13). The current stock boundary results in more even distribution of recreational length samples for estimating compositions compared to other options.

2.4.6 Discussion

The structure of general recreational survey data is amenable to Option A, but this option is problematic for the SRHS data, which did not separate AL and NWFL until 2013 (Figure 2). Additionally, the proposed MS/AL zone in Option A constitutes a relatively small spatial domain, the sampling of which may be inadequate for some abundance indices or composition data in the region. The latter (sample size) constraint in the proposed MS/AL zone may be relaxed by shifting the boundary east, but the resolution at which general recreational catch estimates are available for the Gulf constrains where this boundary could be moved; domain boundaries are currently set around the “Big Bend” region (i.e., Option C; three-area model) and at the Monroe:Collier county border. Additionally, shifting the second boundary east will still require some assumption in how to allocate SRHS catch estimates across FL domains and is still likely to result in a data poor spatial area (i.e., SWFL vs. MS/AL in Option B). The general recreational data can also support Option B (i.e., two-area model; boundary at 9/10) but this option may impede the modeling of landing trends for Louisiana Red Snapper. Any stock boundaries set in western Florida beyond those mentioned will require an additional assumption in how to allocate general recreational catch estimates across Florida domains. Options A and B will both require assumptions in how to partition SRHS catch estimates (across AL and FL), and these assumptions have yet to be explored. Options A and C are likely to result in data poor areas (Option A effectively creates a MS/AL zone while option C results in a SWFL only zone) for the SRHS data as well as the general recreational data.

In summary, the general recreational landings data for Gulf of Mexico Red Snapper seem to support the following Stock ID boundaries for SEDAR 74:

- Status-Quo (i.e., two-area model) – boundary at NMFS stat zone 12/13
- Option A (i.e., three-area model) – boundaries at NMFS stat zone 12/13 and 9/10
- Option B (i.e., two-area model)- boundary at NMFS stat zone 9/10
- Option C (i.e., three-area model) – boundaries at NMFS stat zones 12/13 and 6/7

Of the proposed options the SRHS can support the following options for SEDAR 74:

- Status-Quo (i.e., two-area model) – boundary at NMFS stat zone 12/13
- Option C (i.e., three-area model) - boundary at NMFS stat zones 12/13 and 6/7

References :

Karnauskas, M.and C. B. Paris. 2021. A Lagrangian biophysical modeling framework informs stock structure and spawning-recruitment of red snapper (Lutjanus campechanus) in the northern Gulf of Mexico. SEDAR74-SID-02.SEDAR, North Charleston, SC. 9pp.

Moncrief, Trevor. 2021. Mississippi Red Snapper Data Summary. SEDAR74-SID-04. SEDAR, North Charleston, SC. 16pp.

Nuttall, Matthew A. and Vivian M. Matter. 2021. Hot Spot Maps of General Recreational Landings for Gulf of Mexico Red Snapper. SEDAR74-SID-01. SEDAR, North Charleston, SC. 9pp.

Switzer, Theodore S., Adam G. Pollack, Katherine E. Overly,Christopher Gardner, Kevin A. Thompson,Matt Campbell. 2021. Insights into the Spatial Dynamics of Red Snapper in the Gulf of Mexico from Gulf-Wide Fishery Independent Surveys. SEDAR74-SID-03.SEDAR, North Charleston, SC. 27pp.

2.4.7 Tables

Table 1: Vertical line length samples under the current and alternate Stock Boundary Options.

VL	CURRENT		OPTION A			OPTION B		OPTION C		
	W	E	W	C	E	W	E	W	C	E
1984	3093	963	3093	192	771	3285	771	3093	438	525
1985	3650	634	3650	143	491	3793	491	3650	310	324
1986	2165	1140	2165	912	228	3077	228	2165	912	228
1987	848	699	848	641	58	1489	58	848	641	58
1988	1300	286	1300	136	150	1436	150	1300	182	104
1989	1538	597	1538	487	110	2025	110	1538	519	78
1990	6505	2216	6505	1589	627	8094	627	6505	1989	227
1991	6302	1858	6302	1610	248	7912	248	6302	1823	35
1992	5008	765	5008	733	32	5741	32	5008	733	32
1993	6980	1950	6980	1691	259	8671	259	6980	1880	70
1994	2517	3906	2517	3354	552	5871	552	2517	3824	82
1995	5392	2347	5392	2081	266	7473	266	5392	2298	49
1996	2831	2481	2831	2170	311	5001	311	2831	2389	92
1997	6755	2084	6755	1641	443	8396	443	6755	1918	166
1998	7493	3436	7493	2587	849	10080	849	7493	3314	122
1999	4238	3798	4238	3041	757	7279	757	4238	3382	416
2000	3577	4079	3577	3088	991	6665	991	3577	3916	163
2001	3963	4422	3963	3182	1240	7145	1240	3963	4270	152
2002	5916	4969	5916	3729	1240	9645	1240	5916	4704	265
2003	5125	5623	5125	3919	1704	9044	1704	5125	5249	374
2004	3265	3559	3265	1818	1741	5083	1741	3265	3297	262
2005	3737	3728	3737	1993	1735	5730	1735	3737	3496	232
2006	3802	2841	3802	1763	1078	5565	1078	3802	2601	240
2007	1478	3770	1478	789	2981	2267	2981	1478	3476	294
2008	3129	4070	3129	2573	1497	5702	1497	3129	3884	186
2009	3187	3889	3187	2503	1386	5690	1386	3187	3509	380
2010	4063	4475	4063	2282	2193	6345	2193	4063	3626	849
2011	3718	6606	3718	2974	3632	6692	3632	3718	5808	798
2012	8735	9017	8735	3358	5659	12093	5659	8735	7911	1106
2013	10788	11306	10788	4896	6410	15684	6410	10788	9883	1423
2014	16251	9314	16251	4265	5049	20516	5049	16251	7984	1330
2015	19003	15278	19003	9180	6098	28183	6098	19003	14235	1043
2016	17694	15268	17694	9315	5953	27009	5953	17694	14278	990
2017	17628	11776	17628	6214	5562	23842	5562	17628	10572	1204
2018	12866	13723	12866	7443	6280	20309	6280	12866	12932	791
2019	14121	15373	14121	10540	4833	24661	4833	14121	14290	1083

Table 2: Longline length samples under the current and alternate Stock Boundary Options.

LL	CURRENT		OPTION A			OPTION B		OPTION C		
	W	E	W	C	E	W	E	W	C	E
1984	641	405	641	0	405	641	405	641	0	405
1985	248	294	248	8	286	256	286	248	8	286
1986	57	242	57	0	242	57	242	57	6	236
1987	26	139	26	0	139	26	139	26	0	139
1988	39	122	39	0	122	39	122	39	4	118
1989	218	9	218	0	9	218	9	218	0	9
1990	376	359	376	17	342	393	342	376	51	308
1991	109	103	109	0	103	109	103	109	39	64
1992	114	88	114	2	86	116	86	114	2	86
1993	30	138	30	0	138	30	138	30	0	138
1994	3	90	3	18	72	21	72	3	18	72
1995	74	133	74	0	133	74	133	74	0	133
1996	11	76	11	0	76	11	76	11	0	76
1997	63	65	63	0	65	63	65	63	11	54
1998	253	131	253	0	131	253	131	253	0	131
1999	218	281	218	0	281	218	281	218	0	281
2000	515	263	515	0	263	515	263	515	0	263
2001	180	228	180	24	204	204	204	180	47	181
2002	566	275	566	0	275	566	275	566	40	235
2003	259	301	259	19	282	278	282	259	33	268
2004	482	371	482	0	371	482	371	482	29	342
2005	217	439	217	0	439	217	439	217	0	439
2006	448	253	448	0	253	448	253	448	0	253
2007	137	220	137	0	220	137	220	137	93	127
2008	37	466	37	32	434	69	434	37	153	313
2009	67	101	67	29	72	96	72	67	29	72
2010	61	649	61	0	649	61	649	61	1	648
2011	44	592	44	0	592	44	592	44	23	569
2012	157	210	157	0	210	157	210	157	16	194
2013	148	701	148	0	701	148	701	148	14	687
2014	97	1194	97	0	1194	97	1194	97	4	1190
2015	285	886	285	0	886	285	886	285	28	858
2016	166	751	166	11	740	177	740	166	27	724
2017	232	540	232	15	525	247	525	232	43	497
2018	519	671	519	14	657	533	657	519	142	529
2019	1025	883	1025	22	861	1047	861	1025	104	779

Table 3: SRHS headboat length sample sizes under the current and alternate Stock Boundary Options.

SRHS	CURRENT		OPTION A			OPTION B		OPTION C		
	W	E	W	C	E	W	E	W	C	E
1986	6252	164	--	--	--	--	--	6252	141	23
1987	5978	192	--	--	--	--	--	5978	191	1
1988	4591	195	--	--	--	--	--	4591	194	1
1989	6314	286	--	--	--	--	--	6314	280	6
1990	4263	333	--	--	--	--	--	4263	330	3
1991	3420	497	--	--	--	--	--	3420	496	1
1992	7872	683	--	--	--	--	--	7872	682	1
1993	7055	385	--	--	--	--	--	7055	385	0
1994	6642	1316	--	--	--	--	--	6642	806	510
1995	8325	441	--	--	--	--	--	8325	441	0
1996	5260	496	--	--	--	--	--	5260	496	0
1997	3996	1139	--	--	--	--	--	3996	1139	0
1998	6556	2156	--	--	--	--	--	6556	2156	0
1999	3284	884	--	--	--	--	--	3284	839	45
2000	3194	1135	--	--	--	--	--	3194	1130	5
2001	2531	653	--	--	--	--	--	2531	648	5
2002	2385	1250	--	--	--	--	--	2385	1250	0
2003	2005	1089	--	--	--	--	--	2005	1086	3
2004	808	544	--	--	--	--	--	808	543	1
2005	1015	303	--	--	--	--	--	1015	301	2
2006	766	481	--	--	--	--	--	766	464	17
2007	768	1280	--	--	--	--	--	768	1264	16
2008	401	1223	--	--	--	--	--	401	1221	2
2009	866	947	--	--	--	--	--	866	911	36
2010	796	708	--	--	--	--	--	796	687	21
2011	978	737	--	--	--	--	--	978	722	15
2012	456	607	--	--	--	--	--	456	575	32
2013	2299	1076	2299	581	495	2880	495	2299	1057	19
2014	4773	2150	4773	1631	519	6404	519	4773	2101	49
2015	4013	2264	4013	1650	614	5663	614	4013	2138	126
2016	3793	706	3793	589	117	4382	117	3793	674	32
2017	2887	832	2887	617	215	3504	215	2887	754	78
2018	3936	744	3936	488	256	4424	256	3936	650	94
2019	3788	1509	3788	560	949	4348	949	3788	1413	96

Table 4: Charterboat length sample sizes under the current and alternate Stock Boundary Options.

CB	CURRENT		OPTION A			OPTION B		OPTION C		
	W	E	W	C	E	W	E	W	C	E
1981	22	78	22	62	16	84	16	22	78	0
1982	5	79	5	50	29	55	29	5	79	0
1983	440	165	440	79	86	519	86	440	158	7
1984	219	40	219	2	38	221	38	219	16	24
1985	134	35	134	34	1	168	1	134	34	1
1986	358	169	358	121	48	479	48	358	160	9
1987	265	468	265	250	218	515	218	265	467	1
1988	29	348	29	287	61	316	61	29	345	3
1989	29	156	29	147	9	176	9	29	148	8
1990	48	163	48	150	13	198	13	48	163	0
1991	294	735	294	687	48	981	48	294	734	1
1992	369	1745	369	1526	219	1895	219	369	1741	4
1993	153	668	153	411	257	564	257	153	668	0
1994	166	444	166	346	98	512	98	166	444	0
1995	192	245	192	187	58	379	58	192	245	0
1996	193	219	193	160	59	353	59	193	217	2
1997	162	1188	162	534	654	696	654	162	1183	5
1998	297	2880	297	1301	1579	1598	1579	297	2854	26
1999	126	7352	126	3666	3686	3792	3686	126	7341	11
2000	187	7735	187	2974	4761	3161	4761	187	7732	3
2001	130	6451	130	2866	3585	2996	3585	130	6436	15
2002	683	9995	683	5606	4389	6289	4389	683	9992	3
2003	759	9558	759	5422	4136	6181	4136	759	9512	46
2004	964	6843	964	3160	3683	4124	3683	964	6836	7
2005	846	6389	846	2727	3662	3573	3662	846	6373	16
2006	1110	5135	1110	2264	2871	3374	2871	1110	5118	17
2007	1450	4768	1450	1390	3378	2840	3378	1450	4754	14
2008	824	2107	824	546	1561	1370	1561	824	2090	17
2009	879	1418	879	703	715	1582	715	879	1395	23
2010	135	1708	135	317	1391	452	1391	135	1647	61
2011	672	1654	672	641	1013	1313	1013	672	1652	2
2012	775	1732	775	804	928	1579	928	775	1708	24
2013	1017	920	1017	399	521	1416	521	1017	879	41
2014	486	598	486	221	377	707	377	486	505	93
2015	882	1181	882	404	777	1286	777	882	999	182
2016	760	1597	760	816	781	1576	781	760	1528	69
2017	1077	1546	1077	814	732	1891	732	1077	1359	187
2018	1128	1662	1128	789	873	1917	873	1128	1358	304
2019	746	2504	746	1191	1313	1937	1313	746	2158	346

Table 5: Private length sample sizes under the current and alternate Stock Boundary Options.

PR	CURRENT		OPTION A			OPTION B		OPTION C		
	W	E	W	C	E	W	E	W	C	E
1981	35	111	35	51	60	86	60	35	81	30
1982	153	82	153	20	62	173	62	153	80	2
1983	462	15	462	8	7	470	7	462	8	7
1984	437	21	437	15	6	452	6	437	15	6
1985	631	11	631	3	8	634	8	631	6	5
1986	389	16	389	7	9	396	9	389	11	5
1987	452	175	452	60	115	512	115	452	174	1
1988	490	32	490	9	23	499	23	490	16	16
1989	317	13	317	4	9	321	9	317	5	8
1990	349	57	349	49	8	398	8	349	55	2
1991	449	181	449	179	2	628	2	449	180	1
1992	664	496	664	482	14	1146	14	664	495	1
1993	802	231	802	202	29	1004	29	802	231	0
1994	1101	167	1101	150	17	1251	17	1101	167	0
1995	1867	113	1867	98	15	1965	15	1867	112	1
1996	1425	106	1425	93	13	1518	13	1425	103	3
1997	1348	179	1348	172	7	1520	7	1348	179	0
1998	1159	140	1159	126	14	1285	14	1159	140	0
1999	756	751	756	629	122	1385	122	756	742	9
2000	966	426	966	341	85	1307	85	966	426	0
2001	832	496	832	391	105	1223	105	832	496	0
2002	1349	960	1349	882	78	2231	78	1349	957	3
2003	1620	787	1620	704	83	2324	83	1620	784	3
2004	1495	586	1495	502	84	1997	84	1495	576	10
2005	2088	334	2088	272	62	2360	62	2088	327	7
2006	2424	406	2424	290	116	2714	116	2424	401	5
2007	1431	404	1431	155	249	1586	249	1431	396	8
2008	1126	269	1126	128	141	1254	141	1126	263	6
2009	1345	281	1345	234	47	1579	47	1345	278	3
2010	1005	253	1005	132	121	1137	121	1005	249	4
2011	945	286	945	176	110	1121	110	945	279	7
2012	1032	423	1032	249	174	1281	174	1032	418	5
2013	1355	469	1355	264	205	1619	205	1355	466	3
2014	1766	887	1766	405	482	2171	482	1766	879	8
2015	1845	885	1845	446	439	2291	439	1845	884	1
2016	1382	1127	1382	439	688	1821	688	1382	1111	16
2017	1833	1777	1833	702	1075	2535	1075	1833	1365	412
2018	2218	1261	2218	582	679	2800	679	2218	1188	73
2019	2507	1956	2507	1228	728	3735	728	2507	1890	66

2.4.8 Figures

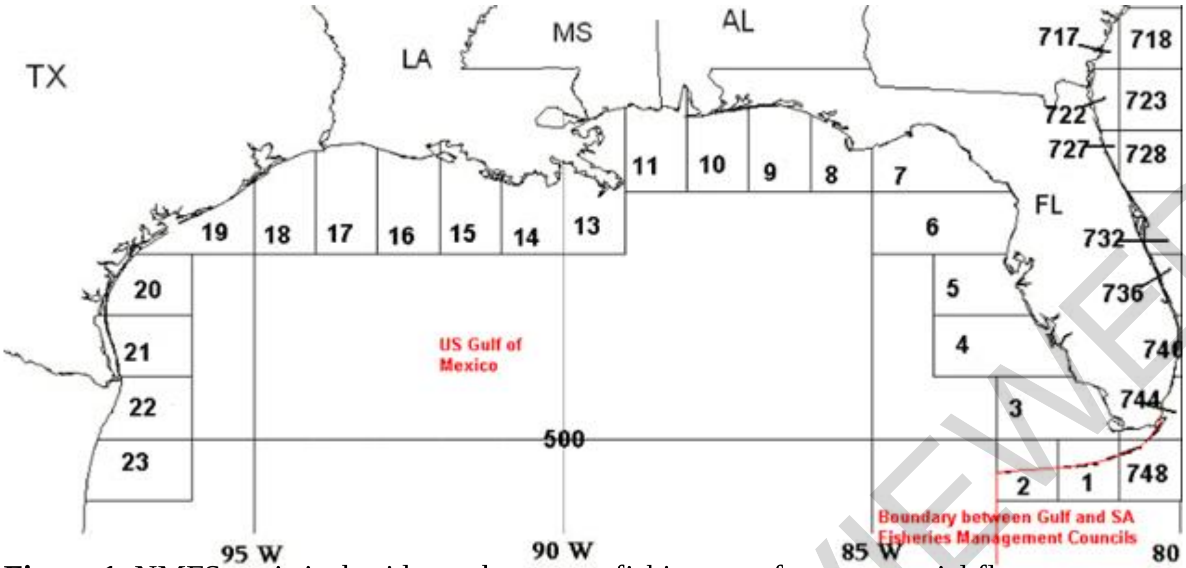
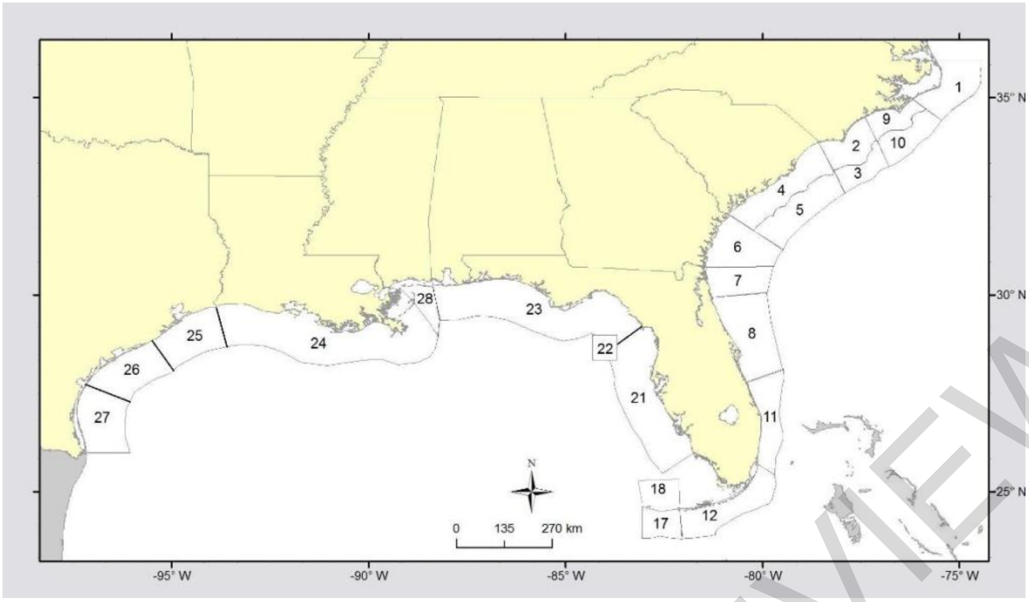


Figure 1: NMFS statistical grids used to report fishing area for commercial fleets.

a)



b)

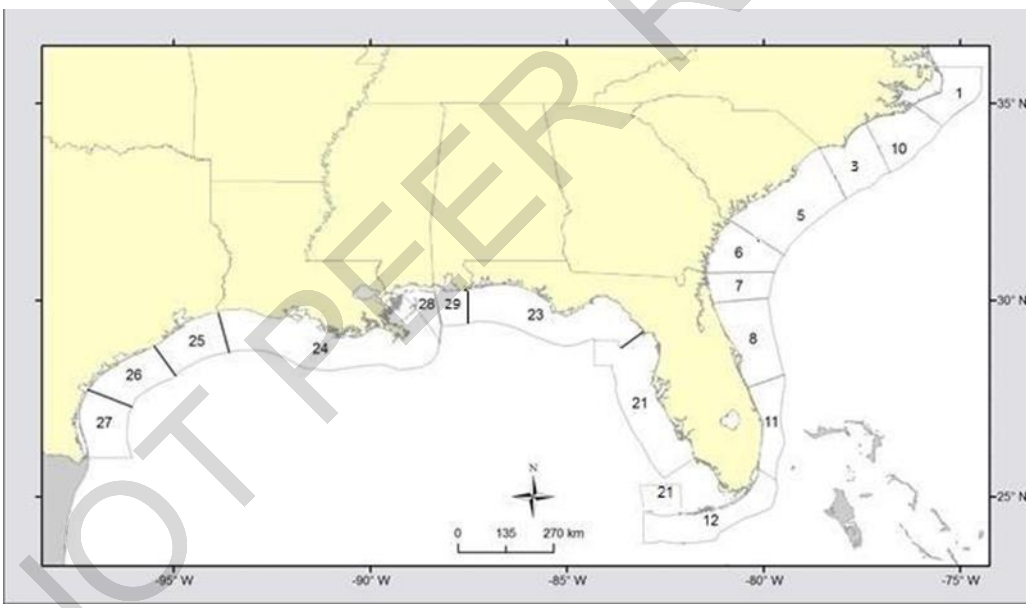


Figure 2. Southeast Regional Headboat Survey statistical areas (1972-2012) (a, top panel) and following the revision 2013-present (b, bottom panel). In 2013 Area 29 was separated from Area 23 in order to allow for separation of AL vessel data from NWFL vessel data.

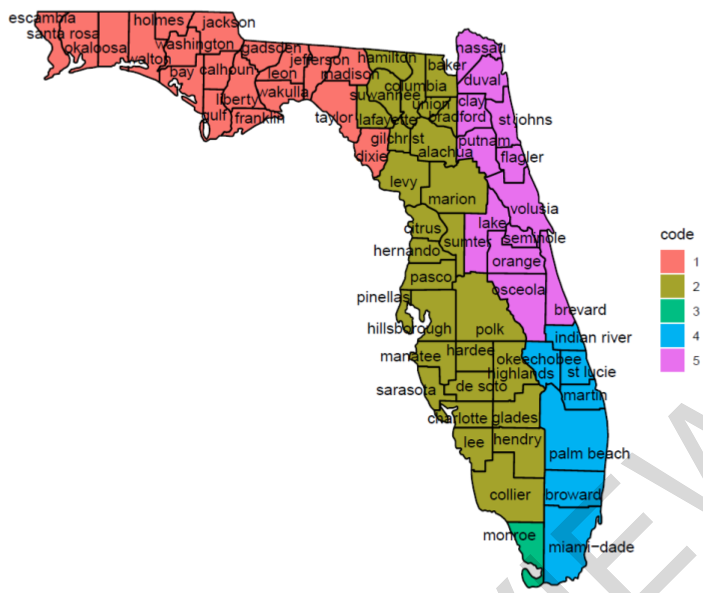


Figure 3. Florida areas in the MRIP survey design, where samples from the Atlantic coast (areas 4 and 5) were deleted and areas 2/3 were aggregated for figures. All other Gulf MRIP stratifications are at state boundaries.

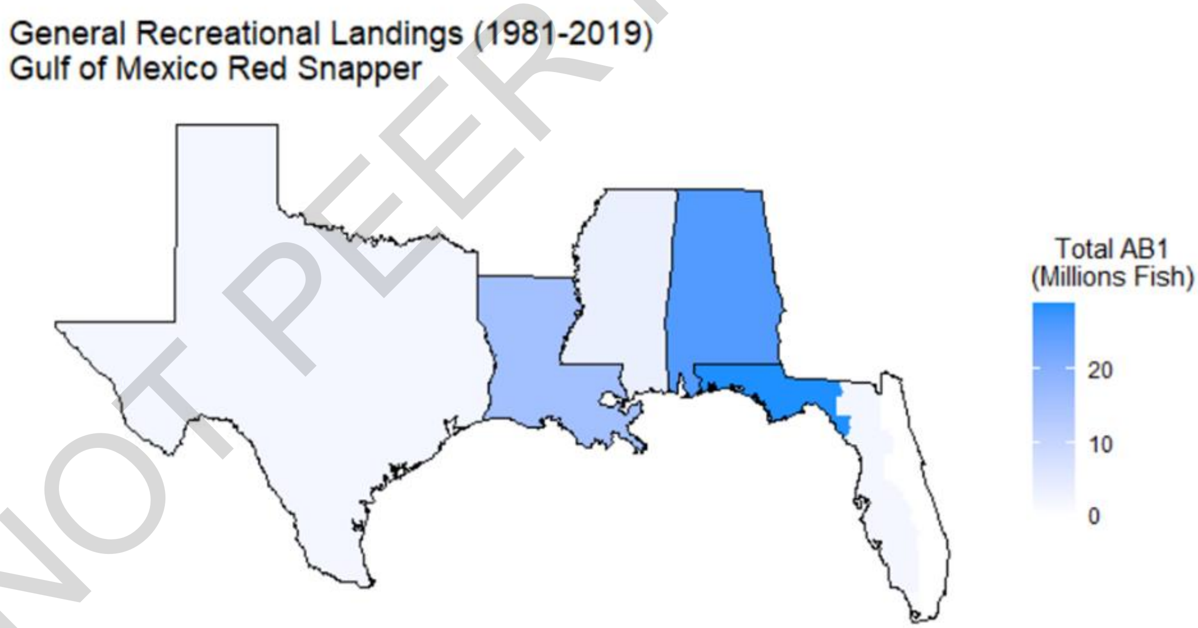


Figure 4. Distribution of general recreational landings (AB1) for Gulf of Mexico Red Snapper across all years (1981-2019) and in millions of fish (MRIP, TPWD, LA Creel).

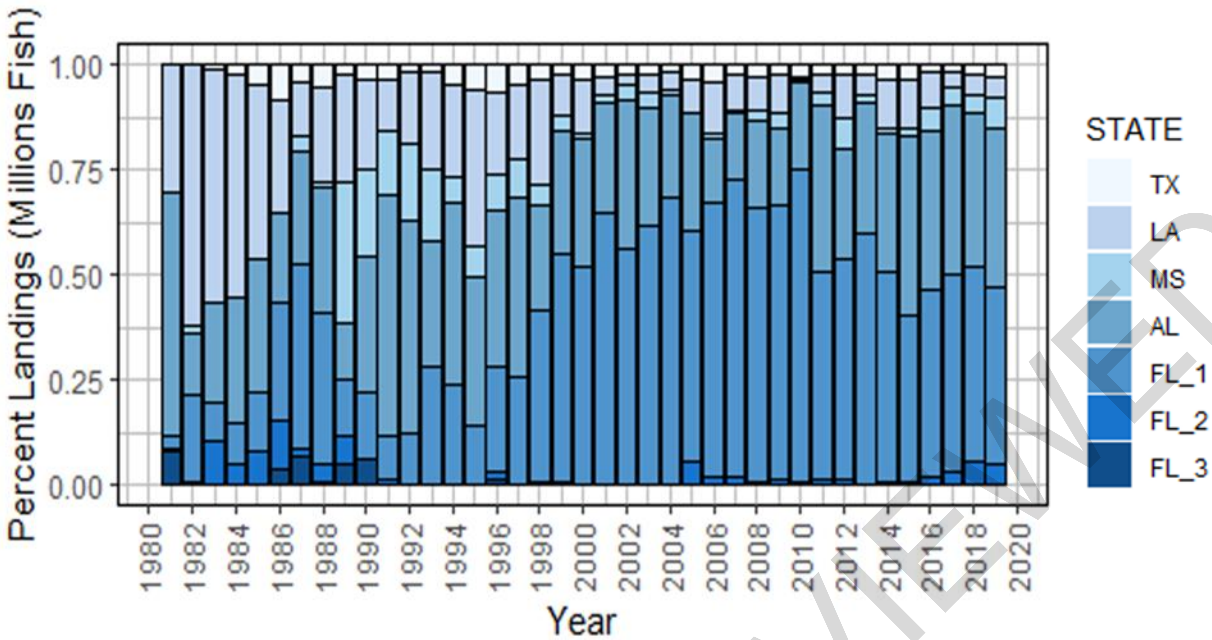


Figure 5. Percent of Red Snapper landings (AB1), in numbers of fish, from each state by year between 1981 and 2019 (MRIP, LACreel 2014+, TPWD).

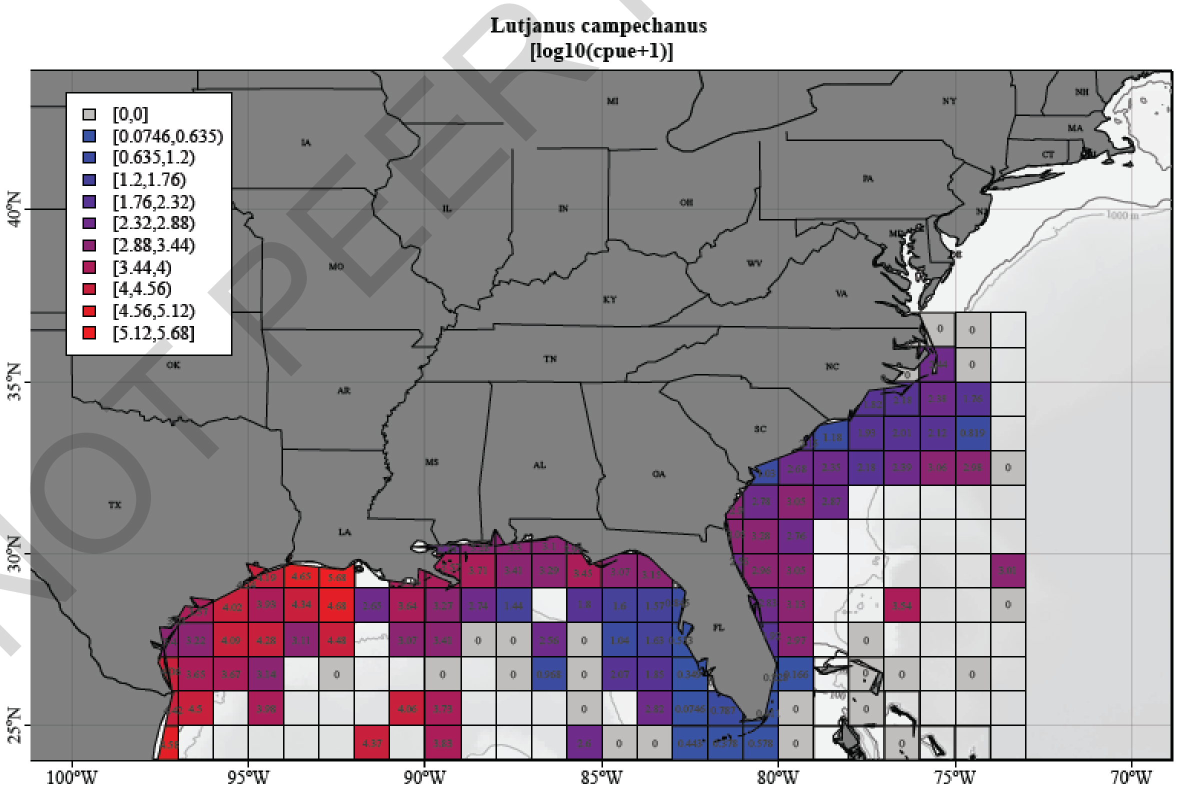


Figure 6. Spatial analysis of SRHS catch records, CPUE analysis.

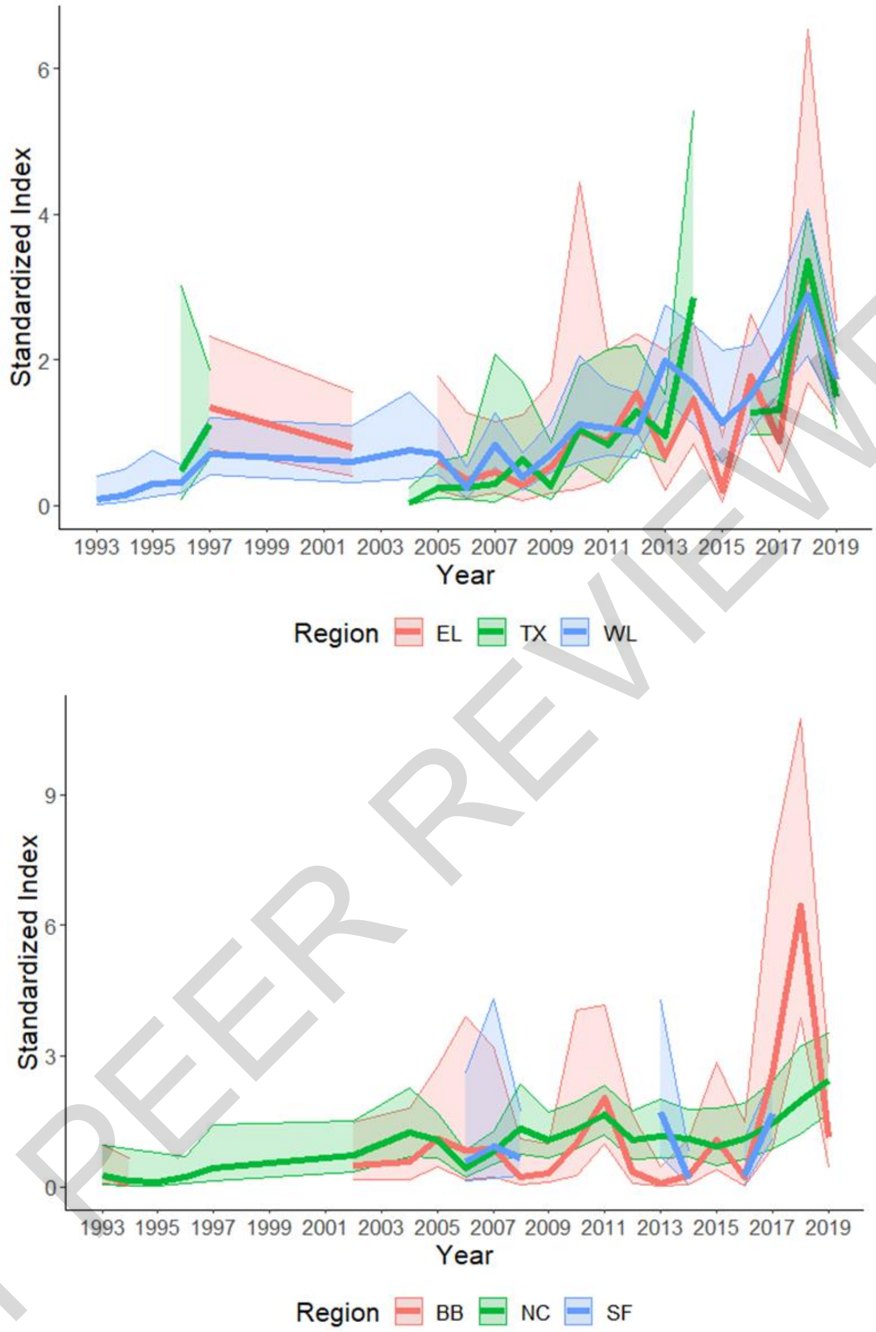


Figure 7. Regional differences in average annual Red Snapper observed per station from the MS Labs reef fish survey for the western Gulf (top panel): Texas (TX), East Louisiana (EL), West Louisiana (WL), and for the eastern Gulf (bottom panel): Big Bend (BB), North Central (NC), and South Florida (SF). Regions are shown geographically on Figure 1. From Switzer et al., SEDAR74-SID-03.

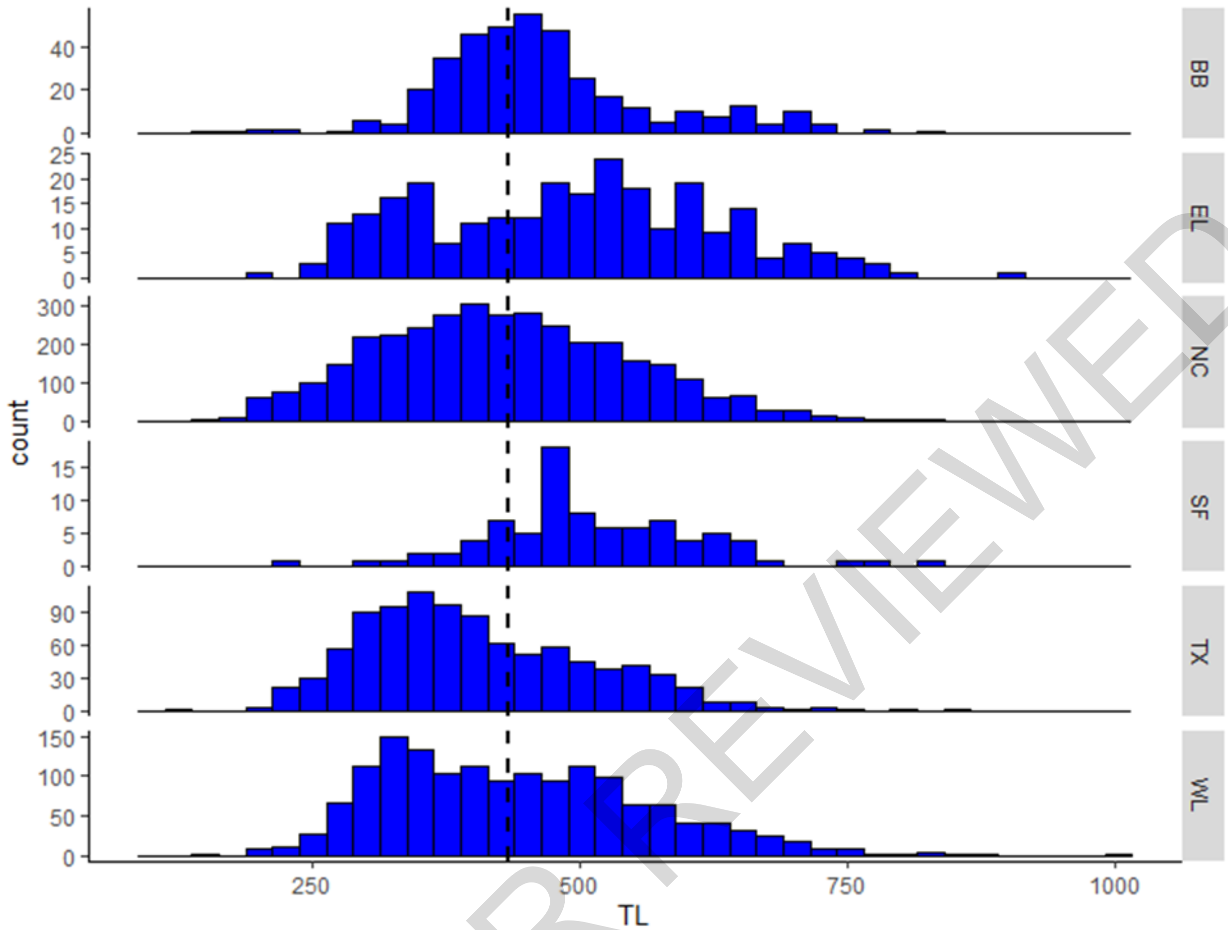


Figure 8. Regional differences in size composition of Red Snapper from the MS Labs reef fish survey for the western Gulf: Texas (TX), East Louisiana (EL), West Louisiana (WL), and for the eastern Gulf: Big Bend (BB), North Central (NC), and South Florida (SF). Regions are shown geographically on Figure 1. Dotted line indicates pooled Gulf-wide mean total length (a = 0, b – 0.95, Fish Base length conversion coefficients FL to TL). From Switzer et al., SEDAR74-SID-03.

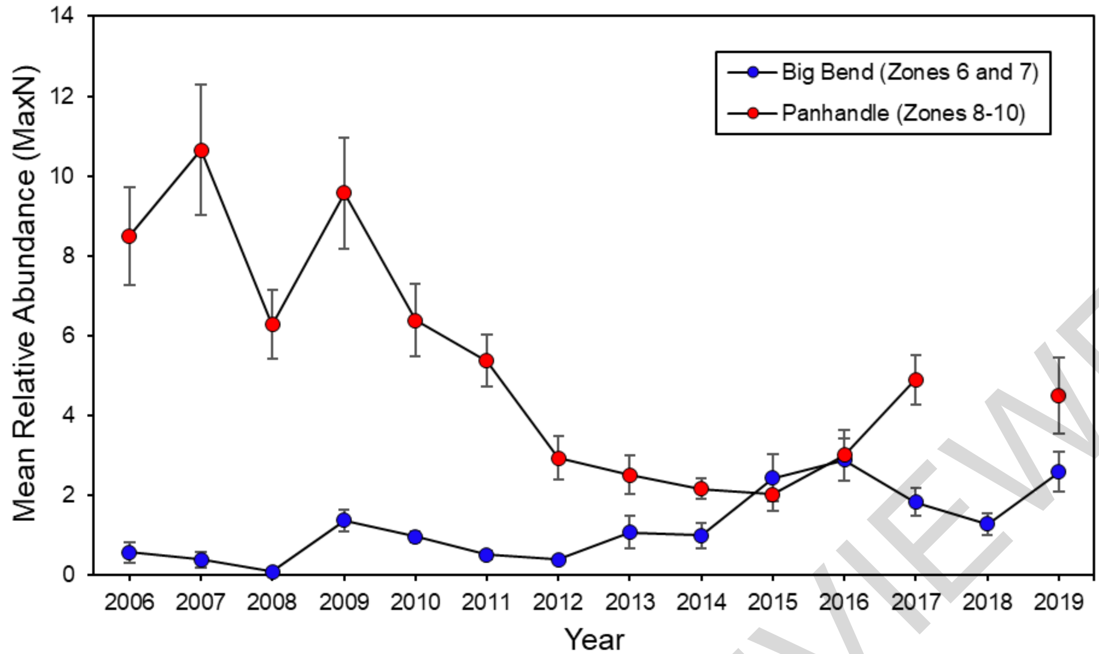


Figure 9. Regional differences in average annual Red Snapper observed per station from the Panama City reef fish survey. From Switzer et al., SEDAR74-SID-03.

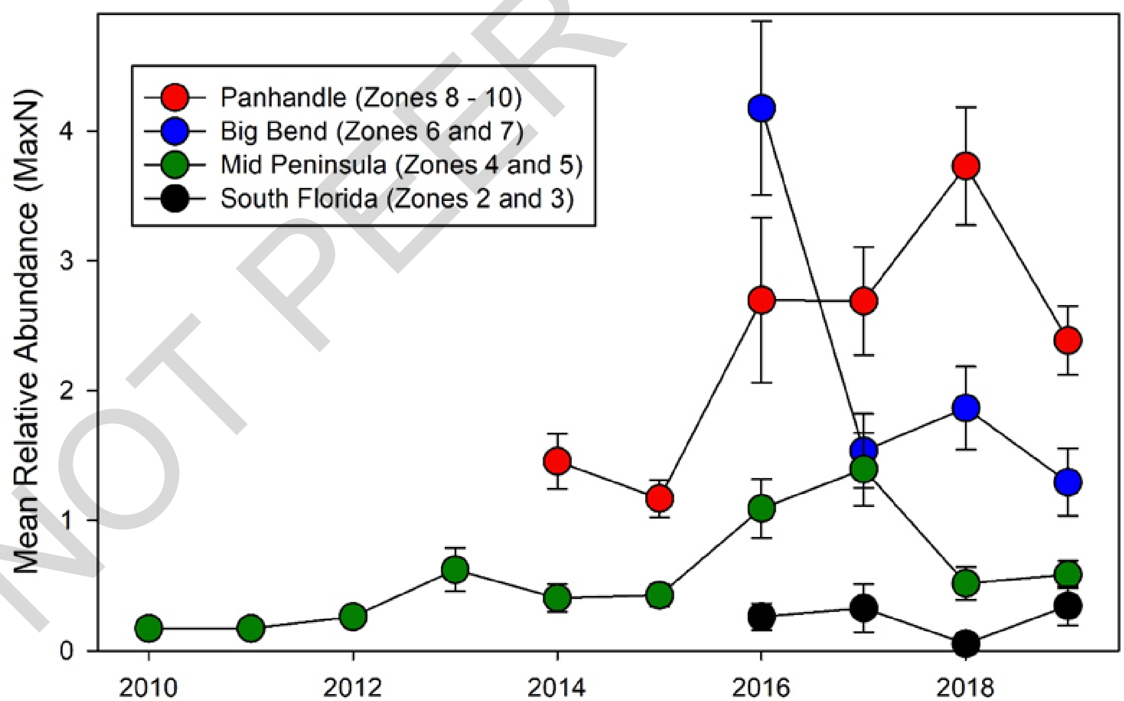


Figure 10. Regional differences in average annual Red Snapper observed per station from the FWRI reef fish survey. From Switzer et al., SEDAR74-SID-03.

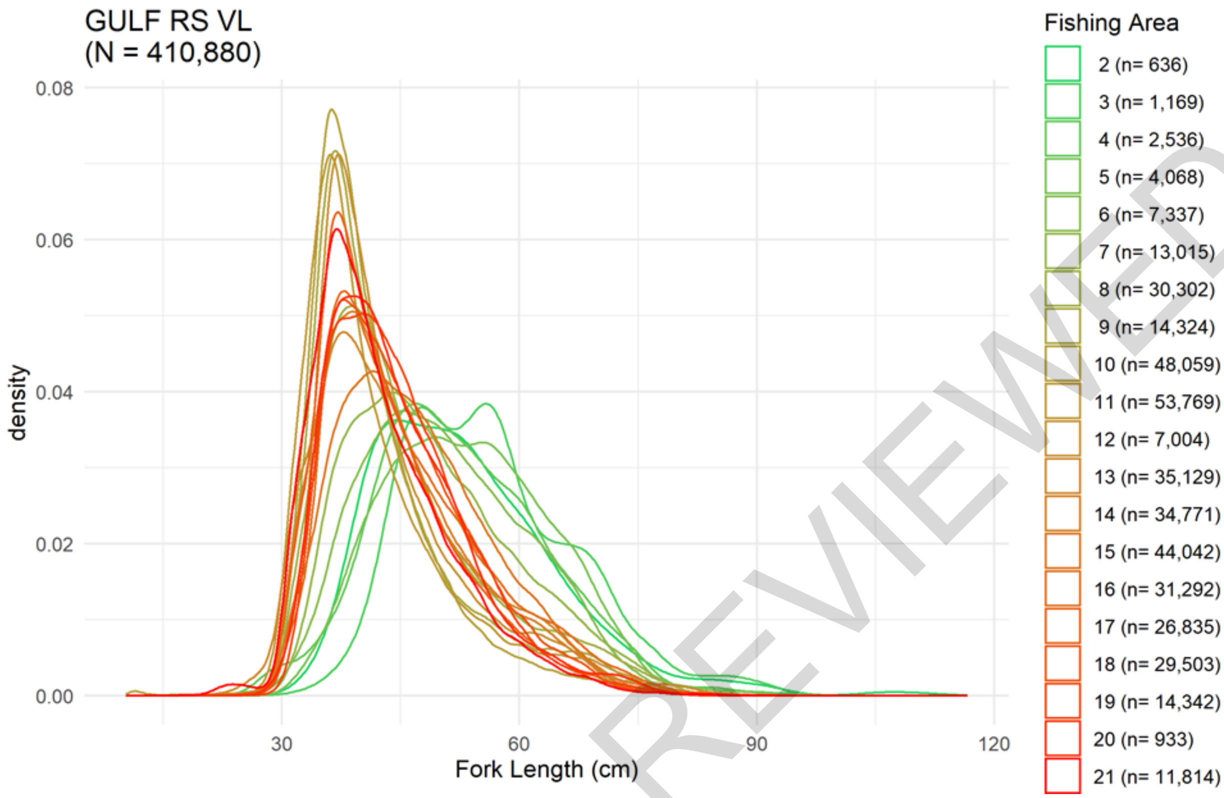


Figure 11: Commercial VL length compositions and sample sizes aggregated across all years (1984-2019) in NMFS statistical grids from the Dry Tortugas (Fishing Area 2) to the Texas/Mexico border (Fishing Area 21) where areas with less than 30 samples were not presented here.

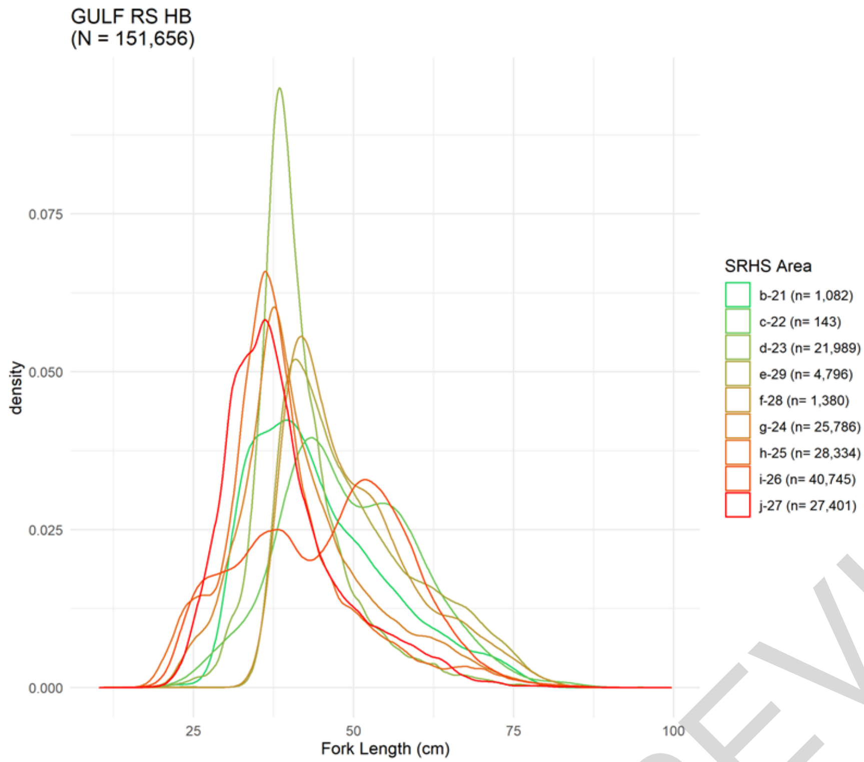


Figure 12: Recreational SRHS HB length compositions and sample sizes aggregated across all years (1986-2019) in HB areas from southwestern Florida (SRHS Area 21) to the Texas/Mexico border (SRHS Area 27) where areas with less than 30 samples were not presented here (top panel).

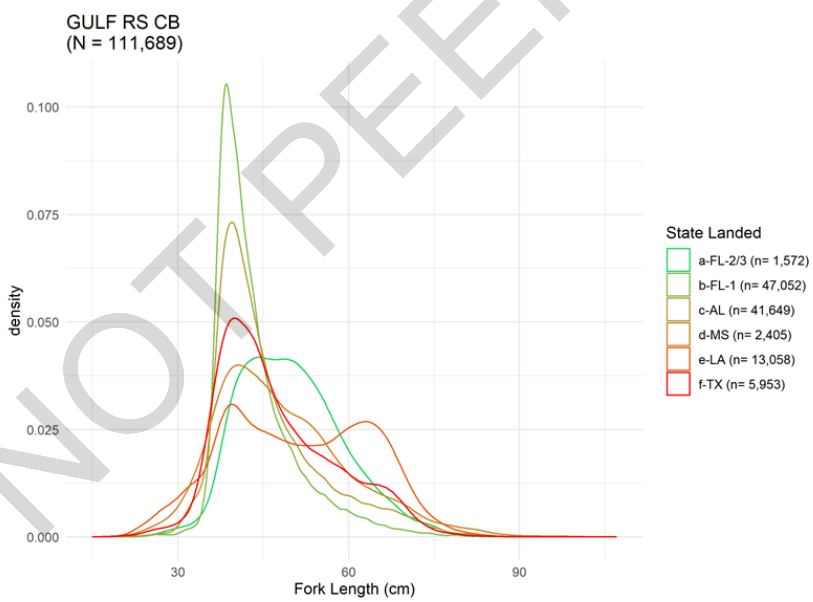


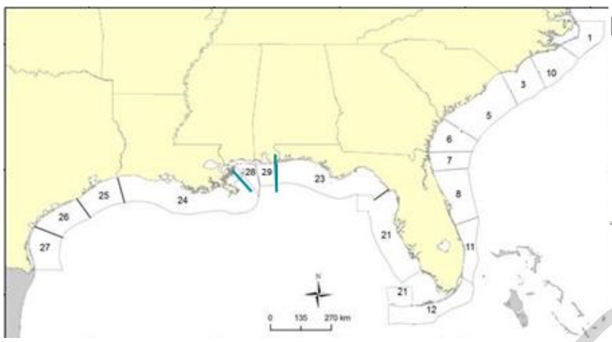
Figure 13. Recreational CB length compositions and sample sizes aggregated across all years (1981-2019) in from southwestern Florida to the Texas/Mexico border.

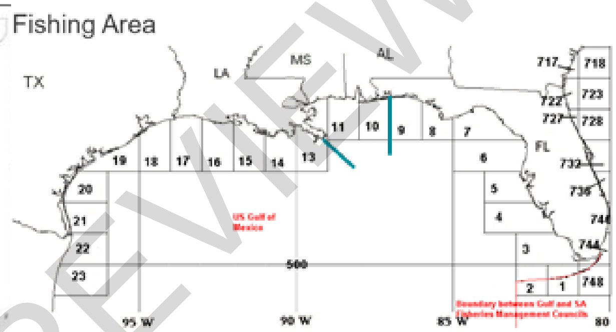
3 APPENDICES

3.1 *Appendix A: SEDAR 74 Red Snapper Stock ID Option A*

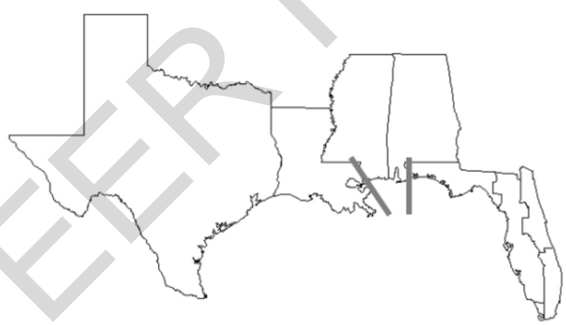
3-area model with boundaries set between stat zones 12/13 and 9/10

Boundary Locations per Data Source:
Commercial - East (1-9), Central (10-12), West (13-23)
MRIP - East (FL), Central (AL, MS), West (TX, LA)
SRHS - East (21, 23), Central (28, 29)-Area 29 can only be split from 2013-2020 (split from 23), West (24-27)





Spatial Domains of General Recreational Estimates in the Gulf of Mexico



Pros:

- Maintains split at the Mississippi outflow, which is supported by larval connectivity research presented by the movement group (Figure A1).
  - Allows assessment model flexibility to parse out recruitment by area.
  - Aligns with topographic impediments to alongshore flow which influence larval transport: the Mississippi river delta and the DeSoto Canyon (Johnson et. al 2009, Figure A2).
- MS and AL are separated from Florida allowing any differences in trends in abundance (inferred from Fishery-Independent Catch Per Unit Effort (CPUE), Figure A3, SEDAR74-SID-03), and fishery dynamics (selectivity and exploitation rates) between the two areas to be modeled independently.
- Creates areas that align with GRSC abundance estimates facilitating the incorporation of this information into the assessment.

- Maintains the 12/13 boundary **possibly** facilitating sensitivity runs comparing the proposed model to the historic 2-area model.
    - 2-areas in the east could potentially be collapsed into one area without placing an undue burden on the data providers.
- Developing a relatively complex (3-area) model would help to evaluate the performance of simpler (2-area) alternatives (e.g,, conditioning an operating model for simulation-evaluation)

Cons:

- Creates a small area (MS and AL) which may create problems for some index, composition and/or discard data
    - Likely not all indices will be able to be constructed for all areas.
    - However, not all indices are needed for each area and options for the MS and AL area exist (e.g., DISL survey).
    - Discard calculations for original eastern region can possibly be partitioned to account for differences in landings while using a similar ratio (10-11, 1-9)
- SRHS data did not separate AL and NWFL until 2013. Estimates prior to 2013 covering AL/NWFL would need to be allocated in their entirety to AL or NWFL, or partitioned between the two states by making assumptions about the relative contribution of each state back in time from the available data after 2013.
- Doesn't go far enough East
    - A number of studies pointed to Cape San Blas as the preferred break point; however, restrictions on how landings data have been recorded precluded this as an option.
    - The next available break point is East of San Blas at the boundary between Dixie and Levy county in Florida (Roughly stat zones 6/7). (See Option C for discussion)

Note: Several panelists (mainly members of the GMFMC SSC) expressed concern that the suite of three options on where to divide the GOM Red Snapper stock could not be explored within the assessment. Because there was no strong evidence from the life-history or genetics group to establish a definitive boundary, it seemed prudent to examine how fit to fisheries independent indices differed with different management boundaries.

- This note was added after the final Stock ID webinar on July 22nd.
- Creating and testing multiple assessment models simultaneously to explore all of the presented stock boundaries is currently beyond the scope of the research track.
- Although the Genetics working group did not find substantial evidence to support a definitive boundary, the research and data explored by other working groups did. For instance, the Age, Growth and Reproduction sub group presented research supporting different growth rates and maximum ages on either side of the Mississippi river outflow. In addition, fisheries data such as multiple fishery- independent reef fish surveys, and recreational data support regional differences in fishing dynamics specifically at Cape San Blas.

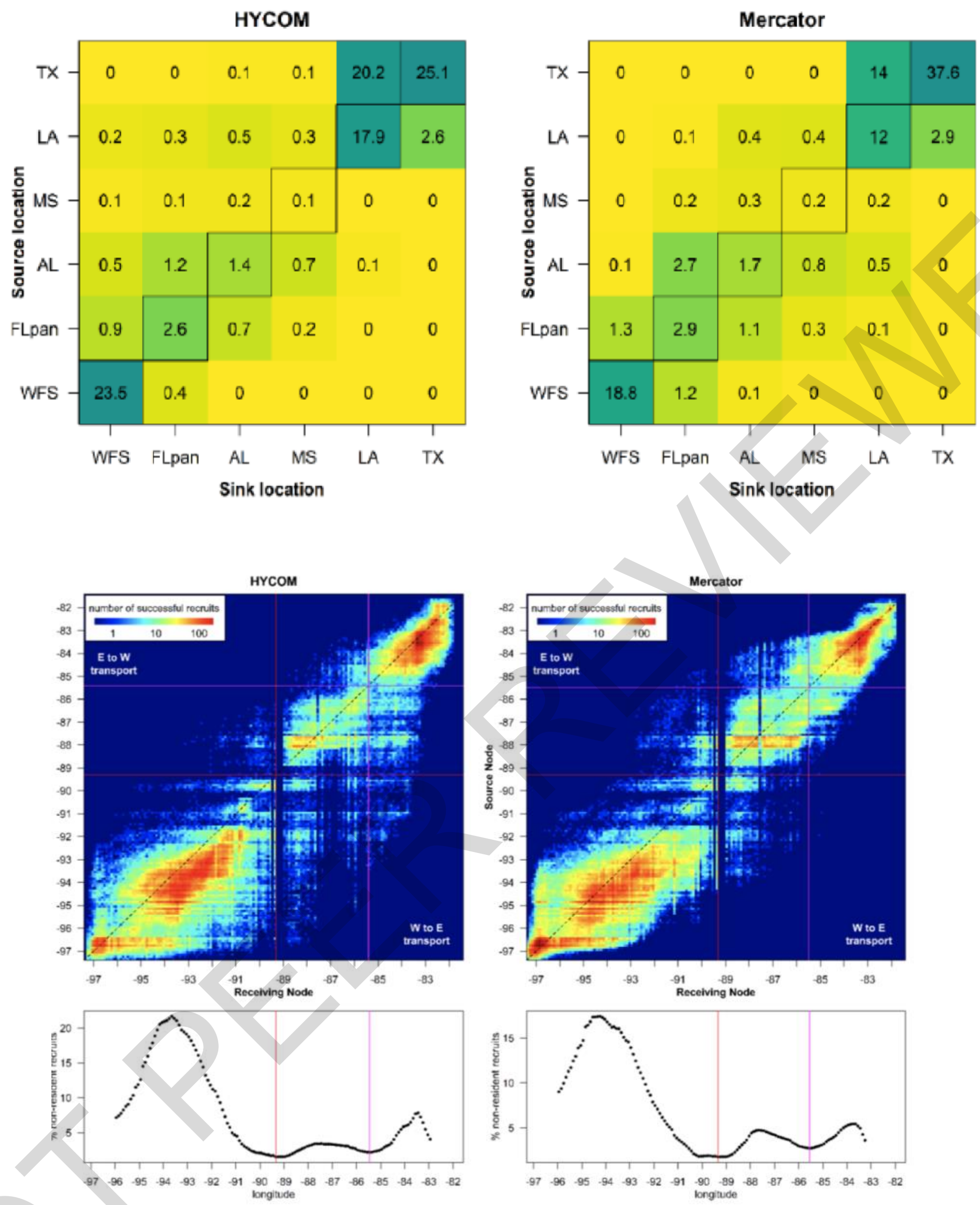


Figure A1. Key plots from Karnauskas & Paris (SEDAR74-SID-02). Select Text

- "Larval abundance is twice as great over the Louisiana–Texas shelf as over the Mississippi–Alabama shelf and four times as great over the Mississippi–Alabama shelf as over the West Florida shelf (Hanisko et al. 2007). The results of our study suggest that only a small fraction of the Louisiana–Texas larvae have a chance of being transported eastward across the Mississippi River delta"
- Primary boundary at ~ 89 degrees (Mississippi River) < 2 % larval transfer rate, 98% of successfully settling larvae were retained in regions in which they were spawned - Karnauskas & Paris (SEDAR74-SID-02)

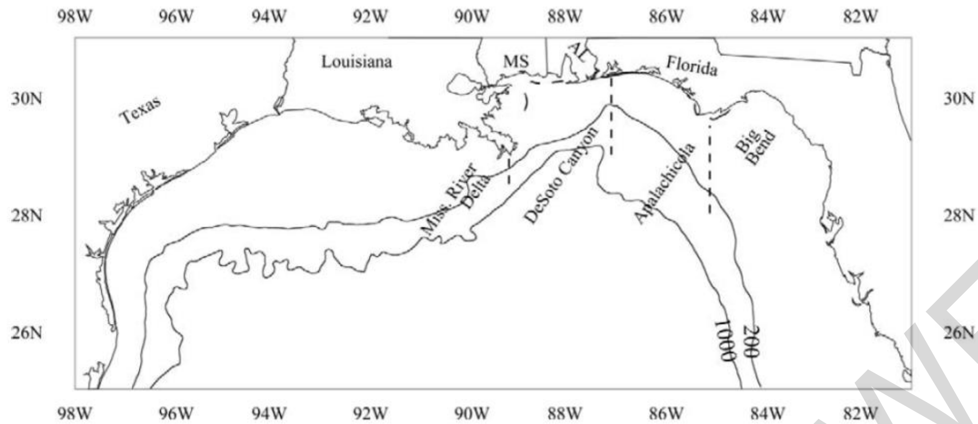


Figure A2. Figure 1 from Johnson et al. 2009, "Area in which the transport of larval red snapper was studies. The dashed lines delineate topographic impediments to alongshore flow."

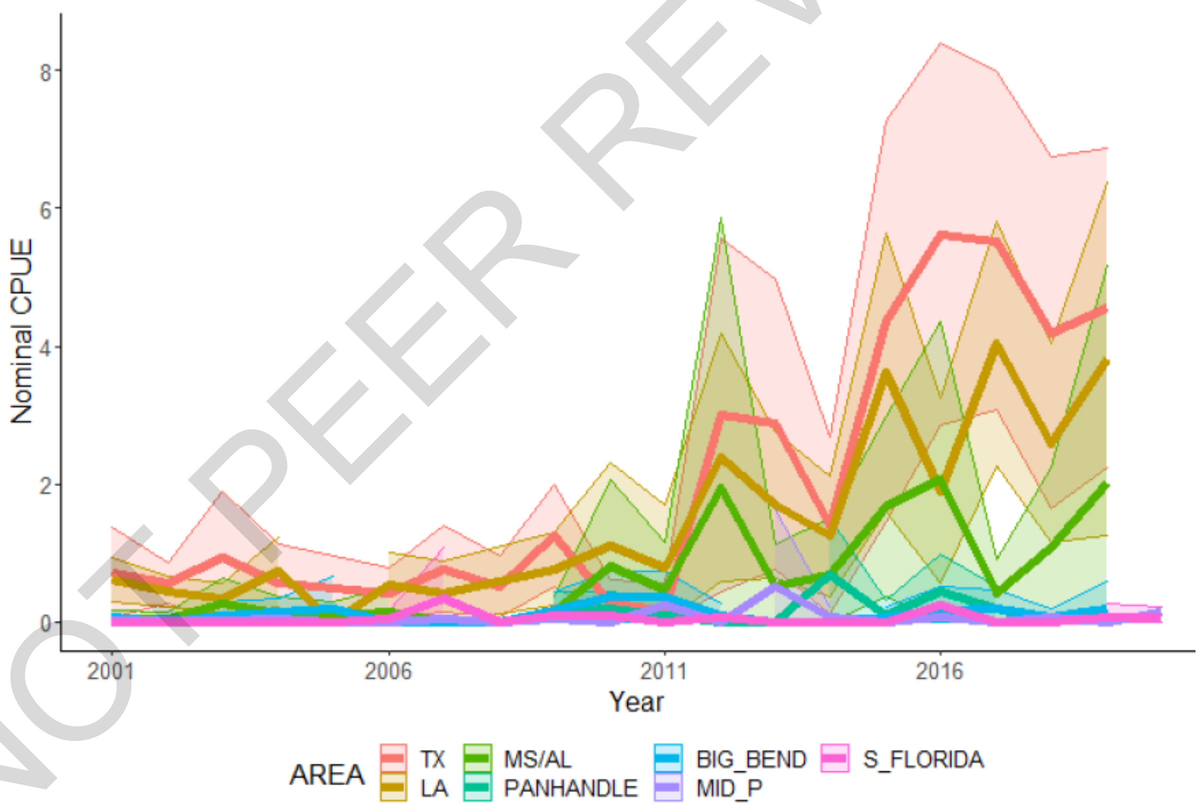
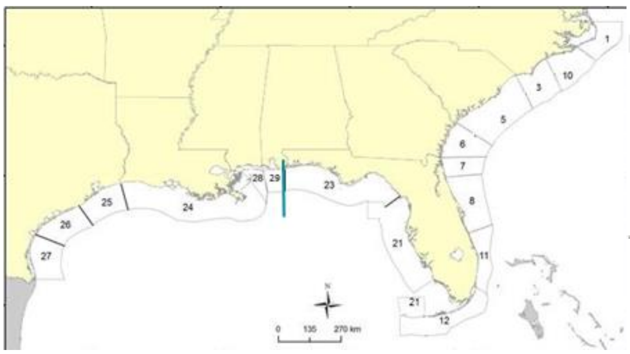


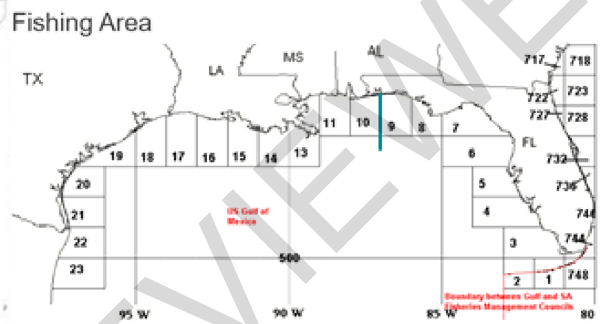
Figure A3. Regional differences in CPUE for red snapper from the NMFS BLL and CSSP BLL surveys for Texas (TX), Louisiana (LA), Mississippi/Alabama (MS/AL), Panhandle, Big Bend, Mid Peninsula (MID_P), and South Florida (S_Florida) (Figure 11 in SEDAR74-SID-03).

3.2 *Appendix B: SEDAR 74 Red Snapper Stock ID Option B*

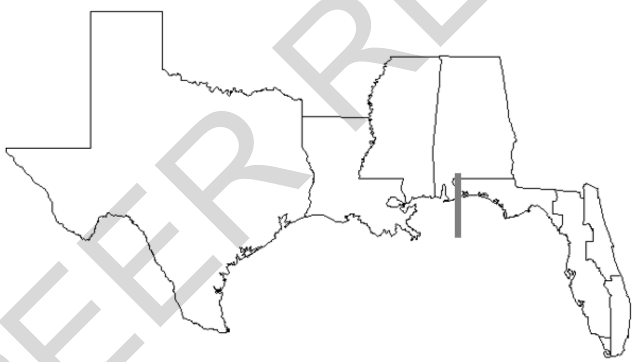
2-area model with boundary set between stat zones 9/10

Boundary Locations per Data Source:
Commercial - East (1-9), West (10-23)
MRIP - East (FL), West (AL, MS, TX, LA)
SRHS - East (21, 23), West (24-29)-Area 29 can only be split from 2013-2020





Spatial Domains of General Recreational Estimates in the Gulf of Mexico



Pros:

- MS and AL are separated from Florida and pooled with TX and LA, which share similar trends in abundance (inferred from Fishery-Independent CPUE, Figure B1, SEDAR74-SID-03)
- Creates areas that align with GRSC abundance estimates facilitating the incorporation of this information into the assessment.
- Boundary aligns with the bio-geographical break and differences in water clarity and sediment types.
- Removes the split at the Mississippi River which is not supported by genetic research.
    - Given little adult movement across the Mississippi River and high site fidelity, larval transport across the Mississippi River boundary may be responsible for the lack of genetic delineation across the river.

Cons:

- Removes split at the Mississippi outflow which is not supported by larval connectivity research (Figure B2) presented by the movement group.
  - Forces the analysts to group recruitment in a way that contradicts the connectivity research. The model would also estimate an exploitation rate for all of the Western GOM, blurring the fishing behavior and population dynamics over a very large area.
  - Having the 12/13 boundary does not conflict with the findings of the CPUE group (BLL or MS reef fish survey), so the reason for its removal is unclear.
- Doesn't go far enough East
  - A number of studies pointed to Cape San Blas as the preferred break point; however, restrictions on how landings data have been recorded precluded this as an option.
  - The next available break point is east of San Blas at the boundary between Dixie and Levy county in Florida (Roughly stat zones 6/7). (See Option C for discussion).
- SRHS data did not separate AL and NWFL until 2013. Estimates prior to 2013 covering AL/NWFL would need to be allocated in their entirety to AL or NWFL, or partitioned between the two states by making assumptions about the relative contribution of each state back in time from the available data after 2013
- Removes the 12/13 boundary making it impossible to conduct sensitivity runs comparing the proposed model to the historic 2-area model.

Note: Several panelists (mainly members of the GMFMC SSC) expressed concern that the suite of three options on where to divide the GOM Red Snapper stock could not be explored within the assessment. Because there was no strong evidence from the life-history or genetics group to establish a definitive boundary, it seemed prudent to examine how fit to fisheries independent indices differed with different management boundaries. When advised by SEDAR and SEFSC staff that only one option could be pursued, several of these same panelists favored option b. However, they were deemed to be in the minority and option c was viewed as the consensus.

- See comments for a similar note for Stock ID Option A

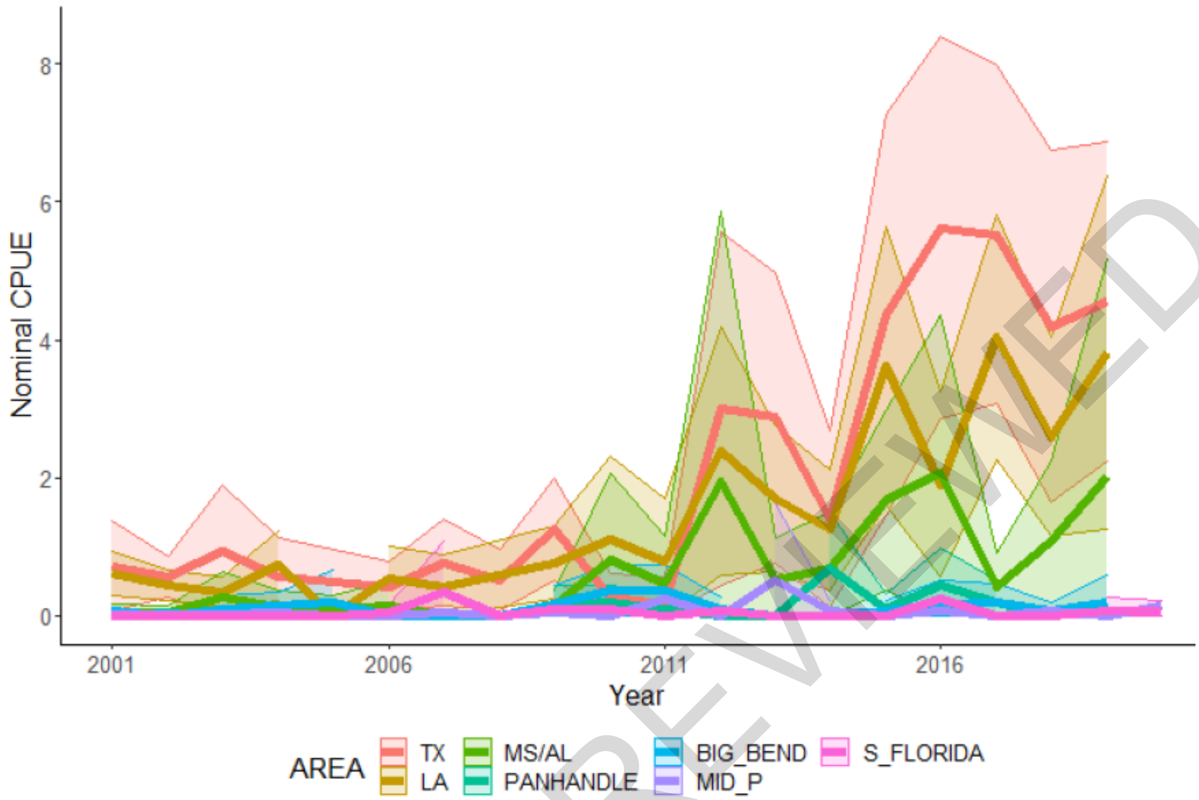


Figure B1. Regional differences in CPUE for red snapper from the NMFS BLL and CSSP BLL surveys for Texas (TX), Louisiana (LA), Mississippi/Alabama (MS/AL), Panhandle, Big Bend, Mid Peninsula (MID_P), and South Florida (S_Florida) (Figure 11 in SEDAR74-SID-03).

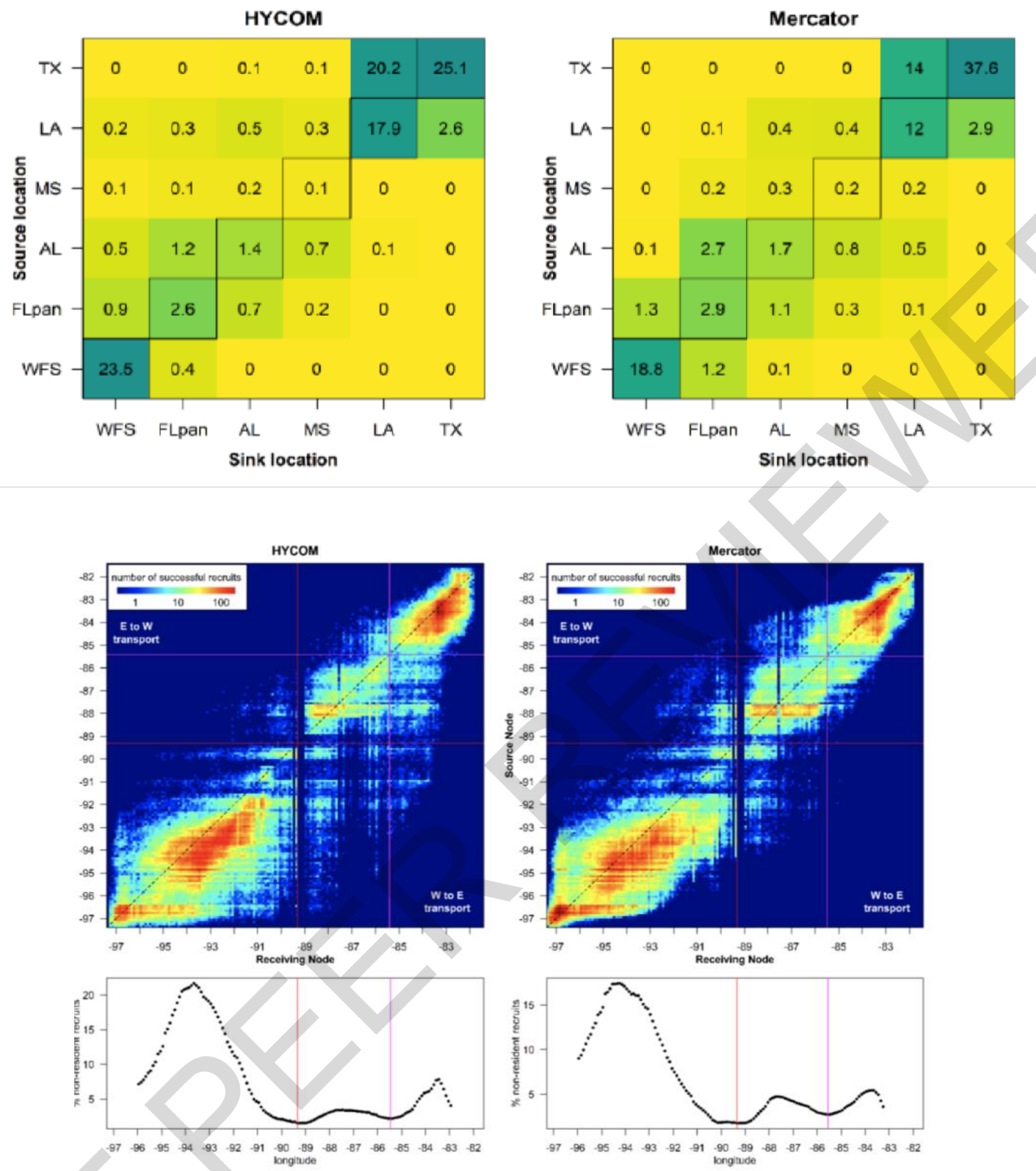


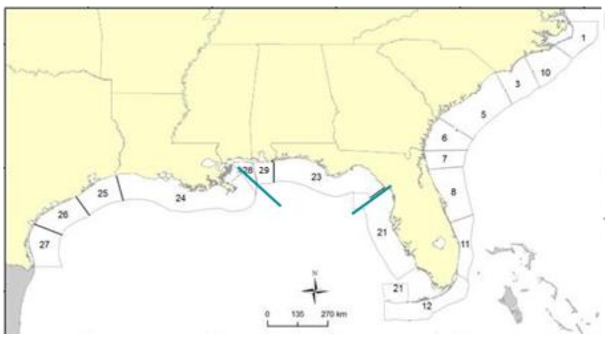
Figure B2. Key plots from Karnauskas & Paris (SEDAR74-SID-02). Select Text

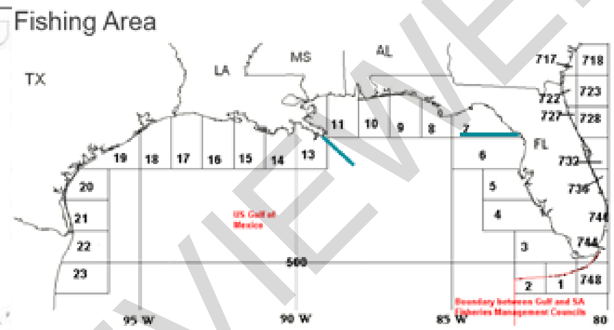
- "Larval abundance is twice as great over the Louisiana–Texas shelf as over the Mississippi–Alabama shelf and four times as great over the Mississippi–Alabama shelf as over the West Florida shelf (Hanisko et al. 2007). The results of our study suggest that only a small fraction of the Louisiana–Texas larvae have a chance of being transported eastward across the Mississippi River delta"
- Primary boundary at ~ 89 degrees (Mississippi River) < 2 % larval transfer rate, 98% of successfully settling larvae were retained in regions in which they were spawned - Karnauskas & Paris (SEDAR74-SID-02)

3.3 *Appendix C: SEDAR 74 Red Snapper Stock ID Option C*

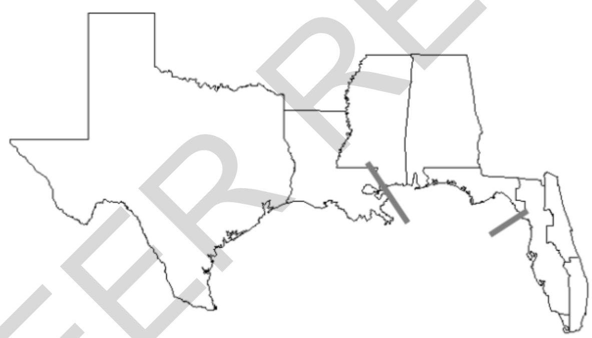
3-area model with boundary set between stat zones 12/13 and 6/7

Boundary Locations per Data Source:
Commercial - East (1-6), Central (7-12) West (13-23)
MRIP - East (FL regions 2&3), Central (FL region 1, AL, MS) West (TX, LA)
SRHS - East (21), Central (23, 28, 29) West (24-27)





Spatial Domains of General Recreational Estimates in the Gulf of Mexico



Pros:

- Maintains split at the Mississippi outflow which is supported by larval connectivity research (Figure C1) presented by the movement group.
    - Allows assessment model flexibility to parse out recruitment
- Creates a Central area (MS, AL, FL panhandle) that appears to have similar fishery dynamics (selectivity and exploitation rates).
    - Caveat: FWRI index shows a difference between the panhandle and the big bend, but the BLL (Figure C2) does not (maybe indexing different sizes/ages of fish).
- Maintains the 12/13 boundary **possibly** facilitating sensitivity runs comparing the proposed model to the historic 2-area model.
    - 2-areas in the east could potentially be collapsed into one area without placing an undue burden on the data providers.
- Developing a relatively complex (3-area) model would help to evaluate the performance of simpler (2-area) alternatives (e.g., conditioning an operating model for simulation-

evaluation)

- Both general recreational (Figure C3) and SRHS data (Figure C4) can be provided at this geographic resolution.

Cons:

- Creates a data poor area in the East area (essentially the west Florida shelf).
  - Video surveys likely provide a route to an index for this area
  - Ability for compositional data to provide annual comps is of paramount concern
- Discard estimation for smaller east GoM regions potentially complicated by reduced sample size
  - If individual landing/discard ratios for the smaller regions cannot be estimated, an East GoM ratio could be used to expand both regions.
- Goes too far east. Majority of studies indicated a natural breakpoint around Cape San Blas. The 6/7 boundary would include data from ~5 Florida counties (Figure C3) that make up the northern half of the "Big Bend" region.
  - Indications are that landings and discards from these counties may be minimal
- Creates areas that do not align with GRSC abundance estimates complicating but not necessarily prohibiting the incorporation of this data
- This option will be extremely difficult to derive management advice from as the current management scheme relies on state specific quotas and the shared area of MS/AL and only part of Florida could be difficult to derive separable quotas.
  - This bullet was added after the final Stock ID webinar on July 22nd where the final discussion and consensus were made. Therefore, this point was unable to be discussed and clarified for the entire panel.
  - State-specific quotas are currently derived from a single gulfwide ABC produced by the assessment model that is split between the states using percentages established in Amendment 50A to the reef fish management plan. This option will not impact the ability to derive management advice for red snapper unless the Council changes the way in which it distributes quota between the states.
- Separating the effort data (FES) to identify effort in two distinct areas of Florida will be difficult and will require several assumptions to be made in generating the MRIP data to estimate landings, discards and CPUE index.
  - The SEFSC uses the template (domain estimation) programs provided by MRIP to calculate estimates for sub-levels of the survey's stratification design (e.g., sub-state). These template scripts are available on MRIP's website (https://www.fisheries.noaa.gov/recreational-fishing-data/recreational-fishing-data-downloads) and use standard design-based estimation that incorporates the MRIP design stratification, clustering, and sample weights. Domain estimation has been used to separate Florida (into five sub-regions) for a number of SEDAR assessments, the process of which has been included in SEFSC automation efforts.

Note: Several panelists (mainly members of the GMFMC SSC) expressed concern that the suite of three options on where to divide the GOM Red Snapper stock could not be explored within the assessment. Because there was no strong evidence from the life-history or genetics group to establish a definitive boundary, it seemed prudent to examine how fit to fisheries independent indices differed with different management boundaries. However, these views were deemed to be in the minority and greater support was found in option c.

- See comments that address a similar note for Stock ID Option A.

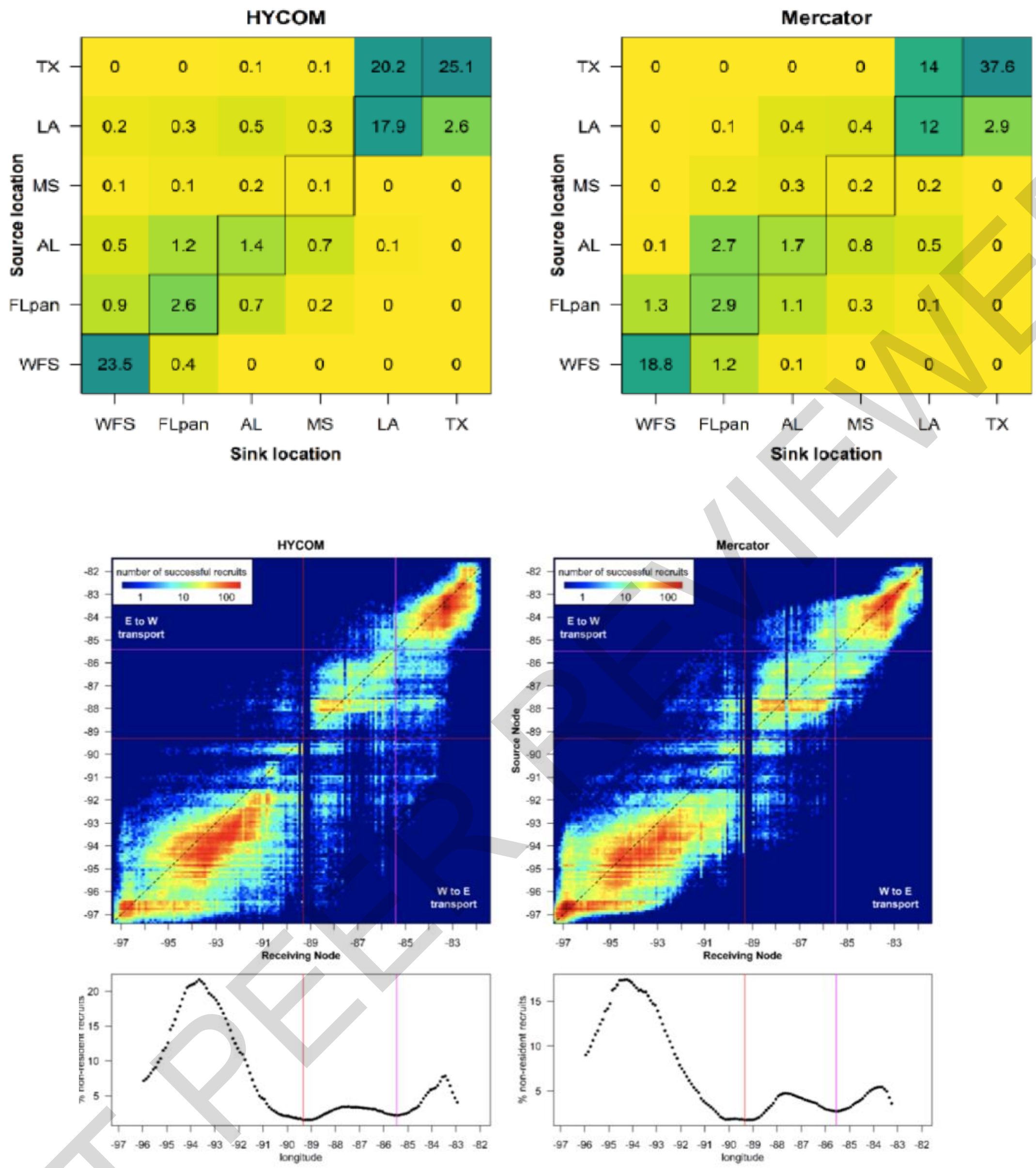


Figure C1. Key plots from Karnauskas & Paris (SEDAR74-SID-02). Select Text

- "Larval abundance is twice as great over the Louisiana–Texas shelf as over the Mississippi–Alabama shelf and four times as great over the Mississippi–Alabama shelf as over the West Florida shelf (Hanisko et al. 2007). The results of our study suggest that only a small fraction of the Louisiana–Texas larvae have a chance of being transported eastward across the Mississippi River delta"
- Primary boundary at ~ 89 degrees (Mississippi River) < 2 % larval transfer rate, 98% of successfully settling larvae were retained in regions in which they were spawned - Karnauskas & Paris (SEDAR74-SID-02)

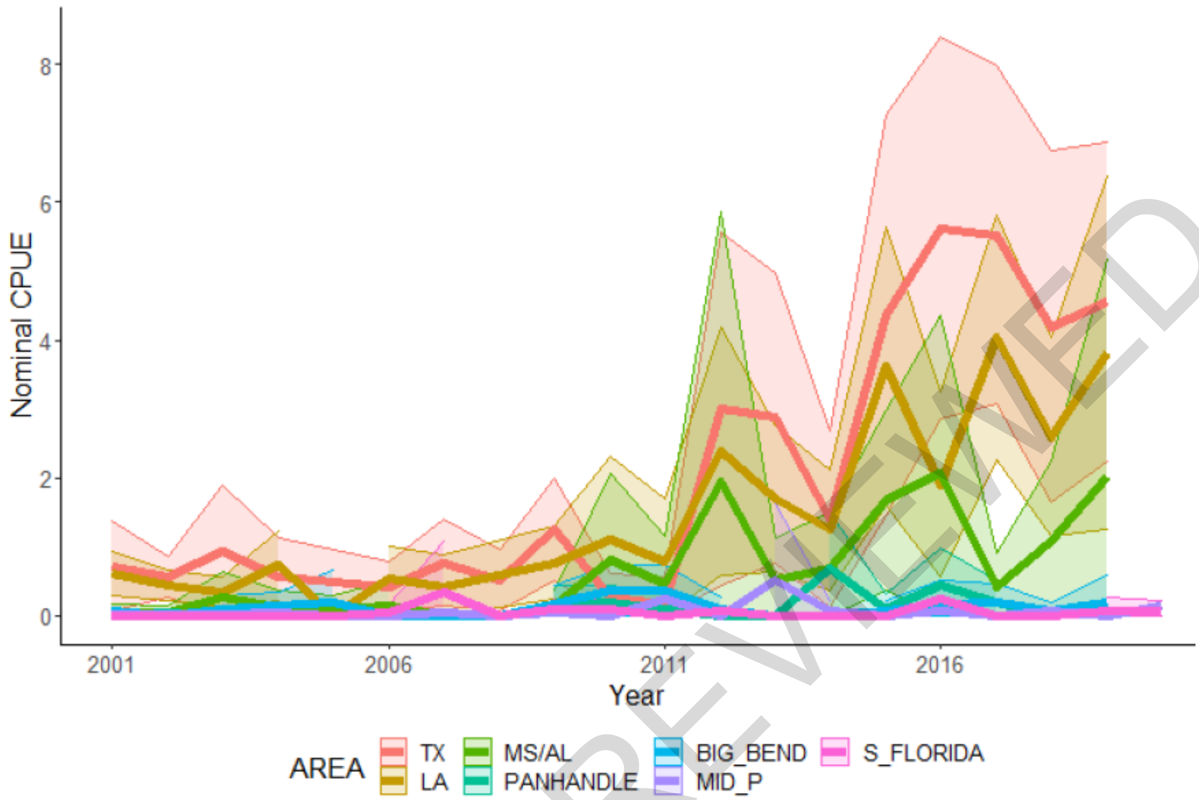


Figure C2. Regional differences in CPUE for red snapper from the NMFS BLL and CSSP BLL surveys for Texas (TX), Louisiana (LA), Mississippi/Alabama (MS/AL), Panhandle, Big Bend, Mid Peninsula (MID_P), and South Florida (S_Florida) (Figure 11 in SEDAR74-SID-03).

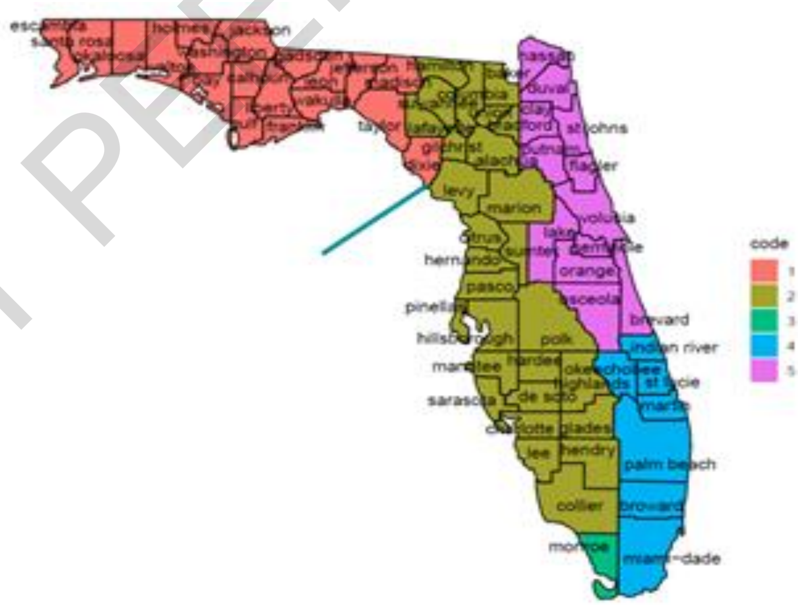


Figure C3. General recreational fishing area color coding, representing the different counties that are within the Big Bend region of the West Florida Shelf.

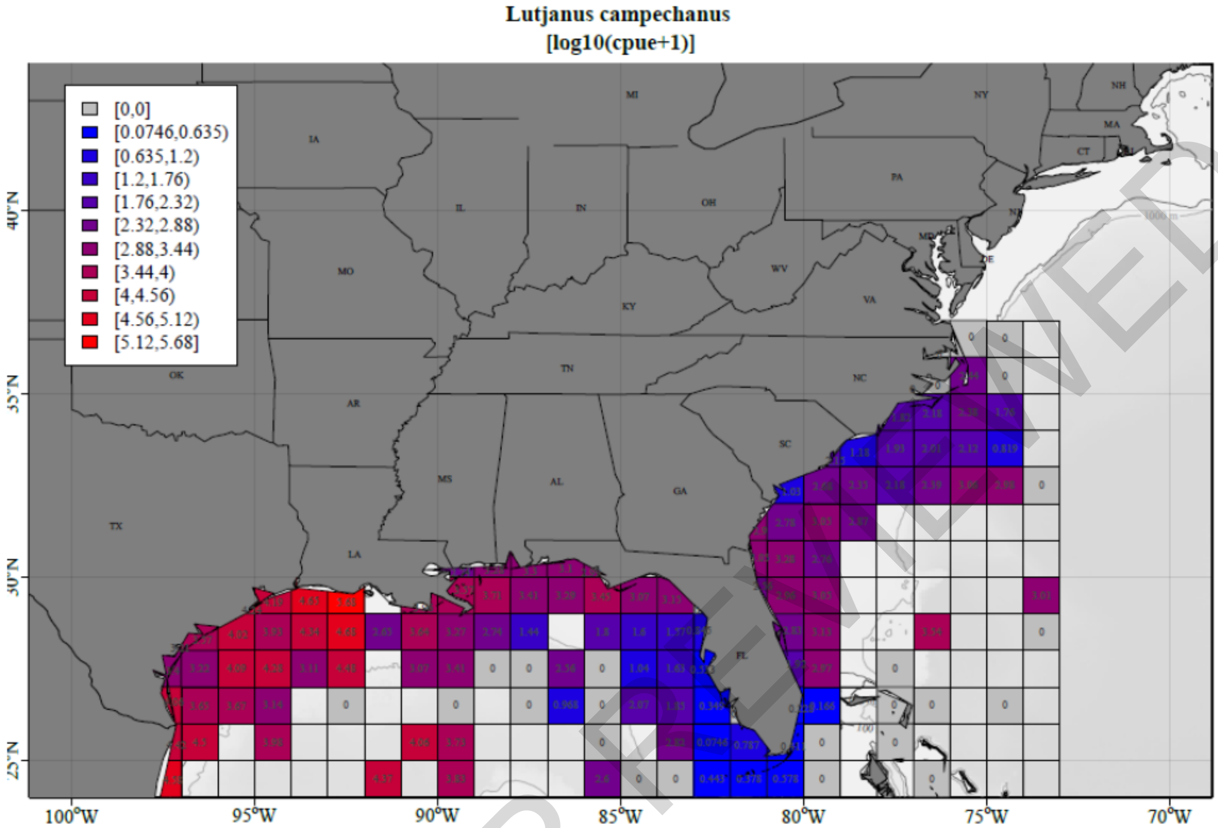


Figure C4. Hotspot analysis of red snapper landings for the Southeast Regional Headboat Survey. Boxes deliniate potential spatial resolution of landings data.