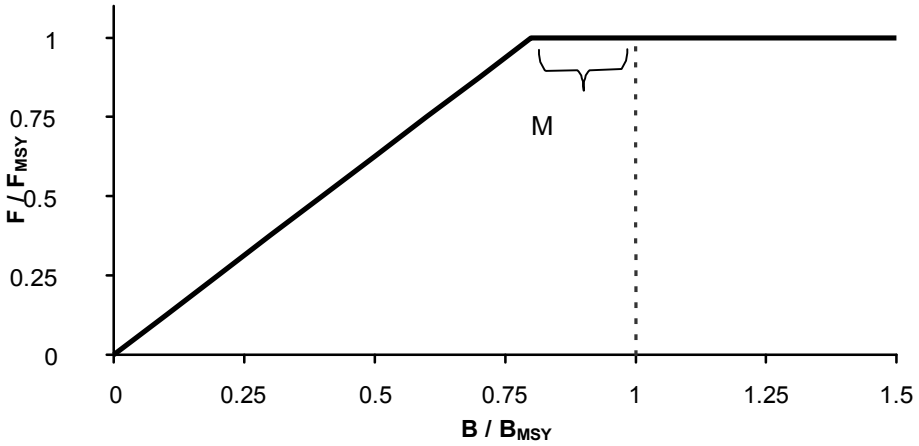
Minimum Stock Size Threshold (MSST) for reef fish stocks with low natural mortality



Options Paper

to the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico

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ABBREVIATIONS USED IN THIS DOCUMENT

Council	Gulf of Mexico Fishery Management Council
FMP	Fishery Management Plan
FMU	Fishery Management Unit
GMFMC	Gulf of Mexico Fishery Management Council
Gulf	Gulf of Mexico
M	Instantaneous Rate of Natural 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
OY	Optimum yield
SEDAR	Southeast Data, Assessment and Review
SPR	Spawning potential ratio

Table of Contents

LIST OF TABLES

LIST OF FIGURES

No table of figures entries found.

CHAPTER 1. INTRODUCTION

1.1 Background

Gulf of Mexico Fishery Management Council

- Responsible for conservation and management of fish stocks
- Consists of 17 voting members, 11 of whom are appointed by the Secretary of Commerce, the National Marine Fisheries Service Regional Administrator, and 1 representative from each of the 5 Gulf states marine resource agencies
- Responsible for developing fishery management plans and amendments, and for recommending actions to National Marine Fisheries Service for implementation

National Marine Fisheries Service

- Responsible for conservation and management of fish stocks
- Responsible for compliance with federal, state, and local laws
- Approves, disapproves, or partially approves Council recommendations
- Implements regulations

What Actions Are Being Proposed?

This Amendment to the Fishery Management Plan for the Reef Fish Fishery of the Gulf of Mexico proposes to modify the definition of minimum stock size threshold (MSST) for select reef fish species with a low (less than 0.15, 0.20, or 0.25) natural mortality rate, and to consider setting a default definition of MSST for all stocks in the reef fish fishery management unit.

Who is Proposing the Action?

The Gulf of Mexico Fishery Management Council (Council) is proposing the action. The Council develops the amendment and submits it to the National Marine Fisheries Service (NMFS) who publishes a rule to implement the amendment on behalf of the Secretary of Commerce. NMFS is an agency in the National Oceanic and Atmospheric Administration within the Department of Commerce.

Why are the Council and NMFS Considering Action?

This amendment would define (or re-define) the MSST for select reef fish species with low natural mortality rates to reduce the likelihood of the stock entering an overfished status due to normal year-to-year fluctuations in biomass levels. MSST is a biomass level set below the level corresponding to maximum sustainable yield (MSY) to allow for fluctuations in abundance while maintaining the capability to produce MSY on a continuing basis. The current definition of MSST used by the Council for most stocks where it has been defined is (1-M)*B_{MSY} (or proxy for B_{MSY}) or 0.5* B_{MSY} (or proxy), whichever is greater. M is the natural mortality rate and B_{MSY} (or proxy) is the biomass or biomass proxy when the stock is at the maximum sustainable yield (MSY) level and considered to be rebuilt. This can be measured in terms of female spawning stock biomass, total (male plus female) spawning stock biomass, or estimated spawning stock egg production. Using this formula, the buffer between MSY and MSST is very small for long-lived stocks that have a low M. Such stocks tend to have smaller natural fluctuations in abundance than high-M stocks, but even small fluctuations in biomass due to natural variations not related to fishing mortality may cause a stock to vary between an overfished or not overfished condition based on current definitions. When a species is identified as overfished, the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requires that a plan be implemented to rebuild the stock. Redefining MSST for species with low natural mortality rates would help to prevent unnecessary overfished designations when small drops in biomass are due to natural variation in recruitment or other environmental variables, and ensure that rebuilding plans are applied to stocks when truly appropriate.

This amendment would also consider establishing a default MSST for all reef fish stocks in the management unit. A previous attempt was made to define MSST as a certain spawning potential ratio (SPR) level for all reef fish species in the Generic Sustainable Fisheries Act Amendment (GMFMC 1999) was rejected by NMFS. Subsequent to that action, the Council began to define MSST and other status determination criteria for stocks as they were assessed, but only if needed in order to establish a rebuilding plan for overfished stocks. MSSTs have not been set for stocks without assessments or assessed stocks that were not in need of a rebuilding plan. Consequently, MSST has been defined for only 6 of the 31 species in the reef fish fishery management unit (Table 1.2).

1.2 Purpose and Need

The purpose for the action is set MSST for reef fish stocks taking into consideration natural mortality rates, and to establish MSST for all stocks in the reef fish fishery management unit. The need for the proposed action is to comply with the National Standard 1 guidelines requiring that stocks have an MSST while giving consideration to preventing reef fish stocks with low natural mortality rates from frequently alternating between overfished and non-overfished conditions due to natural variation in recruitment and other environmental factors.

1.3 History of Management

Following passage of the Sustainable Fisheries Act of 1996, the National Marine Fisheries Service (NMFS) published updated National Standard Guidelines that included the introduction of status determination criteria. The updated guidelines for National Standard 1 (NS1) described maximum fishing mortality threshold (MFMT) to determine when overfishing is occurring, and minimum stock size threshold (MSST) to determine when a stock is overfished. The NS1 guidelines further required that each fishery management plan (FMP) must specify, to the extent possible, objective and measurable status determination criteria for each stock or stock complex covered by that FMP and provide an analysis of how the status determination criteria were chosen and how they relate to reproductive potential.

In 1999, the Council submitted its Generic Sustainable Fisheries Act Amendment (GMFMC 1999), in which it attempted to define MSST and MFMT along with other biological reference points of maximum sustainable yield (MSY) and optimum yield (OY) for stocks under management. All of the definitions were based on static[1] spawning potential ratio (SPR). For reef fish stocks, the amendment proposed the following MFMT and MSST definitions (Table 1.1).

[1] SPR is a measure of reproductive capability, but is measured in two different ways. Static SPR is a measure of spawning-per-recruit relative to the level of spawning-per recruit that would occur in the absence of fishing. It is analogous to yield-per-recruit and is the level of spawning that would occur at equilibrium if fishing occurred at the same rate and selectivity pattern. Transitional SPR is a measure of spawning production per recruit in a given year relative to the spawning production that would have occurred in that year if there had been no fishing. Static SPR is directly related to fishing mortality and can be used as a measure of overfishing. Transitional SPR can be used to indicate how close the age structure of a stock is to being rebuilt, but does not necessarily correlate to absolute biomass levels (GMFMC 1996). Although these terms have fallen out of common use, phrases such as "a mortality rate of 30% SPR" or "yield when fishing at 30% SPR" refer to static SPR.

Table. 1.1. Proposed MSY, OY, MFMT, and MSST definitions in the Generic Sustainable Fisheries Amendment.

Stock	MSY	OY	MFMT	MSST
Nassau grouper Jewfish (goliath grouper)	50% static SPR	50% static SPR	Fishing mortality rate equivalent to 50% static SPR	To be implemented by framework measure as estimates of BMSY and MSST are developed by NMFS, the Reef Fish Stock Assessment Panel, and the Council.
Red snapper	26% static SPR	36% static SPR	Fishing mortality rate equivalent to 26% static SPR	
All other reef fish stocks	30% static SPR	40% static SPR	Fishing mortality rate equivalent to 30% static SPR	

On November 17, 1999, NMFS notified the Council that, while it approved the definitions of MFMT based on static SPR, it disapproved all SPRs submitted as proxies for MSY, OY and MSST because SPR is not biomass-based and is not an acceptable proxy for biomass reference points.

All stocks have an MFMT from the Generic Sustainable Fisheries Act Amendment or as later modified. Other status determination criteria and biological reference points were adopted on a stock-by-stock basis as stocks were assessed, but only if the stock was determined to be in need of a rebuilding plan. Stocks for which MSST has been adopted are shown in Table 2.1.

Table 1.2. Stocks with status determination criteria assigned.

Stock	MFMT	MSST	Source
Gag	F_{MAX}	(1-M)*$fSSB_{MAX}$ (M = 0.15)	Amendment 30B (GMFMC 2008a)
Red grouper	$F_{30\% SPR}$	(1-M)* SSfemale gonad wt_{MSY} (M = 0.2)	Secretarial Amendment 1 (GMFMC 2004a)
Red snapper	$F_{26\% SPR}$	(1-M)*B_{MSY} (M = 0.1)	Amendment 27 (GMFMC 2007)
Vermilion snapper	$F_{30\% SPR}$	(1-M)*B_{MSY} (M = 0.25)	Amendment 23 (GMFMC 2004b)
Gray triggerfish	$F_{30\% SPR}$	(1-M)*$eSSB_{30\% SPR}$ (M = 0.27)	Amendment 30A (GMFMC 2008b)
Greater amberjack	$F_{30\% SPR}$	(1-M)*B_{MSY} (M = 0.25)	Secretarial Amendment 2 (GMFMC 2002)

Several other reef fish species have had stock assessments, but were not in need of rebuilding plans (or in the case of goliath grouper, harvest was already prohibited), and therefore were not assigned status determination criteria. These stocks include mutton snapper, lane snapper, yellowedge grouper, goliath grouper, black grouper, tilefish, and hogfish.

CHAPTER 2. MANAGEMENT ALTERNATIVES

2.1 Action 1 – Define (or re-define) Minimum Stock Size Threshold for Species in the Reef Fish Fishery Management Unit with Low Natural Mortality Rates

Alternative 1: No Action. MSST for species that have a defined specification will not be changed. MSST will remain undefined for species that do not have a definition specified.

Alternative 2: Define (or re-define) the MSST for select species in the reef fish management unit with low natural mortality rates to 75% of B_{MSY} (or proxy). The threshold for adopting this MSST is if the natural mortality rate (M) from a peer-review report (e.g., a SEDAR stock assessment) is

Option a. the estimation of M is 0.15 or lower

Option b. the estimation of M is 0.20 or lower

Option c. the estimation of M is 0.25 or lower

Alternative 3: Define (or re-define) the MSST for select species in the reef fish management unit with low natural mortality rates to 50% of B_{MSY} (or proxy). The threshold for adopting this MSST is if the natural mortality rate (M) from a peer-review report (e.g., a SEDAR stock assessment) is

Option a. the estimation of M is 0.15 or lower

Option b. the estimation of M is 0.20 or lower

Option c. the estimation of M is 0.25 or lower

Discussion:

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 intent of this action is that MSST will be set based on the most recent estimate of M and the actions specified in Action 1 and Action 2.

This amendment does not address what proxy to use for B_{MSY} (e.g., $B_{26\% SPR}$, $B_{30\% SPR}$, B_{MAX}, etc.). Those proxies, where not currently set, will be set in the Generic Status Determination Criteria Amendment or will continue to be set on a case-by-case basis as needed. The purpose of this action is to establish the buffer between B_{MSY} and MSST regardless of what proxy is used.

Alternative 1 makes no changes to MSST. Currently only six species have MSST defined: red snapper, vermilion snapper, red grouper, gag, greater amberjack, and gray triggerfish (Table 1.2). For these species MSST = (1-M)*B_{MSY} (or proxy). The M values for these stocks range from

0.09 to 0.28, and the resulting MSST levels range from 72% to 91% of B_{MSY} (or proxy). The remaining reef fish stocks do not have MSST defined, but have M values ranging from 0.07 to 0.44. For two species, lesser amberjack and Almaco jack, M values could not be found in the published literature. When MSST is only slightly below B_{MSY}, even small fluctuations in biomass levels not related to fishing mortality may cause a stock at or near B_{MSY} to drop below MSST.

Natural fluctuations for stocks with low M values tend to be smaller than those for stocks with higher M values. Such stocks are longer-lived and, when healthy, have a large number of year-classes in the population. The addition of a particularly strong or weak year-class will have less impact and cause less fluctuation in the stock biomass than for a high-M stock that has only a few year-classes. However, the determination of M is imprecise and is an approximation at best. Many different methods exist to estimate M, and can produce dramatically different results. For example, Kenchington (2008) estimated M for the Gulf of Mexico gag stock using 23 different methods, and produced M values ranging from 0.07 to 0.59. Although the extreme estimates may be outliers, the true value of M cannot be known with certainty. Furthermore, when functions are used that allow the estimate of M to vary with age (e.g., Lorenzen 1996), the overall true M may vary when the age distribution of the stock varies. Setting MSST too close to B_{MSY} may not allow for uncertainty and variation in the true M when determining a stock's condition.

Alternative 2 sets MSST = 75% of B_{MSY} for selected stocks that have M at or below a certain value. This MSST is mid-way between B_{MSY} and 50% of B_{MSY}, which is the smallest value allowed under the National Standard guidelines. For the selected stock, this creates a larger buffer than under **Alternative 1**, reducing the likelihood of an overfished determination due to natural fluctuations. The possible M value thresholds are **Option a**: M=0.15, **Option b**: M=0.20, or **Option c**: M=0.25. The stocks included under each option are shown in Tables 2.1, 2.2, and 2.3.

Alternative 3 sets MSST = 50% of B_{MSY} for selected stocks that have M at or below a certain value. This is the smallest MSST value allowed under the National Standard guidelines. This alternative creates a larger buffer than either **Alternative 1** or **Alternative 2**. While this would reduce the likelihood of a stock being declared overfished even further, once a stock is declared overfished, it would require a more restrictive rebuilding plan to rebuild the stock within the time constraints of the Magnuson-Stevens Act and the National Standard 1 guidelines. This MSST definition is currently used for stocks managed by three of the Regional Fishery Management Councils (NEFMC, MAFMC, and NPFMC). In addition, the SAFMC sets MSST = 50% of B_{MSY} for dolphin because the natural mortality rate for dolphin is estimated at M = 0.68-0.80, which would place MSST beyond the 50% limit allowed by the National Standard 1 guidelines (SAFMC 2011). As with **Alternative 2**, the possible M value thresholds are **Option a**: M=0.15, **Option b**: M=0.20, or **Option c**: M=0.25. The stocks included under each option are shown in Tables 2.1, 2.2, and 2.3.

Table 2.1. Reef fish species with natural mortality estimates of 0.15 or lower (Option a).

Common Name	Scientific Name	M	Source
Snappers			
Mutton snapper	Lutjanus analis	0.11	SEDAR 15A (2008)
Red snapper	Lutjanus campechanus	0.094277	SEDAR 31 (2013)
Groupers			
Yellowedge grouper	Hyporthodus flavolimbatus	0.073	SEDAR 22 (2011a)
Goliath grouper	Epinephelus itajara	0.12	SEDAR 23 (2011c)
Red grouper	Epinephelus morio	0.14	SEDAR 12 (2007)
Black grouper	Mycteroperca bonaci	0.136	SEDAR 19 (2010)
Gag	Mycteroperca microlepis	0.134	SEDAR 33 (2014a)

Table 2.2. Reef fish species with natural mortality estimates of 0.20 or lower (Option b).

Common Name	Scientific Name	M	Source
Snappers			
Mutton snapper	Lutjanus analis	0.11	SEDAR 15A (2008)
Red snapper	Lutjanus campechanus	0.094277	SEDAR 31 (2013)
Yellowtail snapper	Ocyurus chrysurus	0.194	O'Hop et al. (2012)
Groupers			
Yellowedge grouper	Hyporthodus flavolimbatus	0.073	SEDAR 22 (2011a)
Goliath grouper	Epinephelus itajara	0.12	SEDAR 23 (2011c)
Red grouper	Epinephelus morio	0.14	SEDAR 12 (2007)
Black grouper	Mycteroperca bonaci	0.136	SEDAR 19 (2010)
Gag	Mycteroperca microlepis	0.134	SEDAR 33 (2014a)
Tilefishes			
Tilefish	Lopholatilus chamaeleonticeps	0.13	SEDAR 22 (2011b)
Other Species			
Hogfish	Lachnolaimus maximus	0.179	Cooper et al. (2013)

Table 2.3. Reef fish species with natural mortality estimates of 0.25 or lower (Option c).

Common Name	Scientific Name	M	Source
Snappers			
Mutton snapper	Lutjanus analis	0.11	SEDAR 15A (2008)
Red snapper	Lutjanus campechanus	0.094277	SEDAR 31 (2013)
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 (2011a)
Goliath grouper	Epinephelus itajara	0.12	SEDAR 23 (2011b)
Red grouper	Epinephelus morio	0.14	SEDAR 12 (2007)
Black grouper	Mycteroperca bonaci	0.136	SEDAR 19 (2010)
Gag	Mycteroperca microlepis	0.134	SEDAR 33 (2014a)
Tilefishes			
Tilefish	Lopholatilus chamaeleonticeps	0.13	SEDAR 22 (2011c)
Other Species			
Hogfish	Lachnolaimus maximus	0.179	Cooper et al. (2013)

* Lane snapper may or may not be included in Option c depending on which reference is used for the natural mortality estimate.

Table 2.4. Reef fish species with natural mortality estimates above 0.25.

Common Name	Scientific Name	M	Source
Jacks			
Greater amberjack	Seriola dumerili	0.28	SEDAR 33 (2014b)
Other Species			
Gray triggerfish	Balistes capriscus	0.27	SEDAR 9 (2006b)

2.2 Action 2 – Default Minimum Stock Size Threshold

Alternative 1: No Action. Except as specified in the proposed alternative of Action 1, MSST for species that have a defined specification will not be changed. MSST will remain undefined for species that do not have a definition specified.

Alternative 2: MSST = (1-M)*B_{MSY} (or proxy) or 0.50* B_{MSY} (or proxy), whichever is greater, for all reef fish stocks in the reef fish management unit except where otherwise specified in this amendment or other subsequent management action.

Alternative 3: MSST = 0.75*B_{MSY} (or proxy) for all reef fish stocks in the reef fish management unit except where otherwise specified in this amendment or other subsequent management action.

Alternative 4: MSST = 0. 50*B_{MSY} (or proxy) for all reef fish stocks in the reef fish management unit except where otherwise specified in this amendment or other subsequent management action.

Discussion:

As with the previous action, 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 intent of this action is that MSST will be set based on the most recent estimate of M and the actions specified in Action 1 and Action 2.

This action would consider establishing a default MSST for all reef fish stocks in the management unit other than those for which MSST is set in Action 1. This action only sets the formula for MSST. The specific MSY proxy to be used for each species (e.g., 30% SPR, maximum-yield-per-recruit, etc.) will be established in the Generic Status Determination Criteria Amendment (currently under development) or on a case-by-case basis as needed.

Alternative 1 leaves MSST undefined for reef fish species except for those species included in Action 1 or which already have a defined parameter (Table 1.2). Depending upon which alternative is selected in Action 1, up to 13 species may have MSST defined, leaving 18 or more species without a defined MSST. For these species, MSST will continue to be set on a case-by-case basis as needed.

Alternative 2 sets the MSST at (1-M)*B_{MSY} (or proxy) or 0.50* B_{MSY} (or proxy) for those reef fish species not included in the preferred alternative of Action 1. This is the MSST that is most commonly adopted on a case-by-case basis. This alternative was recommended as the default proxy by Restrepo et al (1998). It allows the buffer between B_{MSY} and MSST to vary between species depending upon life-history characteristics. Long-lived species with a low natural mortality rate (M) have populations consisting of a large number of age-classes, or cohorts. Consequently, the introduction of a particularly strong or weak cohort is likely to cause only a small fluctuation in biomass levels. Therefore, even if MSST is close to B_{MSY}, with only small

year-to-year natural fluctuations there is less likelihood of those fluctuations dropping below MSST and triggering a false or transient overfished determination. The benefit to having MSST set close to B_{MSY} is to allow a stock that is in decline to be identified early before highly restrictive management measures are needed to rebuild the stock. Conversely, short-lived species with a high M have only a few age-classes in the population, and the introduction of a particularly strong or weak cohort will result in greater fluctuations in biomass levels. In such cases it is more advantageous to have a larger buffer between MSST and B_{MSY} to avoid a false or transient overfished determination.

Status determination criteria include both MSST and a maximum fishing mortality threshold (MFMT). MFMT cannot be set any higher than F_{MSY} (or proxy), whereas MSST can (and usually is) set below B_{MSY} (or proxy). This makes MFMT a more restrictive criterion than MSST. The Magnuson-Stevens Act requires that overfishing be ended immediately once it is determined to be occurring whereas an overfished stock is allowed a rebuilding period of ten years or less (or more if it cannot be rebuilt in ten years) The more restrictive MFMT requirements make it more likely that stock management will be controlled more by the MFMT than by MSST even if the buffer between between MSST and B_{MSY} is small, provided it is large enough to account for natural fluctuations.

Alternative 3 sets MSST at a fixed $0.75*B_{MSY}$ (or proxy). It the M for a given stock is less than 0.25, this would result in a wider buffer between MSST and B_{MSY} than **Alternative 2**. For species other than those in the selected alternative in Action 1, if M for a given stock is greater than 0.25, this would result in a smaller buffer than **Alternative 2**. If **Action 1, Alternative 2 or Alternative 3** is selected, this would have no effect on species with M less than that selected in Action 1 (M = 0.15, 0.20, or 0.25) since Action 1 will have already set MSST for those species to either 75% or 50% of B_{MSY}. **Alternative 3** allows greater natural fluctuations in biomass than **Alternative 2**, but increases the likelihood that restrictive measures will be need to rebuild the stock if it drops below MSST and is determined to be overfished.

Alternative 4 sets MSST at a fixed $0.50*B_{MSY}$ (or proxy). This is the smallest MSST allowed by the National Standard Guidelines. No reef fish stocks currently in the Reef Fish FMP have M equal to or higher than 0.50. Therefore, this would result in a wider buffer between MSST and B_{MSY} than **Alternative 2 or Alternative 3** for all stocks not included in Action 1. **Alternative 4** allows the greatest natural fluctuations in biomass of the alternatives in this action. It greatly increases the likelihood that restrictive measures will be need to rebuild the stock if it drops below MSST and is determined to be overfished. However, if management is successful at maintain the fishing mortality rate at or below MFMT, the likelihood of the stock biomass dropping to this level of MSST is small.

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