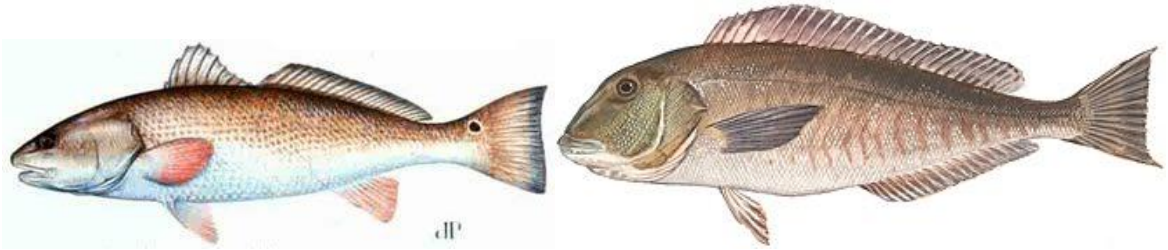
Status Determination Criteria and Optimum Yield for Reef Fish and Red Drum



Draft
Amendment 48 to the Reef Fish Fishery Management Plan
Amendment 5 to the Red Drum Fishery Management Plan

August 2019

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ENVIRONMENTAL ASSESSMENT COVER SHEET

Name of Action

Status Determination Criteria and Optimum Yield for Reef Fish and Red Drum, Amendment 48 to the Reef Fish Fishery Management Plan and Amendment 5 to the Red Drum Fishery Management Plan.

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Summary/Abstract

ABBREVIATIONS USED IN THIS DOCUMENT

ABC	Acceptable biological catch
ACL	Annual catch limit
ACT	Annual catch target
AM	Accountability measures
B	Biomass
B_{MSY}	Stock biomass level capable of producing an equilibrium yield of MSY
Council	Gulf of Mexico Fishery Management Council
DLM	Data Limited Method
DLMTool	Data Limited Methods Tool
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EIS	Environmental impact statement
ESA	Endangered Species Act
F	Instantaneous rate of fishing mortality
F_{MAX}	Fishing mortality rate corresponding to maximum yield-per-recruit
F_{MSY}	Fishing mortality rate corresponding to an equilibrium yield of MSY
F_{OY}	Fishing mortality rate corresponding to an equilibrium yield of OY
F_{PROXY}	Fishing mortality rate corresponding to an MSY proxy
$F_{REBUILD}$	Fishing mortality rate corresponding to a stock rebuilding plan
$F_{x\% SPR}$	Fishing mortality corresponding to an x percent spawning potential ratio
FMP	Fishery Management Plan
FRFA	Final Regulatory Flexibility Analysis
Gulf	Gulf of Mexico
IFQ	Individual Fishing Quota
IRFA	Initial regulatory flexibility analysis
M	Mortality
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MFMT	Maximum fishing mortality threshold
MSST	Minimum stock size threshold
MSY	Maximum sustainable yield
NMFS	National Marine Fisheries Service
NS1	National Standard 1 guidelines
OFL	Overfishing level
OY	Optimum yield
Reef Fish FMP	Fishery Management Plan for the Reef Fish Resources in the Gulf of Mexico
RFA	Regulatory Flexibility Act of 1980
RIR	Regulatory impact review
SDC	Status determination criteria
Secretary	Secretary of Commerce
SEDAR	Southeast Data, Assessment and Review
SEFSC	Southeast Fisheries Science Center
SEIS	Supplemental environmental impact statement

SFA	Sustainable Fisheries Act
South Atlantic Council	South Atlantic Fishery Management Council
SSB	Spawning stock biomass
SSBR	Spawning stock biomass per recruit
SSC	Scientific and Statistical Committee
SPR	Spawning potential ratio
TAC	Total allowable catch

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CHAPTER 1. INTRODUCTION

1.1 Background

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requires the National Marine Fisheries Service (NMFS) and the Regional Fishery Management Councils to end overfishing, rebuild overfished stocks, and achieve, on a continuing basis, the optimum yield (OY) from federally managed fish stocks. These mandates are intended to ensure fishery resources are managed for the greatest overall benefit to the nation, particularly with respect to providing food production, recreational opportunities, and protecting marine ecosystems.

Status Determination Criteria and Biological Reference Points

The National Standard 1 (NS1) guidelines require that each fishery management plan (FMP) describe objective and measurable criteria to determine overfishing and overfished status for each stock or stock complex, such as a minimum stock size threshold (MSST) and maximum fishing mortality threshold (MFMT), or an overfishing limit (OFL) collectively known as status determination criteria (SDC). These thresholds represent the point at which a stock is determined to be overfished (MSST) or experiencing overfishing (MFMT or OFL). The FMP must also specify a maximum sustainable yield (MSY) or proxy, and an OY for each stock or stock complex.

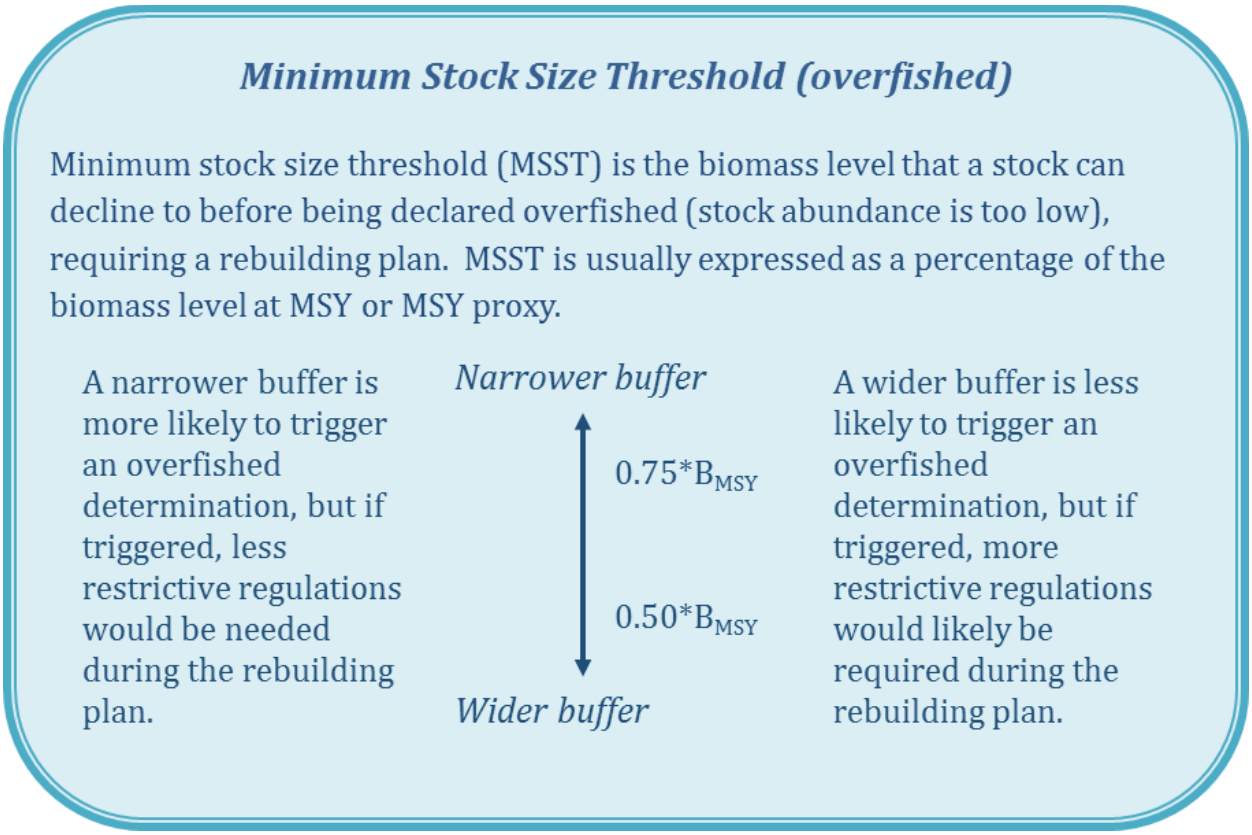
Catch Level Reference Points

MSY and OY are long-term average catch levels. They are usually measured in terms of biomass (pounds) caught but could be measured in terms of numbers of fish caught. MSY is the largest, long-term average catch that can be taken from a stock or stock complex under prevailing ecological, environmental conditions and fishery technology characteristics, and the distribution of catch among fleets. OY is a long-term average catch level based on MSY as reduced by any relevant economic, social, or ecological factors. Therefore, OY cannot exceed MSY. When data are insufficient to estimate MSY directly a proxy may be used. The most common proxy is a yield that will allow the stock to maintain a certain level of egg production or spawning potential ratio (SPR). Other proxies are described in Appendix B.

Stock Biomass Reference Points

A biomass reference point measures how many fish are left in the water rather than how many fish are caught. This can be measured in terms of biomass (e.g., pounds left in the water), numbers of fish, or the expected egg production from the spawning stock biomass (SSB) of the adult stock. The long-term average size of a stock that results from harvesting at the MSY level is called the biomass at MSY (B_{MSY}). If the stock level falls below B_{MSY}, it cannot sustain harvest at the MSY level without further depletion. However, biomass may fluctuate over time, due to changes in environmental conditions, recruitment to the stock, or other variables. Because

of these natural fluctuations, a stock is not considered to be overfished until it drops to some level further below B_{MSY}. This is the MSST level. The Gulf of Mexico Fishery Management Council (Council) has broad latitude in deciding how far the MSST can be set below B_{MSY}, except that is the MSST cannot be set below 50% of B_{MSY}. The wider the gap between B_{MSY} and MSST, the less likely a stock is to be declared overfished, but the more difficult it may be to rebuild the stock back to B_{MSY}. The narrower the gap between B_{MSY} and MSST, the more likely a stock is to be declared overfished, but the less difficult it may be to rebuild the stock. If MSST is set too close to B_{MSY}, natural fluctuations may cause the stock to enter an overfished condition even if the stock or stock complex is well-managed.



Fishing Mortality Rate Reference Points

MSY, OY, and MSST are all considered to be biomass reference points that refer to either the amount of fish harvested (MSY and OY) or the amount of fish left in the ocean. In contrast, fishing mortality (F) and MFMT refer to rates of removal of fish by fishing.[1]

The F_{MSY} is the fishing mortality rate that, if applies over the long-term, would result in harvesting the MSY. The fishing mortality rate above which overfishing is occurring is MFMT.

[1] Think of your car's dashboard. The speedometer tells you your rate of travel (e.g. 50 miles per hour), but does not tell you how far you have travelled. An odometer tells you how far you have travelled, but not the rate of travel. The speedometer and odometer are therefore analogous to fishing mortality rates and biomass levels, respectively.

MFMT is also the fishing mortality rate that results in catching the OFL level on an annual basis. For this reason, exceeding the OFL is also considered overfishing. MFMT cannot be set higher than F_{MSY}, but it can be set lower. It is often set equal to F_{MSY}, but under some conditions it may be desirable to set it at a more conservative level. For example, an overfished stock that is required to be rebuilt in a certain number of years may require a maximum fishing mortality rate less than F_{MSY} in order to reach its rebuilding target.

Long-term vs. Annual Reference Points

Once calculated, the MSY and OY reference points do not change unless some new information about the productivity of the stock is identified, or the Council modifies the MSST or MFMT. On the other hand, the OFL, acceptable biological catch (ABC), annual catch limit (ACL), and annual catch target (ACT) are annual catch levels that may change from year to year depending upon the stock condition. The ABC, ACL, and ACT are all based on OFL; whereas, OY, B_{MSY}, and MSST are all based on MSY.

The OFL is the catch level that results from fishing at the MFMT rate. If MFMT is set equal to F_{MSY}, then OFL is the annual catch when fishing at F_{MSY}, and can be considered an annualized MSY. If the stock biomass level is higher than B_{MSY} (which can occur if fishing pressure has been relatively light or if a strong spawning year-class has entered the fishery), then OFL will be higher than the long-term MSY, but will gradually be reduced as the stock is fished down to its B_{MSY} level. On the other hand, if the stock biomass level is below B_{MSY} (as in an overfished stock), then OFL will be less than MSY, but will gradually be increased as the stock rebuilds to its B_{MSY} level.

The Council currently has MFMT and OFL defined for all stocks. However, MSY proxies, MSST, and OY are defined for some, but not all, reef fish stocks and not for red drum. The Generic Sustainable Fisheries Act Amendment (GMFMC 1999) established fishing mortality based reference points for all stocks, but the proposed biomass reference points were not approved by NMFS. Reference points were subsequently adopted in plan amendments for some stocks as other management changes were needed.

The actions in this amendment are intended to establish reference points where they do not currently exist, and in some cases to consider modifying existing reference points. For other stocks, stock assessment scientists adopted reference points based on their scientific recommendations, but without being formally adopted by the Council through a fishery management plan. To comply with the Magnuson-Stevens Act and NS1 guidelines, and to provide measurable reference points for determining overfished and overfishing status, MSY proxies, MFMT, MSST, and OY must be established for all stocks. The reef fish stocks that currently have assigned SDC are described in Table 1.1.1.

Table 1.1.1. Stocks with Status Determination Criteria assigned.

Stock	MSY	MFMT	MSST*	OY	Source
Gag	**Yield at F_{MAX}****	**F_{MAX}****	**0.50*B_{MAX}****	**Yield at 75% of F_{MAX}****	**Amendment 30B (GMFMC 2008a)**
Red grouper	**Yield at $F_{30\% SPR}$**	**$F_{30\% SPR}$**	**0.50* $B_{30\% SPR}$**	**Yield at 75% of F_{MSY}**	**Secretarial Amendment 1 (GMFMC 2004a)**
Red snapper	**Yield at $F_{26\% SPR}$**	**$F_{26\% SPR}$**	**0.50*B_{MSY}**	**Yield at 75% of $F_{26\% SPR}$**	**Amendment 22 (GMFMC 2004b) Amendment 27 (GMFMC 2007)**
Vermilion snapper	**Yield at $F_{30\% SPR}$**	**$F_{30\% SPR}$**	**0.50*$B_{30\% SPR}$**	**Yield at 75% of $F_{30\% SPR}$**	**Amendment 23 (GMFMC 2004c) Amendment 47 (GMFMC 2017a)**
Gray triggerfish	**Yield at $F_{30\% SPR}$**	**$F_{30\% SPR}$**	**0.50*$B_{30\% SPR}$**	**Yield at 75% of $F_{30\% SPR}$**	**Amendment 30A (GMFMC 2008b)**
Greater amberjack	**Yield at $F_{30\% SPR}$**	**$F_{30\% SPR}$**	**0.50*$B_{30\% SPR}$**	**Yield at $F_{40\% SPR}$**	**Secretarial Amendment 2 (GMFMC 2002)**
Hogfish	**Yield at $F_{30\% SPR}$**	**$F_{30\% SPR}$**	**0.50*$B_{30\% SPR}$**	**Yield at $F_{20\% SPR}$**	**Amendment 1 (GMFMC 1989) Amendment 43 (GMFMC 2016)**
Gray Snapper***	**Yield at $F_{26\% SPR}$**	**$F_{26\% SPR}$**	**0.50*$B_{26\% SPR}$**	**Yield at 90% of $F_{26\% SPR}$**	**Amendment 51 (GMFMC 2019)**

* MSST was set equal to 0.50*$B_{MSY\ proxy}$ in Amendment 44 (GMFMC 2017b).
** F_{MAX} and B_{MAX} refer to the fishing mortality rate and biomass level that produce maximum yield-per-recruit.
*** Status determination criteria noted for gray snapper are currently the preferred alternatives selected in Reef Fish Amendment 51.

Further, the South Atlantic Fishery Management Council (South Atlantic Council) has established MSY proxies, MSST, and OY for all four stocks that occur in both Councils' jurisdictions (Table 1.1.2). All of the status determination criteria defined for these single stocks apply to the stock throughout its range, with the exception of the OY definitions that only apply to the South Atlantic Council's jurisdiction apportionment of black grouper, mutton snapper, and yellowtail snapper.

Table 1.1.2. Stocks assessed across both Councils' jurisdictions with Status Determination Criteria assigned by the South Atlantic Council.

Stock	MSY	MFMT	MSST	OY	Source
Black Grouper	Yield at $F_{30\% SPR}$	$F_{30\% SPR}$	$0.75*SSB_{30\% SPR}$	ACL = OY = ABC	Amendment 11 (SAFMC 1998) Amendment 21 (SAFMC 2014) Amendment 25 (SAFMC 2011)
Mutton Snapper	Yield at $F_{30\% SPR}$	$F_{30\% SPR}$	$0.75*SSB_{30\% SPR}$	ACL = OY = ABC	Amendment 11 (SAFMC 1998) Amendment 41 (SAFMC 2017)
Yellowtail Snapper	Yield at $F_{30\% SPR}$	$F_{30\% SPR}$	$0.75*SSB_{30\% SPR}$	ACL = OY = ABC	Amendment 11 (SAFMC 1998) Amendment 15 (SAFMC 2013) Amendment 21 (SAMFMC 2014)
Goliath Grouper	Yield at $F_{40\% SPR}$	$F_{40\% SPR}$	[(1-M) or 0.5 whichever is greater]$*B_{MSY}$ M=0.12	$F_{50\% SPR}$	Amendment 11 (SAFMC 1998)

Traditionally, management measures have been implemented using MSY proxies in species-specific stock assessments. However, red drum and many of the stocks in the Fishery Management Plan (FMP) for the Reef Fish Resources in the Gulf of Mexico (Reef Fish FMP) have not had stock assessments and are unlikely to be assessed in the near future. In these cases, the National Standard 1 (NS1) guidelines allow an MSY proxy to be assigned to a stock complex under certain conditions. A stock complex is defined as a group of stocks that are sufficiently similar in geographic distribution, life history, and vulnerabilities to the fishery such that the impact of management actions on the stocks is similar. Stocks may be grouped into complexes for various reasons, including where stocks in a multispecies fishery cannot be targeted independent of one another and MSY cannot be defined on a stock-by-stock basis; where there are insufficient data to measure their status relative to SDC; or when it is not feasible for fishermen to distinguish individual stocks among their catch. The Generic ACL/Accountability Measures (AM) Amendment defined the five stock complexes listed in Table 1.1.3 (GMFMC 2011). Farmer et al. (2010) conducted an analysis to develop a scientific basis for defining multiple stocks for management purposes and a variety of life history parameters, landings data, and depth and area fished information were utilized from a large number of fishery independent and fishery-dependent data sources for the analysis. Each complex is managed using a complex ACL, AM, and OFL.

The Council can choose to manage a complex using an indicator stock, which is a stock with measurable SDC. Possible indicator species are those that have had stock assessments. There are currently two complexes (other shallow-water grouper, and deep-water grouper) that include a species that has been assessed. It should be noted that there was an assessment on tilefish (golden) completed and review by the SSC during its May 2011 meeting. However, the SSC felt that although the assessment was based on best scientific information available, it did not capture

the dynamics of the Gulf tilefish stock to sufficiently provide useful management advice. Thus, the SSC recommended that a data poor Tier 3a approach of the ABC Control Rule (GMFMC 2011) to set the stock's ABC.

Table 1.1.3. Stock complexes and possible indicator species

Stock Complex	Species	Possible Indicator Species
Tilefishes	Tilefish (Golden) Blueline Tilefish Goldface Tilefish	Tilefish (Golden)
Other Shallow-water Grouper	Black Grouper Scamp Yellowmouth Grouper Yellowfin Grouper	Black Grouper
Deep-water Grouper	Yellowedge Grouper Warsaw Grouper Snowy Grouper Speckled Hind	Yellowedge Grouper
Jacks	Lesser Amberjack Almaco Jack Banded Rudderfish	None
Mid-water Snappers	Silk Snapper Wenchman Blackfin Snapper Queen Snapper	None

Maximum Sustainable Yield Proxy

Maximum sustainable yield (MSY) is the theoretical maximum largest average amount of fish that can be caught each year on a continuing basis. MSY can rarely be calculated with accuracy, so a proxy that can be more readily calculated is typically used to represent a sustainable level of harvest.

Maximum Fishing Mortality Threshold (Overfishing)

Maximum fishing mortality threshold (MFMT) is the rate of fishing mortality above which a stock is declared to be experiencing overfishing (fish are being removed at too rapid a rate). MFMT is also the fishing mortality rate that results in catching the OFL level on an annual basis. MFMT may not exceed the rate of fishing associated with MSY or the MSY proxy.

Optimum Yield

Optimum yield (OY) is a level of harvest that is based on MSY as reduced by any relevant economic, social, or ecological factors takes into account the protection of marine ecosystems, and in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the MSY or MSY proxy.

Spawning Potential Ratio (SPR)

Spawning potential ratio (SPR) assumes that a certain amount of fish must survive and spawn in order to replenish the stock. It is calculated as the average number of eggs per fish over its lifetime when the stock is fished, compared to the average number of eggs per fish over its lifetime when the stock is not fished. The optimum SPR is dependent upon life history of the species, but in general, SPRs of 20% to 40% are considered sustainable.

1.2 Purpose and Need

The purpose of this action is to establish or modify MSY proxies, MFMT, MSST, and OY that are consistent with the current NS1 guidelines for stocks in the Reef Fish and Red Drum FMPs.

The need is to have biological reference points that can be used for determining status of the stocks or stock complexes.

1.3 History of Management

This history of management covers events pertinent to the development of status determination criteria for reef fish and red drum in the Gulf. A complete history of management for the Reef Fish FMP is available on the Council's website[2].

1.3.1 Reef Fish History of Management – Status Determination Criteria

The Reef Fish FMP (with its associated environmental impact statement [EIS]) was implemented in November 1984. The management objectives included, "Rebuild the declining reef fish stocks wherever they occur within the fishery". The FMP defined MSY as 51 million pounds for all snappers and groupers combined, and 500,000 pounds for all sea basses combined. The OY was defined as 45 million pounds for all snappers and groupers combined, and 500,000 pounds for all sea basses combined.

Amendment 1 (with its associated environmental assessment (EA), regulatory impact review (RIR), and regulatory flexibility analysis (RFA)) to the Reef Fish FMP, implemented in 1990, had a primary objective to stabilize long-term population levels of all reef fish species by establishing a spawning age survival rate to achieve at least 20% spawning stock biomass per recruit (SSBR), relative to the SSBR that would occur with no fishing. This stock level was to be achieved for each stock in need of rebuilding by January 1, 2000. This amendment also revised the definition of OY to allow specification at the species level, and implemented a framework procedure to allow for annual management changes in the reef fish fishery.

Amendment 3 (with its associated EA and RIR), implemented in July 1991, revised the target for stock rebuilding from 20% SSBR to 20% SPR, a more general term that allowed the stock status to be expressed in terms of total adult fish biomass (number alive x average weight), gonad biomass (number alive x average gonad weight), or eggs produced (number alive x average number of eggs spawned) for each age-class of fish. The amendment also changed the target date for rebuilding red snapper from January 1, 2000 to January 1, 2007 because the original target date was unattainable for red snapper, and it provided additional flexibility in the annual framework procedure for specifying total allowable catch (TAC) by allowing the target date for rebuilding an overfished stock to be changed depending on changes in scientific advice, except that the rebuilding period cannot exceed 1.5 times the generation time of the species under consideration.

[2] http://gulfcouncil.org/fishery-management/implemented-plans/reef-fish/

Amendment 11 (with its associated EA and RIR), implemented in January 1996, included revision to dealer and vessel permit requirement and to fish trap endorsements. It also included three proposed measures that were disapproved by NMFS. These included: 1) a proposed redefinition of OY; 2) use of ABC range for specification of TAC; and 3) re-specification of the Generation Time Multiplier for the Recovery periods. In April 1997, the Council resubmitted the disapproved measure for specifying OY with a proposal that OY be defined as a yield level that would result in at least 30% SPR. NMFS disapproved the resubmission on May 4, 1998 on the basis that, for the grouper species, some of which change sex or for which biological information was currently unavailable, an OY based on 40% SPR was more appropriate than one base on 30% SPR [63 FR 24522].

Amendment 22 (with its associated supplemental environmental impact statement (SEIS), RIR, and IRFA, implemented July 5, 2005 revised the red snapper rebuilding plan. It set the Sustainable Fisheries Act (SFA) parameters MSY, OY, MFMT, and MSST for red snapper, and sets bycatch reporting methodologies for the permitted reef fish fisheries.

Amendment 23 (with its associated SEIS, RIR, and RFA), implemented July 8, 2005, established a rebuilding plan for vermilion snapper, and set the SFA parameters (MSY, OY, MFMT, and MSST) for vermilion snapper. For MSY, no proxy was selected. MSY for vermilion snapper was set at the yield associated with the assessment calculation of F_{MSY} when the stock is at equilibrium, estimated to be 3.37 mp whole weight. MFMT was set equal to F_{MSY}, and MSST was set (1-M)*B_{MSY} (where M = 0.15). OY was set at the yield when fishing at 75% of F_{MSY}, which was estimated to be approximately 94 percent of MSY, except that, during rebuilding, allowable harvest for each year based on the rebuilding strategy.

Amendment 27 implemented February 28, 2008, except for reef fish bycatch reduction measures that became effective on June 1, 2008. This amendment addressed overfishing and revised the stock rebuilding for red snapper. It changed the MSY proxy for red snapper to be yield when fishing at $F_{26\% SPR}$. It also required the use of non-stainless steel circle hooks when using natural baits to fish for Gulf reef fish, and required the use of venting tools and dehooking devices when participating in the commercial or recreational reef fish fisheries effective June 1, 2008.

Amendment 30A (with its associated SEIS, RIR, and RFA), implemented August 2008, revised the greater amberjack rebuilding plan and established a rebuilding plan for gray triggerfish. For gray triggerfish, it set the MSY proxy as the yield associated with $F_{30\% SPR}$, set MFMT equal to $F_{30\% SPR}$, set MSST equal to (1-M)*SSB_{MSY}, and set OY as the yield associated with 75% of F_{MSY} when the stock is at equilibrium.

Amendment 30B (with its associated final EIS, RIR, and IRFA), implemented August 2008, contained measures to end overfishing of gag and revise red grouper management measures. For gag, it set status determination criteria based on maximum-yield-per-recruit. The MSY proxy was the yield when fishing at a rate corresponding to maximum-yield-per-recruit (F_{MAX}). MFMT was set equal to F_{MAX}, and MSST was set at (1-M)*SSB_{MAX} (where M = 0.15). The OY was set at the yield at 75% of F_{MAX}.

Amendment 43 (with its associated EA, RIR, and RFA), implemented August 24, 2017, defined the geographical boundaries for Gulf stock of hogfish. It set the MSY proxy for hogfish at the equilibrium yield at $F_{30\% SPR}$, MFMT at $F_{30\% SPR}$, and MSST at 75% of the spawning stock biomass when fishing at $F_{30\% SPR}$,

Amendment 44 (with its associated EA), was approved on December 21, 2017 (there was no rulemaking associated with this amendment, and therefore no implementation date). The amendment re-defined MSST for seven reef fish species: gag, red grouper, red snapper, vermilion snapper, gray triggerfish, greater amberjack, and hogfish. For these stocks, MSST was re-defined to be 50% of the B_{MSY} proxy.

Secretarial Amendments

Section 304(c)(1) and Section 304 (e)(5) of the Magnuson-Steven Act provides for circumstances under which the Secretary of Commerce (Secretary) may prepare a fishery management plan or amendment. The following amendments have been developed as Secretarial Amendments to the Reef Fish FMP in conjunction with the Council.

Secretarial Amendment 1, including an EA, RIR, and Final Regulatory Flexibility Analysis (FRFA), implemented in July 2004, established MSY, F_{msy}, MFMT, SSB_{msy}, MSST, and OY for the U.S. Gulf red grouper stock.

Secretarial Amendment 2, including EA, RIR, and RFA, was submitted to NMFS in November 2002, and implemented on June 17, 2003. It specified MSY, OY, MFMT, and MSST levels for greater amberjack in compliance with the Magnuson-Stevens Act, and established a rebuilding plan for greater amberjack based on 3-year intervals. The MSY proxy was the yield associated with $F_{30\% SPR}$. OY was set at the yield associated with an $F_{40\% SPR}$ when the stock is at equilibrium. MFMT was set at $F_{30\% SPR}$, and MSST was set at (1-M)*B_{MSY} (where M = 0.25).

1.3.2 Red Drum History of Management – Status Determination Criteria

A **Secretarial FMP for the Red Drum Fishery of the Gulf of Mexico** (with its associated EA and RIR) was implemented December 19, 1986. It prohibited directed commercial harvest of red drum from the exclusive economic zone (EEZ) for 1987. The FMP provided for a recreational bag limit of one fish per person per trip, and an incidental catch allowance for commercial net and shrimp fishermen. It established an escapement goal of 20% of juvenile red drum to the offshore spawning stock. MSY was defined as the combination of inshore and offshore fishing mortality rates which maximizes the yield-per-recruit times present inshore recruitment, subject to the constraint that spawning stock biomass per recruit is no less than 30% of what it would be if there were no exploitation. Inshore equilibrium yield was estimated to be 10.2 million pounds, but the overall range of MSY estimates was between 6.1 million pounds and 63.2 million pounds.

Amendment 2, implemented in 1988, prohibited retention and possession of red drum from the EEZ. Overfishing was defined as a fishing mortality that prohibits attaining the spawning

stock goal or threshold which is currently set at a 20 percent SSBR ratio. OY was defined as all red drum recreationally and commercially harvested from state waters landed consistent with state laws and regulations, under a goal of allowing 30 percent escapement of the juvenile population. In addition, all red drum commercially or recreationally harvested from the Primary Area of the EEZ under the TAC level and allocations specified under the provisions of the FMP, and a zero retention level from the Secondary Areas of the EEZ. A Southeast Fisheries Science Center (SEFSC) Stock Assessment report (Goodyear 1988) indicated the SSBR would likely decline to 13%. The 1989 Stock Assessment Panel report recommended ABC for the EEZ be maintained at zero, and that the states increase escapement to 30%.

1.3.3 Generic Amendments – Status Determination Criteria

Generic Sustainable Fisheries Act Amendment (with its associated EA, RIR, and IRFA), partially approved and implemented in November 1999, set the MFMT) for most reef fish stocks at $F_{30\% \text{ SPR}}$. Estimates of MSY, MSST, and OY were disapproved because they were based on SPR proxies rather than biomass based estimates.

The **Generic ACL/AM Amendment** addressed a requirement in the Reauthorized Magnuson-Stevens Act of 2006 to establish Annual Catch Limits and Accountability Measures for federally managed species. The amendment also established five stock complexes and to allows the annual catch limits and management measures to be applied on the complex.

1.3.4 South Atlantic Council – Status Determination Criteria

Comprehensive Sustainable Fisheries Act
Amendment 11, implemented in 1999 established and MSY Proxy for goliath and Nassau grouper = 40% static SPR; all other species = 30% static SPR; OY: hermaphroditic groupers = 45% static SPR; goliath and Nassau grouper = 50% static SPR; all other species = 40% static SPR. Defined MFMT for goliath grouper as $F_{40\% \text{ SPR}}$ and established MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}.

Regulatory Amendment 21 redefined the overfished threshold for red snapper, blueline tilefish, gag, black grouper, yellowtail snapper, vermilion snapper, red porgy, and greater amberjack. The current definition of the MSST for these species, which is used to determine if a species is overfished, is function of the natural mortality rate (M). MSST equals SSB_{MSY}*(1-M or 0.5, whichever is greater), where SSB_{MSY} is the biomass when the stock is at the MSY level and considered to be rebuilt.

Regulatory Amendment 13 Modified the existing specification of OY and the ACL for yellowtail snapper in the South Atlantic.

Amendment 25 Comprehensive Annual Catch Limit Amendment was implemented in 2012. This Amendment established ABC control rules, ABCs, ACLs, and AMs for species not undergoing overfishing; removed some species from South Atlantic Fishery Management Unit and designated others as ecosystem component species; specified allocations between the

commercial and, recreational sectors for species not undergoing overfishing; limited the total mortality for federally managed species in the South Atlantic to the ACLs.

CHAPTER 2. MANAGEMENT ALTERNATIVES

2.1 Action 1 - Maximum Sustainable Yield (MSY) Proxies

Sub-action 1.1. MSY Proxies for Assessed stocks

Alternative 1. No action. The MSY proxy for black grouper, yellowedge grouper, mutton snapper, and yellowtail snapper will remain undefined in the fishery management plan (FMP).

Alternative 2. For black grouper, yellowedge grouper, mutton snapper, and yellowtail snapper the MSY proxy is the yield when fishing at 30% spawning potential ratio ($F_{30\%SPR}$). These are assessed stocks where an MSY proxy was recommended by the Gulf of Mexico Fishery Management Council's (Council) Scientific and Statistical Committee (SSC), but where the MSY proxy has not yet been incorporated in the FMP.

Alternative 3. For black grouper, yellowedge grouper, mutton snapper, and yellowtail snapper the MSY proxy is the yield when fishing at 30% spawning potential ratio ($F_{30\%SPR}$). These are assessed stocks where an MSY proxy was recommended by the Gulf of Mexico Fishery Management Council's (Council) Scientific and Statistical Committee (SSC), but where the MSY proxy has not yet been incorporated in the FMP. For future assessments of black grouper, yellowedge grouper, mutton snapper, and yellowtail snapper the MSY proxy equals the yield produced by F_{MSY} or F_{PROXY} recommended by the Council's SSC and subject to approval by the Council through a plan amendment.

Table 2.1.1. MSY proxies used in recent assessments

Stock	MSY Proxy: Assessed Yield at	Source
Black grouper (IFQ)	$F_{30\% SPR}$	SEDAR 19 (2010)
Yellowedge grouper (IFQ)	$F_{30\% SPR}$	SEDAR 22 (2011b)
Mutton snapper	$F_{30\% SPR}$	SEDAR 15A Update (2015).
Yellowtail snapper	$F_{30\% SPR}$	SEDAR 27A (O'Hop et al. 2012)

Discussion:

Stocks need an estimate of MSY and the fishing mortality rate associated with catching the maximum sustainable yield (MSY) (F_{MSY}) in order to determine overfished and overfishing status. Under the Magnuson-Stevens Act, the SSC is tasked with recommending MSY to the Council for implementation for each managed stock in the FMP. However, the actual MSY can rarely be estimated with certainty due to the difficulty in accurately estimating the relationship between the size of the spawning stock and the subsequent annual recruitment. Thus, proxies that are easier to measure are typically used. Generally, MSY proxies used in the Gulf are based on some percentage of spawning potential ratio (SPR) and are expressed as yield when fishing at F_{PROXY}.

For eight reef fish stocks (gag, red grouper, red snapper, vermilion snapper, gray triggerfish, greater amberjack, hogfish, gray snapper[3]), the MSY proxy used by the SSC for status determination has been adopted by the Council in various plan amendments (Table 1.1.1). The Council currently working on Reef Fish Amendment 51 for gray snapper in a separate amendment (GMFMC 2019). Four additional stocks (black grouper, goliath grouper, mutton snapper, and yellowtail snapper), which have been assessed as single stocks that span both the South Atlantic Fishery Management Council (South Atlantic Council) and Gulf Council's areas of jurisdiction, have been assessed under Southeast Data, Assessment, and Review (SEDAR) (Table 2.1.1). The South Atlantic Council has implemented MSY proxies for these species within their Snapper-Grouper FMP through plan amendments (Table 1.1.2). However, the Gulf Council has not developed a plan amendment to the Fishery Management Plan for the Reef Fish Resources in the Gulf of Mexico (Reef Fish FMP) that would assign MSY proxies for these species that occur as single stocks in the Gulf and U.S. South Atlantic.

Spawning Potential Ratio (SPR)

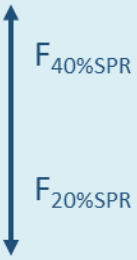
The SPR assumes that a certain amount of fish must survive and spawn in order to replenish the stock.

The SPR is calculated as the average number of eggs per fish over its lifetime when the stock is fished compared to the average number of eggs per fish over its lifetime when the stock is not fished.

The optimum SPR is dependent upon life history of the species, but in general, SPRs of 20% to 40% are considered sustainable.

More conservative

A more conservative SPR results in a lower ACL in the short-term, but would help ensure stable catch levels over the long-term.



A less conservative SPR results in a higher ACL in the short-term, but could result in less stable or lower catch levels over the long-term.

Less conservative

Alternative 1 would leave the MSY proxy for the four stocks listed in Table 2.1.1 undefined in the Reef Fish FMP, and in non-compliance with the Magnuson-Stevens Act. Assessment scientists and the SSC would continue to provide recommendations as to the most appropriate

[3] The MSY proxy for gray snapper is being addressed in Reef Fish Amendment 51 (GMFMC 2019) and based on the current preferred alternative, the MSY proxy is the yield when fishing at 26% spawning potential ratio ($F_{26\%SPR}$).

MSY proxy. Under the proxy currently used (yield at $F_{30\% SPR}$), none of the stocks in this sub-action are overfished or experiencing overfishing.

Alternative 2 would define MSY proxies for the four stocks listed in Table 2.1.1 in the Reef Fish FMP. MSY proxies defined in the Reef Fish FMP would be based on the scientific analysis generated from the stock assessments, and recommendations by the SSC to the Council. Based on the yield at $F_{30\%SPR}$ MSY proxy, none of these stocks were determined to be overfished or experiencing overfishing. The South Atlantic Council has also defined the MSY proxy for black grouper, mutton snapper, and yellowtail snapper where the MSY proxy is the yield when fishing at 30% spawning potential ratio ($F_{30\%SPR}$). See table 1.1.2 for more details.

Alternative 3 is identical to **Alternative** 2 but also provides a streamlined process for modifying the defined MSY proxy in the Reef Fish FMP should the results of a future stock assessment lead to changes in the SSC's recommendation of an MSY proxy for the four stocks listed in Table 2.1.1.

Under the no action alternative, **Alternative 1**, the yield at $F_{30\% SPR}$ would likely continue to be used as the MSY proxy in future stock assessments but would not be defined within the Reef Fish FMP. The Magnuson-Steven Act requires that MSY be defined for species managed within an FMP. Not defining MSY for the four stocks listed in Table 2.1.1 in the Reef Fish FMP is not compliant with Magnuson-Stevens Act. **Alternative 2** would establish an MSY proxy based on the yield at $F_{30\%}$ SPR. This would be consistent with the MSY proxies established by the South Atlantic Council for black grouper, mutton snapper, and yellowtail snapper. However, **Alternative 2** provides no efficient mechanism for modifications to the MSY definition in the Reef Fish FMP if results from a future stock assessment results in the SSC recommending changes to the MSY or the MSY proxy to the Council. **Alternative 3** allows for a streamlined procedure to modify the MSY proxy defined in the Reef Fish FMP in the future. Currently, in order to adopt the new recommended proxy, the Council must create an action in a plan amendment that contains a range of alternative proxies along with an analysis of those alternatives. **Alternative 3** would allow the Council to adopt the new MSY proxy simply by noting the change in a plan amendment rather than by requiring a full action with alternatives. **Alternative 3** would not eliminate the Council's discretion in adopting an MSY proxy based on an SSC recommendation. The Council could return a recommendation to the SSC with questions of clarification which could affect the SSC's recommendation or choose to retain the current definition or establish a different MSY proxy than recommended by the SSC. In addition, the SSC might recommend more than one MSY proxy and leave the selection up to the Council. In this situation, a plan amendment action with alternatives may be required. This alternative could be applied to the setting of an MSY proxy for a stock being assessed for the first time as well as to changes for stocks previously assigned a proxy. For further explanation of other MSY proxies see Appendix B.

Sub-action 1.2. MSY Proxies for Stock Complexes and Other Unassessed Stocks

Alternative 1. No action. The MSY proxy for unassessed stocks and assessed stocks or complexes that did not include an MSY proxy will remain undefined.

Alternative 2: Establish an MSY proxy for the shallow-water grouper complex

Option a: Use black grouper as an indicator species. Currently the MSY proxy for black grouper is $F_{SPR\ 30\%}$.

Option b: $F_{SPR20\%}$

Option c: $F_{SPR\ 30\%}$ (do not use black grouper as an indicator)

Option d: $F_{SPR\ 40\%}$

Other Shallow-water Grouper complex (IFQ)
- Black grouper (potential indicator species)
- Scamp
- Yellowmouth grouper
- Yellowfin grouper

Alternative 3: Establish an MSY proxy for the deep-water grouper complex

Option a: Use yellowedge grouper as an indicator species. Currently the MSY proxy for yellowedge grouper is $F_{SPR\ 30\%}$.

Option b: $F_{SPR\ 20\%}$

Option c: $F_{SPR\ 30\%}$ (do not use yellowedge grouper as an indicator)

Option d: $F_{SPR\ 40\%}$

Deep-water grouper complex (IFQ)
- Yellowedge grouper (potential indicator species)
- Warsaw grouper
- Snowy grouper
- Speckled hind

Alternative 4: Establish an MSY proxy for the tilefish complex

Option a: $F_{SPR\ 20\%}$

Option b: $F_{SPR\ 30\%}$

Option c: $F_{SPR\ 40\%}$

Tilefishes Stock complex (IFQ)
- Tilefish (golden)
- Blueline tilefish
- Goldface tilefish

Alternative 5: Establish an MSY proxy for the jacks complex

Option a: $F_{SPR\ 20\%}$

Option b: $F_{SPR\ 30\%}$
Option c: $F_{SPR\ 40\%}$

Jacks complex
-Lesser amberjack
-Almaco jack
- Banded rudderfish

Alternative 6: Establish an MSY proxy for the mid-water snapper complex
Option a: $F_{SPR\ 20\%}$
Option b: $F_{SPR\ 30\%}$
Option c: $F_{SPR\ 40\%}$

Mid-water snappers complex
- Silk snapper
- Wenchman
- Blackfin snapper
- Queen snapper

Alternative 7: Establish an MSY proxy for cubera snapper as an individual stock
Option a: $F_{SPR\ 20\%}$
Option b: $F_{SPR\ 30\%}$
Option c: $F_{SPR\ 40\%}$

Alternative 8: Establish an MSY proxy for lane snapper as an individual stock
Option a: $F_{SPR\ 20\%}$
Option b: $F_{SPR\ 30\%}$
Option c: $F_{SPR\ 40\%}$

Alternative 9: Establish an MSY proxy for goliath grouper as an individual stock *
Option a: $F_{SPR\ 30\%}$
Option b: $F_{SPR\ 40\%}$
Option c: $F_{SPR\ 50\%}$

*Note: Goliath grouper is a stock that occurs in both the Gulf and South Atlantic Council's jurisdictions and is assessed as one stock throughout its range. The South Atlantic Council has established a MSY proxy of $F_{SPR\ 40\%\ SPR}$ for goliath grouper.

Discussion:

This sub-action includes alternatives to establish MSY proxies for species managed in five stock complexes that were defined in the Generic Annual Catch Limits/Accountability Measures (ACL/AM) Amendment (GMFMC 2011), as well as MSY proxies for cubera snapper, lane snapper, and goliath grouper, which are not managed as part of a complex. The methodology used to establish the stock complexes in the Generic ACL/AM Amendment was described in Farmer et al. 2010, and is summarized in Appendix A. Two of the five stock complexes have a

stock that has been assessed, and the stock status determined using an $F_{30\% SPR}$ based MSY proxy (black grouper for the other shallow-water groupers complex and yellowedge grouper for the deep-water grouper complex). These stocks could be considered as indicator species for their respective stock complexes. However, the MSY proxy for these stocks has not yet been established in a plan amendment. **Options 2a**, and **Option 3a**, in this sub-action assume that MSY proxies would be established in Sub-action 1.1. If that does not occur, these options cannot be considered. The remaining three stock complexes (tilefish complex, jacks complex, and mid-water snappers complex) do not include any stocks with accepted stock assessments and thus, no indicator species would be used rather the MSY proxy would be established for all stocks in the complex.

For the stocks that are not managed as part of complex, the MSY proxies must be established for each stock. Goliath grouper is considered a single stock throughout the Gulf of Mexico and U.S. South Atlantic and the MSY proxy selected should be consistent in both Gulf and South Atlantic. The Options in this Sub-action contain a broad range from **$F_{20\% SPR}$ – $F_{40\% SPR}$** for **Alternatives 2-8** and **$F_{30\% SPR}$ – $F_{50\% SPR}$** goliath grouper (**Alternative 9**).

Alternatives 2 and **3 Option b** and **Alternatives 4-8 (Option a)** is the yield at **$F_{20\% SPR}$**. This is the least conservative proxy considered by the SSC. It may be a sustainable level, but at a higher risk level than the remaining options of driving the stock below the true B_{MSY}. Since the stock has not been assessed, this would act as a placeholder until an assessment is completed.

Alternatives 2 and **3 Option c** and **Alternatives 4-8 (Option b)** is the yield at **$F_{30\% SPR}$**. This is the proxy usually selected by the SSC for assessed reef fish stocks. It is likely a sustainable level with a lower risk of driving the stock below the true B_{MSY} than **$F_{20\% SPR}$**. All the reef fish stocks except red snapper, gag, and potentially gray snapper have a MSY proxy of $F_{30\% SPR}$ (Table 1.1.1).

Alternatives 2 and **3 Option d** and **Alternatives 4-8 (Option c)** is the yield at **$F_{40\% SPR}$**. This is the proxy recommended by Harford et al. (2019) for gonochoristic (non-sex changing) species. This is likely a sustainable level, with a lower risk of driving the stock below the true B_{MSY} than the $F_{20\% SPR}$ or $F_{30\% SPR}$ options.

Alternative 9 (Option c) yield at $F_{50\% SPR}$. This is the proxy recommended by Harford et al. (2019) for hermaphroditic (sex changing) species. These are the stocks in the list marked with an (h). This is a sustainable level, with little risk of driving the stock below the true B_{MSY} for most reef fishes.

Alternative 1 would leave the MSY proxy undefined for the three stocks and five stock complexes subject to this sub-action and would not be compliant with the Magnuson-Stevens Act.

Alternatives 2-6 use stock complexes for MSY. The methodology used to establish the stock complexes in the Generic Annual Catch Limit (ACL)/Accountability Measure (AM) Amendment (GMFMC 2011) was described in Farmer et al. 2010, and is summarized in Appendix A.

Alternative 2 would establish an MSY proxy for the shallow-water grouper stock complex, including black grouper, scamp, yellowmouth grouper, and yellowfin grouper. Black grouper is an assessed species that would have an MSY proxy assigned under Sub-action 1.1 (unless the no action alternative is selected). The remaining stocks do not have stock assessments or MSY proxies. **Option 2a** would result in black grouper serving as a proxy for the stock complex. If black grouper is found to be overfished or experiencing overfishing, then that designation would apply to the entire stock complex. **Option 2b** would establish the MSY proxy as the yield when fishing at $F_{20\% SPR.}$ **Options 2c** and **2d** would establish the MSY proxy as the yield when fishing at $F_{30\% SPR}$ and fishing at $F_{40\% SPR}$ respectively.

Alternative 3 would establish an MSY proxy for the deep-water complex, including yellowedge grouper, warsaw grouper, snowy grouper, and speckled hind. These stocks are currently managed as a complex under the Grouper-Tilefish individual fishing quote (IFQ) program for the commercial sector. Yellowedge grouper is an assessed species that would have an MSY proxy assigned under Sub-action 1.1 (unless the no action alternative is selected). The remaining stocks do not have stock assessments or MSY proxies. **Option 3a** would result in yellowedge grouper serving as a proxy for the stock complex. If yellowedge grouper is found to be overfished or experiencing overfishing, then that designation would apply to the entire stock complex. Similar to the options a and b in **Alternative 2**, **Option 3b** would establish the MSY proxy as the yield when fishing at $F_{20\% SPR}$ while **Options 3c** and **3d** would establish the MSY proxy as the yield when fishing at $F_{30\% SPR}$ and fishing at $F_{40\% SPR}$ respectively.

Alternative 4 would establish an MSY proxy for the tilefishes' stock complex, consisting of tilefish (golden), blueline tilefish, and goldface tilefish. Tilefish is an assessed species; however, the assessment was not considered adequate for the basis of harvest level recommendations and thus, is not appropriate as indicator stock. These stocks are currently managed as a complex under the Grouper-Tilefish IFQ program for the commercial sector. **Alternative 4** contains three options (**Options 4a**-**4c**) that would establish the MSY proxy as the yield when fishing at $F_{20\% SPR,}$ $F_{30\% SPR, or}$ $F_{40\% SPR,}$ respectively.

Alternative 5 would establish an MSY proxy for the jacks complex, including lesser amberjack, almaco jack, and banded rudderfish. Similar to the tilefish complex (**Alternative 4**), there are no assessed stocks in this group, and therefore no option to use an indicator species. An MSY proxy would be established for the entire group as the yield when fishing at $F_{20\% SPR,}$ $F_{30\% SPR, or}$ $F_{40\% SPR}$ (**Options 5a**-**5c**).

Alternative 6 would establish an MSY proxy for the mid-water snapper complex, including silk snapper, wenchman, blackfin snapper, and queen snapper. Similar to the tilefish and jacks complexes (**Alternatives 4**-**5**), there are no stocks with a accepted assessments in this group, and therefore, no option to use an indicator species. An MSY proxy would be established for the entire group as the yield when fishing at $F_{20\% SPR,}$ $F_{30\% SPR, or}$ $F_{40\% SPR}$ (**Options 6a**-**6c**).

Alternatives 7-**9** would establish MSY proxies for three stocks not included in a complexes**.** **Alternative 7** would define an MSY proxy for cubera snapper and similar to **Alternatives 2**-**6**, includes three options: $F_{20\% SPR,}$ $F_{30\% SPR, or}$ $F_{40\% SPR}$ (**Options 7a**-**7c**). Cubera snapper is a data

poor stock with relatively low annual landings and the annual catch limit was established in the Generic ACL/AM Amendment (GMFMC 2011) using tier 3a of the ABC control rule.

Alternative 8 would define an MSY proxy for lane snapper and, similar to **Alternatives 2-7**, includes three options: $F_{20\% SPR,}$ $F_{30\% SPR, or}$ $F_{40\% SPR}$ (**Options 8a-8c**). Lane snapper is a data poor stock with relatively low annual landings and the annual catch limit was established in the Generic ACL/AM Amendment (GMFMC 2011) using tier 3a of the ABC control rule. Lane snapper, was assessed under SEDAR 49 (2016) using the DLMTool. Based on the results of the DLMTool analysis, the SSC recommended that OFL be set at the catch recommendation result of the "Itarget" analysis, which is 364,100 pounds (GMFMC 2017c). However, no management changes were made as the change in the harvest level recommendation was modest and MSY (or proxy) was not determined in the assessment.

Alternative 9 would define an MSY proxy for goliath grouper. This species occurs as a single stock in the Gulf and U.S. and South Atlantic and is vulnerable to overfishing because of its long life-span and slow growth rate. This species has been closed to harvest since 1990 in the Gulf and South Atlantic, but no stock assessment has been completed for this species. **Alternative 9** contains three options (**Options 9a-9c**) that would establish the MSY proxy as the yield when fishing at $F_{30\% SPR,}$ $F_{40\% SPR, or}$ $F_{50\% SPR,}$ respectively. In comparison to the other alternatives in the sub-action, the options are biologically more conservative with **Option 9c and** would establish the MSY proxy $F_{50\% SPR.}$ The 1999 Sustainable Fisheries Act (SFA) Amendment had proposed an MSY proxy of 50% SPR. That proposal was rejected by the National Marine Fisheries Service (NMFS) on the basis that SPR by itself was not an acceptable proxy for biomass. However, the yield form fishing at $F_{50\% SPR}$ is an acceptable proxy, and it accomplishes the intent of the SFA Amendment. The South Atlantic Council has established a MSY proxy of $F_{SPR\ 40\% SPR}$ for goliath grouper which is **Option 9b** in this document.

Sub-action 1.3. MSY Proxy for Red Drum

Alternative 1. The MSY proxy for red drum remains undefined.

Alternative 2. The MSY proxy for red drum is the yield that provides for an escapement rate of juvenile fish to the spawning stock biomass (SSB) equivalent to 30% of those that would have escaped had there been no inshore fishery.

Alternative 3. The MSY proxy for red drum is the yield when fishing at $F_{30\% SPR}$.

Discussion:

The directed commercial harvest of red drum from the exclusive economic zone (EEZ) has been prohibited since 1987, and all harvest from the EEZ has been prohibited since 1988. In 1989, the acceptable biological catch (ABC) in the EEZ was set equal to zero, where it has remained. Harvest in state waters has continued. The Council, in Red Drum Amendment 2 (1988) requested that all Gulf states implement rules within their jurisdictions that would provide for an escapement rate of juvenile fish to the SSB equivalent to 30% of those that would have escaped had there been no inshore fishery.

Alternative 1 leaves the MSY proxy for red drum undefined. This is inconsistent with the current allowance of a state harvest. This is also inconsistent with the NS1 guidelines that state that SDC be measurable and objective. Technically, the MSY proxy is not considered an SDC, but the factors that are SDC (MFMT, OFL, and MSST) are based on the proxy.

Alternative 2 sets the MSY proxy for red drum at the yield that provides for an escapement rate of juvenile fish to the SSB equivalent to 30% of those that would have escaped had there been no inshore fishery. This is the management objective adopted by the states in response to the Council's request, and could function as an alternative proxy to the yield at $F_{X\% SPR}$. One drawback to this alternative is that, while it is generally assumed that a 30% escapement is approximately equivalent to 30% SPR, the relationship between escapement and SPR is not known. Another drawback is that, while escapement may be a measurable objective, there is no standard way of measuring it. Consequently, escapement estimates from the different states, measured in different ways, may not be comparable. If this alternative is adopted, NMFS and the states should work to develop standard and compatible methods for estimating escapement.

Alternative 3 sets the MSY proxy for red drum equal to the yield when fishing at $F_{30\% SPR}$. As discussed above, the current policy of a 30% escapement is considered approximately equivalent to 30% SPR, but the relationship between escapement and SPR is not known. Although fishing mortality rate may be measurable in state waters, the resulting value cannot be extended to federal waters because on changes in the size distribution. Thus, this alternative is not measurable at a Gulf-wide level, and would be considered a placeholder until a Gulf-wide assessment is conducted.

2.2 Action 2 - Maximum Fishing Mortality Threshold

Alternative 1. No action. Maintain current definitions of the Maximum Fishing Mortality Threshold (MFMT). These are:$F_{26\% SPR}$ for red and gray snapper[4]; $F_{50\% SPR}$ for goliath grouper; F_{MAX} for gag (where MAX is maximum yield per recruit); and $F_{30\% SPR}$ for all other reef fish stocks and red drum.

Alternative 2. For stocks where an MSY proxy has not been defined, set the MFMT equal to the fishing mortality at the MSY proxy for each stock or stock complex as determined in sub-actions 1.1, 1.2., and 1.3.

Alternative 3. If a stock is in a rebuilding plan, set the MFMT equal to the fishing mortality rate that is projected to rebuild the stock to B_{MSY} within the rebuilding time period ($F_{Rebuild}$). After the stock has recovered, the MFMT is equal to the fishing mortality at the stock's MSY proxy.

*Note: **Alternative 2** and **Alternative 3** can be selected together as preferred alternatives.

Discussion:

The Generic ACL/AM Amendment (GMFMC 2011) established two methods for determining if overfishing is occurring.

1. The NS1 guidelines define MFMT as the level of fishing mortality above which overfishing is occurring. The MFMT or reasonable proxy may be expressed either as a single number (a fishing mortality rate), or as a function of spawning biomass or other measure of reproductive potential. Under the provisions of the Generic ACL/AM Amendment (GMFMC 2011), in years where there is a stock assessment, overfishing is occurring if the stock assessment's estimate of the current fishing mortality rate is above MFMT.
2. The OFL is a yield that corresponds to fishing at MFMT. Under the provisions of the Generic ACL/AM Amendment (GMFMC 2011), in years when there is not a stock assessment, or for stocks that do not have assessments that provide estimates of fishing mortality, overfishing is occurring if the annual harvest exceeds the OFL.

The Generic SFA Amendment (GMFMC 1999) set MFMT equal to $F_{50\% SPR}$ for Nassau grouper and goliath grouper. It set MFMT equal to $F_{30\% SPR}$ for all other reef fish stocks except red snapper. It also set MFMT equal to $F_{30\% SPR}$ for red drum. For gag, the fishing mortality rate proxy for MSY (F_{MSY} proxy) and MFMT were subsequently set equal to the fishing mortality rate corresponding to maximum yield per recruit (F_{MAX}) in Amendment 30B (GMFMC 2008a). Following additional analyses conducted for the 2005 benchmark assessment of red snapper (SEDAR 7 2005), Amendment 27 (GMFMC 2007) and subsequent management actions used $F_{26\% SPR}$ as the red snapper proxy for F_{MSY} and MFMT.

[4] This reflects the preferred alternative for gray snapper in Amendment 51.

Alternative 1 (No Action) would leave MFMT unchanged. All reef fish stocks plus red drum have an MFMT as a result of the Generic SFA Amendment (GMFMC 1999), or subsequent amendments.

Alternative 2 would set MFMT equal to the fishing mortality rate based on the MSY proxies adopted in Action 1. In most cases, this would be the same as **Alternative 1**, but if an MSY proxy is changed in Action 1 or in a future amendment, the MFMT would also change to reflect the new proxy. For example, this may be the case for goliath grouper. The South Atlantic Council established a MSY proxy and corresponding MFMT level of the yield at $F_{SPR\ 40\%\ SPR}$ for goliath grouper. If the Gulf Council concurs with this change then the corresponding MFMT would also need to be updated in this action.

If an F_{Proxy} based MSY proxy is adopted where the fishing mortality rate cannot be determined, the MFMT would be a placeholder until a stock assessment can be conducted and fishing mortality (F) values estimated. Overfishing status could not be determined using F_{Proxy} because the value of F_{Proxy} is unknown. However, such stocks could still be determined to be undergoing overfishing if the OFL is exceeded.

Alternative 3 is the same as **Alternative 2** for stocks that are not in a rebuilding plan. However, if a stock is in a rebuilding plan, then MFMT would be equal to $F_{Rebuild}$ instead of F_{MSY}. This alternative would result in an overfishing determination if the stock is harvested at a level inconsistent with the rebuilding plan, i.e., above $F_{Rebuild}$. The OFL would be set at the more conservative $F_{Rebuild}$ rather than F_{MSY} and the ABC yield stream projections would then be a reduction from the $F_{Rebuild}$ level.

2.3 Action 3 - Minimum Stock Size Threshold

Alternative 1. No action. Do not define minimum stock size threshold (MSST) for stocks and stock complexes in sub-actions 1.1-1.3. Stocks with established minimum stock size threshold (MSST) will be retained for gag, gray triggerfish, greater amberjack, hogfish, red grouper, red snapper, vermillion snapper, and gray snapper[5].

Alternative 2. MSST = (1-M)* B_{MSY} (or proxy) where M is the natural mortality rate. This alternative applies to stocks and stock complexes in sub-actions 1.1-1.3.

Alternative 3. MSST = 0.75*B_{MSY} (or proxy). This alternative applies to stocks and stock complexes in sub-actions 1.1-1.3.

Alternative 4. MSST = 0.50*B_{MSY} (or proxy). This alternative applies to stocks and stock complexes in sub-actions 1.1-1.3.

Alternative 5. MSST = 0.50*B_{MSY} (or proxy) for all stocks and stock complexes in sub-actions 1.1-1.3 with the exception of stocks assessed across the South Atlantic and Gulf Council's jurisdictions (Goliath grouper, mutton snapper, yellowtail snapper, and black grouper). MSST for Goliath grouper, mutton snapper, yellowtail snapper, and black grouper stocks would use existing definitions of MSST defined by the South Atlantic Council.

Discussion:

MSST is a biomass level set at or below the biomass level capable for producing MSY or the MSY proxy (B_{MSY} (or proxy)) for a stock or stock complex. It is used to determine when a stock or stock complex is overfished. Reef Fish Amendment 44 (GMFMC 2017b) recently revised the MSST for seven reef fish stocks where it was previously defined (gag, red grouper, red snapper, vermilion snapper, gray triggerfish, greater amberjack, and hogfish). For these seven stocks, Amendment 44 set MSST equal to 0.50*B_{MSY} (or proxy). The preferred alternative in Reef Fish Amendment 51 (GMFMC 2019) would define MSST equal to 0.50*B_{MSY} (or proxy) for gray snapper. The remaining reef fish stocks and stock complexes have not had MSST defined, nor has it been defined for red drum in the FMP for the Red Drum Fishery of the Gulf of Mexico. The action proposes to define MSST for the remaining reef fish stocks and stock complexes as well as for red drum.

The NS1 guidelines allow MSST to be set at a level below B_{MSY} (or proxy), but no lower than 0.50* B_{MSY} (or proxy). If the fishing mortality can be kept below the overfishing threshold (MFMT), the stock or stock complex biomass is unlikely to drop below the overfished level (MSST). However, the stock or stock complex biomass can fluctuate due to environmental variability, or due to management being unsuccessful in constraining fishing mortality. In such cases, there are concerns with setting MSST either too close to or too far from B_{MSY} (or proxy).

[5] This reflects the preferred alternative for gray snapper in Amendment 51.

Concerns When Setting MSST

- If MSST is too close to B_{MSY}
  - It may not allow for natural fluctuations in the stock biomass
  - It may not be detectably different from B_{MSY}

- If MSST is too far from B_{MSY}
  - Stock could become in danger of recruitment collapse due to uncertainty about the 50% B_{MSY} level.
  - A stock that drops below MSST will require a more restrictive rebuilding plan.

Each of the alternatives sets MSST equal to some multiple of the stock or stock complex biomass corresponding to MSY or the MSY proxy (B_{MSY} (or proxy)). For data-poor stocks B_{MSY} (or proxy) may not be known. If B_{MSY} (or proxy) is unknown, then MSST is also unknown. For these stocks and stock complexes, the MSST definition is a placeholder until B_{MSY} (or proxy) can be calculated.

Four stocks, goliath grouper, black grouper, mutton snapper, and yellowtail snapper have been assessed as single stocks that span both the South Atlantic and Gulf Council's areas of jurisdiction. Neither the Gulf or South Atlantic Council's Scientific and Statistical Committee was able to endorse the goliath grouper assessment, so the condition of the stock is unknown. For black grouper, mutton snapper, and yellowtail snapper the stock acceptable biological catch (ABC) is allocated between the Council's for management (Table 2.2.1). For these stocks, the South Atlantic Council has already set MSST values. The MSST for goliath grouper is (1-M)*B_{MSY} and the MSST for black grouper, mutton snapper, and yellowtail uses 0.75*$SSB_{30\%SPR}$.

Table 2.2.1. South Atlantic Council MSST definitions for four snapper-grouper stocks and South Atlantic:Gulf allocations for three stocks.

Species	MSST	Allocation S Atl:Gulf
Mutton snapper	**0.75*$SSB_{30\%SPR}$**	**82:18**
Yellowtail snapper	**0.75*$SSB_{30\%SPR}$**	**75:25**
Black grouper	**0.75*$SSB_{30\%SPR}$**	**47:53**
Goliath grouper	**(1-M)*B_{MSY}**	**---**

Under **Alternative 1** (No Action), MSST is undefined and would need to be established on a case-by-case basis. This is inconsistent with the NS1 guidelines, which require that managed species have quantitative definitions of the status determination criteria.

Alternative 2 sets MSST at (1-M)*B_{MSY} (or proxy) for reef fish stocks and stock complexes as well as red drum. In the past, this method has often been the de facto MSST used to determine overfished status for stocks where MSST is undefined. When MSST is defined as equal to (1-M)*B_{MSY} (or proxy), stocks with a low mortality (M) can end up with an MSST that is only slightly below the B_{MSY} (or proxy) spawning stock biomass level. In such situations it can be difficult to determine if a stock is actually below MSST due to imprecision and accuracy of the data. In addition, natural fluctuations in stock biomass levels around the B_{MSY} level may temporarily drop the spawning stock biomass below MSST, although analysis from the Southeast Fisheries Science Center (SEFSC) suggests that this is unlikely except at very low natural mortality rates (see below). Setting a wider buffer between B_{MSY} (or proxy) and MSST can avoid these issues. In addition, setting a wider buffer can allow a greater opportunity for management to end a decline in a stock that is approaching an overfished condition without the constraints imposed by a rebuilding plan that is required if the stock drops below MSST and is declared overfished. However, if a stock does drop below MSST and is declared overfished, a more restrictive rebuilding plan may be needed than if there were a narrower buffer between B_{MSY} and MSST. This formula is used for at least some stocks managed by four of the Regional Management Councils (South Atlantic, Caribbean, Pacific, Western Pacific), plus the Highly Migratory Species Decision of NMFS. This is the MSST value used by the South Atlantic Council for goliath grouper, a species that has a single stock assessment shared by the South Atlantic and the Gulf Councils.

Alternative 2 requires that there be an estimate of M. Such estimates have been made through stock assessments. Estimates for the stocks considered in sub-actions 1.1-1.2 are shown in Table 2.2.2. These estimates range from a low of 0.073 (yellowedge grouper) to a high of 0.30 (maximum estimate for lane snapper), and the resulting MSST values using this formula range from 70% to 93% of the B_{MSY} (or proxy). For the stock complexes, the MSST for the shallow-water and deep-water grouper stock complexes would use the M for black grouper (0.136) and yellowedge grouper (0.073) if these species are selected as indicator species in Sub-action 1.2. For the tilefish complex, only tilefish (golden) has an estimate of M (0.13) from the Gulf and this could be used as a proxy for this complex upon SSC recommendation and Council approval. For the jack and mid-water snapper complexes as well as for cubera snapper, there are no Gulf estimates of M. The SEFSC and the SSC would need to determine if proxies for M could be developed by other means (e.g., estimates of M from the literature or from species sharing similar life history characteristics). A proxy for M would also need to be developed for lane snapper as literature-based estimates of M in the Gulf range from 0.11 to 0.30.

Under **Alternative 2**, if any species are added to the management unit, or if the estimate of M is changed in a peer-review report or SEDAR assessment for any existing species in the management unit, the MSST would be adjusted based on the most recent estimate of M if applicable under the preferred alternative selected in this action.

Alternative 3 sets MSST at 0.75*B_{MSY} (or proxy) for all reef fish stocks and stock complexes as well as for red drum. This alternative does not require an estimate of M because it sets the MSST at a fixed percentage of the B_{MSY} (or proxy). It is halfway between the B_{MSY} (or proxy) stock level and the 50% of B_{MSY} (or proxy) level, which is the minimum MSST level allowed by the NS1 guidelines. Therefore, this alternative is more conservative than **Alternative 4**.

Relative to **Alternative 2**, the effect of this alternative depends on the M of the individual species (Table 2.2.2). For species where natural mortality is greater than M = 0.25, **Alternative 3** is more conservative than **Alternative 2** (e.g., lane snapper). Where M is equal to 0.25, **Alternative 3** is equal to **Alternative 2**. Where M is less than 0.25, **Alternative 3** is less conservative than **Alternative 2**.

Alternative 4 sets MSST 0.50*B_{MSY} (or proxy) for reef fish stocks and stock complexes as well as red drum. This would set MSST at the 50% level for all stocks and stock complexes in Sub-actions 1.1-1.3. This level of MSST would match the MSST level established for seven other reef fish stocks in Amendment 44. This is the widest buffer allowed under the NS1 guidelines and is the least conservative alternative. This buffer is used for at least some stocks managed by three of the Regional Management Councils (New England, Mid-Atlantic, and North Pacific).

Table 2.2.2. Reef fish species with estimates of M from stock assessments for the Gulf stocks.

Common Name	Scientific Name	M	Source
Snappers			
Mutton snapper	*Lutjanus analis*	0.11	SEDAR 15A (2015)
Lane snapper*	*Lutjanus synagris*	0.30 0.11-0.24	Ault et al. (2005) Johnson et al. (1995)
Yellowtail snapper	*Ocyurus chrysurus*	0.194	O'Hop et al. (2012)
Vermilion snapper	*Rhomboplites aurorubens*	0.25	SEDAR 9 (2006a)
Groupers			
Yellowedge grouper	*Hyporthodus flavolimbatus*	0.073	SEDAR 22 (2011b)
Goliath grouper	*Epinephelus itajara*	0.12	SEDAR 23 (2011b)
Black grouper	*Mycteroperca bonaci*	0.136	SEDAR 19 (2010)
Tilefishes			
Tilefish	*Lopholatilus chamaeleonticeps*	0.13	SEDAR 22 (2011a)

* Lane snapper: Ault et al. (2005) estimated M=0.30 for lane snapper in the Florida Keys. Johnson et al. (1995) reported a range of M estimates from 0.11 to 0.24 for lane snapper from the northern Gulf.

Alternative 5 would set the definition of MSST at 0.50*BMSY (or proxy) for all stocks and stock complexes in sub-actions 1.1-1.3 with the exception of stocks assessed across the South Atlantic and Gulf Councils' jurisdictions. The South Atlantic Council established MSST for these stocks as (1-M)*B_{MSY} (or proxy) for goliath grouper and 0.75*B_{MSY} (or proxy) for mutton snapper, yellowtail snapper, and black grouper. For the rest of the stocks and stock complexes being considered in this action, the MSST would be equivalent to Alternative 4, or 0.50*B_{MSY} (or proxy). Using the South Atlantic Council's MSST for goliath grouper, mutton snapper, yellowtail snapper, and black grouper would provide a single overfished definition. If it is even possible to apply two different overfished definitions to mutton snapper, yellowtail snapper, and black grouper, this could result in a stock being considered overfished in one jurisdiction while not in the other. Any rebuilding plan would be complicated because the stock ABC would have to be reallocated between jurisdictions along the rebuilding yield stream. By using the same MSST definitions, the stock as a whole would be considered overfished and the current allocations could be applied to the rebuilding yield streams.

2.4 Action 4 – Optimum Yield

Alternative 1. No action. Do not define optimum yield (OY) for stocks and stock complexes in sub-actions 1.1-1.3. For hogfish and other reef fish stocks not listed above, Amendment 1 (GMFMC 1989) established OY as the yield when fishing at 20% SSBR (later, 20% SPR).

Alternative 2. Define OY for the shallow-water grouper complex. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 3. Define OY for the deep-water grouper complex. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 4. Define OY for the tilefish complex. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 5. Define OY for the jacks complex. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 6. Define OY for the mid-water snapper complex. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 7. Define OY for cubera snapper. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 8. Define OY for lane snapper. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option 2c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 9. Define OY for goliath grouper. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 10. Define OY for mutton snapper. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 11. Define OY for yellowtail snapper. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 12. Define OY for the hogfish west Florida stock. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Alternative 13. Define OY for red drum. Optimum yield implicitly accounts for relevant economic, social, or ecological factors by fishing at:

Option a. 50% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option b. 75% of F_{MSY} ($_{or\ MSY\ proxy}$).
Option c. 90% of F_{MSY} ($_{or\ MSY\ proxy}$).

Note: Stocks with previously defined OY are listed in Table 2.4.1.

Discussion:

The Magnuson-Stevens Act and NS1 guidelines state that OY should be based on MSY as reduced by relevant economic, social, or ecological factors. The NS1 guidelines provide additional detail in considering such factors and state that OY should include some consideration of uncertainty. The NS1 guidelines also state that if the estimates of MFMT and current biomass are known with a high level of certainty, and management controls can accurately limit catch, then OY could be set very close to MSY, assuming no other reductions are necessary for social, economic, or ecological factors. To the degree that such MSY estimates and management controls are lacking or unavailable, OY should be set farther from MSY.

Alternative 1 (No Action) would leave OY undefined for the stocks and stock complexes identified in Table 2.4.1. Leaving stocks or stock complexes with OY undefined is inconsistent with the NS1 guidelines.

Table 2.4.1. Current OY definitions as implemented in plan amendments

Stock	OY	Source
Gag	Yield at 75% of F_{MAX}	Amendment 30B (GMFMC 2008a)
Red grouper	Yield at 75% of F_{MSY}	Secretarial Amendment 1 (GMFMC 2004a)
Red snapper	Yield at 75% of F_{MSY}	Amendment 22 (GMFMC 2004b)
Vermilion snapper	Yield at 75% of $F_{MSY\ proxy}$	Amendment 47 (GMFMC 2017a)
Gray triggerfish	Yield at 75% of $F_{MSY\ proxy}$	Amendment 30A (GMFMC 2008b)
Greater amberjack	Yield at $F_{40\%\ SPR}$	Secretarial Amendment 2 (GMFMC 2002)
Gray snapper	Yield at 90% of F_{MSY}	Amendment 51 (GMFMC 2019)
Hogfish and other reef fish stocks not listed above	20% SSBR (later, 20% SPR)	Amendment 1 (GMFMC 1989)

Alternatives 2-13 would specify a long-term OY for the stocks and complexes included in Table 2.4.2 based on fixed percentages fishing at the yield between 50% and 90% of $F_{MSY\ (or\ MSY\ proxy)}$. **Alternatives 2-13** each contain three Options. **Option a** would define OY as 50% of $F_{MSY\ (or\ MSY\ proxy)}$ and is the most conservative of the options considered, as the yield would be the furthest below MSY. This option would provide the greatest protection for the stock or stock complex;

however, setting the OY this low may have negative social and economic costs as fewer fish would be available to the reef fish fishery. Fishing at 90% of $F_{MSY\ (or\ MSY\ proxy)}$ (**Option c**) would be the least conservative, as OY would be closest to MSY. This option would provide the least protection to the stock or stock complex, but would provide more fish to the fishery and likely have greater social and economic benefits. **Option b** (75% of $F_{MSY\ [or\ MSY\ proxy]}$) is intermediate to **Option a** and is the established OY for a majority of the reef fish stocks. **Option c** is also consistent with OYs set for other reef fish stocks (Table 2.4.1).

Alternatives 2-6 would apply to stock complexes and the OY selected would apply to all stocks in the complex. **Alternatives 7-12** would define OY for six reef fish stocks where OY is not defined. **Alternative 13** would define OY for red drum. Since a majority of the stocks or complexes considered in **Alternatives 2**–**9** do not have an accepted stock assessment, the MSY proxy and subsequent OY established for each stock or complex would act as a placeholder until an assessment is completed.

Black grouper (**Alternative 2)**, goliath grouper, mutton snapper, and yellowtail snapper (**Alternatives 9-11**) are single stocks assessed throughout the Gulf and South Atlantic Council jurisdictions. The South Atlantic Council has previously defined OY for their apportionment of these stocks where OY = ABC = ACL. However, this approach is not consistent with the revised NS1 guidelines. Thus, the Gulf Council is unable to adopt a concurrent definition for these stocks, and coordination between the Gulf and South Atlantic Councils will be necessary to develop compatible definitions of OY for jointly managed species.

Alternatives 2-13 can be selected concurrently in this action and the preferred option does not have to be consistent among the alternatives in this action. OY should be selected based on the unique characteristics of the affected stock or stock complex. However since a majority of the stocks or complexes considered in this action do not have an accepted stock assessment, the MSY proxy and corresponding OY established for each stock or complex would act as a placeholder until an assessment is completed.

Table 2.4.2. Stocks or stocks complexes that do not have an accepted definition of OY and are included in Action 4.

Alternative	Complex	Stock	Option a 50% of $F_{MSY\ (or\ MSY\ proxy)}$	Option b 75% of $F_{MSY\ (or\ MSY\ proxy)}$	Option c 90% of $F_{MSY\ (or\ MSY\ proxy)}$
2	Shallow-water grouper	Black grouper*			
		Scamp			
		Yellowmouth grouper			
		Yellowfin grouper			

3	Deep-water grouper	Yellowedge grouper			
		Warsaw grouper			
		Snowy grouper			
		Speckled hind			
4	Tilefish	Golden tilefish			
		Blueline tilefish			
		Goldface tilefish			
5	Jacks	Lesser amberjack			
		Almaco jack			
		Banded rudderfish			
6	Mid-water snapper	Silk snapper			
		Wenchman			
		Blackfin snapper			
		Queen snapper			
7	---	Cubera snapper			
8	---	Lane snapper			
9	---	Goliath grouper**			
10	---	Mutton snapper*			
11	---	Yellowtail snapper*			
12	---	Hogfish			
13	---	Red drum			

* Stocks are jointly managed with the South Atlantic Fishery Management Council and they have defined OY = ABC = ACL in their region.

* Goliath grouper is a single stock in both the Gulf and South Atlantic Council's jurisdictions. The South Atlantic Council has defined OY = 50% static SPR in the South Atlantic region.

CHAPTER 3. REFERENCES

Ault, J.S., S.G. Smith, and J.A. Bohnsack. 2005. Evaluation of average length as an estimator of exploitation status for the Florida coral-reef fish community. ICES Journal of Marine Science 62:417-423.

Farmer, N. A. and R.P. Malinowski. 2010. Species groupings for management of the Gulf of Mexico reef fish fishery. SERO-LAPP-2010-03. NOAA Fisheries Service, Southeast Regional Office, St. Petersburg, Florida. 47 pp.
http://gulfcouncil.org/docs/Species%20Groupings/Species%20groupings%20for%20management%20in%20the%20Gulf%20of%20Mexico%20-%20DRAFT%20of%200%20Jan%202010.pdf

Froese, R. and D. Pauly. Editors. 2014. FishBase Key facts summary.www.fishbase.org, version (08/2014).

a. Wenchman:
http://www.fishbase.se/PopDyn/KeyfactsSummary_2v2.php?ID=198&GenusName=Pristipomoides&SpeciesName=aquilonaris&vStockCode=212&fc=323
b. banded rudderfish:
http://fishbase.sinica.edu.tw/PopDyn/KeyFactsSummary_2v2.php?ID=1008&GenusName=Seriola&SpeciesName=zonata&vStockCode=1024&fc=314

GMFMC. 1989. Amendment 1 to the reef fish fishery management plan includes environmental assessment, regulatory impact review, and regulatory flexibility analysis. Gulf of Mexico Fishery Management Council, Tampa, Florida. 356 pp.
http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/RF%20Amend-01%20Final%201989-08-rescan.pdf

GMFMC. 1999. Generic sustainable fisheries act amendment, includes environmental assessment, regulatory impact review, and initial regulatory flexibility analysis. Gulf of Mexico Fishery Management Council, Tampa, Florida. 318 pp.
http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Generic%20SFA%20amendment%201999.pdf

GMFMC. 2002. Secretarial Amendment 2 to the Reef Fish Fishery Management Plan to set greater amberjack sustainable fisheries act targets and thresholds and to set a rebuilding plan includes environmental assessment and regulatory impact review. Gulf of Mexico Fishery Management Council. Tampa, Florida. 105 pp.
http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Secretarial-Amendment-2-RF.pdf

GMFMC. 2004a. Secretarial Amendment 1 to the reef fish management plan to set a 10-year rebuilding plan for red grouper, with associated impacts on gag and other groupers includes environmental assessment, regulatory impact review and final regulatory flexibility analyses.

Gulf of Mexico Fishery Management Council. Tampa, Florida. 367 pp. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Secretarial-Amendment-1-RF.pdf

GMFMC. 2004b. 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. 2004c. Final amendment 23 to the reef fish fishery management plan to set vermilion snapper sustainable fisheries act targets and thresholds and to establish a plan to end overfishing and rebuild the stock, including a final supplemental environmental impact statement and regulatory impact review. Gulf of Mexico Fishery Management Council. Tampa, Florida. 296 pp. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/VS%2023%20Oct%20Final%2010-21-04%20with%20Appendix%20E.pdf

GMFMC. 2007. Final amendment 27 to the reef fish fishery management plan and amendment 14 to the shrimp fishery management plan including supplemental environmental impact statement, regulatory impact review, and regulatory flexibility act analysis. Gulf of Mexico Fishery Management Council. Tampa, Florida. 490 pp with appendices. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Final%20RF%20Amend%2027-%20Shrimp%20Amend%2014.pdf

GMFMC. 2008a. Final Amendment 30B: gag – end overfishing and set management thresholds and targets. Red grouper – set optimum yield, TAC, and management measures, time/area closures, and federal regulatory compliance including environmental impact statement, regulatory impact review, and regulatory flexibility act analysis. Gulf of Mexico Fishery Management Council, Tampa, Florida. 427 pp. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Final%20Amendment%2030B%2010_10_08.pdf

GMFMC. 2008b. Final reef fish amendment 30A: greater amberjack – revised rebuilding plan, accountability measures; gray triggerfish – establish rebuilding plan, end overfishing, accountability measures, regional management, management thresholds and benchmarks including supplemental environmental impact statement, regulatory impact review, and regulatory flexibility act analysis. Gulf of Mexico Fishery Management Council. Tampa, Florida. 346 pp. http://www.gulfcouncil.org/docs/amendments/Amend-30A-Final%20208.pdf

GMFMC. 2011. Final generic annual catch limits/accountability measures amendment for the Gulf of Mexico fishery management council's red drum, reef fish, shrimp, coral and coral reefs fishery management plans, including environmental impact statement, regulatory impact review, regulatory flexibility analysis, and fishery impact statement. Gulf of Mexico Fishery Management Council. Tampa, Florida. 378 pp. http://www.gulfcouncil.org/docs/amendments/Final%20Generic%20ACL_AM_Amendment-September%209%202011%20v.pdf

GMFMC. 2016. Final Amendment 43 to the fishery management plan for the reef fish resources of the Gulf of Mexico. Hogfish stock definition, status determination criteria, annual catch limit, and size limit. Gulf of Mexico Fishery Management Council, Tampa, Florida. 164 pp. http://gulfcouncil.org/docs/amendments/Final%20Amendment%2043%20-%20Hogfish_10-11-2016.pdf

GMFMC. 2017a. Final amendment 47 to the reef fish fishery management plan: establish a vermilion snapper MSY proxy and adjust the stock annual catch limit, including environmental assessment, fishery impact statement, regulatory impact review, and regulatory flexibility act analysis. Gulf of Mexico Fishery Management Council. Tampa, Florida. 146 pp. http://gulfcouncil.org/wp-content/uploads/Final-Amendment-47-Vermilion-snapper-ACL-and-MSY-proxy.pdf

GMFMC. 2017b. Final amendment 44 to the fishery management plan for the reef fish resources of the Gulf of Mexico: Minimum stock size threshold (MSST) revision for reef fish stocks with existing status determination criteria, including environmental assessment and fishery impact statement. Gulf of Mexico Fishery Management Council. Tampa, Florida. 121 pp. http://gulfcouncil.org/wp-content/uploads/B-4a-Public-Hearing-Draft-Amendment-44-MSST-GOM-Reef-Fish.pdf

GMFMC. 2017c. Standing, shrimp, reef fish, and socioeconomic SSC meeting summary, March 27-19, 2017. Tampa, Florida. 15 pp.

GMFMC. 2019. Amendment 51 to the fishery management plan for the reef fish resources of the Gulf of Mexico: Establish gray snapper status determination criteria, reference points, and modify annual catch limits. Gulf of Mexico Fishery Management Council. Tampa, FL. 100 pp. http://gulfcouncil.org/wp-content/uploads/RF-Amendment-51-Gray-Snapper-07112019-_PublicHearingDraft.pdf

Goodyear, C. P. 1988. The Gulf of Mexico fishery for reef fish species, a descriptive profile. National Marine Fisheries Service, Southeast Fisheries Center, Miami Laboratory, CRD 87/88-19.

Harford, W.J., S.R. Sagarese, and M. Karnauskas. (2019). Selecting proxy fishing mortality reference points for grouper-snapper fisheries under uncertainty about stock-recruitment steepness. Cooperative Institute for Marine and Atmospheric Studies, University of Miami, and NOAA Southeast Fisheries Science Center, Sustainable Fisheries Division, Miami, FL. 21 pp.

Johnson, A.G., L. A. Collins, J. Dahl, and M. S. Baker, Jr., 1995. Age, growth, and mortality of lane snapper from the northern Gulf of Mexico. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 49:178-186. http://www.seafwa.org/pdfs/articles/JOHNSON-178-186.pdf

O'Hop, J., M. Murphy, and D. Chagaris. 2012. The 2012 stock assessment report for yellowtail snapper in the south Atlantic and Gulf of Mexico. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, Florida. 341 pp. http://sedarweb.org/docs/sar/YTS_FWC_SAR.pdf

SAFMC. 1998. Comprehensive amendment addressing sustainable fishery act definitions and other required provisions in fishery management plans of the South Atlantic region: amendment 4 to the shrimp fishery management plan, 2 to the red drum fishery management plan, amendment 11 to the snapper grouper fishery management plan, amendment 11 to the coastal migratory pelagics fishery management plan, amendment 2 to the golden crab fishery management plan, amendment 6 to the spiny lobster fishery management plan, amendment 5 to the coral, coral reefs, and live/hard bottom habitat fishery management plan. 311 pp. http://safmc.net/wp-content/uploads/2016/06/SnapGroupAmend11-1.pdf

SAFMC. 2011. Comprehensive annual catch limit (ACL) amendment for the South Atlantic region: amendment 2 to the fishery management plan for the dolphin wahoo fishery of the Atlantic: amendment 2 to the fishery management plan for pelagic sargassum habitat of the South Atlantic region : amendment 5 to the fishery management plan for the golden crab fishery of the South Atlantic region: amendment 25 to the fishery management plan for the snapper grouper fishery of the South Atlantic region. South Atlantic Fishery Management Council, North Charleston, South Carolina. 755 pp. https://www.dropbox.com/s/iz8wn5vec36hpis/CompACLAm_101411_FINAL.pdf?dl=0

SAFMC. 2013. Regulatory amendment 15 to the fishery management plan for the snapper grouper fishery of the South Atlantic region: yellowtail snapper, and shallow water groupers, environmental assessment, regulatory impact review, Regulatory Flexibility Act analysis. 240 pp. https://sero.nmfs.noaa.gov/sustainable_fisheries/s_atl/sg/2013/reg_am15/documents/pdfs/sa_reg_amend15_final.pdf

SAFMC. 2014. Regulatory Amendment 21 to the fishery management plan for the snapper grouper fishery of the South Atlantic region: Minimum stock size threshold (MSST) for snapper grouper stocks with low natural mortality. South Atlantic Fishery Management Council, North Charleston, South Carolina. 156 pp. https://sero.nmfs.noaa.gov/sustainable_fisheries/s_atl/sg/2014/reg_am21/documents/pdfs/sg_reg_am21_ea.pdf

SAFMC 2017. Amendment 41 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council. North Charleston, South Carolina. 165 pp. plus appendices. http://safmc.net/download/SGAm41_022817_FINAL.pdf

SEDAR 7. 2005. Stock assessment report of SEDAR 7 Gulf of Mexico red snapper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. 480 pp. http://sedarweb.org/docs/sar/S7SAR_FINAL-redsnapper.pdf

SEDAR 9. 2006. Stock assessment report 3 of SEDAR 9: Gulf of Mexico vermilion snapper assessment report 3. Southeast Data, Assessment, and Review. North Charleston, South Carolina. 231 pp. http://sedarweb.org/docs/sar/SEDAR9_SAR3%20GOM%20VermSnap.pdf

SEDAR 15A Update. 2015. Stock assessment of mutton snapper (*Lutjanus analis*) of the U.S. south Atlantic and Gulf of Mexico through 2013 – SEDAR update assessment. Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida. 142 pp. http://sedarweb.org/docs/suar/SEDAR%20Update%20Stock%20Assessment%20of%20Mutton%20Snapper%202015_FINAL.pdf

SEDAR 19. 2010. Stock assessment report Gulf of Mexico and South Atlantic black grouper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. 661 pp. http://sedarweb.org/docs/sar/Black_SAR_FINAL.pdf

SEDAR 22. 2011a. Stock assessment report Gulf of Mexico tilefish. Southeast Data, Assessment, and Review. North Charleston, South Carolina. 467 pp. http://sedarweb.org/docs/sar/tilefish_SAR_FINAL.pdf

SEDAR 22. 2011b. Stock assessment report Gulf of Mexico yellowedge grouper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. 423 pp. http://sedarweb.org/docs/sar/YEG_final_SAR.pdf

SEDAR 23. 2011c. Stock assessment report South Atlantic and Gulf of Mexico goliath grouper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. 248 pp. http://sedarweb.org/docs/sar/S23_SAR_complete_and_final.pdf

SEDAR 27A. 2012. The 2012 stock assessment report for yellowtail snapper in the South Atlantic and Gulf of Mexico. Southeast Data, Assessment, and Review. Florida Fish and Wildlife. 341 pp. http://sedarweb.org/docs/sar/YTS_FWC_SAR.pdf

SEDAR 49. 2016. Stock assessment report for Gulf of Mexico data-limited species: red drum, lane snapper, wenchman, yellowmouth grouper, speckled hind, snowy grouper, almaco jack, lesser amberjack. Southeast Data, Assessment, and Review. North Charleston, SC. 618 pp. http://sedarweb.org/docs/sar/SEDAR_49_SAR_report.pdf

APPENDIX A. METHODOLOGY FOR ESTABLISHING STOCK COMPLEXES

The following is a condensed version of the discussion on stock complexes included in the Generic ACL/AM Amendment (GMFMC 2011). For a more detailed description of the analysis, refer to the analysis report by Farmer et al. (2010).

Traditionally, management measures have been implemented using MSY proxies in species-specific stock assessments. However, red drum and many of the stocks in the Fishery Management Plan (FMP) for the Reef Fish Resources in the Gulf of Mexico (Reef Fish FMP) have not had stock assessments and are unlikely to be assessed in the near future. In these cases, the National Standard 1 (NS1) guidelines allow an MSY proxy to be assigned to a stock complex under certain conditions. Stock complex is defined as a group of stocks that are sufficiently similar in geographic distribution, life history, and vulnerabilities to the fishery such that the impact of management actions on the stocks is similar. Stocks may be grouped into complexes for various reasons, including where stocks in a multispecies fishery cannot be targeted independent of one another and MSY cannot be defined on a stock-by-stock basis; where there are insufficient data to measure their status relative to status determination criteria (SDC); or when it is not feasible for fishermen to distinguish individual stocks among their catch.

Analysis of the relationships between reef fish stocks was conducted by Farmer et al (2010) for purposes of establishing the stock complexes in the Generic ACL/AM Amendment (GMFMC 2011), and used here.

The objectives of the National Marine Fisheries Service (NMFS) stock groupings analysis specified in Farmer et al. (2010) were threefold: 1) To determine whether species assemblages can be identified in the Gulf of Mexico (Gulf) among the managed Reef Fish FMP species, 2) To determine if these assemblages are consistent between commercial and recreational fisheries, and 3) To develop species complexes that are "…sufficiently similar in geographic distribution, life history, and vulnerabilities to the fishery such that the impact of management actions on the stocks is similar" per NS1.

Methods

Following Lee and Sampson (2000), multiple statistical techniques were used to identify species assemblages: 1) species life history and depth of occurrence, 2) percent landings and percent trips by dataset, 3) dimension reduction and hierarchical cluster analyses based on life history; abundance; and presence-absence, 4) correlation matrices, 5) nodal analyses, and 6) maps of species distributions. These results were synthesized across analyses to develop potential species complexes for ACL management sufficiently similar in geographic distribution, life history, and vulnerabilities to the fishery such that the impact of management actions on the stocks would be similar.

Life History and Landings Data

Life history parameters were assembled from peer-reviewed literature, Southeast Data Assessment and Review (SEDAR) reports, unpublished data from the NMFS Panama City Laboratory, Stock Assessment and Fishery Evaluation reports, and from FishBase (Froese and Pauly 2014). Data from the Gulf of Mexico (Gulf) were used whenever possible. Depth of occurrence records were assimilated from FishBase, with minimum and maximum depths of occurrence recorded (Froese and Pauly 2014).

Commercial logbook, commercial observer, headboat logbook, recreational survey, and fishery-independent bottom longline data were used to evaluate similarities in spatial and temporal patterns of fisheries exploitation in the Gulf for species in the Reef Fish FMP. Commercial logbook records (SEFSC logbook data, accessed 6 May 2010) summarize landings on a trip level, with information for each species encountered including landings (in pounds), primary gear used, and primary area and depth of capture. Depth of capture is an important consideration when evaluating similarities in fisheries vulnerability and is only available in logbook records from 2005 onward, reported as a mean depth of capture, by species captured. It should be noted that a single depth of fishing is reported for each species per trip, although they may be encountered at numerous depths during multiple sets, and even within a single drifting longline set. Additionally, depth is occasionally misreported in fathoms rather than feet.

For the purposes of these analyses, logbook landings were summarized by species, year, month, gear type, statistical area, and depth. Trip-level adjustments were made to black grouper and gag landings to account for geographic differences in misidentification rates following recommendations from SEDAR 10 (2006). Year and month were defined by the date the fish were landed. Vertical line (e.g., handline and electric rig) and longline gear types were evaluated separately. Area fished was based on the 21 Gulf commercial logbook statistical areas (Figure 1). Depth of capture was aggregated into atmospheric pressure bins (e.g., 33 ft = 2 atm, 66 ft = 3 atm, etc.). Records with no reported depth or area of capture were removed from consideration; these represented approximately 9% of the total available records for both the longline and vertical line clusters. Overall, 27,566 longline and 121,767 vertical line commercial logbook records from 2005-2009 were evaluated.

For the commercial logbook data, separate analyses were conducted for commercial longline and commercial vertical line gear types. Landings were binned by month to maximize the variety of species landed while still capturing temporal trends in abundance. Fishermen will typically make multiple sets on a trip, sometimes in geographically distant areas, targeting different species. Binning by area and depth (commercial) reduced the probability of grouping species caught during the same time period that would likely not co-occur during any given set due to disparate geographic distributions.

In July 2006, NMFS implemented a mandatory reef fish observer program (RFOP) to characterize the reef fish fishery operating in the U.S. Gulf of Mexico. The mandatory RFOP provides general fishery bycatch characterization, estimates managed finfish discard and release mortality levels, and estimates protected species bycatch levels. The RFOP provides set-level

information on species encountered on trips using bottom longline, electric (bandit) reel, and handlines. Overall, 140,204 records representing 9,031 sets from 2005-2009 were evaluated.

The recreational headboat sector of the reef fish fishery was evaluated using headboat survey logbook data (Southeast Region Headboat Survey data, accessed 19 April 2010) reported by headboat operators. Headboats are large, for-hire vessels that typically accommodate 20 or more anglers on half or full day trips. Headboat records are arranged similar to commercial logbook records, and contain trip-level information on number of anglers, trip duration, date, area fished, and landings (number fish) and releases (number fish) of each species. Headboat landings and encounters (landings plus releases) were summarized by species, year, month, trip duration, and area fished. Trip duration was considered the best proxy for depth fished, as trips of longer duration are more likely to go farther offshore. Area fished was aggregated at the most common reporting level (1° latitude by 1° longitude). As with the commercial fishery data, area fished is self-reported and this introduces error into the analysis. Additionally, vessels fishing in multiple areas during a trip would be constrained by the current data form to select one area fished for the trip, which limits the spatial precision of the analysis. Records with no geographic area reported (~3%) were removed from consideration. Overall, 121,334 headboat records from 2004-2009 were evaluated.

The private, rental, and for-hire charter components were evaluated using data from the Marine Recreational Fisheries Statistics Survey (MRFSS) dockside intercept records. MRFSS intercepts collect data on port agent observed landings ('A' catch) and angler reported landings ('B1' catch) and discards ('B2' catch) in numbers by species, two-month wave (e.g., Wave 1 = Jan/Feb, … Wave 6 = Nov/Dec), area fished (inland, state, and federal waters), mode of fishing (charter, private/rental, shore), and state (west Florida, Alabama, Mississippi, and Louisiana). All MRFSS intercepts from the Gulf from 2000-2009 were aggregated by year, wave, mode, and area fished; computing a catch-per-angler-per-trip by species for the whole catch (e.g., 'A'+'B1'+'B2' catch). Overall, 64,782 dockside intercept records from 2000-2009 were evaluated.

REFERENCES

Farmer, N. A.& Malinowski, R.P. 2010. Species groupings for management of the Gulf of Mexico reef fish fishery. SERO-LAPP-2010-03. NOAA Fisheries Service, Southeast Regional Office, St. Petersburg, Florida. 47 pp. http://gulfcouncil.org/docs/Species%20Groupings/Species%20groupings%20for%20management%20in%20the%20Gulf%20of%20Mexico%20-%20DRAFT%20of%200%20Jan%202010.pdf

Froese, R. and D. Pauly. Editors. 2014. FishBase Key facts summary.www.fishbase.org, version (08/2014).

GMFMC. 2011. Final generic annual catch limits/accountability measures amendment for the Gulf of Mexico fishery management council's red drum, reef fish, shrimp, coral and coral reefs fishery management plans, including environmental impact statement, regulatory impact review, regulatory flexibility analysis, and fishery impact statement. Gulf of Mexico Fishery

Management Council. Tampa, Florida. 378 pp.
http://www.gulfcouncil.org/docs/amendments/Final%20Generic%20ACL_AM_Amendment-September%209%202011%20v.pdf

Lee, Y., and B. Sampson.2000. Spatial and temporal stability of commercial groundfish assemblages off Oregon and Washington as inferred from Oregon trawl logbooks. Canadian Journal of Fisheries and Aquatic Sciences 57:2443–2454.

SEDAR 10. 2006. Gulf of Mexico Gag Grouper Stock Assessment Report 2. Southeast Data, Assessment, and Review. North Charleston, South Carolina.
http://sedarweb.org/docs/sar/S10SAR2%20GOM%20Gag%20Assessment%20Report.pdf

APPENDIX B: FURTHER EXPLANATION OF *MSY PROXIES*

Alternative MSY proxies can include proxies based on reference points other than SPR. Below is a brief description of some alternative reference points and the reasons why they are not being considered in this amendment.

Yield at maximum yield per recruit (F_{MAX})

In addition to SPR-based MSY proxies, SEDAR standard assessment for Gulf of Mexico (Gulf) vermilion snapper (SEDAR 45 2016) investigated two maximum yield-per-recruit based proxies for MSY. Maximum yield-per-recruit means the maximum pounds of fish that can be harvested per individual fish recruited to the stock. Computing F_{MAX} entails finding the fishing mortality rate and age at first capture (assuming knife-edge selectivity for a single fleet) that produces the maximum yield per recruit. In practice, F_{MAX} is not particularly useful as an MSY proxy for management purposes, because many of the assumptions made during its calculation are not reflective of reality. For example, F_{MAX} assumes knife-edge selectivity (i.e., all fish are caught at a specific size or age). In reality, the fishery consists of multiple fleets, operating with disparate non-knife-edged selectivities, which are overlaid with substantial bycatch and discard mortality. Furthermore, F_{MAX} is calculated assuming no stock recruitment relationship, which nearly always results in F_{MAX} overestimating F_{MSY} (Gabriel and Mace 1999). In the case of SEDAR 45 (Gulf vermilion snapper), setting the age at first capture to 3 or 4 years resulted in nearly the same yield-per-recruit and corresponded with SPR values of 13% and 20%, respectively (Figure 2.1.1). Given the nearly identical yield-per-recruits associated with the two SPR values, the more conservative 20% SPR was the preferred result from the analysis. However, because this knife-edge age-based selectivity is dramatically different from the actual fleet selectivity dynamics, the Southeast Fisheries Science Center (SEFSC) recommended that these values should not be put forward as plausible alternatives for management[6].

[6] E-mail from Matthew Smith, SEFSC to Steven Atran, Gulf Council, dated July 11, 2016.

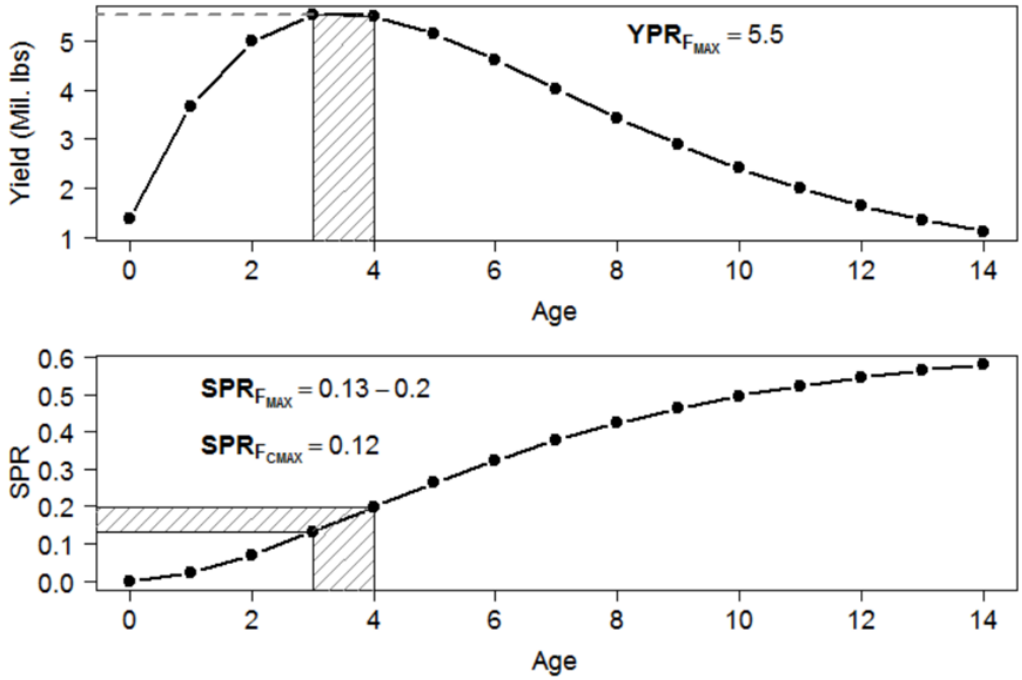


Figure B.1. Results of the global yield per recruit projections assuming a single fleet with optimal knife-edge selectivity at a given age, no bycatch or discards, and near infinite fishing mortality. The maximum yield occurs with recruitment to the fishery between ages 3 and 4 and results in a SPR between 13% and 20%. SPR associated with FCMAX analysis is displayed for reference.
Source: SEDAR 45 (2016)

Yield at conditional maximum yield per recruit (F_{CMAX})

In addition to F_{MAX}, which uses knife-edge selectivity at either age 3 or age 4, the fishing mortality rate that maximizes yield-per-recruit conditional on existing selectivity, bycatch, and discard patterns (F_{CMAX}) was calculated. Discards of the directed fleets were minimal and not incorporated into the model for SEDAR 45; however, bycatch from the shrimp fishery was included, and for the purpose of F_{CMAX} calculations, assumed to remain fixed at recent levels. Like the traditional F_{MAX} calculation, stock recruitment dynamics are not included in F_{CMAX} computations. F_{CMAX} was estimated to be 0.246 for Gulf vermilion snapper, which was projected to result in equilibrium SPR of 12%.

Despite the fact that $F_{MAX,}$ for the reasons stated above, is generally a poor proxy for F_{MSY}, ongoing research being conducted at the SEFSC has shown that the estimated equilibrium spawning stock biomass (SSB_{MAX}) and corresponding SPR value associated with F_{MAX} can be considered minimum biomass thresholds for sustainable management. Consequently, the SEDAR 45 stock assessment report recommended that any F_{MSY} proxy used to manage Gulf vermilion snapper result in a SPR value greater than or equal to 20%. Consequently, when the results of SEDAR 45 were presented to the Scientific and Statistical Committee (SSC), SEFSC staff did not recommend the use of F_{CMAX} as a viable proxy for F_{MSY} since it resulted in an SPR value well below the 20% threshold associated with $F_{MAX.}$

Yield at $F_{0.1}$

Because of the issues associated with using F_{MAX}, an alternative referred to as $F_{0.1}$ was developed and promoted as a more prudent alternative (Gulland and Boerema 1973). Technically, $F_{0.1}$ is defined as the fishing mortality rate corresponding to 10% of the slope of the yield-per-recruit curve at the origin. Although $F_{0.1}$ is commonly interpreted as a conservative or cautious estimate of F_{MSY}, this is not always the case (Mace 1994; Mace and Sissenwine 1993). Even when $F_{0.1}$ does underestimate F_{MSY}, the equilibrium yields associated with the two reference points may be relatively very close (based on the argument that the difference between the equilibrium yields associated with F_{MAX} and $F_{0.1}$ are usually small, and F_{MSY} is usually less than F_{MAX}) (Gabriel and Mace 1999). Therefore, $F_{0.1}$ is also considered not to be plausible for management.