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Modifying the Shrimp Effort Threshold

Shrimp Amendment 18

to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters

Including Environmental Assessment, Fishery Impact Statement, Regulatory Impact Review, and Regulatory Flexibility Act Analysis

October 2018

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ENVIRONMENTAL ASSESSMENT COVER SHEET

Name of Action

Modifying the Shrimp Effort Threshold: Amendment 18 to the Shrimp Fishery Management Plan Including Environmental Assessment, Fishery Impact Statement, Regulatory Impact Review, and Regulatory Flexibility Act Analysis

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Type of Action

( ) Administrative
(X) Draft
( ) Legislative
( ) Final

Summary/Abstract

ABBREVIATIONS USED IN THIS DOCUMENT

ABC	acceptable biological catch
BRD	bycatch reduction device
Council	Gulf of Mexico Fishery Management Council
EA	Environmental Assessment
EEZ	exclusive economic zone
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FIS	Fishery Impact Statement
FMP	Fishery Management Plan
Gulf	Gulf of Mexico
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MMPA	Marine Mammal Protection Act
MSY	maximum sustainable yield
NMFS	National Marine Fisheries Service
OY	optimum yield
SEDAR	Southeast Data, Assessment and Review
SEFSC	Southeast Fisheries Science Center

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FISHERY IMPACT STATEMENT

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requires that a fishery impact statement (FIS) be prepared for all amendments to fishery management plans. The FIS contains: 1) an assessment of the likely biological/conservation, economic, and social effects of the conservation and management measures on fishery participants and their communities; 2) an assessment of any effects on participants in the fisheries conducted in adjacent areas under the authority of another Fishery Management Council; and 3) the safety of human life at sea. Detailed discussion of the expected effects for all alternatives considered is provided in Chapter 4. The FIS provides a summary of these effects and will be completed for the final draft of the document.

CHAPTER 1. INTRODUCTION

1.1 Background

The Gulf of Mexico Fishery Management Council (Council) and the National Marine Fisheries Service (NMFS) began managing the shrimp fishery in the Gulf of Mexico (Gulf) in 1981. Four species are included in the fishery management plan (FMP): brown shrimp, *Penaeus aztecus*; pink shrimp, *Penaeus duorarum*; white shrimp, *Penaeus setiferus*; and royal red shrimp, *Pleoticus robustus*.

Reef Fish Amendment 22 (GMFMC 2004) established a new rebuilding plan for red snapper that was set to end in 2032. The Southeast Data, Assessment and Review (SEDAR) 7 stock assessment for Gulf red snapper indicated the species was overfished and undergoing overfishing (SEDAR 2005). Bycatch of red snapper by the Gulf shrimp fishery was identified as a primary factor affecting the recovery of Gulf red snapper, with the highest red snapper fishing mortality rate attributed to the western Gulf shrimp fishery, followed by the eastern Gulf recreational red snapper fishery and the western Gulf commercial red snapper fishery (SEDAR 2005). It was determined that bycatch levels in both the directed red snapper and shrimp fisheries were likely to jeopardize the success of the red snapper rebuilding plan implemented in 2005 (GMFMC 2007). The assessment indicated a need for a 74% reduction in the red snapper bycatch mortality attributed to shrimp trawls, compared to levels of effort and mortality experienced during the 2001-2003 period (GMFMC 2007). In order to end overfishing of red snapper and rebuild the red snapper stock, the Council took action to reduce shrimp fishing effort in statistical zones 10-21 in 10-30 fathom water depths of the western Gulf (i.e, the area monitored for juvenile red snapper bycatch) through Amendment 14 to the FMP for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters (Amendment 14; GMFMC 2007) [1]. Amendment 14 established a shrimp fishing effort threshold of 74% below a baseline average of the years 2001-2003. The threshold level was reduced to 67% in 2011 as outlined in Amendment 14. Further, Amendment 14 identified that the target reduction goal should decrease (i.e. shrimp effort could increase) to 60% by 2032 (terminal year of red snapper rebuilding plan) via framework action, but the framework procedure to implement this reduction was never established.

To date, the Gulf shrimp fishery has not exceeded the allowable threshold effort level in the area monitored for juvenile red snapper since the implementation of the threshold, though it did come within a percentage point in 2014, 2016, and 2017 (Table 1.1.1). The fishery has been contracting since the establishment of the federal commercial Gulf shrimp moratorium permit in 2006, which was extended until 2026 by Amendment 17A to the FMP (GMFMC 2016). Additionally, the shrimp fishery continues to experience economic losses, primarily due to high fuel costs and reduced prices caused by competition with imports. These economic losses resulted in the exodus of vessels from the fishery, and consequently, a reduction in effort.

[1] Also Reef Fish Amendment 27

Table 1.1.1. Percent effort reductions in the shrimp fishery in the area monitored for juvenile red snapper (statistical zones 10-21 in 10-30 fathom water depths) and the threshold levels established by Amendment 14. The threshold level is the minimum reduction that the shrimp fishery should achieve (i.e. the % effort reduction must be higher).

Year	Threshold level	% Effort reduction of industry from 2001-2003 baseline
2008	74	83.6
2009	74	77.9
2010	74	80.7
2011	74*	67.8
2012	67	81.7
2013	67	73.1
2014	67	67.4
2015	67	71.7
2016	67	68.6
2017	67	67.1

Source: Southeast Fishery Science Center (SEFSC), 2018
*This is the year that amendment 14 scheduled the threshold to reduce to 67%, and rulemaking was implemented in 2011.

In 2018, the red snapper fishery was determined to be no longer overfished nor undergoing overfishing, although the stock is still rebuilding consistent with the plan (SEDAR 2018). Also, recent research indicates that the effect of the shrimp fishery on red snapper mortality is less than previously thought (Gallaway et al., 2017). At its April 2018 meeting, the Council requested that the NMFS Southeast Fishery Science Center (SEFSC) conduct an analysis to determine if effort in the shrimp fishery could increase in the area monitored for juvenile red snapper bycatch without affecting red snapper rebuilding. The SEFSC conducted the analyses using several different scenarios of increasing shrimp effort for shrimp effort Gulf-wide (i.e. not just the area monitored for juvenile red snapper bycatch) (Goethel and Smith 2018; Appendix A). Several of the scenarios indicate that increasing shrimp effort to a level outlined in Amendment 14 (60% below the baseline years of 2001–2003 in statistical zones 10-21 from 10-30 fathoms) is unlikely to affect the rebuilding timeline of red snapper, and it will have negligible effects on yearly red snapper annual catch limit projections. The action in this amendment evaluates decreasing the target bycatch reduction threshold goal, which could allow shrimp fishing effort to increase in statistical zones 10-21 in 10-30 fathoms, the area monitored for juvenile red snapper bycatch.

Gulf of Mexico Fishery Management Council

- Consist of 17 voting members: 11 appointed by the Secretary of Commerce; 1 representative from each of the 5 Gulf states, the Southeast Regional Director of NOAA Fisheries Service; and 4 non-voting members
- Develops fishery management plans and amendments; and recommends actions to NOAA Fisheries Service for implementation

NOAA Fisheries Service

- Approves, disapproves, or partially approves Council recommendations
- Implements regulations

1.2 Purpose and Need

The purpose of this action is to reduce the red snapper bycatch reduction target in the federal Gulf shrimp fishery in response to the latest Gulf red snapper stock assessment.

The need for this action is to promote economic stability in the federal Gulf shrimp fishery by reducing effort constraints and to equitably distribute the benefits from rebuilding, while continuing to protect, the Gulf red snapper stock.

1.3 History of Management

The FMP for the Shrimp Fishery of the Gulf, U.S. Waters, supported by an environmental impact statement (EIS), was implemented on May 15, 1981. The FMP defined the shrimp fishery management unit to include brown shrimp, white shrimp, pink shrimp, royal red shrimp, seabobs (*Xiphopenaeus kroyeri*), and brown rock shrimp (*Sicyonia brevirostris*). Seabobs and rock shrimp were subsequently removed from the FMP. The actions implemented through the FMP and its subsequent amendments have addressed the following objectives:

1. Optimize the yield from shrimp recruited to the fishery.
2. Encourage habitat protection measures to prevent undue loss of shrimp habitat.
3. Coordinate the development of shrimp management measures with the shrimp management programs of the several states, when feasible.
4. Promote consistency with the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA).
5. Minimize the incidental capture of finfish by shrimpers, when appropriate.
6. Minimize conflict between shrimp and stone crab fishermen.
7. Minimize adverse effects of obstructions to shrimp trawling.
8. Provide for a statistical reporting system.

A comprehensive list of management actions and amendments to the FMP is outlined in Amendment 17B to the FMP[2]. Below are a subset of those actions specifically pertaining to the management action in this document.

Amendment 9/supplemental EIS (1997) required the use of a NMFS-certified bycatch reduction device (BRD) in shrimp trawls used in the exclusive economic zone (EEZ) from Cape San Blas, Florida to the Texas/Mexico border, and provided for the certification of BRDs and specifications for the placement and construction. The purpose of this action was to reduce the bycatch mortality of juvenile red snapper by 44% from the average mortality for the years 1984 through 1989 (the required bycatch reduction was reduced to 30% in 2008 through a framework action). This amendment exempted from the BRD requirement shrimp trawls fishing for royal red shrimp seaward of the 100-fathom contour, as well as groundfish and butterfish trawls. It also excluded small try nets and allowed no more than two ridged frame roller trawls of limited size. Amendment 9 also provided mechanisms to change the bycatch reduction criterion and to certify additional BRDs.

Amendment 10/environmental assessment (EA) (2002) required BRDs in shrimp trawls used in the Gulf east of Cape San Blas, Florida. Certified BRDs for this area are required to demonstrate a 30% reduction by weight of finfish.

Amendment 11/EA (2001) required owners and operators of all vessels harvesting shrimp from the EEZ of the Gulf to obtain a federal commercial vessel permit. This amendment also prohibited the use of traps to harvest royal red shrimp from the Gulf and prohibited the transfer of royal red shrimp at sea.

[2] http://gulfcouncil.org/wp-content/uploads/Final-Shrimp-Amendment-17B.pdf

Amendment 13/EA (2005) established an endorsement to the federal shrimp vessel permit for vessels harvesting royal red shrimp; defined the overfishing and overfished thresholds for royal red shrimp; defined maximum sustainable yield (MSY) and optimum yield (OY) for the penaeid shrimp stocks in the Gulf; established bycatch reporting methodologies and improved collection of shrimping effort data in the EEZ; required completion of a Gulf Shrimp Vessel and Gear Characterization Form by vessels with federal shrimp permits; established a moratorium on the issuance of federal commercial shrimp vessel permits; and required reporting and certification of landings during the moratorium.

August 2006 Regulatory Amendment (2006) changed the BRD certification criterion for red snapper from penaeid shrimp trawling in the EEZ. The BRD certification criterion addressed shrimp trawl bycatch more comprehensively and increased flexibility, promoted innovation, and allowed for a wider variety of BRDs which allowed fishermen to choose the most effective BRD for fishing conditions and therefore reduce overall finfish bycatch.

Amendment 14/EIS (2007) was a joint amendment with Amendment 27 to the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico. It established a target red snapper bycatch mortality goal for the shrimp fishery in the western Gulf and defined seasonal closure restrictions that can be used to manage shrimp fishing efforts in relation to the target red snapper bycatch mortality reduction goal. It also established a framework procedure to streamline the management of shrimp fishing effort in the western Gulf.

Shrimp Electronic Logbook (ELB) Framework Action (2013) established a cost-sharing system for the ELB program, and described new equipment and procedures for the program.

Amendment 17A/EA (2016) extended the Gulf shrimp permit moratorium for another 10 years until October 26, 2026.

Amendment 17B/EA (2017) defined the aggregate MSY of 112,531,374 pounds of tails for all shrimp species and an aggregate OY of 85,761,596 pounds of tails for all shrimp species. This amendment allows for the creation of a reserve permit pool when certain conditions are met, and mandates that the Council convene a review panel to review the details of a permit pool if the number of permits reaches 1,175. This amendment also allows vessels possessing shrimp to transit through federal waters without a federal permit if their trawl doors and nets are out of the water and bag straps are removed.

CHAPTER 2. MANAGEMENT ALTERNATIVES

2.1 Action 1 – Adjust the target reduction goal for juvenile red snapper mortality in the federal Gulf of Mexico shrimp fishery in statistical zones 10-21 in the 10-30 fathom depth zone.

Alternative 1: No Action - Do not modify the target reduction goal for juvenile red snapper trawl bycatch mortality in the federal shrimp fishery of the northern and western Gulf of Mexico (Gulf). The current reduction goal for the shrimp fishery is 67% less than the benchmark years of 2001-2003.

Alternative 2: Modify the target reduction goal for juvenile red snapper shrimp trawl bycatch mortality on red snapper from 67% less than the benchmark years of 2001-2003 to:

Option a. 63%
Option b. 60%
Option c. 56%

Alternative 3. Modify the target reduction goal for red snapper shrimp trawl bycatch mortality on red snapper from 67% less than the benchmark years of 2001-2003 to the percentage chosen by increments. Each increment would be an approximately equal percent reduction designed to reach the target reduction by 2032. The incremental changes would begin in the year of the effective date of the implementing rule and then occur:

Option a. Every 2 years
- **Suboption a**: 60%
- **Suboption b**: 56%

Option b. Every 5 years
- **Suboption a**: 60%
- **Suboption b**: 56%

Option a: Change every 2 years									
Target	Total % change	% Change each interval	2020	2022	2024	2026	2028	2030	2032
Suboption a: 60	7	1	66	65	64	63	62	61	60
Suboption b: 56	11	1.6	65.4	63.9	62.3	60.7	59.1	57.6	56
Option b: Change every 5 years									
Target	Total % change	% Change each interval	2020	2025	2030	2032	-	-	-
Suboption a: 60	7	1.75	65.25	63.5	61.75	60	-	-	-
Suboption b: 56	11	2.75	64.25	61.5	58.75	56	-	-	-

Discussion:

The red snapper stock is no longer overfished nor undergoing overfishing, though the stock is still in a rebuilding plan (SEDAR 2018). Also, the red snapper stock acceptable biological catch (ABC) has consistently increased under the rebuilding plan, but the shrimp fishery has not seen similar benefits to the rebuilding of the red snapper stock. In April 2018, the Gulf of Mexico Fishery Management Council (Council) requested that the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) evaluate the impact of increases in shrimp fishing effort in the area monitored for juvenile red snapper bycatch (statistical zones 10-21 in 10-30 fathoms water depth). That analysis, which was based on Southeast Data, Assessment, and Review (SEDAR) 52 and new projections incorporating an increase in shrimp effort (or a reduction in the effort threshold to 60%), found that this increase in shrimp effort is unlikely to impact ABCs for Gulf red snapper (Goethel and Smith 2018; Appendix A). Additionally, the analysis evaluated greater increases in shrimp effort and found that moderate changes in red snapper bycatch levels from increased shrimp effort are unlikely to alter the red snapper rebuilding schedule or ABCs. The analysis concluded that red snapper mortality due to discards in the closed recreational season is much higher than was thought at the times the shrimp effort reduction threshold was put in place and the natural mortality values in previous assessments assumed for age 0 and age 1 fish has changed (Goethel and Smith 2018; Appendix A); the natural mortality of juvenile red snapper is higher. The SEFSC analysis was based on a reduction in the threshold being applied Gulf-wide rather than specifically to the area monitored for juvenile red snapper bycatch. The results projected negligible changes in ABCs for 60% and 56% reductions below the baseline (Table 2.1.1).

Table 2.1.1. ABC projections for red snapper based on SEDAR 52, with different scenarios decreasing the shrimp effort target reduction threshold. Values are in millions of pounds whole weight for each of the scenarios.

Year	ABC					
	SEDAR 52 Base (current 67%)	Reduce to 60%	Reduce to 56%	Reduce to 40%	Reduce to 0%	Assessment based on F in 2001-2003
2019	16.0	16.0	16.0	14.7	13.1	13.3
2020	15.0	15.0	15.0	13.9	12.5	12.7
2021	14.3	14.3	14.2	13.3	12.0	12.2
2022	13.8	13.7	13.7	12.8	11.5	11.7
2023	13.4	13.3	13.3	12.4	11.1	11.2
2024	13.2	13.1	13.0	12.2	10.7	10.9
2025	13.1	13.0	12.9	12.0	10.6	10.7
2026	13.0	13.0	12.8	12.0	10.5	10.7
2027	13.0	12.9	12.8	12.0	10.5	10.6
2028	13.0	12.9	12.8	11.9	10.5	10.6
2029	13.0	12.9	12.8	11.9	10.5	10.6
2030	13.0	12.9	12.8	11.9	10.4	10.6
2031	13.0	12.9	12.8	11.9	10.4	10.6
2032	13.0	12.9	12.8	11.9	10.4	10.6

Source: Goethel and Smith, 2018.

The primary determinants of shrimp fishing effort are environmental conditions, price of shrimp, and price of fuel. It is possible for shrimp fishing effort to increase, but there are several factors to consider. The Gulf federal shrimp fishery has been contracting since the implementation of a permit moratorium in 2006. The fleet is ageing, and the number of moratorium permits has been decreasing because of non-renewal. This, combined with the new information regarding the red snapper stock, suggests that in a year where effort may exceed the implemented threshold, the consequences of exceeding that effort threshold might be unnecessarily punitive. The shrimp effort threshold is not monitored in real time, and results indicating an excess of the target reduction one year would necessitate a closure in the following year. As the red snapper stock is rebuilding, and the ABC has been steadily increasing, it stands to reason that the shrimp fishery should also have restrictions eased for fairness.

Alternative 1 would not reduce the threshold cap in the area monitored for juvenile red snapper mortality. This means that should shrimp fishing effort in this area exceed a 67% percent reduction from the baseline years of 2001-2003, the shrimp fishery would close. In Amendment

14 to the Fishery Management Plan (FMP) for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters (Amendment 14), the Council determined that this shrimp effort reduction should be reduced to 60% by 2032; however, a procedure to implement such a reduction was not put in place. Therefore, the Council would need to develop a new amendment (as is the case in this document) to implement this reduction unless NMFS determines that this reduction can be made automatically in 2032. As the red snapper fishery is no longer overfished nor undergoing overfishing, and the ABC has been steadily increasing each year, perception may be that it is unfair to keep the current restrictions on the federal shrimp fishery.

Alternative 2 would reduce the effort threshold to 63% (**Option a**), 60% (**Option b**), or 56% (**Option c**). Amendment 14 outlined a reduction to 60% by 2032. **Option a** would require a subsequent plan amendment to further reduce the threshold to 60% in the year 2032, unless NMFS determines that this reduction can be made automatically based on what is outlined in Amendment 14. The Council would need to determine if this new reduction replaces the reduction schedule outlined in Amendment 14 if it does not want to have the effort reduction threshold reduced to 60% by 2032. **Option b** would put into place a reduction to 60% once this amendment was implemented. **Option c** would reduce the reduction to 56% below the threshold which is outside the scope of analyses produced in Amendment 14, but was included in the analysis produced by the SEFSC (Goethel and Smith 2018). **Option b** and **Option c** are both under consideration because an increase in shrimp effort consistent with these lower thresholds would not impact the ABC projections in the short term (next 3 years) more than 100,000 pounds (whole weight) and over the long term more than 200,000 pounds (whole weight) (Table 2.1.1).

Alternative 3 outlines a stepped approach to reducing the bycatch reduction effort threshold. **Option a** would make a reduction in the effort threshold every 2 years. **Option b** differs from **Option a** in that the stepped approach would be implemented every 5 years instead of every 2 years. The Council would need to choose which reduction target should be met in the suboptions under each option. **Suboption a**, 60%, is consistent with what was outlined in Amendment 14. **Suboption b** would decrease the effort reduction to 56%. For both **Option a**, and **Option b**, **Suboption a** and **Suboption b** are both under consideration because, in the short term (next 3 years), red snapper ABCs would not vary from the current threshold by more than 100,000 pounds (whole weight), and, in the long term, would not differ from each other by more than 200,000 pounds (whole weight) (Table 2.1.1).

CHAPTER 3. LIST OF AGENCIES AND PERSONS CONSULTED

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Matt Freeman	Economist	Economic analysis, regulatory impact review and reviewer	GMFMC
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- Southeast Fisheries Science Center
- Southeast Regional Office
    - Protected Resources
    - Habitat Conservation
    - Sustainable Fisheries

NOAA General Counsel
U.S. Coast Guard

CHAPTER 4. REFERENCES

Gallaway, B.J., W.J. Gazey, and J.G. Cole. 2017. An updated description of the benefits and consequences of red snapper shrimp trawl bycatch management actions in the Gulf of Mexico. North American Journal of Fisheries Management. 37:414-419.

GMFMC. 2004. Amendment 22 to the fishery management plan for the reef fish fishery of the Gulf of Mexico, U.S. waters, with supplemental environmental impact statement, regulatory impact review, initial regulatory flexibility analysis, and social impact assessment. Gulf of Mexico Fishery Management Council. Tampa, Florida. 291 pp. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Amend%2022%20Final%2070204.pdf

GMFMC. 2007. Amendment 27 to the reef fish fishery management plan and Amendment 14 to the shrimp fishery management plan. Gulf Fishery Management Council, 2203 N. Lois Ave, Tampa, Florida 33607. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Final%20RF%20Amend%2027-%20Shrimp%20Amend%2014.pdf

GMFMC. 2016. Amendment 17A to the fishery management plan for the shrimp fishery of the Gulf of Mexico, U.S. Waters. Gulf of Mexico Fishery Management Council, 2203 N. Lois Ave, Tampa, Florida 33607. http://archive.gulfcouncil.org/docs//amendments/Final%20Shrimp%20Amendment%2017A.pdf

Goethel, D.R. and M.W. Smith. 2018. The impact of a reduction in shrimp effort thresholds on SEDAR 52 Gulf of Mexico red snapper catch limit projections. Southeast Fisheries Science Center. Miami, Florida. 10 pp.

SEDAR 7. 2005. Stock assessment report of SEDAR 7 Gulf of Mexico red snapper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://sedarweb.org/docs/sar/S7SAR_FINAL-redsnapper.pdf

SEDAR 52. 2018. Stock assessment report for Gulf of Mexico red snapper. Southeast Data, Assessment, and Review. North Charleston, SC. 434 pp. https://sedarweb.org/docs/sar/S52_Final_SAR_v2.pdf

APPENDIX A. THE IMPACT OF A REDUCTION IN SHRIMP EFFORT THRESHOLDS ON SEDAR 52 GULF OF MEXICO RED SNAPPER CATCH LIMIT PROJECTIONS

Southeast Fisheries Science Center
July 11, 2018

Daniel R. Goethel and Matthew W. Smith

Executive summary

The Gulf of Mexico Fishery Management Council requested an evaluation of the impact of potential increases in shrimp effort (or shrimp days) on the red snapper resource. Results from new projections of the SEDAR 52 assessment indicate that increasing gulfwide shrimp effort by 8% (i.e., reducing the shrimp effort threshold to 60% of 2001 – 2003 average levels) would be unlikely to substantially impact ABCs for Gulf of Mexico red snapper. Further increases in effort were also evaluated to determine at what threshold value a substantial impact would occur. Overall, moderate increases in shrimp effort are unlikely to alter rebuilding schedules or ABCs, while allowing effort to return to 2001 – 2003 levels would cause substantial declines in ABCs.

1. Introduction

In a memo dated April 16, 2018, the Gulf of Mexico Fishery Management Council (GMFMC) requested the Southeast Fishery Science Center (SEFSC) to perform a series of alternate projections to demonstrate the impact of an increase in shrimp effort (analogous to shrimp days) on acceptable biological catches (ABCs) for the Gulf of Mexico red snapper fishery. Due to bycatch of juvenile red snapper in the shrimp fishery, Amendment 14 to the Shrimp Fishery Management Plan required a reduction of shrimp effort in areas where red snapper bycatch was high (i.e., 10-30 fathom depth zones in statistical areas 10-21 in the Gulf of Mexico). Effort reductions of 74% from the 2001-2003 average were initially required and updated in 2011 to 67% with a long-term target of 60% by 2032 (i.e., the target rebuilding date for red snapper). Although red snapper is still in a rebuilding plan (due to its being below the SSB_{MSY} proxy of SPR 26%), it is no longer considered overfished, because it is above the minimum stock size threshold (MSST) of 0.5 * $SSB_{SPR26\%}$ (SSB_{2016} / MSST = 1.41). Therefore, the GMFMC is interested in lowering the target shrimp effort reduction thresholds in the Gulf of Mexico. Based on the request to investigate the impact of increasing shrimp effort on Gulf of Mexico red snapper rebuilding schedules and ABCs, the SEFSC performed a series of alternate ABC projections where shrimp bycatch levels were increased by various proportions compared to the 2001 – 2003 baseline levels.

2. Methods

Deterministic projections were run using the final SEDAR 52 Stock Synthesis 3 (SS3; Methot 2015; Methot and Wetzel 2013) base model accepted by the Gulf of Mexico SSC (SEDAR 2018a). Projection settings followed the methods outlines in the SEDAR 52 projections document as described in the OFL and ABC section therein (SEDAR 2018b). Projections began in 2017 using the same parameter values and population dynamics as the base model. A full

description of the model settings can be found in **Table 1**. Because the base model assumes a fixed steepness of essentially 1.0, the projections assumed that forecasted recruitment would continue at recent average levels (i.e., projected recruitment was near the 'virgin' recruitment level for the recent productivity regime, 1984 – 2016, of 163 million fish) and historical average recruitment apportionment levels were assumed (i.e., 34% to the east and 66% to the west). For all years of the projections it was assumed that recent fishery dynamics would continue indefinitely including maintaining a 51% to 49% allocation of commercial to recreational catch. The selectivity for each fleet was taken from the terminal timeblock and relative harvest rates for the directed fisheries were assumed to stay in proportion to the terminal three year average (2013 – 2016) values. Similarly, discarding and retention practices were assumed to continue as they had in the three most recent years (2013 - 2016). The projected fishing mortality levels for the six bycatch fleets (shrimp bycatch, recreational closed season, and commercial closed season/no-IFQ) were assumed to be the same as in 2016 (i.e., fixed at their associated 2016 values; see **Figure 1** for terminal year relative fishing mortality rates by fleet) in the Base projections, but the fishing mortality for the shrimp bycatch fleets were varied depending on the scenario (as outlined below and in **Table 2**).

For SPR-based analyses, the harvest rate (total number killed / total abundance) that led to a gulfwide SPR of 26% (i.e., SPR = $(SSB/R)/(SSB_0/R_0)$= 0.26 which is equivalent to SSB/SSB_0 when steepness = 1.0 and recruitment is constant) was obtained by iteratively adjusting yield streams. Basically, the fishing mortality rates exerted by the directed fleets were scaled up or down by the same proportional amount (with the fishing mortality rates exerted by the bycatch and discard fleets held constant) until the fishing mortality that achieved a SPR of 26% was obtained.

Overfishing limits (OFLs) were calculated as the median (50^{th} percentile) of the probability density function (PDF) of retained yield (millions of pounds) using the projection of $F_{SPR26\%}$ (i.e., the yields that achieved a SPR of 26% in equilibrium). ABCs were obtained through rebuilding projections based on a $F_{Rebuild}$ that achieved a SPR of 26% by 2032, where the ABC was calculated assuming a probability of overfishing (P*) of 0.40 (i.e., the 40^{th} percentile of the PDF of the landings in retained yield from $F_{Rebuild}$). All projections included 2017 provisional landings (15.36 million pounds) and a fully utilized 2018 ACL (13.74 million pounds). Uncertainty in derived quantities (including retained yield) was carried through the projections from the parameter estimation phase in the stock assessment model and represented the approximate variance from the inversion of the Hessian matrix. The probability density function (PDF) and 95% confidence intervals are calculated assuming a normal distribution of the derived quantity.

A total of five sensitivity runs were carried out. Each examined different increases in the level of shrimp bycatch fishing mortality (as a proxy for an increase in effort). Runs were compared to the base model runs used for setting ABCs and OFLs through projected yield streams and associated SPR values from 2019 (the first year of catch advice set using the SEDAR 52 projections) to 2032 (the rebuilding date for Gulf of Mexico red snapper).

Although the initial GMFMC request asked for 1% decrements from the current 67% reduction in shrimp effort to 60%, initial explorations indicated that the maximum decrement in shrimp effort threshold requested (i.e., 60%) resulted in mostly negligible reductions in ABCs.

Therefore, it was determined that a more informative analysis would be to perform a handful of sensitivity runs with more extreme increases in shrimp effort ranging from the maximum reduction threshold requested (i.e., a 60% reduction from the 2001 – 2003 average effort) to a 0% reduction (including intermediate values representing 56% and 40% reductions from the 2001 – 2003 average).

A number of assumptions needed to be made to translate percent increases in shrimp effort to percent increases in associated shrimp bycatch fishing mortality (i.e., the fixed fishing mortality values used in the projections). The major assumption was that fishing mortality was directly proportional to fishing effort and that a percent increase in effort (or shrimp days) represented a matching percent increase in fishing mortality rates. Secondly, it was assumed that a percent increase in total effort corresponded to an equal increase in effort in both regions. Because the assessment model includes two regions, east and west Gulf of Mexico, each with its own shrimp bycatch fleet, it was necessary to scale the fishing mortality in each region. Unfortunately, the shrimp effort increases outlined in Amendment 14 were associated with statistical areas 10-21, which intersected the statistical areas assumed for the eastern and western Gulf of Mexico in the SEDAR 52 assessment model (i.e., east corresponded to areas 1-12 and west corresponded to areas 13-21). Therefore, without further guidance as to the relative increases in effort by area, it was necessary to assume an equal proportional increase in each area. Additionally, because of the mismatch in statistical areas for officially calculating the relative decrease in effort from the 2001 – 2003 levels compared to the effort values used in the SEDAR 52 assessment, the relative reductions varied slightly between methods. Based on statistical zones 10 – 21 (i.e., those used in Amendment 14), there has been a 69% reduction in effort. However, using areas 1-21 (i.e., the total effort used in the SEDAR 52 assessment), there has only been a 63% reduction in effort compared to the 2001 -2003 average levels.

It is important to understand that the relationship between the percent change in the threshold effort level and the change in effort needed to achieve that threshold is not linear, because the distribution of effort between regions varies among the two time periods (i.e., the eastern gulf represents 15% of the shrimp effort in 2016, whereas it represented 24% during the 2001 – 2003 baseline period). Thus, because effort changes are assumed proportional among regions, the relationship between the percent change from baseline levels (i.e., the threshold value) and the percent change in effort required to achieve those threshold values is not directly proportional (i.e., to move from a 63% threshold to a 60% threshold requires an 8% increase in gulfwide effort).

Runs were carried out representing a 60% reduction compared to the SEDAR 52 total effort levels from 2001 – 2003 (i.e., matching the maximum threshold reduction and maximum percentage increase in effort of 8% requested by the GMFMC; *Reduce_60*), a 56% reduction from the SEDAR 52 total effort levels from 2001 -2003 (*Reduce_56*), a 40% reduction from the SEDAR 52 total effort levels from 2001 -2003 (*Reduce_40*), and a 0% reduction (i.e., effort equivalent to that in 2001 – 2003, *Reduce_0*; see **Table 2** for a list of scenarios and associated fishing mortality values). Given the assumptions required to translate effort (shrimp day) increases into associated fishing mortality increases (i.e., that they are proportional), a 0% reduction does not result in fishing mortality values for the shrimp bycatch fleets that match the 2001 -2003 average estimated shrimp bycatch fishing mortalities from the SEDAR 52

assessment. An additional scenario (*Asses_F_2001_2003*) was thus carried out that utilized the estimated average shrimp bycatch fishing mortality rates for 2001 to 2003 from the SEDAR 52 assessment as an alternate approach to projecting the dynamics of the shrimp fleets during the baseline period (i.e., 2001 – 2003).

3. Results

Increasing shrimp bycatch effort within the limits proposed in the GMFMC memo (i.e., reducing the threshold to 60% or increasing effort by 8%) has relatively minimal impacts on ABCs. The *Reduce_60* and *Reduce_56* scenarios decreased catches by approximately 100,000 and 200,000 pounds per year, respectively, over the course of the red snapper rebuilding period (**Table 3**) and had almost no impact on the resulting SPR values (**Table 4**). Intermediate increases in shrimp effort (e.g., the *Reduce_40* scenario) had a stronger influence and resulted in a loss of about a million pounds per year in the ABC over the rebuilding period. Both the *Reduce_0* and the *Asses_F_2001_2003* scenarios demonstrated similar results with losses in ABC of about 2.5 million pounds per year, but with a maximum of 3 million pounds in 2019 (the first year of catch advice).

4. Discussion

Results indicate that increasing shrimp effort (or shrimp days) by the amounts proposed in the GMFMC memo would be unlikely to substantially impact ABCs for Gulf of Mexico red snapper. Allowing shrimp effort to increase back to the baseline levels from 2001 – 2003 would cause strong declines in ABC levels. Overall, moderate changes in shrimp bycatch levels are unlikely to alter rebuilding schedules or ABCs.

As described in the methods, bycatch and discard fleets are treated in a similar manner as natural mortality in the projections. This implies that retained yield by the directed fleets is maximized following the removals due to the bycatch/discard fleets. Given the way that bycatch and discard fleets are handled, resultant ABCs will typically increase when bycatch/discards decrease and vice versa. The reason for this is that total dead removals which achieve a desired SPR rebuilding target are relatively invariant, and the model can trade removals between bycatch/discard or directed fleets. In the current projections, as bycatch increased the resulting retained yield (ABCs) had to decrease to maintain the same level of dead removals in order to achieve the rebuilding target.

Although shrimp bycatch still represents one of the larger sources of mortality for red snapper (particularly in the western region), mortality due to discards from the recreational fleets during closed seasons (especially in the eastern region) is now much higher (**Figure 1**). The increase in recreational closed season discards over the last decade has acted to diminish the impact of shrimp bycatch levels on ABCs and rebuilding schedules. Additionally, compared to previous assessments and associated projections (e.g., prior to SEDAR 31), the relatively high natural mortality values assumed for age-0 and 1 fish (i.e., those ages primarily caught as bycatch in shrimp trawls) likely acts to additionally reduce the impact of shrimp bycatch on rebuilding schedules. Because a higher proportion of these juvenile fish are assumed to die from natural

causes, shrimp bycatch has a lesser impact on the resource, and moderate increases in shrimping effort is unlikely to greatly impact ABCs.

There are a number of important caveats for these projections. First, these calculations do not account for the highly variable nature of recruitment events nor the fundamental relation between adult spawners and subsequent recruits. Projections are completely deterministic and based on the assumption that future recruitment will remain constant at recent averages (i.e., steepness is approximately 1.0). The constant recruitment assumption is appropriate for short-term projections where SSB is not likely to decrease rapidly, but can lead to inappropriate long-term or equilibrium projections. Additionally, the multiple assumptions required to translate increases in shrimp effort into associated increases in shrimp bycatch fishing mortality (i.e., that they are directly proportional) along with the slight differences in how effort is tallied between the assessment model and Amendment 14 imply that these results should only be used for informational purposes. The resultant ABCs should not be used for setting management advice without more detailed analyses.

5. Acknowledgements

The SEDAR 52 assessment would not have been possible without the efforts of the numerous SEFSC, SERO, and GMFMC staff along with the many academic and research partners involved throughout the Gulf of Mexico. In particular, those who helped compile the documents and input data sets including: Julie Neer (SEDAR Coordinator); Ryan Rindone (Management History); Refik Orhun and Beth Wrege (Commercial Catch); Vivian Matter and Kelly Fitzpatrick (Recreational Catch and Discards); Kevin McCarthy (Commercial discards); Adyan Rios and Skyler Sagarese (Recreational CPUE); Robert Allman, Gary Fitzhugh, and Linda Lombardi-Carlson (Life History); Adam Pollack, Walter Ingram, Kevin Thompson, Matt Campbell, David Hanisko, Sean Powers, John Walter, and Mandy Karnauskas (Fishery Independent Indices); Rick Hart and Jeff Isely (Shrimp bycatch); Ching-Ping Chih (Size and Age composition); Matthew Campbell and Beverly Sauls (Discard mortality); Dominique Lazarre (Headboat Discard Length Frequency); and Elizabeth Scott-Denton (Shrimp Bycatch Length Frequency).

6. References

Methot, R. 2015. User Manual for Stock Synthesis: Model Version 3.30. NOAA Fisheries. Seattle, WA.

Methot, R., and Wetzel, C. 2013. Stock Synthesis: a biological and statistical framework for fish stock assessment and fishery management. Fisheries Research, 142: 86-99.

SEDAR. 2018a. SEDAR 52 Stock Assessment Report: Gulf of Mexico Red Snapper. SEDAR, North Charleston, SC. 434p. Available online at: http://sedarweb.org/docs/sar/S52_Final_SAR_v2.pdf.

SEDAR. 2018b. SEDAR 52 Stock Assessment Report: Gulf of Mexico Red Snapper. SEDAR, North Charleston, SC. 434p. Available online at: http://sedarweb.org/docs/sar/S52_Final_SAR_v2.pdf.

7. Tables

Table 1. Summary of projection settings and equations. Citations to Tables and Figures refer to those in the SEDAR 52 stock assessment report (SEDAR 2018a,b).

Derived quantity	Equation	Parameter values
Recruitment (R)	$R_{Reg,Year} = P_{Area}\frac{4hR_0SSB_{Year}}{SSB_0(1-h)+SSB_{Year}(5h-1)}$	P_{East} = 0.23, P_{West} = 0.77, h = 0.99, R_0 = 163 million fish
Growth Curve	$L(t) = L_\infty\left[1-e^{-k(t-t_0)}\right]$	L_∞ = 85.64cm, k = 0.19yr^{-1}, t_0 = -0.39, See **Figure 2.4**
Weight-Length Relationship	$Weight = aL^b$	a = 1.7E-5, b = 3, See **Figure 2.5**
Fecundity-at-Age (Fec)	Input	See **Table 2.3**
Selectivity (S)	Input	See **Figure 4.9**
Retention (Ret)	Input	See **Figure 4.13**
Discard Mortality (DM)	Input	See **Table 2.2**
Natural Mortality (M)	Input	See **Table 2.1**
Directed Fishing Mortality (F_{Dir}) by Fleet	$F^{Fleet}_{Dir,Reg,Age,Year} = S^{Fleet}_{Dir,Reg,Age}F^{Fleet}_{Dir\_Mult,Reg,year}Ret^{Fleet}_{Dir,Reg,Age}$	Directed Fleets are HL, LL, HBT, and MRIP
Directed Discard Fishing Mortality (F_{Disc}) by Fleet	$F^{Fleet}_{Disc,Reg,Age,Year} = F^{Fleet}_{Dir\_Mult,Reg,year}(1-Ret^{Fleet}_{Dir,Reg,Age})\,DM^{Fleet}_{Dir}$	Fishing mortality due to open season discards for a directed fleet
Total Directed Fishing Mortality (F_{Tot_Dir}) by Fleet	$F^{Fleet}_{Tot\_Dir,Reg,Age,Year} = F^{Fleet}_{Dir,Reg,Age,Year} + F^{Fleet}_{Disc,Reg,Age,Year}$	Total fishing mortality for a directed fleet
Bycatch/Closed Season Discard Fishing Mortality (F_{Byc}) by Fleet	$F^{Fleet}_{Byc,Reg,Age,Year} = S^{Fleet}_{Byc,Reg,Age}F^{Fleet}_{Byc\_Mult,Reg,year}$	Bycatch and Closed Season Discard Fleets are C_No_IFQ, R_Closed, and SHR
Total Fishing Mortality (F_{Tot})	$F_{Tot,Reg,Age,Year} = \sum_{Fleet} F^{Fleet}_{Tot\_Dir,Reg,Age,Year} + F^{Fleet}_{Byc,Reg,Age,Year}$	Total Fishing Mortality Summed Across All Fleets
Total Mortality (Z)	$Z_{Reg,Age,Year} = F_{Tot,Reg,Age,Year} + M_{Age}$	Total Mortality Summed Across All Fleets
Abundance-at-Age (N)	$N_{Reg,Age+1,Year+1} = N_{Reg,Age,Year}e^{-Z_{Reg,Age,Year}}$	Total Abundance by Region
Spawning Stock Biomass (SSB)	$SSB_{Year} = \sum_{Reg}\sum_{Age=0}^{20}(Fec_{Age}N_{Reg,Age,Year}e^{-0.5Z_{Reg,Age,Year}})$	Note that Mortality is Discounted for Midyear Spawning
Retained Catch-at-Age (C) by Fleet	$C^{Fleet}_{Dir,Reg,Age,Year} = N_{Reg,Age,Year}(1-e^{-Z_{Reg,Age,Year}})\frac{F^{Fleet}_{Dir,Reg,Age,Year}}{Z_{Reg,Age,Year}}$	Retained Catch for a Directed Fleet
Retained Yield (Y) by Fleet	$Y^{Fleet}_{Dir,Reg,Year} = \sum_{Age=0}^{20}\overline{W^{Fleet}_{Age}}C^{Fleet}_{Dir,Reg,Age,Year}$	See SS3 Manual (Methot 2015) for a Complete Description of the Length Integrated Fleet-Specific Weight-at-Age (W)
Spawning Potential Ratio (SPR)	$SPR = \frac{\frac{SSB}{R}}{\frac{SSB_0}{R_0}}$	SSB_0 = 4.72E+15 eggs

Table 2. Scenarios and associated fishing mortality rates. The *Asses_F_2001_2003* scenario uses the estimated average shrimp bycatch fishing mortality rates for 2001 to 2003 from the SEDAR 52 assessment as an alternate approach to projecting the dynamics of the shrimp fleets during the baseline period. Therefore, the percent change is not in shrimp days, but the change in actual fishing mortality rates from the assessment model.

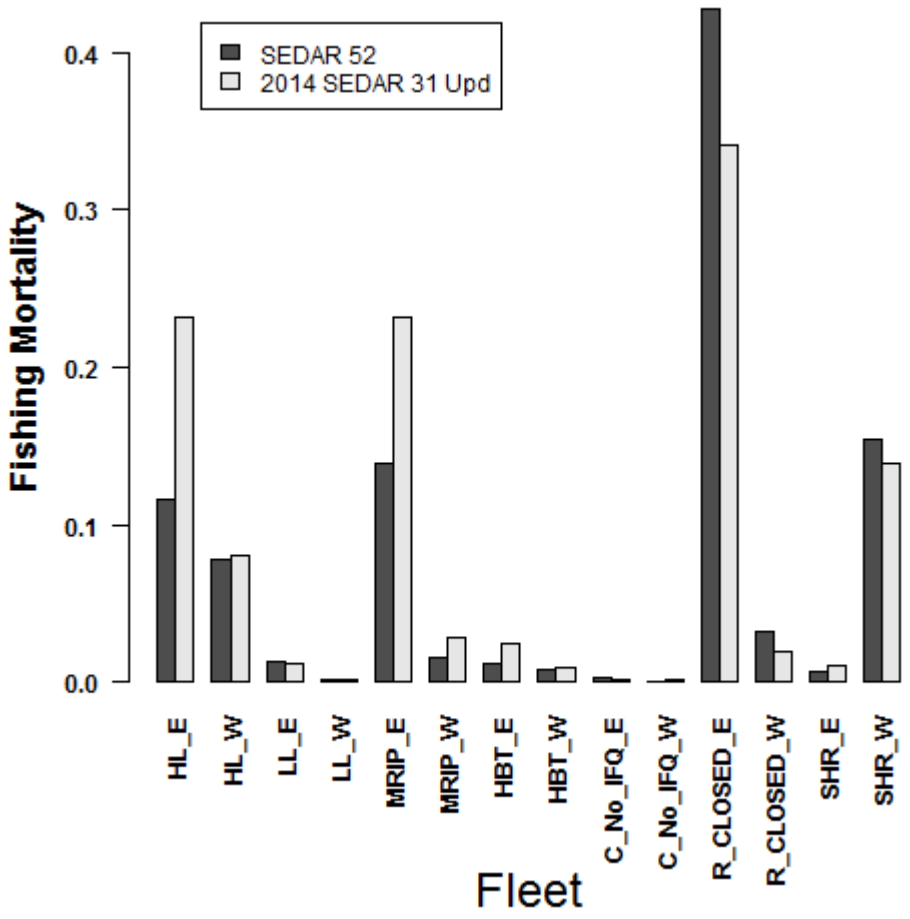
Scenario Run	SEDAR 52 Base	Reduce_60	Reduce_56	Reduce_40	Reduce_0	Assess_F_2001_2003
% Reduction In Gulfwide Shrimp Days	63%	60%	56%	40%	0%	--
Compared to 2001-2003 Average % Increase in Shrimp Days Compared to Base Model	--	8%	20%	63%	270%	447% east*, 247% west*
East Shrimp Bycatch F	0.0069	0.0075	0.0083	0.0113	0.0187	0.0310
West Shrimp Bycatch F	0.1537	0.1660	0.1844	0.2505	0.4150	0.3797

*These values represent changes in fishing mortality rates not shrimp days.

Table 3. ABCs (in millions of pounds whole weight) for each of the scenarios.

	ABC					
Year	**SEDAR 52**	**Reduce_60**	**Reduce_56**	**Reduce_40**	**Reduce_0**	**Assess_F_2001_2003**
2019	16.0	16.0	16.0	14.7	13.1	13.3
2020	15.0	15.0	15.0	13.9	12.5	12.7
2021	14.3	14.3	14.2	13.3	12.0	12.2
2022	13.8	13.7	13.7	12.8	11.5	11.7
2023	13.4	13.3	13.3	12.4	11.1	11.2
2024	13.2	13.1	13.0	12.2	10.7	10.9
2025	13.1	13.0	12.9	12.0	10.6	10.7
2026	13.0	13.0	12.8	12.0	10.5	10.7
2027	13.0	12.9	12.8	12.0	10.5	10.6
2028	13.0	12.9	12.8	11.9	10.5	10.6
2029	13.0	12.9	12.8	11.9	10.5	10.6
2030	13.0	12.9	12.8	11.9	10.4	10.6
2031	13.0	12.9	12.8	11.9	10.4	10.6
2032	13.0	12.9	12.8	11.9	10.4	10.6

	SPR					
Year	**SEDAR 52**	**Reduce_60**	**Reduce_56**	**Reduce_40**	**Reduce_0**	**Assess_F_2001_2003**
2019	0.22	0.22	0.22	0.22	0.22	0.22
2020	0.23	0.23	0.23	0.23	0.23	0.23
2021	0.24	0.24	0.24	0.24	0.24	0.24
2022	0.24	0.24	0.24	0.25	0.25	0.25
2023	0.25	0.25	0.25	0.25	0.25	0.25
2024	0.25	0.25	0.25	0.25	0.26	0.26
2025	0.25	0.25	0.25	0.25	0.26	0.26
2026	0.25	0.25	0.25	0.26	0.26	0.26
2027	0.26	0.25	0.25	0.26	0.26	0.26
2028	0.26	0.26	0.25	0.26	0.26	0.26
2029	0.26	0.26	0.25	0.26	0.26	0.26
2030	0.26	0.26	0.26	0.26	0.26	0.26
2031	0.26	0.26	0.26	0.26	0.26	0.26
2032	0.26	0.26	0.26	0.26	0.26	0.26



F**igure 1.** The terminal year fishing mortalities used in the projections for the SEDAR 52 Base Model (black bars) and the 2014 SEDAR 31 Update Assessment (grey bars). The directed fleet fishing mortalities represent three year averages from the terminal three years of the associated assessment model. The projections assume the directed fleet fishing mortalities are held in a constant proportion based on these values, whereas the bycatch and discard fleet fishing mortalities are fixed at the levels shown here for every year of the projection (except as altered for each scenario; see text and **Table 2** for scenarios and new fishing mortality rates used in each).