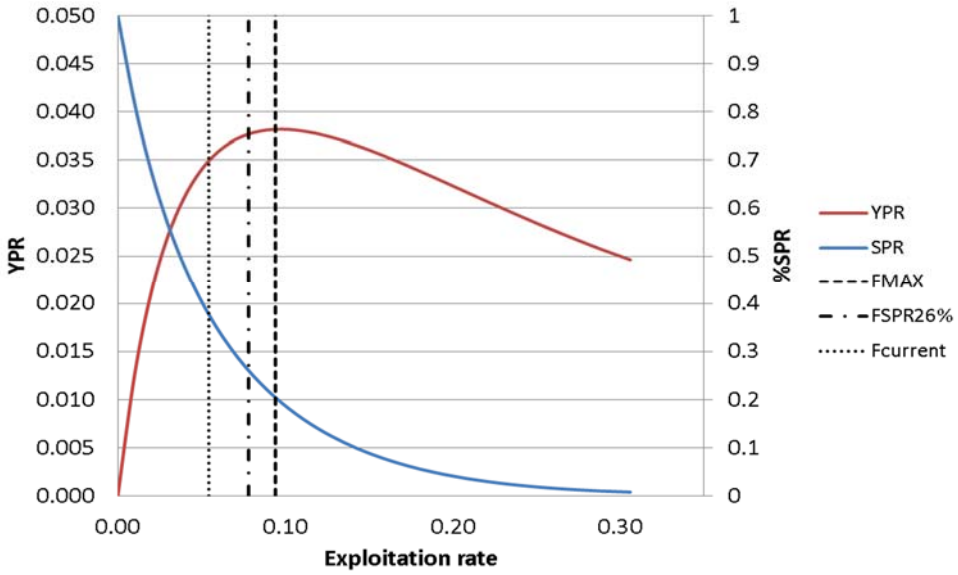
Options Paper to Define Status Determination Criteria and Optimum Yield for Reef Fish and Red Drum



Options Paper for

Amendment x to the Reef Fish Fishery Management Plan
Amendment y to the Red Drum Fishery Management Plan

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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 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.

Gulf of Mexico Fishery Management Council

- Responsible for conservation and management of fish stocks
- Consist of 17 voting members: 11 appointed by the Secretary of Commerce; 1 representative from each of the 5 Gulf states, the Southeast Regional Director of National Marine Fisheries Service; and 4 non-voting members
- Develops fishery management plans and amendments; and recommends actions to National Marine Fisheries Service for implementation in federal waters.

National Marine Fisheries Service

- Responsible for preventing overfishing while achieving optimum yield
- Approves, disapproves, or partially approves Council recommendations
- Implements regulations in federal waters

Status Determination Criteria and Biological Reference Points

The National Standard 1 (NS1) guidelines require that stocks each have measurable values for minimum stock size threshold (MSST), maximum fishing mortality threshold (MFMT), and overfishing limit (OFL), collectively known as status determination criteria (SDC). Stocks must also have a maximum sustainable yield (MSY) or proxy, optimum yield (OY), and annual catch limit (ACL). The Council currently has these reference points defined for some, but not all, stocks (Table 1.1). The Generic Sustainable Fisheries Act Amendment (GMFMC 1999) established fishing mortality based reference points for all stocks, but the proposed biomass reference points were disapproved by NMFS. Reference points were subsequently adopted in plan amendments for some stocks as rebuilding plans were needed. For other stocks, stock assessment scientists adopted reference points based on their scientific judgment, but without being formally adopted by the Council. In order to comply with the Magnuson-Stevens Act and NS1 guidelines, and to provide measurable reference points for determining overfished and

overfishing status, MSY proxies, MSST, MFMT, and OY must be established for all stocks. 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 some stocks, particularly those that are data-limited, it may be appropriate to combine stocks into a stock complex and assign the biological reference points to the stock complex or to an indicator species for the complex. Five such stock complexes were defined in the Generic Annual Catch Limits/Accountability Measures Amendment (GMFMC 2011) and are shown in Table 1.2.

1.2 Purpose and Need

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

The need is to have biological reference points that can be used for setting management targets and for determining overfished and overfishing status of the stocks.

1.3 History of Management

Seven reef fish stocks have MSY proxies, MSST, and MFMT established (or proposed and under review by NMFS) as shown in Table 1.1. In addition, OY has been established for six of these stocks.

Amendment 1 (GMFMC 1989) established OY as a harvest level for each species which maintains, or is expected to maintain, over time a survival rate of biomass into the stock of spawning age to achieve at least a 20 percent spawning stock biomass per recruit (SSBR) population level, relative to the SSBR that would occur with no fishing. The SSBR terminology was later changed to spawning potential ratio (SPR). In 1996, the Sustainable Fisheries Act and subsequent National Standard guidelines provided new criteria for defining status determination criteria and biological reference points. The Generic Sustainable Fisheries Act Amendment (GMFMC 1999) proposed new definitions of MSY proxy, MSST, MFMT, and OY for all stocks managed by the Council. However, NMFS accepted only the fishing mortality rate reference points (MFMT). SPR-based definitions for biomass reference points (MSY proxy, MSST, OY) were rejected on the basis that SPR was not a suitable proxy for biomass (NMFS later accepted the yield when fishing at $F_{X\% SPR}$ as a suitable proxy). Biomass reference points were aswsigned on a stock-by-stock basis as stock assessments were completed and a stock was determined to be in need of rebuilding. To date, six stocks have had acceptable biomass proxies established (Table 1.1). In addition, a seventh stock, hogfish, has had MSY proxy and MSST proposed in Amendment 44, but not OY.

For stocks that did not have accepted biomass reference points in the Generic Sustainable Fisheries Act Amendment or in subsequent amendments, OY remains at the Amendment 1 definition of the yield at 20% SPR. However, this definition may not be consistent with the requirements of the Sustainable Fisheries Act Amendment or current National Standard guidelines.

The terms MSST and MFMT did not exist when Amendment 1 was implemented. Therefore, stocks other than those in Table 1.1 do not have these status determination criteria defined. However, Amendment 1 did define overfished and overfishing as follows.

1. A reef fish stock or stock complex is overfished when it is below the level of 20 percent of the spawning stock biomass per recruit that would occur in the absence of fishing.

2. When a reef fish stock or stock complex is overfished, overfishing is defined as harvesting at a rate that is not consistent with a program that has been established to rebuild the stock or stock complex to the 20 percent spawning stock biomass per recruit level.

3. When a .reef fish stock or stock complex is not overfished, overfishing is defined as a harvesting rate that if continued would lead to a state of the stock or stock complex that would not at least allow a harvest of OY on a continuing basis.

As with OY, these definitions may not be consistent with the requirements of the Sustainable Fisheries Act Amendment or current National Standard guidelines.

Table 1.1. Stocks with status determination criteria assigned.

Stock	MSY	MSST (proposed*)	MFMT	OY	Source
Gag	Yield at F_{MAX}	$0.50*B_{MAX}$	F_{MAX}	Yield at 75% of F_{MAX}	Amendment 30B (GMFMC 2008a)
Red grouper	Yield at $F_{30\% SPR}$	$0.50* B_{30\% SPR}$	$F_{30\% SPR}$	Yield at 75% of F_{MSY}	Secretarial Amendment 1 (GMFMC 2004a)
Red snapper	Yield at $F_{26\% SPR}$	$0.50*B_{MSY}$	$F_{26\% SPR}$	Yield at 75% of $F_{26\% SPR}$	Amendment 22 (GMFMC 2004b) Amendment 27 (GMFMC 2007)
Vermilion snapper	Yield at $F_{30\% SPR}$	$0.50**B_{30\% SPR}$	$F_{30\% SPR}$	Yield at 75% of $F_{30\% SPR}$	Amendment 23 (GMFMC 2004c) Amendment 47 (GMFMC 2017a)
Gray triggerfish	Yield at $F_{30\% SPR}$	$0.50**B_{30\% SPR}$	$F_{30\% SPR}$	Yield at75% of $F_{30\% SPR}$	Amendment 30A (GMFMC 2008b)
Greater amberjack	Yield at $F_{30\% SPR}$	$0.50*B_{30\% SPR}$	$F_{30\% SPR}$	Yield at $F_{40\% SPR}$	Secretarial Amendment 2 (GMFMC 2002)
Hogfish	Yield at $F_{30\% SPR}$	$0.50*B_{30\% SPR}$	$F_{30\% SPR}$	**	Amendment 43 (GMFMC 2016a) Under NMFS review

* MSST was set equal to $0.50*B_{MSY\ proxy}$ in Amendment 44 (GMFMC 2017b).
** For hogfish and other reef fish stocks not listed above, Amendment 1 (GMFMC 1989) established OY as the yield when fishing at 20% spawning stock biomass per recruit (later, 20% SPR). However, this definition has not been evaluated for consistency with the Sustainable Fisheries Act of 1996.
Biomass may be measured either in terms of stock pounds or in terms of egg production.
Vermilion snapper MSY proxy was set at the yield corresponding to $F_{30\% SPR}$ in Amendment 47 (GMFMC 2017a), .

The NS1 guidelines allow status determination criteria and biological reference points to be established for stock complexes as well as individual stocks. Stock complexes should, where practicable, consist of stocks with similar geographic distribution, life history characteristics, and vulnerabilities to fishing pressure. The MSY proxy, MSST, MFMT, and OY can be set for either the stock complex as a whole, or for an indicator species that is part of the stock complex. The Generic ACL/AM Amendment defined five stock complexes (Table 1.2). Possible indicator species are those that have had stock assessments.

Table 1.2. 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	
Mid-water Snappers	Silk Snapper Wenchman Blackfin Snapper Queen Snapper	

The NS1 guidelines state that an indicator stock is a stock with measurable SDC that can be used to help manage and evaluate unassessed stocks that are in a stock complex. Possible indicator species are those that have had stock assessments.

CHAPTER 2. MANAGEMENT ALTERNATIVES

Action 1. Maximum Sustainable Yield (MSY) Proxies

Alternative 1. No action. Stocks with MSY proxies (Table 1.1) will retain the MSY proxies. For stocks with undefined MSY proxies, the proxy will be defined as needed for each stock by plan amendment.

Alternative 2. MSY proxy for each stock in the Reef Fish FMP is established as follows:

Stock	MSY Proxy: Yield at					
	$F_{SPR\ 20\%}$	$F_{SPR\ 26\%}$	$F_{SPR\ 30\%}$	F_{MAX}	F_{MSY}	Tier 3 or DLM OFL
Gag				X		
Red grouper			X			
Red snapper		X				
Vermilion snapper			X			
Gray triggerfish			X			
Greater amberjack			X			
Hogfish			X			
Grouper, Black			X			
Grouper, Goliath			X			
Grouper, Yellowedge			X			
Snapper, Mutton			X			
Snapper, Yellowtail			X			
Tilefish						X
Snapper, Queen						X
Snapper, Blackfin						X
Snapper, Cubera						X
Snapper, Gray						X
Snapper, Lane						X
Snapper, Silk						X
Wenchman						X
Speckled Hind						X
Grouper, Warsaw						X
Grouper, Snowy						X
Grouper, Yellowmouth						X

Scamp						X
Grouper, Yellowfin						X
Tilefish, Goldface						X
Tilefish, Blueline						X
Amberjack, Lesser						X
Almaco Jack						X
Banded Rudderfish						X
Red Drum						X

Alternative 3. Stock complex MSY proxies are established as follows. The MSY proxy will apply to the stock complex as a whole unless an indicator species is selected.

Stock Complex	**MSY Proxy: Yield at**					
	$F_{SPR\ 20\%}$	$F_{SPR\ 26\%}$	$F_{SPR\ 30\%}$	F_{MAX}	F_{MSY}	Tier 3 or DLM OFL
Tilefishes **-Tilefish (Golden)** **- Blueline tilefish** **- Goldface tilefish**						
Other Shallow-water Grouper **- Black grouper** **- Scamp** **- Yellowmouth grouper** **- Yellowfin grouper**						
Deep-water grouper **-Yellowedge grouper** **-Warsaw grouper** **- Snowy grouper** **- Speckled hind**						
Jacks **-Lesser amberjack** **-Almaco jack** **- Banded rudderfish**						
Mid-water snappers **- Silk snapper** **- Wenchman** **- Blackfin snapper** **- Queen snapper**						

Additional MSY proxy alternatives may be developed in consultation with the SSC.

Discussion:

Alternative 1 would maintain the MSY proxies previously assigned for 7 reef fish stocks as shown in Table 1.1; 30% SPR for red grouper, vermilion snapper, gray triggerfish, greater amberjack, and hogfish, 26% SPR for red snapper, and maximum yield per recruit for gag. The MSY proxy for all other reef fish stocks would remain unassigned, which does not comply with the Magnuson-Stevens Act and NS1 guidelines.

Alternative 2 would set the MSY proxy individually for each stock in the Reef Fish FMP plus red drum.

- As discussed above, seven reef fish stocks (the first seven listed) already have MSY proxies. The Council can choose to keep the existing proxies or to change them on a case by case basis.
- Several other stocks have had stock assessments that assumed an MSY proxy of 30% SPR, but the proxy was not formally adopted.
- Many stocks have either not had stock assessments, or the assessment was not able to determine an SPR. For these stocks, an SPR based proxy would be meaningless because there is no way to quantify the MSST or MFMT with respect to SPR. Under the NS1 guidelines, MSST and MFMT must be measureable. Some measurement other than SPR is needed to evaluate MSY. One possibility is to set the MSY proxy equal to the constant catch OFL as determined by either Tier 3 of the ABC control rule or by a data-limited method.

Alternative 3 could be adopted in combination with **Alternative 2**. It would establish MSY proxies for stock complexes rather than individual stocks. If the MSY proxy is an MSY for the stock complex as a whole, this would likely need to be done through a Tier 3 or data-limited method. An option would be to designate a stock within the complex that has had a stock assessment as the indicator species. However, not all stock complexes have a species with a stock assessment (Table 1.2). Stocks selected for a stock complex MSY proxy would be removed from the table in **Alternative 2** and would not have individual MSY proxies.

Action 2. Minimum Stock Size Threshold (MSST)

Alternative 1: No Action. Stocks with MSST will retain the MSST. For stocks with undefined MSST, the MSST will be defined as needed for each stock by plan amendment..

Alternative 2: For stocks where MSST is currently undefined, MSST = (1-M)*$B_{MSY\ (or\ proxy)}$.

Alternative 3: For stocks where MSST is currently undefined, MSST = (1-M) *$B_{MSY\ (or\ proxy)}$ or 0.75*$B_{MSY\ (or\ proxy)}$, whichever provides a larger buffer between MSST and $B_{MSY\ (or\ proxy)}$.

Alternative 4: For stocks where MSST is currently undefined, MSST = 0.85*$B_{MSY\ (or\ proxy)}$.

Alternative 5: For stocks where MSST is currently undefined, MSST = 0.75*$B_{MSY\ (or\ proxy)}$.

Alternative 6: For stocks where MSST is currently undefined, reef fish stocks MSST = 0.50*$B_{MSY\ (or\ proxy)}$.

Discussion:

MSST is a stock biomass level set at or below the biomass level capable for producing maximum sustainable yield (MSY) or the MSY proxy ($B_{MSY\ (or\ proxy)}$). It is used to determine when a stock is overfished. Amendment 44 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 remaining 24 reef fish stocks have not had MSST defined, nor has it been defined for red drum in the Red Drum FMP. The action proposes to define MSST for the remaining reef fish stocks and 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 MFMT, stock biomass is unlikely to drop below MSST. However, stock 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 or too far from $B_{MSY\ (or\ proxy)}$.

- If MSST is too close to B_{MSY}
  - It may not allow for natural fluctuations
  - 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 stock 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, the MSST definition is a placeholder until $B_{MSY\ (or\ proxy)}$ can be calculated.

Under **Alternative 1**, MSST is undefined and would need to be established on a case by case basis. This is inconsistent with the National Standard 1 guidelines, which require that managed species have quantitative definitions of the status determination criteria.

Alternative 2 sets MSST for all stocks where MSST is currently undefined at $(1\text{-}M)*B_{MSY\ (or\ proxy)}$. In the past, this has often the de facto MSST used to determine overfished status for stocks where MSST is undefined. When MSST is defined as equal to $(1\text{-}M)*B_{MSY\ (or\ proxy)}$, stocks with a low natural mortality rate (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.

Alternative 2 requires that there be an estimate of natural mortality (M). Such estimates have been made through stock assessments for 14 of the 31 reef fish stocks in the Gulf (Table 2.1.1). These estimates range from a low of 0.073 (yellowedge grouper) to a high of 0.28 (greater amberjack), and the resulting MSST values using this formula range from 72% to 91% of the $B_{MSY\ (or\ proxy)}$. An additional 14 stocks have natural mortality estimates from other regions, either in the published literature or in Southeast Data, Assessment, and Review (SEDAR) assessments done for South Atlantic stocks (Table 2.1.2). The SEFSC and the Scientific and Statistical Committee (SSC) would need to determine if these estimates are applicable to the Gulf stocks or if separate Gulf estimates are needed. Three stocks (goldface tilefish, lesser amberjack, Almaco jack) have no published estimates of natural mortality (Table 2.1.2). Unless a natural mortality rate can be estimated, this formula cannot be used, and those three stocks would continue to have MSST undefined.

Alternative 3 sets MSST for all stocks where MSST is currently undefined at $0.75*B_{MSY\ (or\ proxy)}$ for stocks that have M = 0.25 or less, and uses the $(1\text{-}M)*B_{MSY}$ formula for stocks where M is greater than 0.25. As a result, all reef fish stocks would have a buffer of at least $0.75*B_{MSY\ (or\ proxy)}$. Stocks with M greater than 0.25 would use the $(1\text{-}M)*B_{MSY}$ formula, which would result in a wider buffer between B_{MSY} and MSST. Those stocks that would have MSST defined at $0.75*B_{MSY\ (or\ proxy)}$ are:

Mutton snapper (M=0.11)	Blackfin snapper (M=0.23)*	Snowy grouper (M=0.12)
Yellowtail snapper (M=0.194)	Cubera snapper (M=0.15)	Yellowmouth gr. (M=0.14)*
Yellowedge grouper (M=0.073)	Gray snapper (M=0.25)	Scamp (M= 0.14)*
Goliath grouper (M=0.12)	Silk snapper (M = 0.19)*	Yellowfin grouper (M=0.20)
Black grouper (M=0.136)	Speckled hind (M=0.15)*	Blueline tilefish (M=0.10)

Tilefish (M=0.13) Warsaw grouper (M=0.08)

Stocks with natural mortality rates greater than M=0.25, for which the (1-M)*B_{MSY} formula would be used, include:

Lane snapper (M=0.1=30, MSST – 0.70*$B_{MSY\ (or\ proxy)}$)*
Queen snapper (M=0.33, MSST – 0.67*$B_{MSY\ (or\ proxy)}$)
Wenchman (M=0.44, MSST – 0.56*$B_{MSY\ (or\ proxy)}$)
Banded rudderfish (M=0.41, MSST – 0.59*$B_{MSY\ (or\ proxy)}$)

*Some stocks had more than one natural mortality estimate in the literature. For those stocks, the most recent estimate (and the lower estimate if a range of estimates was provided) was used in the above listings.

For the three stocks (goldface tilefish, lesser amberjack, Almaco jack) that have no published estimates of natural mortality, the (1-M)*B_{MSY} formula cannot be used. Therefore, these three stocks would be included in the list of stocks where MSST= 0.75*$B_{MSY\ (or\ proxy)}$.

Alternative 4 sets MSST for all stocks where MSST is currently undefined at 0.85*$B_{MSY\ (or\ proxy)}$ for all reef fish stocks. Compared to **Alternative 2**, this would create a wider (less conservative) buffer for the following 9 stocks where M is less than 0.15: mutton snapper, yellowedge grouper, goliath grouper, black grouper, tilefish, Warsaw grouper, snowy grouper, yellowmouth grouper, and blueline tilefish.. Compared to all other alternatives, this would create a narrower (more conservative) buffer.

Alternative 5 sets MSST for all stocks where MSST is currently undefined at 0.75*$B_{MSY\ (or\ proxy)}$ for all reef fish stocks. This would set MSST at the 0.75 level for all 24 reef fish stocks for which MSST is addressed in this action and for red drum.

Alternative 6 sets MSST 0.50*$B_{MSY\ (or\ proxy)}$ for all reef fish stocks. This would set MSST at the 0.50 level for all 24 reef fish stocks for which MSST is addressed in this action and for red drum, and it would match the MSST level established for seven other reef fish stocks in Amendment 44. This is the widest buffer allowed under the National Standard 1 guidelines. This buffer is used for at least some stocks managed by three of the Regional Management Councils (New England, Mid-Atlantic, North Pacific).

Under **Alternative 2** and **Alternative 3**, if any species are added to the management unit, or if the estimate of natural M is changed in a peer-review report or SEDAR assessment for any existing species in the management unit, the MSST will be adjusted based on the most recent estimate of M if applicable under the preferred alternative selected in this action.

Table 2.1. Reef fish species with natural mortality estimates from stock assessments for the Gulf of Mexico stocks.

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 (2006c)
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)
Greater amberjack	*Seriola dumerili*	0.28	SEDAR 33 (2014b)
Gray triggerfish	*Balistes capriscus*	0.27	SEDAR 9 (2006az)

* 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 of Mexico.

Table 2.2. Reef fish species with no estimate of Gulf of Mexico natural mortality. Natural mortality estimates, where shown, are for stocks from other regions, primarily the Florida Keys, U.S. South Atlantic, or Caribbean.

Common Name	Scientific Name	M	Source
Snappers			
Queen snapper	*Etelis oculatus*	0.843 0.33-0.76	Murray and Moore (1992) Bryan et al. (2011)
Blackfin snapper	*Lutjanus buccanella*	0.23 0.73	Ault et al. (1998) Tabash and Sierra (1996)
Cubera snapper	*Lutjanus cyanopterus*	0.15	Ault et al. (1998)
Gray (mangrove) snapper	*Lutjanus griseus*	0.25 0.18-0.43	Ault et al. (2005) Burton (2000)
Silk snapper	*Lutjanus vivanus*	0.23 0.19-0.86 0.86	Ault et al. (1998) Bryan et al. (2011) Tabash and Sierra (1996)
Wenchman	*Pristipomoides aquilonaris*	0.44	Froese and Pauly (2014a)
Groupers			
Speckled hind	*Epinephelus drummondhayi*	0.20	Ault et al. (1998)

		0.15	Ziskin (2008)
Warsaw grouper	*Hyporthodus nigritus*	0.08	Ault et al. (1998)
Snowy grouper	*Hyporthodus niveatus*	0.12	SEDAR 36 (2013)
Yellowmouth grouper	*Mycteroperca interstitialis*	0.14-0.24*	Burton et al. (2014)
Scamp	*Mycteroperca phenax*	0.15 0.14	Potts and Brennan (2001) Ault et al. (2005)
Yellowfin grouper	*Mycteroperca venenosa*	0.20	Ault et al. (2005)
Tilefishes			
Goldface tilefish	*Caulolatilus chrysops*	n/a	
Blueline tilefish	*Caulolatilus microps*	0.10	SEDAR 32 (2013)
Jacks			
Lesser amberjack	*Seriola fasciata*	n/a	
Almaco jack	*Seriola rivoliana*	n/a	
Banded rudderfish	*Seriola zonata*	0.41	Froese and Pauly (2014b)

* For yellowmouth grouper, Burton et al. (2013) gave age specific natural mortality rates calculated three ways, but did not provide an average. The values in this table are the range of average values for each method for the adult age groups (ages 3 to 31).

Action 3. Maximum Fishing Mortality Threshold (MFMT)

Alternative 1. No action. The current definitions for MFMT will be retained, as shown in Tables 1.1 and 1.2. These are:

- $F_{26\% SPR}$ for red snapper
- $F_{50\% SPR}$ for Nassau grouper and goliath grouper
- F_{MAX} for gag
- $F_{30\% SPR}$ for all other reef fish and for red drum

Alternative 2. MFMT = F_{PROXY} for for all stocks, where Proxy is the MSY proxy for each stock as determined in Action 1.

Alternative 3. MFMT = F_{PROXY} for stocks that are not in a rebuilding plan or that have exceeded the maximum time for rebuilding.
MFMT = $F_{REBUILD}$ for stocks that are in a rebuilding plan

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 (i.e., F), on an annual basis, above which overfishing is occurring. The MFMT or reasonable proxy may be expressed either as a single number (a fishing mortality rate or F value), 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 overfishing limit (OFL) is a yield that corresponds to fishing at MFMT. Under the provisions of the Generic ACL/AM Amendment (GMFMC 2011), in years where there is not a stock assessment, or for stocks that do not have assessments that provide estimates of F, overfishing is occurring if the annual harvest exceeds the OFL.

The Generic Sustainable Fisheries Act 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. The gag F_{MSY} proxy and MFMT were subsequently set equal to 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.

Alternative 1 leaves 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. However, these are specific values (e.g., $F_{30\% SPR}$ instead of F_{proxy}), and they may not match the MSY proxy if it is changed in Action 1 or in future amendments.

Alternative 2 sets MFMT equal to F_{proxy} based on the MSY proxies adopted in Action 1. In most cases, this will be the same as **Alternative 1**, but if an MSY proxy is changed in Action 1 or in a future amendment, the MFMT will also change to reflect the new proxy.

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 is equal to $F_{Rebuild}$ instead of F_{MSY}. Stocks that are rebuilding will not be rebuilt by the target date if fished at F_{MSY}, yet they are not currently considered to be undergoing overfishing. This alternative would result in an overfishing determination if the stock us harvested at a level inconsistent with the rebuilding plan, i.e., above $F_{Rebuild}$. OFL would be set at the more conservative $F_{Rebuild}$ rather than F_{MSY}. ABC would then be a reduction from the FRebuild level. This is being done informally for red snapper, but **Alternative 3** would make it official.

Action 4. Optimum Yield (OY)

Alternative 1. No action. For stocks with undefined OY, the reference point will be defined as needed for each stock by plan amendment.

Alternative 2. OY is the equilibrium yield that implicitly accounts for relevant economic, social, or ecological factors by fishing at

Option a. 50% of F_{MSY} (or 50% of MSY when F_{MSY} cannot be determined)

Option b. 75% of F_{MSY} (or 50% of MSY when F_{MSY} cannot be determined)

Option c. 90% of F_{MSY} (or 50% of MSY when F_{MSY} cannot be determined)

Alternative 3. OY is the equilibrium yield that explicitly accounts for relevant economic, social, or ecological factors by the use of a decision tool that considers such factors when reducing OY from MSY. (Factors used in the stock prioritization tool may be included in the OY decision tool.)

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, including:

> (1) The benefits of food production derived from providing seafood to consumers; maintaining an economically viable fishery together with its attendant contributions to the national, regional, and local economies; and utilizing the capacity of the Nation's fishery resources to meet nutritional needs.
>
> (2) The benefits of recreational opportunities reflect the quality of both the recreational fishing experience and non-consumptive fishery uses such as ecotourism, fish watching, and recreational diving. Benefits also include the contribution of recreational fishing to the national, regional, and local economies and food supplies.
>
> (3) The benefits of protection afforded to marine ecosystems are those resulting from maintaining viable populations (including those of unexploited species), maintaining adequate forage for all components of the ecosystem, maintaining evolutionary and ecological processes (e.g., disturbance regimes, hydrological processes, nutrient cycles), maintaining productive habitat, maintaining the evolutionary potential of species and ecosystems, and accommodating human use.

Two types of OY discussed in the NS1 guidelines, a long-term (equilibrium) OY and an annual OY. An annual OY if defined cannot exceed the annual ACL, and must be consistent with achieving a long-term OY. Therefore, an annual OY cannot be set in the absence of a long-term OY. An annual OY is optional. Given that, with the use of ACLs and ACTs, annual OY appears superfluous, this action focuses on determining the long-term OY.

Alternative 1 leaves OY undefined for stocks that currently have no definition, and unchanged for those stocks that have an OY definition (Table 4.1). Leaving stocks with OY undefined is inconsistent with the NS1 guidelines.

Table 2.3. Current OY definitions

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)

Alternative 2 specifies a long-term OY for each stock. The long-term OY is an equilibrium yield around which the yield may fluctuate. Under **Alternative 2**, OY is some fixed percentage of MSY (or the yield at some fixed percentage of F_{MSY}) that is considered to implicitly account for relevant economic, social, or ecological factors when specifying OY.

Under **Alternative 3**, a decision tool would be developed that would be used assign a value to explicitly incorporate relevant economic, social, or ecological factors into the determination of OY. The stock prioritization tool incorporates some of these factors, and could be used in the development of a decision tool.

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