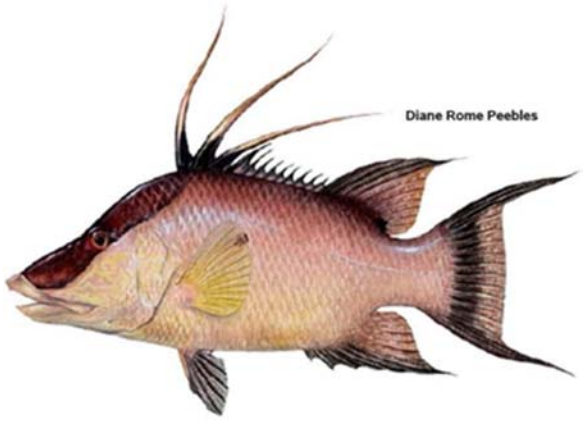
Tab B, No. 13
6/8/2016

Hogfish Stock Definition, Status Determination Criteria, Annual Catch Limit, and Size Limit



Final Action Draft Amendment 43

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

June 2016

This is a publication of the Gulf of Mexico Fishery Management Council Pursuant to National Oceanic and Atmospheric Administration Award No. NA15NMF4410011.

This page intentionally blank

ENVIRONMENTAL ASSESSMENT COVER SHEET

Name of Action

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

Responsible Agencies and Contact Persons

Gulf of Mexico Fishery Management Council (Council)
2203 North Lois Avenue, Suite 1100
Tampa, Florida 33607
Steven Atran (Steven.Atran@gulfcouncil.org)

813-348-1630
813-348-1711 (fax)
gulfcouncil@gulfcouncil.org
http://www.gulfcouncil.org

National Marine Fisheries Service (Lead Agency)
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701
Peter Hood (Peter.Hood@noaa.gov)

727-824-5305
727-824-5308 (fax)
http://sero.nmfs.noaa.gov

Type of Action

( ) Administrative
(X) Draft

( ) Legislative
( ) Final

ABBREVIATIONS USED IN THIS DOCUMENT

ABC	Acceptable biological catch
ACL	Annual catch limit
ACT	Annual catch target
ALS	Accumulated Landings System
AMs	Accountability measures
APA	Administrative Procedures Act
B	Biomass
B_{MSY}	Stock biomass level capable of producing an equilibrium yield of MSY
Council	Gulf of Mexico Fishery Management Council
CS	consumer surplus
CZMA	Coastal Zone Management Act
DQA	Data Quality Act
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential fish habitat
EIS	Environmental impact statement
EJ	Environmental justice
ELMR	Estuarine living marine resources
ESA	Endangered Species Act
F	Instantaneous rate of fishing mortality
FL	fork length
F_{MSY}	Fishing mortality rate corresponding to an equilibrium yield of MSY
F_{OY}	Fishing mortality rate corresponding to an equilibrium yield of OY
$F_{30\% SPR}$	Fishing mortality corresponding to 30% spawning potential ratio
FMP	Fishery Management Plan
FTE	Full time equivalent
FWRI	Florida Wildlife Research Institute
GMFMC	Gulf of Mexico Fishery Management Council
LOF	List of fisheries
M	Mortality
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MFMT	Maximum fishing mortality threshold
MMPA	Marine Mammal Protection Act
mp	million pounds
MRFSS	Marine Recreational Fisheries Survey and Statistics
MRIP	Marine Recreational Information Program
MSST	Minimum stock size threshold
MSY	Maximum sustainable yield
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	Same as NMFS
nm	nautical mile
NOR	net operating revenues

NOS	National Ocean Service
NS1	National Standard 1 guidelines
OFL	Overfishing level
OMB	Office of Management and Budget
OY	Optimum yield
PRA	Paperwork Reduction Act
PS	Producer surplus
RFA	Regulatory Flexibility Act of 1980
RIR	Regulatory impact review
RQ	regional quotient
SAFMC	South Atlantic Fishery Management Council
SAV	Submerged aquatic vegetation
Secretary	Secretary of Commerce
SEDAR	Southeast Data, Assessment and Review
SEFSC	Southeast Fisheries Science Center
SERO	Southeast Regional Office
SSB	Spawning stock biomass
SSC	Scientific and Statistical Committee
SPR	Spawning potential ratio
SRHS	Southeast Region Headboat Survey
TPWD	Texas Parks and Wildlife Department
ww	whole weight

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FISHERY IMPACT STATEMENT

CHAPTER 1. INTRODUCTION

1.1 Background

In 2004, a hogfish stock assessment (SEDAR 6 2004b) was prepared by the University of Miami under contract to the Florida Fish and Wildlife Conservation Commission (FWC). However, when it was submitted to a Southeast Data, Assessment, and Review (SEDAR) review panel, several errors in the analyses were discovered. Among the errors in the assessment: some of the age-length data was not handled correctly; the use of recreational catch rates based on hook-and-line catches was inappropriate given that spearfishing is the dominant method used to harvest hogfish; and the commercial catch-per-unit-index did not account for the implementation of a minimum size limit in 1994[1]. Consequently the SEDAR review panel was unable to provide management advice based on the assessment other than a qualitative suggestion that an increase in the size limit would likely give an increase in the yield to the fishery, and the Standing and Special Reef Fish Scientific and Statistical Committee (SSC) rejected the assessment as not being the best scientific information available[2].

In 2013-2014, FWC conducted a new benchmark assessment for hogfish (SEDAR 37 2014). This assessment divided hogfish into three stocks based upon genetic analysis. The three stocks were defined as:

- West Florida stock
- East Florida/Florida Keys stock
- Georgia through North Carolina stock

Although hogfish occur throughout the Gulf of Mexico (Gulf), they are caught primarily off the Florida coast. Only small amounts of commercial and recreational hogfish landings have been reported from the other Gulf states. In 1951, there were about 4,600 pounds reported as commercially harvested from Louisiana, and from 1993-1995 a total of just 80 pounds was reported commercially harvested from Louisiana. Recreationally, only nine total intercepts had recorded catching Hogfish from Gulf states other than Florida during 1981-2012 (SEDAR 37 2014).

The assessment evaluated the stock status as of 2012 relative to several reference points: F_{MSY}, $F_{30\% SPR}$, $F_{35\% SPR}$, and $F_{40\% SPR}$. The Gulf hogfish stock has a maximum fishing mortality threshold (MFMT) of $F_{30\% SPR}$, but the minimum stock size threshold (MSST) is currently undefined. SEDAR 37 determined the status of the three hogfish stocks as follows:

- West Florida stock: Under all MSST reference points the stock is not overfished, i.e., biomass is above MSST. The stock is experiencing overfishing at the $F_{40\% SPR}$ reference point, but is not experiencing overfishing under the other MFMT reference points.

[1] Testimony from SEDAR 6 Review Panel representative Mike Murphy to the Reef Fish Committee at the May 2004 Council meeting.
[2] Minutes of the April 29, 2004 Standing and Special Reef Fish SSC meeting

- East Florida/Florida Keys stock: Under all MSST and MFMY reference points, the stock is overfished, i.e., biomass is below MSST, and experiencing overfishing, i.e., the fishing mortality rate is above MFMT.
- Georgia-North Carolina stock: The stock is overfished under all of the MSST reference points except the MSST associated with the F_{MSY} point. Under all MFMT reference points, the stock is experiencing overfishing.

A small portion of the east Florida/Florida Keys stock extends into the Gulf of Mexico Fishery Management Council's (Gulf Council) jurisdiction in south Florida, and would need to be included in the rebuilding plan that the South Atlantic Fishery Management Council is currently developing. When the Gulf Council's SSC reviewed the hogfish stock assessment, it felt that the South Atlantic SSC should take the lead in setting the overfishing limit (OFL) and acceptable biological catch (ABC) for that stock, and focused their attention on the west Florida shelf (Gulf) portion of the stock assessment. The assessment projections produced annual yields for OFL and ABC for the west Florida stock for 2016 through 2026 based on an overfishing threshold of $F_{30\% SPR}$. However, due to increasing uncertainty with long-range projections, the SSC only provided OFL and ABC yields for three years, 2016 through 2018.

The OFL is the yield when the stock is fished at F_{MSY} or the F_{MSY} proxy ($F_{30\% SPR}$). This is the yield beyond which overfishing is occurring, and is determined as part of the stock assessment output. However, there is always scientific uncertainty as to the true value of OFL. Consequently, ABC is a yield set below the OFL to take into account the scientific uncertainty. To determine the ABC yield, the SSC used the ABC control rule developed in the Generic Annual Catch Limits/Accountability Measures Amendment (GMFMC 2011a). For the hogfish stock, the level for probability of overfishing (P*) was set at 0.4 based on the results of the tier 1 analysis in the control rule, and a coefficient of variance (CV) of 0.37 was used based on the results of pooled assessments compiled by the Pacific Fishery Management Council for stocks in their jurisdiction.

The SSC provided two alternative scenarios for OFL and ABC during the period 2016-2018. The first is an OFL and ABC that changes each year in response to changes in projected stock abundance if the stock is fished at the F_{MSY} proxy ($F_{30\% SPR}$) rate (Table 1.1.1). The second is a constant catch OFL and ABC that is equivalent in impact to the stock over the 2016-2018 period (Table 1.1.2). The west Florida hogfish stock is currently above the abundance level needed to maintain MSY, so fishing at the $F_{30\% SPR}$ rate (Table 1.1.1) will cause the stock to gradually decline toward the equilibrium level. Fishing at the corresponding constant catch rate (Table 1.1.2) will also result in a gradual decline in the stock, and will require a new assessment in 2018 or shortly thereafter to reassess the catch rate.

Table 1.1.1. Constant Fishing Mortality Rate OFL and ABC for west Florida stock of hogfish for 2016-2018, plus equilibrium yields.

Year	OFL	ABC
2016	257,100 lbs ww	240,400 lbs ww
2017	229,400 lbs ww	216,800 lbs ww
2018	211,000 lbs ww	200,800 lbs ww
Equilibrium	161,900 lbs ww	159,261 lbs ww

Source: Summary report of the May 20, 2015 meeting of the SSC.

Table 1.1.2. Constant Catch OFL and ABC for west Florida stock of hogfish for 2016-2018.

Year	OFL	ABC
2016 - 2018	232,000 lbs ww	219,000 lbs ww

Source: Summary report of the January 5-6, 2016 meeting of the SSC.

1.2 Purpose and Need

The purpose is to consider: redefining the geographic range of the Gulf of Mexico hogfish stock (referred to as the west Florida stock); setting status determination criteria (maximum fishing mortality threshold, minimum stock size threshold, and maximum sustainable yield proxy); setting annual catch limits and annual catch targets based on a recent stock assessment for the Gulf of Mexico hogfish stock; revising the hogfish minimum size limit to reduce the likelihood of a season closure due to the annual catch limit being reached, and removing the powerhead exception for harvest of hogfish in the stressed area.

The need is to establish a stock definition that is consistent with the best scientific information available, to prevent overfishing, to adjust annual catch limits consistent with the SEDAR 37 stock assessment, and to achieve optimum yield (OY) consistent with the requirements of the Magnuson-Stevens Fishery Conservation and Management Act.

1.3 History of Management

This history of management covers events pertinent to the hogfish management unit, status determination criteria, annual catch limit, and minimum size limit. A complete history of management for the Fishery Management Plan (FMP) for the Reef Fish Resources of the Gulf of Mexico is available on the Council's website: http://www.gulfcouncil.org/fishery_management_plans/reef_fish_management.php including recent hogfish actions. The final rule for the Reef Fish FMP (with its associated environmental impact statement [EIS]) (GMFMC 1981) was effective November 8, 1984. Currently hogfish is regulated by a 12-inch fork length (FL) minimum size limit for both the commercial and recreational sectors, and a 5-fish recreational bag limit. There is no allocation between the commercial and recreational sectors. Other reef fish fishery management measures that affect hogfish fishing include reef fish permit requirements for the commercial and for-hire sectors.

The fishing season for both sectors is usually open year-round, January 1-December 31. However, if the annual catch limit (ACL) for the combined commercial and recreational sectors is exceeded in any year, then in the following year the hogfish season is closed on the date when the ACL is projected to be met. This occurred once since ACLs were implemented. In 2012, hogfish landings exceeded the ACL by 85,000 lbs (40% overage). Subsequently in 2013, the hogfish season was closed on December 2, upon NMFS determining that the 2013 ACL had been harvested. This still resulted in a 2013 ACL overage of 35,000 lbs (17% overage). However, the ACL was not exceeded in 2014, and the season remained open year-round in 2014 and 2015.

Hogfish management unit: Hogfish were labeled a species included in the fishery, but not in the fishery management unit in the original FMP. Hogfish were not added to the management unit until **Amendment 16B** (GMFMC 1999a; with its associated environmental assessment [EA], regulatory impact review [RIR], and regulatory flexibility analysis [RFA]). The rulemaking from this amendment was effective in November 1999.

Status determination criteria: The **Generic Sustainable Fisheries Act Amendment** (GMFMC 1999b; EA/RIR/RFA), was partially approved and implemented in November 1999. It set the MFMT for most reef fish stocks including hogfish at $F_{30\% SPR}$. Estimates of maximum sustainable yield, MSST, and OY were disapproved because they were based on spawning potential ratio proxies rather than biomass based estimates.

Annual catch limits (ACL) and annual catch targets (ACT): The **Generic ACL/AM Amendment** (GMFMC 2011a), established a hogfish overfishing limit (OFL), ACL, and ACT. Hogfish were classified as a Tier 3a species in the Council's ABC control rule. This tier is applied to stocks where no assessment is available, but landings data do exist, and recent landings do appear sustainable. As a Tier 3a species, the OFL was set equal to the mean of 1999-2008 landings plus two standard deviations and equaled 272,000 lbs ww. To account for scientific uncertainty, the Gulf Council's SSC applied the default buffer from the OFL using the formula ABC = mean of the landings plus 1.0 * standard deviation. This resulted in an ACL of 208,000 lbs ww and a risk of exceeding OFL of 16%. This amendment also established an ACT for hogfish using the ACL/ACT control rule to account for management uncertainty. The control rule indicated a 14% buffer should be applied to the ACL resulting in an ACT of 179,000 lbs ww. However, the ACT is not currently used for management purposes.

Minimum size limit: The 12-inch FL minimum size limit (as well as the 5-fish bag limit) were implemented through **Amendment 16B** (GMFMC 1999a) which also added the species to the fishery management unit (see discussion above).

CHAPTER 2 - ACTIONS AND ALTERNATIVES

2.1 Action 1 – Definition of the Management Unit

Alternative 1: No Action. The hogfish management unit in the Reef Fish Fishery Management Plan (FMP) is defined as all hogfish found in the Gulf of Mexico north and west of the Gulf of Mexico and South Atlantic Fishery Management Councils' jurisdictional boundary.

Preferred Alternative 2: South of Cape Sable. The hogfish management unit in the Reef Fish FMP is defined as the west Florida (or Gulf of Mexico) stock of hogfish. The geographical range of this unit is all waters of the Gulf of Mexico north of a line extending west from **25° 09' north latitude** to the outer boundary of the exclusive economic zone (EEZ) and northward and westward throughout the rest of the Gulf of Mexico.

Alternative 3: Shark Point. The hogfish management unit in the Reef Fish FMP is defined as the west Florida stock of hogfish. The geographical range of this unit is all waters of the Gulf of Mexico north of a line extending west from **25° 23' north latitude** to the outer boundary of the EEZ and northward and westward throughout the rest of the Gulf of Mexico.

Alternative 4: Monroe/Collier county line. The hogfish management unit is the west Florida stock of hogfish. The geographical range of this unit is defined as all waters of the Gulf of Mexico north of a line extending west from **25° 48' north latitude** to the outer boundary of the EEZ and northward and westward throughout the rest of the Gulf of Mexico.

Note: Under **Preferred Alternative 2**, **Alternative 3**, or **Alternative 4**, the Gulf of Mexico Fishery Management Council (Gulf Council) will request the Secretary of Commerce to designate the South Atlantic Fishery Management Council (South Atlantic Council) as the responsible Council for hogfish south of the demarcation line.

Discussion:

The Reef Fish FMP includes a list of stocks in the management unit, but currently it does not explicitly define the geographic range of the management unit for each stock. Rather it includes all individuals from the Gulf of Mexico (Gulf) in the management unit. This implies that all of the individual fish are part of a single stock. However, the recent hogfish stock assessment (SEDAR 37 2014) identified three separate stocks based upon recent genetic analyses: Georgia/North Carolina, east Florida/Florida Keys, and west Florida shelf stocks. The division between the west Florida shelf stock and the east Florida/Florida Keys stock occurs somewhere between Naples and the Florida Keys (Seyoum et al. 2014). The assessment used the Monroe/Collier county line, which is 21 nautical miles (nm) south of Naples, as the dividing line between the west Florida shelf stock and the east Florida/Florida Keys stock. The assessment concluded that the west Florida shelf hogfish stock was neither overfished nor undergoing overfishing (except under the most conservative overfishing threshold of $F_{40\% SPR}$). The east Florida/Florida Keys stock in the South Atlantic Council's jurisdiction; however, was overfished and undergoing overfishing, and in need of a rebuilding plan.

Under **Alternatives 2-4**, harvest of hogfish south of the boundary selected to define the hogfish management unit will be subject to the management measures established by the South Atlantic Council for the east Florida/Florida Keys stock, including bag limits, size limits, quotas, and closed seasons. However, regardless of which boundary is selected to define the hogfish management unit, commercial and for-hire vessels fishing for hogfish in the Gulf, i.e., north and west of the GMFMC/SAFMC jurisdictional boundary will be required to have the appropriate Gulf reef fish permit, and vessels fishing for hogfish in the south Atlantic, i.e., south and east of the GMFMC/SAFMC jurisdictional boundary will be required to have the appropriate South Atlantic snapper-grouper permit, and will be required to follow the sale and reporting requirements associated with that permit.

Alternative 1 leaves the hogfish stock as all individuals in the Gulf. The jurisdictional boundary between the Gulf and South Atlantic Councils follows in part along 24º 35' north latitude. This is 73 nm south of the Monroe/Collier county line, which was the demarcation used in the SEDAR 37 stock assessment between the west Florida and east Florida/Florida Keys stocks. This alternative continues the implicit assumption that all hogfish in the Gulf are part of a single stock. This is inconsistent with the SEDAR 37 (2014) stock assessment, which determined that there are two hogfish stocks off the coast of Florida, with a dividing line south of Naples. While the west Florida hogfish stock was found to be neither overfished nor undergoing overfishing (except under the most conservative overfishing threshold), the east Florida/Florida Keys stock was found to be both overfished and undergoing overfishing. This will require different management strategies and a rebuilding plan for those hogfish that comprise the east Florida/Florida Keys stock.

Preferred Alternative 2, Alternative 3, and **Alternative 4** define a boundary off southwest Florida, south of which the west Florida stock is undefined. Hogfish in this region will not be part of the fishery management unit, and will not be subject to management under the Reef Fish FMP. It is the intent of the Gulf Council that under **Preferred Alternative 2, Alternative 3,** and **Alternative 4**, the Council will request the Secretary of Commerce to designate the South Atlantic Council as the responsible Council for managing hogfish south of the demarcation line.

Preferred Alternative 2 defines the boundary for the hogfish management unit in the Gulf off Florida at 25° 09' north latitude, which is just south of Cape Sable on the west coast of Florida. It is 38 nm south of the Monroe/Collier county line. This line is currently used by the Florida Fish and Wildlife Conservation Commission (FWC) as a regulatory boundary for state managed species such as permit. It is also considered by FWC to be far enough north of the Florida Keys and far enough south of Naples and Marco Island so that regulatory issues are not simply shifted north to Collier County. However, this creates a discontinuity with the SEDAR 37 stock assessment, which used the Monroe/Collier county line as the demarcation between hogfish stocks. The farther south from the Monroe/Collier county line the boundary is set, the greater the discontinuity between the assessment and management, and the greater the likelihood that part of the east Florida/Florida Keys stock will be under Gulf Council jurisdiction rather than the South Atlantic Council.

Alternative 3 defines the boundary for the hogfish management unit in the Gulf off Florida at 25° 23' north latitude, which corresponds to the Shark Point reference point in the Everglades on

the west coast of Florida. It is 25 nm south of the Monroe/Collier county line. According to information provided by Council members, fishing trips originating south of this boundary rarely travel north of the boundary, and trips originating north of the boundary rarely travel south. Therefore, this boundary serves as a natural demarcation for fishermen, although there is some discontinuity with the stock assessment boundary. As with **Alternative 2**, this boundary creates a discontinuity with the SEDAR 37 stock assessment, which used the Monroe/Collier county line as the demarcation between hogfish stocks. However, the discontinuity under **Alternative 3** (25 nm) is not as great as **Alternative 2** (38 nm).

Alternative 4 defines the boundary for the hogfish management unit in the Gulf at the Monroe/Collier County line, which is consistent with the boundary used by the SEDAR 37 (2014) stock assessment. Commercial accumulated landings system (ALS), Florida trip ticket, Marine Recreational Fisheries Survey and Statistics (MRFSS), and Marine Recreational Information Program (MRIP) landings can all be resolved to the county level, allowing landings reports to be consistent with the stock boundary. However, unlike **Alternative 3**, vessels leaving from ports near this boundary may travel either north or south. Consequently, the region where the fish are landed may not necessarily reflect the region where they were caught.

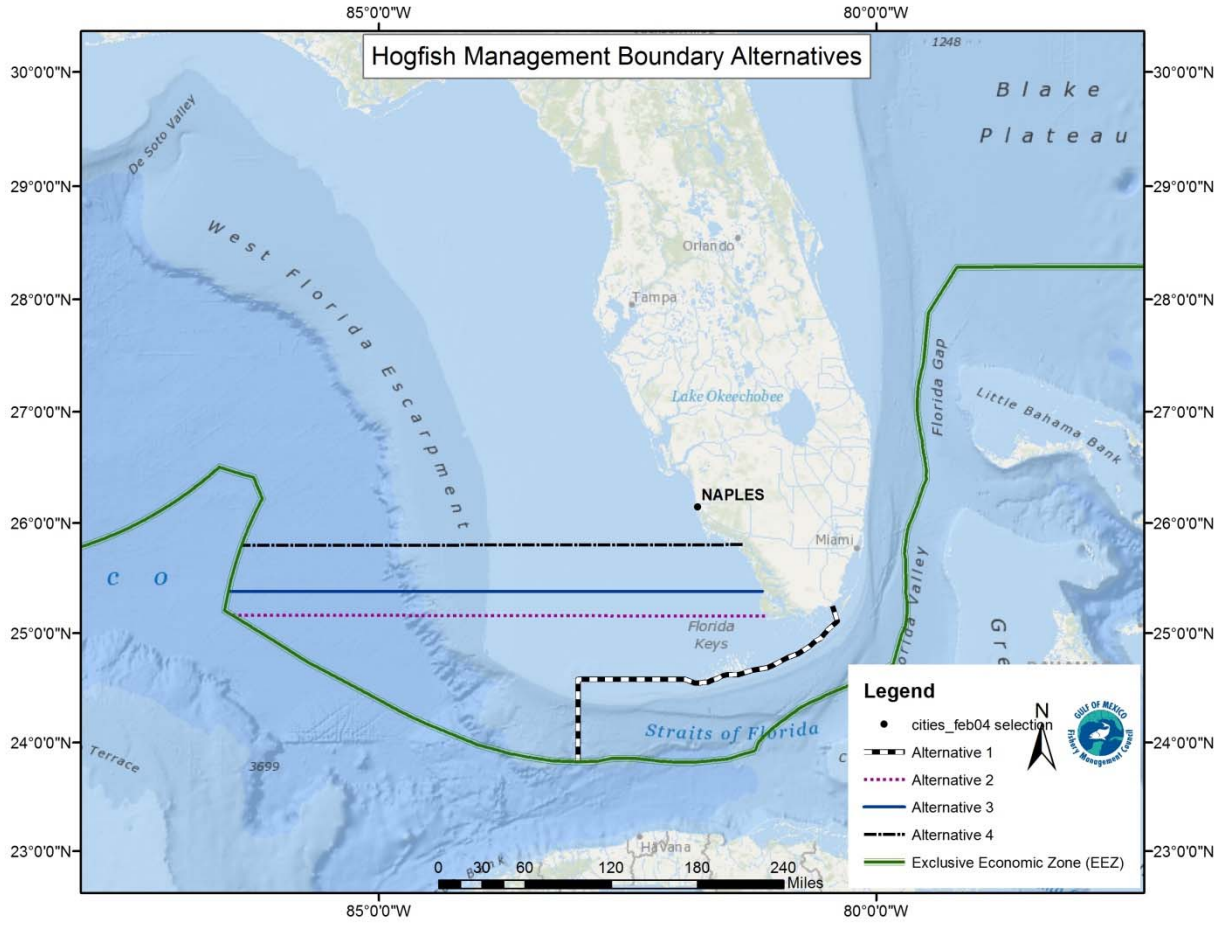


Figure 2.1.1. Hogfish management boundary alternatives. **Alternative 2** is the Council's preferred alternative.

2.2 Action 2 –Status Determination Criteria for Hogfish in the Gulf of Mexico Fishery Management Unit

Alternative 1: No Action. Maximum sustainable yield (MSY) is undefined, minimum stock size threshold (MSST) is undefined, and maximum fishing mortality threshold (MFMT) = $F_{30\% SPR}$ where F is fishing mortality rate and SPR is spawning potential ratio.

Alternative 2: MSY = the point estimate of MSY in the most recent stock assessment.
MFMT = F_{MSY} in the most recent stock assessment
MSST =

Option 2a: (1-M)*SSB_{MSY}, where M (natural mortality rate) = 0.179 and SSB is the spawning stock biomass
Option 2b: 0.75*SSB_{MSY}
Option 2c: 0.50*SSB_{MSY}

Preferred Alternative 3: MSY = equilibrium yield at $F_{30\% SPR}$
MFMT = $F_{30\% SPR}$
MSST =

Option 3a: (1-M)*$SSB_{30\% SPR}$, where M = 0.179
Preferred Option 3b: 0.75*$SSB_{30\% SPR}$
Option 3c: 0.50*$SSB_{30\% SPR}$

Alternative 4: MSY = equilibrium yield at $F_{40\% SPR}$
MFMT = $F_{40\% SPR}$
MSST =

Option 4a: (1-M)*$SSB_{40\% SPR}$, where M = 0.179
Option 4b: 0.75*$SSB_{40\% SPR}$
Option 4c: 0.50*$SSB_{40\% SPR}$

Discussion:
The formula will be the controlling factor for defining the status determination criteria. The point values may change if a new stock assessment provides additional information, but as of SEDAR 37, the point values for each of the above alternatives are shown in Table 2.2.1.

Table 2.2.1 Status determination criteria values for several MSY proxies.

	Alt. 1 Proxy undef.	Alt. 2 Model MSY	Pref. Alt. 3 30% SPR	Alt. 4 40% SPR
MSY (1000 lbs ww)	n/a	169	162	146
MFMT	0.095	0.150	0.095	0.062
Equilibrium SSB (1000 lbs ww)	n/a	1,027	1,591	2,215
MSST (1000 lbs ww)				
Option a	n/a	844	1,306	1,819
Preferred Option b	n/a	771	1,193	1,661
Option c	n/a	514	795	1,108

Source: SEDAR 37, Table 11.2.7.1.1. and Florida FWC (8/21/2015).

Current Stock Status

The west Florida hogfish stock is neither overfished nor undergoing overfishing under all of the Action 2 alternatives for status determination criteria. The current fishing mortality rate (based on the geometric mean for 2010-2012) is below all Action 2 options for the maximum fishing mortality threshold (MFMT) of F_{MSY} (or proxy). The spawning stock biomass (SSB) as of 2012 is estimated at 2.955 mp. This is above all Action 2 options for the minimum stock size threshold (MSST) (Table 2.2.1) and is also above the equilibrium stock size for all of the proxies capable of supporting maximum sustainable yield, SSB_{MSY} (or proxy) (Table 2.2.1).

Maximum sustainable yield (MSY) is defined in the National Standard 1 Guidelines as the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological, environmental conditions and fishery technological characteristics (e.g., gear selectivity), and the distribution of catch among fleets. MSY can usually be calculated within a stock assessment, but a good estimate requires a strong stock-recruit relationship. If the spawner/recruit relationship is weak or uncertain, which is often the case, then a proxy can be used.

Alternative 1 leaves MSY and MSST undefined. MFMT was defined under the Sustainable Fisheries Act Generic Amendment (GMFMC 1999b). These status determination criteria are required under the National Standard 1 Guidelines for each stock being managed. If left undefined in this amendment, these criteria can be defined in the Minimum Stock Size Threshold Amendment which is currently under development.

Alternative 2 uses the model generated estimate of MSY. This produces the highest yield levels but at the lowest level of spawning stock biomass (SSB). The SEDAR 37 assessment did not make a recommendation as to whether the stock-recruit relationship was strong enough to use the estimated MSY. However, the assessment noted that the model produced relatively stable predictions of SSB levels throughout the model period. This lack of contrast in stock-recruit data additionally led to a relatively flat likelihood profile for steepness in this stock and the sensitivity run where the steepness prior was removed led steepness to be estimated near the upper bounds of steepness (h)=.9999. Under these conditions there is essentially no discernable relationship between stock and recruitment, and an MSY proxy is generally used when this occurs.

Preferred Alternative 3 uses spawning potential ratio (SPR) as the basis for an MSY proxy, and sets the proxy at the equilibrium yield from fishing at $F_{30\% SPR}$. The spawning potential ratio 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. It assumes that a certain amount of fish must survive and spawn in order to replenish the stock. Analyses of stocks with various life histories suggests that, in general, SPR levels of 30% to 40% are most commonly associated with MSY (FSAP 1998a,b). The equilibrium yield at $F_{30\% SPR}$ is the proxy used for most Gulf reef fish stocks, and is consistent with the current MFMT for hogfish (MFMT= $F_{30\% SPR}$). This MFMT value was set in 1999 under the Generic Sustainable Fisheries Act Amendment (GMFMC 1999b). However, the MSST and a MSY proxy proposed

in that amendment were disapproved by the National Marine Fisheries Service (NMFS) and are currently undefined.

Alternative 4 sets the MSY proxy at a more conservative level compared to **Preferred Alternative 3**. It would set the MSY proxy at the equilibrium yield from fishing at $F_{40\% SPR}$. This is at the upper end of the range of SPR proxies recommended by the Scientific and Statistical Committee (SSC), but is more commonly used as a proxy for optimum yield than for MSY. If this alternative is adopted, then based on the SEDAR 37 stock assessment, the current fishing mortality rate for hogfish exceeds $F_{40\% SPR}$, and the stock is therefore experiencing overfishing. The SSC would need to reevaluate its acceptable biological catch (ABC) recommendation, and the Council would likely be required to take action to end overfishing.

Under **Alternatives 2, Preferred Alternative 3,** and **Alternative 4**, three options are provided for determining MSST. In each option, MSST is set to a proportion of SSB_{MSY} or proxy. **Options 2a, 3a**, and **4a** set MSST equal to (1-M)*SSB_{MSY} or proxy (M is equal to the hogfish natural mortality rate of 0.179, so this formula sets MSST equal to 82.1% of SSB_{MSY} or proxy). **Option 2b, Preferred Option 3b,** and **Option 4b** set MSST equal to 75% of SSB_{MSY} or proxy, and **Options 2c, 3c,** and **4c** set MSST equal to 50% of SSB_{MSY} or proxy. The resulting MSST biomass levels corresponding to each option are shown in Table 2.2.1.

All of the options under each alternative protect the stock by declaring the stock overfished at some point of decline, thereby requiring a rebuilding plan be implemented. **Options 2a, 3a,** and **4a** provide an MSST that is closest to the respective SSB_{MSY} or proxy. This provides the greatest protection to the stock by declaring the stock overfished at an early stage of decline. However, they provide the highest likelihood of a stock being declared overfished due to year-to-year fluctuations in biomass. **Option 2b, Preferred Option 3b,** and **Option 4b** provide less protection to the stock by declaring the stock overfished at an intermediate stage of decline. However, there is less likelihood of a stock being declared overfished due to year-to-year fluctuations, and greater management flexibility to reverse a decline before the stock becomes declared overfished. If the stock does fall below MSST and is declared overfished, the resulting rebuilding plan may require more restrictive management actions than without the overfished determination. **Options 2c, 3c,** and **4c** provide the least protection to the stock by setting MSST at lowest level allowed under the Magnuson-Stevens Fishery Conservation and Management Act and National Standard Guidelines. This allows the stock to drop into a large decline before being declared overfished. However, this also allows the greatest management flexibility to reverse a decline before the stock becomes declared overfished.

In summary, for each alternative, **Option a** provides the greatest protection to the stock. **Preferred Option b** provides an intermediate level of protection to the stock. **Option c** provides the least protection to the stock. However, decreased protection to the stock is offset by increased flexibility for management to take less restrictive action to stop a decline than might be required under an overfished determination and rebuilding plan.

For each set of options, **Options 2a, 3a,** and **4a** provide the same proportional reduction from the respective SSB_{MSY} or proxy, and therefore have the same relative impacts. This also applies to **Option 2b, Preferred Option 3b,** and **Option 4b**, and to **Options 2c, 3c,** and **4c**.

The Council is working on a separate amendment to define MSST for all reef fish stocks. The MSST options in this action mirror the alternatives presently being considered in the MSST amendment.

2.3 Action 3 – Annual Catch Limit and Annual Catch Target for Hogfish

Alternative 1: No Action. ACL = 208,000 lbs ww, and ACT = 179,000 lbs ww. Weights are based on the Generic ACL/AM Amendment and Tier 3a (using 1999-2008 landings) of the ABC control rule.

Alternative 2: ACL equals the ABC for each year 2016-2018. The ACL for years following 2018 will then revert to the equilibrium ABC yield until modified by rulemaking.

2016 ACL = 240,400 lbs ww
2017 ACL = 216,800 lbs ww
2018 ACL = 200,800 lbs ww
2019+ ACL = 159,300 lbs ww

Option 2a: ACT will not be defined

Option 2b: ACT will be set based on the ACL/ACT control rule at 87% of the ACL

Preferred Alternative 3: A constant catch ACL is set at 219,000 lbs ww based on the constant catch ABC recommendation for the years 2016-2018 of the SSC. The ACL will remain at 219,000 lbs after 2018 until modified by rulemaking.

Preferred Option 3a: ACT will not be defined

Option 3b: ACT will be set based on the ACL/ACT control rule at 87% of the ACL.

Note: In September 2015 the SSC passed the following motion: "By a vote of 8 to 2, the Committee recommends that if at the end of the projection period no new assessment is available, and the equilibrium ABC is below the ABC of the constant catch yield stream, ABC should revert to the equilibrium ABC." Based on this motion, if Alternative 3 is retained as the preferred alternative, it will need to be revised by replacing the second sentence with the following: ***The ACL for years following 2018 will then revert to the equilibrium ABC yield of 159,300 lbs ww until modified by rulemaking.***

Alternative 4: A constant catch ACL is set at the equilibrium ABC level of 159,300 lbs ww. This ACL will remain in place in subsequent years until modified by rulemaking.

Option 4a: ACT will not be defined

Option 4b: ACT will be set based on the ACL/ACT control rule at 87% of the ACL.

Discussion:

Alternative 2, Preferred Alternative 3, and **Alternative 4** each include an option to set an annual catch target (ACT) at 87% of the ACL. This is based on the results of the ACL/ACT

control rule, which recommends a 13% buffer between the ACL and ACT (Appendix D). The ACT yields for each of these options is shown in Table 2.3.1.

Table 2.3.1. ACTs (corresponding to 87% of ACL) under Options b for Alternatives 2, 3, and 4. Yields are in pounds whole weight.

Year	ACT		
	Option 2b	**Option 3b**	**Option 4b**
2016	209,100	190,500	138,600
2017	188,600	190,500	138,600
2018	174,700	190,500	138,600
2019+	138,600	138,600	138,600

Under **Alternative 1**, the hogfish ACL and ACT will remain at the levels established in 2012 under the Generic Annual Catch Limits/Accountability Measures Amendment (GMFMC 2011a). These catch levels were set using ABC control rule tier 3a, a data poor method. The mean catch from 1999-2008 was calculated (mean = 143,500 lbs ww) and a standard deviation was calculated. The ACT was set at the mean plus one standard deviation (179,000 lbs ww) and the ACL was set at the mean plus two standard deviations (208,000 lbs ww). This allowed the stock some leeway to fluctuate above the mean landings. From 1986 through 2014, hogfish landings in the Gulf (excluding Monroe County) have ranged from 59,667 lbs ww to 366,615 lbs ww. Since the ACL was implemented in 2012, landings have averaged 190,724 lbs ww, and exceeded the 208,000 lb ww ACL in 2013, one of the three years since ACLs were established (Table 2.3.2).

Based on the SEDAR 37 convention of counting Monroe County landings as part of the east Florida/Florida Keys stock, hogfish landed in Monroe County, which previously accounted for about half the Gulf landings, are now counted as landings in the South Atlantic's jurisdiction. Hogfish caught in the Florida Keys have been smaller on average compared to hogfish caught in the rest of the Gulf. However, hogfish landed in Monroe County are included in the average weight estimate for Gulf hogfish (N. Farmer, Southeast Regional Office, pers. comm.). As a result, the estimates of pounds landed by the recreational sector from the Gulf of Mexico stock may be underestimated; however, this approach is consistent with how hogfish weights were estimated in SEDAR 37. This is also consistent with how hogfish landings in weight will be monitored in the immediate future unless future assessments remove the Monroe County hogfish from the Gulf of Mexico stock prior to average weight assignments. Table 2.3.2 shows the historical landings for Gulf-caught hogfish, excluding Monroe County landings.

Alternative 2 sets an annual ABC for each year from 2016 through 2018 based on the annual yield projections recommended by the SSC when fishing at a constant fishing mortality rate. The overfishing limit (OFL) was set at the yield when fishing at $F_{30\% SPR}$, and the ABC was set a level below OFL to reduce the probability of overfishing to 40% (P* = 0.40). The ACL is set equal to the ABC. If the Council chooses to set an MFMT other than $F_{30\% SPR}$, the SSC will need to reevaluate its ABC recommendation. The stock spawning stock biomass (SSB) is currently above its maximum sustainable yield (MSY) level, so this rate of fishing is projected to gradually reduce the stock to slightly above its MSY level (Figure 2.3.1). If there is no new stock assessment by 2018 (no assessment is currently planned), the ABC and ACL will revert to the

equilibrium ABC level of 159,300 lbs ww. This is because, although the SSC recommended only three years of ABCs, the projected yield trend continues downward for several years (Figure 2.3.1). Maintaining the 2018 ABC and ACL indefinitely in the absence of a new assessment would likely to result in overfishing. For that reason, the SSC recommended at its September 2015 meeting that, if at the end of an ABC projection period, no new assessment is available, and the equilibrium ABC is below the ABCs for the projected period, the ABC should revert to the equilibrium ABC.

Table 2.3.2. Hogfish landings 1986-2014, and projected 2016 landings. Units are in pounds whole weight.

Year	Recreational Landings	Commercial Landings	Total Landings
1986	116,228	25,437	141,665
1987	190,156	28,713	218,869
1988	151,232	27,478	178,710
1989	121,167	55,301	176,468
1990	38,596	61,481	100,077
1991	238,806	53,974	292,780
1992	232,194	64,789	286,983
1993	224,964	94,073	319,037
1994	135,262	58,935	194,197
1995	181,757	25,408	207,165
1996	65,977	20,650	86,627
1997	117,811	23,401	141,212
1998	99,697	15,942	115,639
1999	120,607	23,111	143,718
2000	71,574	21,108	92,682
2001	110,311	27,059	137,370
2002	76,350	30,387	106,737
2003	205,684	28,036	233,720
2004	76,852	25,254	102,106
2005	45,547	20,110	65,657
2006	44,349	15,630	59,979
2007	48,849	18,112	66,961
2008	167,431	24,150	191,581
2009	97,656	32,316	129,972
2010	195,357	34,926	230,283
2011	72,500	45,995	118,495
2012	144,591	42,989	187,580
2013	242,292	24,874	267,166
2014	82,977	34,533	117,510
2015	*incomplete*	*incomplete*	*incomplete*
2016	*156,620*	*34,132*	*190,752*

Source: NMFS Southeast Regional Office, ACL dataset (October 2015).

Recreational landings have Monroe County landings included in Gulf mean weight computations but are excluded from Gulf landings provided here, consistent with Southeast Fisheries Science Center (SEFSC) Recreational ACL datasets for 2016-on. 2015 landings are incomplete. 2016 landings are projections based on the average of 2012-2014 landings.

The Council can choose to either use an ACT (**Option 2b**), or to not use an ACT (**Option 2a**). If used, the ACT would be set at 87% of the ACL based on the ACL/ACT control rule (Figure 2.3.3). This control rule evaluates several components of management uncertainty under a point system and converts the point to an ACT buffer of between 0% and 25% below the ACL. Some stocks, such as red snapper, have an accountability measure that sets the season or other management measures based on the ACT in order to reduce the likelihood of the ACL being exceeded if there is an overage. There is no such accountability measure for hogfish, and therefore the ACT has no function. The accountability measure for hogfish is to monitor landings for both sectors. If landings exceed the ACL in a given year, then in the subsequent year the season will be closed at such time as is projected to prevent the ACL from being exceeded again.

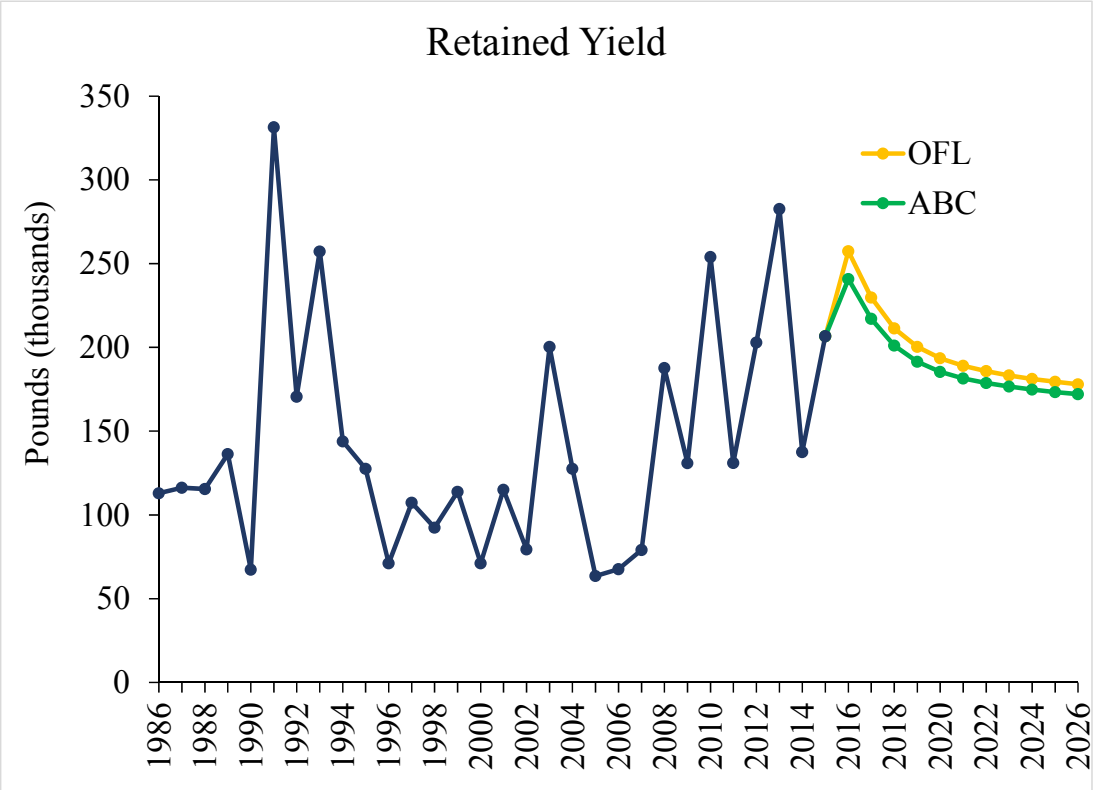


Figure 2.3.1. West Florida hogfish stock landings (1986-2015) and projected OFL and ABC yields (2016-2026)
Source: Florida FWCC presentation to SSC, September 2015

Preferred Alternative 3 sets a constant catch ACL for a specified number of years based on an alternative constant catch ABC recommended by the SSC of 219,000 lbs ww (Table 1.1.2). This ABC is the average of the annual ABCs for 2016-2018 shown in **Alternative 1**. This catch level has only been exceeded 5 times since 1986 (Table 2.3.2). This ABC has a similar conservation

equivalency to the constant F ABC yield stream in **Alternative 2**. If there is no new stock assessment by 2018 (no assessment is currently planned), the ABC and ACL will remain at 219,000 lbs ww until modified by subsequent rulemaking[3]. Florida FWC has tentatively scheduled a new hogfish assessment for 2018 according to information provided by the Florida FWC representative at the April 2016 Council meeting. Therefore, any subsequent modification of the ACL would likely occur in 2019 at the earliest. **Preferred Option 3a** would discontinue designation of an ACT. As discussed above, the ACT for hogfish has no function. **Option 3b** regarding the ACT would result in a constant catch ACT that is lower than **Option 2b** in 2016, but a higher ACT in 2017 and 2018 (Table 2.3.1). Relative to **Option 4b**, **Option 3b** would result in a higher ACT for all years.

Alternative 4 sets a constant catch ACL at the equilibrium ABC of 159,300 lbs ww. During the 19-year period 1986-2014, Gulf hogfish landings have been below this level for 16 years and have exceeded it in 13 years (Table 2.3.2). This is the level at which the yield is projected to remain constant without further declines in the stock level if fished over a long period of time. Overfishing is unlikely to occur at this level, and future adjustments to the ACL should theoretically be unnecessary. However, due to uncertainties in the data and likely fluctuations in recruitment which cannot be predicted and are not taken into account when making projections, a new assessment should still be conducted periodically and the equilibrium ABC recalculated. **Option 4a** would discontinue designation of an ACT. As discussed above, the ACT for hogfish has no function. **Option 4b** would result in a constant catch ACT that is lower than **Option 2b** and **Option 3b** for 2016-2018 (Table 2.3.1).

[3] In September 2015 the SSC passed the following motion: "By a vote of 8 to 2, the Committee recommends that if at the end of the projection period no new assessment is available, and the equilibrium ABC is below the ABC of the constant catch yield stream, ABC should revert to the equilibrium ABC." Based on this motion, if **Alternative 3** is retained as the preferred alternative, it will need to be revised by replacing the second sentence with the following: **The ACL for years following 2018 will then revert to the equilibrium ABC yield of 159,300 lbs ww until modified by rulemaking**.

2.4 Action 4 – Hogfish Minimum Size Limit for Commercial and Recreational Sectors

Alternative 1: No Action. The hogfish minimum size limit remains at 12 inches fork length (FL).

Alternative 2: Set the hogfish minimum size limit at 14 inches FL.

Alternative 3: Set the hogfish minimum size limit at 15 inches FL.

Preferred Alternative 4: Set the hogfish minimum size limit at 16 inches FL.

Discussion:

The size limit alternatives in this action apply to both the recreational and commercial sectors.

When considering increases in minimum size limit two factors are reviewed. First the size and age reproductive maturity for both sexes and discard mortality. A female hogfish reaches maturity at approximately age 1 to 1.5 and a length of 6 inches fork length (FL) to 7.5 inches FL (SEDAR 37 2014). Based on the von Bertalanffy growth equation[4] in SEDAR 37, it takes just under three years for a hogfish to grow to 12 inches FL. It then takes approximately 6 additional months for a hogfish to grow from 12 inches FL to 13 inches FL. This would not be enough time to allow any additional spawning to occur. To grow from 12 inches FL to 14 inches FL or larger takes approximately 11 months or longer (Table 2.4.1). Increasing the size limit to 14 inches FL or larger would allow the opportunity for at least one additional spawning season, while increasing the size limit to 16 inches FL would allow two additional spawning seasons. A 13 inch FL size limit increase would not provide sufficient time for any additional spawning season. Therefore, 13 inch FL minimum size limit is not included in the range of size limits to be considered.

Table 2.4.1. Approximate time for a hogfish to grow from 12 inches FL.

Length	Approximate time
12 inches FL	-
13 inches FL	6 months
14 inches FL	11 months
15 inches FL	17 months
16 inches FL	24 months

Although the west Florida hogfish stock is not overfished or undergoing overfishing, it could be subject to ACL closures under the ACL alternatives in Action 3. Under each of the ACL alternatives in Action 3, hogfish landings have exceeded the proposed ACL at least once in the three years since ACLs were adopted in 2012 and for which landings are available (Table 2.3.2). The accountability measures for hogfish state that if the ACL is exceeded in a given year, harvest

[4] Von Bertalanffy growth equation for hogfish from SEDAR 37: $FL(cm) = 84.89885132*(1-e^{-0.1057678*(t+1.3290378)})$

will be closed in the following year on the date when the ACL is reached or projected to be reached (GMFMC 2011a). Increasing the minimum size limit could reduce the directed harvest rate and help to avoid an ACL closure, or extend the length of the season if there is an ACL closure.

Size of Female Maturity and Male Transition

Hogfish are protogynous hermaphrodites that form harems. All fish mature as females first, and eventually become male if they live long enough. A single male maintains harems of 5 to 15 females (Colin 1982, Munoz et al. 2010) during extended spawning seasons that last for months. Spawning activity occurs predominantly during the months of December through April. Spawning begins (and ends) slightly earlier in the Florida Keys than on the west Florida shelf (SEDAR 37 2014). Although hogfish form harems, males only spawn with one female at a time (Davis 1976, Colin 1982), and spawning occurs daily during the spawning season (McBride and Johnson 2007, Collins and McBride 2008, Munoz et al. 2010). The size (197-727 mm FL) and age (1-11 years) range at which sexual transition occurs indicates that transition is socially mediated (Collins and McBride 2011). Sex change can take several months (McBride and Johnson 2007), so removal of the dominant male has the potential to significantly affect harem stability and decrease reproductive potential (Munoz et al. 2010).

Life history studies have estimated **female size and age at 50% maturity to occur between 6 inches FL and 7.5 inches FL and at approximately 1 to 1.5 years** (McBride et al., 2008; Collins and McBride 2011). Males may occur as small as 7.8 inches FL, but **size and age at which 50% of the hogfish have transitioned to males has been estimated at 16.8 inches FL about 6.5 years in the west Florida shelf** (McBride et al., 2008; Figure 2.4.1). Sex change in hogfish is estimated to take several months (McBride and Johnson 2007), so removal of the dominant male has the potential to significantly affect harem stability and decrease reproductive potential (Munoz et al. 2010; McBride et al. 2008). Size limits above 16 inches FL (**Alternative 4**) may provide hogfish greater opportunities to form harems and transition to males. Research on the west Florida shelf demonstrated that hogfish in this region will transition to male earlier and younger in shallow water less than 30 meters (approximately 98 feet) (13.5 inches FL and 4.9 years versus 25.2 inches FL and 9.8 years within deep water) (SEDAR 37 2014, McBride et al. 2008).

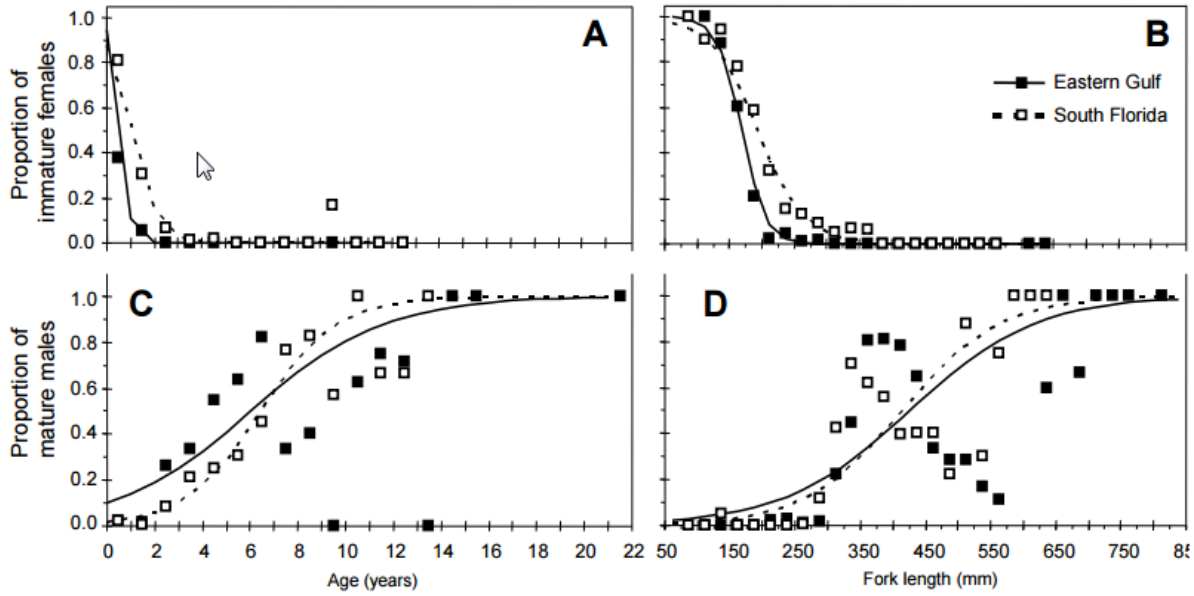


Figure 2.4.1. Maturation of hogfish (*Lachnolaimus maximus*) from the eastern Gulf of Mexico and south Florida for (A) females by age, (B) females by size, (C) males by age, and (D) males by size (Fig. 4 in McBride et al. 2008).

All of the size limit alternatives including **Alternative 1** (No Action) are above the 50% size of female maturity. All of the alternatives are also below the 50% size of transition to male, although **Alternative 4** is very close to that size.

Discard Mortality

The following is taken from SEDAR 37 (2014). Hogfish are primarily landed by spearfishing (88% of commercial landings in pounds and 83% of recreational landings in numbers 2007-2012), so there are minimal data regarding catch-and-release mortality (SEDAR 37 2014). SEDAR 37 (2014) estimates that 100% of commercial discards and 0% of recreational discards are from spear gear. Approximately 1% of commercial and 0% of recreational removals come from spearfishing discards (SEDAR 37 2014). Anecdotal reports indicate that hook-and-line gear are increasingly being used to target the species (Captains Pat Bennet and Ed Walker, pers. comm.); however, release mortality is still suspected to be minimal due to the fact that most hogfish in deeper water, greater than 30 meters (approximately 98 feet) (where barotrauma is more likely to occur) are of legal size (> 12 inches FL; Collins and McBride 2011), and are therefore unlikely to be released under the current management regime (minimum size limit of 12 inches FL and no closed seasons). The extent of mortality due to divers shooting sublegal fish is unknown. For the purpose of this assessment, a discard mortality rate of 10% was assumed for hook-and-line gear and 100% for spearfishing.

Table 2.4.2. Proportion of commercial landings of west Florida hogfish by gear type.

Year	Commercial Spearfishing	Commercial Hook & Line	Commercial Pots & Traps
2009	91%	9%	0.0%
2010	83%	16%	0.4%
2011	87%	13%	0.1%
2012	91%	9%	0.0%
Average	88%	12%	<1%

Source: SEDAR 37, Table 6.2.2.4

Table 2.4.3. Proportion of recreational harvest (types A+B1) of west Florida hogfish by gear type from MRIP for the west Florida stock.

Year	Recreational Spearfishing	Recreational Hook & Line
2009	83%	17%
2010	86%	14%
2011	71%	29%
2012	81%	19%
Average	82%	18%

Source: SEDAR 37, Table 7.2.1.3

Table 2.4.4. Hogfish total discards (live and dead) for the west Florida stock. Discard mortality from spearfishing is assumed to be 100%. Discard mortality from hook-and-line is assumed to be 10%. Discards are estimated in numbers of fish.

Year	Commercial Spearfishing	Commercial Vertical Line	Recreational Spearfishing	Recreational Hook and Line	Total
2009	103	0	0	5,357	5,460
2010	141	0	0	7,165	7,306
2011	128	0	0	838	966

Note: Discard estimates for 2012 were incomplete.
Source: SEDAR 37, Tables 6.3.1.1 and 7.3.1.1, and Section 7.3.1

Although larger minimum size limits are expected to increase discards and discard mortality in the hook-and-line fisheries, due to the low discard mortality rate the additional numbers of dead discards are expected to be small. Additional discard mortality from recreational spearfishing, which is the predominant method of capture, should be negligible since there are currently no reported discards, and spearfishing is sight fishing. Nevertheless, due to the magnification effect underwater such that fish appear larger than they really are, a lack of discard mortality of hogfish from spearfishing should not be assumed.

Alternative 1 (No Action), leaves the minimum size limit at 12 inches FL. At this minimum size limit, discards and discard mortality is estimated to be low relative to total landings (Tables 2.3.2 and 2.4.1). This is likely because in recent years more than 80% of the commercial harvest and more than 70% of the recreational harvest is from spearfishing (Tables 2.4.2 and 2.4.3),

which reported a low amount of discards from the commercial sector, and no discards from the recreational sector (Table 2.4.4). Note that discard mortality from spear fishing is 100% and the discard mortality from hook-and-line fishing is estimated to be 10%. However, the combined recreational and commercial hogfish landings have exceeded the ACL in two of the last three years even when ACL closures were in effect (Table 2.3.2). The highest ACL in the alternatives in Action 3 is 240,000 lbs ww in 2016. Landings in 2012 and 2013 exceeded even this relatively high ACL. This suggests that ACL closures will continue under any of the alternatives in Action 3 under the current size limit.

Alternative 2 increases the minimum size limit to 14 inches FL. This increase was recommended by the Reef Fish Advisory Panel (AP) to reduce the harvest rate and extend the season length. This size limit is projected to reduce the recreational harvest rate by 10% to 35% depending upon wave and mode of fishing (headboat, charter, or private) (Table 2.4.5). This will extend the season length until there is an ACL closure, and may avoid an ACL closure in the initial year under Action 2, Alternative 2.

Alternative 3 increases the minimum size limit to 15 inches FL. This size limit was recommended by one member of the Reef Fish AP. It is consistent with the size limit proposed by the South Atlantic Council for the east Florida/Florida Keys hogfish stock and would help simplify the regulations for fishermen in south Florida. This size limit is projected to reduce the recreational harvest rate by 18% to 56% depending upon wave and mode of fishing (headboat, charter, or private) (Table 2.4.5). Compared to **Alternative 2**, this alternative is expected to further extend the season and reduce the likelihood of ACL closures.

Table 2.4.5. Percent reductions in Gulf of Mexico landings (in lbs. ww), by mode, at different proposed minimum size limits.

Size Limit	Headboat	Charter						
	Annual	Jan/Feb	Mar/Apr	May/June	July/Aug	Sept/Oct	Nov/Dec	Annual
12	0%	0%	0%	0%	0%	0%	0%	0%
14	35%	33%	41%	32%	19%	27%	10%	30%
15	56%	60%	59%	52%	69%	54%	52%	57%
16	66%	76%	84%	74%	76%	73%	54%	75%

Size Limit	Private						
	Jan/Feb	Mar/Apr	May/June	July/Aug	Sept/Oct	Nov/Dec	Annual
12	0%	0%	0%	0%	0%	0%	0%
14	11%	8%	20%	27%	24%	19%	17%
15	23%	18%	27%	31%	28%	40%	26%
16	50%	41%	46%	43%	45%	69%	45%

Size Limit	Commercial											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
12	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14	15%	10%	8%	21%	22%	12%	6%	11%	11%	28%	14%	21%
15	26%	16%	16%	27%	25%	14%	10%	20%	23%	36%	21%	34%
16	46%	48%	53%	35%	41%	25%	18%	30%	34%	44%	31%	51%

Size Limit	Recreational Total	Commercial Total
12	0%	0%
14	18%	17%
15	28%	24%
16	46%	40%

Note: There were insufficient samples to model monthly impacts of proposed size limits for headboats; headboat catch effort file for 2014 is not available. MRIP landings for Monroe County are not included for charter and private modes because these have been assigned to the South Atlantic Council, consistent with SEDAR 37 (2014) decisions.
Sources: Headboat CRNF file (mean 2011-2013), MRIP Catch-Effort Files (mean 2012-2014).

Preferred Alternative 4 increases the minimum size limit to 16 inches FL. At the time of this writing, this was the preferred minimum size limit selected by the South Atlantic Fishery Management Council for the east Florida/Florida Keys hogfish stock. Selecting this preferred alternative would therefore provide a consistent minimum size limit for hogfish through the Florida coastline. This size limit is projected to reduce the recreational harvest rate by 46% (Table 2.4.5). It is very close to the size at which 50% of the hogfish have transitioned to males (16.8 inches FL, McBride et al., 2008), meaning that most of the hogfish caught above this size limit would be males. Therefore, this size limit would protect most mature females. For protogynous stocks such as hogfish, disproportionate fishing on males may increase the possibility of reduced fertilization rates, but there is a general lack of information on the importance of sperm limitation for this hogfish (Brooks et al. 2008). However, the stock SSB is currently well above the SSB_{MSY} threshold under all proxies for MSY, which suggests that sperm limitation is not a constraining factor. This size limit would further extend the season and decrease the likelihood of an ACL closure.

2.5 Action 5 – Use of Powerheads to Harvest Hogfish in the Stressed Area

Alternative 1: No Action. The prohibition on the use of powerheads to take Gulf reef fish in the stressed area does not apply to hogfish.

Preferred Alternative 2: Remove the provision in 50 CFR 622.35(a)(1) that exempts hogfish from the prohibition on the use of powerheads to take Gulf reef fish in the stressed area.

Discussion:

The stressed area begins at the shoreward boundary of federal waters and generally follows the 10 fathom contour from the Dry Tortugas to Sanibel Island; the 20 fathom contour to Tarpon Springs; the 10 fathom contour to Cape San Blas; the 25 fathom contour to south of Mobile Bay; the 13 fathom contour to Ship Island, Mississippi; the 10 fathom contour off Louisiana; and the 30 fathom contour off Texas (Figure 2.5.1). Within the stressed area, the use of powerheads to take reef fish and the use of roller trawls is prohibited. Fish traps were also prohibited in the stressed area prior to their being banned from the entire Gulf EEZ in 2007 (GMFMC 1997a, 1981).

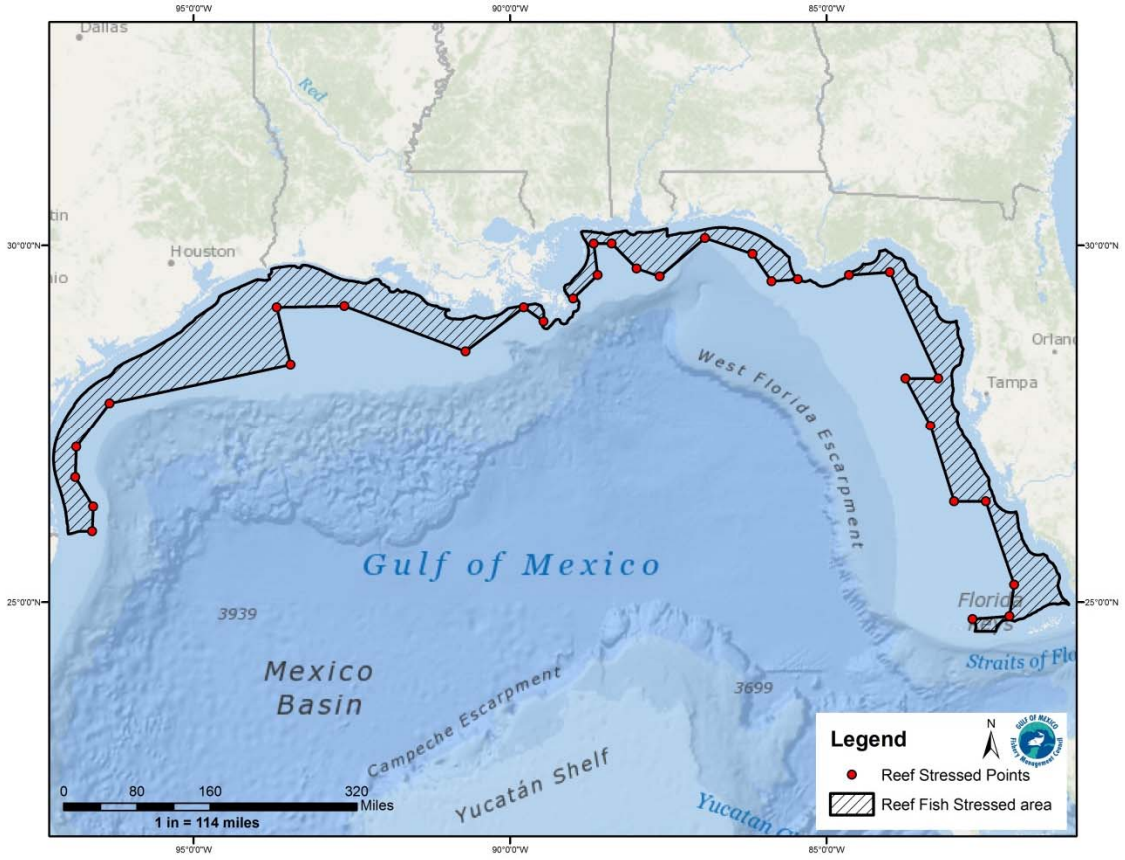


Figure 2.5.1. Gulf of Mexico stressed area. The state boundary line does not reflect recent changes in jurisdiction for reef fish management.

Powerhead means any device with an explosive charge, usually attached to a speargun, spear, pole, or stick, that fires a projectile upon contact (50 CFR 622.2). Damage to the fish is caused primarily by the percussion from the expanding gasses rather than from a projectile.

Section 622.35(a)(1) of the Code of Federal Regulations currently reads as follows:

> A powerhead may not be used in the stressed area to take Gulf reef fish. Possession of a powerhead and a mutilated Gulf reef fish in the stressed area or after having fished in the stressed area constitutes *prima facie* evidence that such reef fish was taken with a powerhead in the stressed area. The provisions of this paragraph do not apply to hogfish.

At one time, hogfish were included in the Reef Fish FMP in the list of "species in the fishery but not the management unit." That list was included for data collection purposes only, and management regulations including the stressed area restrictions did not apply to that list. In 1996, when the regulations for the fisheries of the Caribbean, Gulf, and South Atlantic were consolidated into one part, the distinction between reef fish "species in the management unit" and "species in the fishery but not in the management unit" was erroneously dropped from the Code of Federal Regulations. As a result, the powerhead prohibition was applied to both "species in the fishery but not the management unit" and to "species in the management unit".

Amendment 15 (GMFMC 1997b) removed 25 species of sea basses, grunts and porgies from the Reef Fish FMP. Most of these species were in the list of "species in the fishery but not the management unit." When NMFS approved the amendment, it added a provision which reinstated the allowance of powerheads in the stressed area to harvest the four remaining species in the list of "species in the fishery but not the management unit", i.e., hogfish, Queen triggerfish, sand perch, and dwarf sand perch.

In 1999 Amendment 16B (GMFMC 1999a) eliminated the distinction between reef fish species in the management unit and those in the fishery but not in the management unit. At the time, hogfish, sand perch, dwarf sand perch, and Queen triggerfish were the only species left on the "in the fishery" list. Even though the "species in the fishery but not the management unit" no longer existed, these species continued to be listed as exempt from the stressed area restrictions. Queen triggerfish was removed from the FMP in Amendment 16B (GMFMC 1999a), and sand perch and dwarf sand perch were removed in the Generic ACL/AM Amendment (GMFMC 2011a), leaving only hogfish from the old list. Powerheads are generally used against larger fish, and it is unlikely that hogfish are harvested with powerheads.

Alternative 1 (No Action) leaves in place the allowance to take hogfish with powerheads in the stressed area in place. Spearfishing is the dominant method for the harvest of hogfish, but there are no records as to how many hogfish are taken using powerheads. Given the relative small size of hogfish compared to fish such as sharks and greater amberjack, and the amount of damage that can be done to the fish by a powerhead discharge, it is unlikely that many, if any, hogfish in the stressed area are taken using a powerhead.

Preferred Alternative 2 removes the exemption in Section 622.35(a)(1) that reads, "The provisions of this paragraph do not apply to hogfish." Hogfish would then be subject to the same

stressed area regulations as other reef fish. Specifically, the prohibition on the use of powerheads in the stressed area would apply to all reef fish including hogfish. Hogfish are subject to all other applicable reef fish regulations, including bag limits, minimum size limits, and ACLs. The exception allowing the use of powerheads in the stressed area is an artifact of hogfish being the only remaining species from the "list of species in the fishery but not the management unit." Reinstating the powerhead prohibition is likely to have little if any impact on hogfish spearfishing in the stressed area, but may improve enforcement by establishing the prohibition uniformly to all reef fish in the stressed area.

CHAPTER 3. AFFECTED ENVIRONMENT

3.1 Description of the Fishery

Hogfish are protogynous hermaphrodites in the wrasse (Labridae) family and have been observed to live as long as 23 years (McBride and Richardson 2007). All fish older than 10 are expected to be males (SEDAR 37 2014). The species occurs from Bermuda and North Carolina, south through the Caribbean Sea and northern Gulf of Mexico (Gulf), continuing to the north coast of South America[5]. In the Gulf, harvest occurs primarily off of Florida, with the majority of the landings coming from South/Southeastern and Western Florida (SEDAR 37 2014).

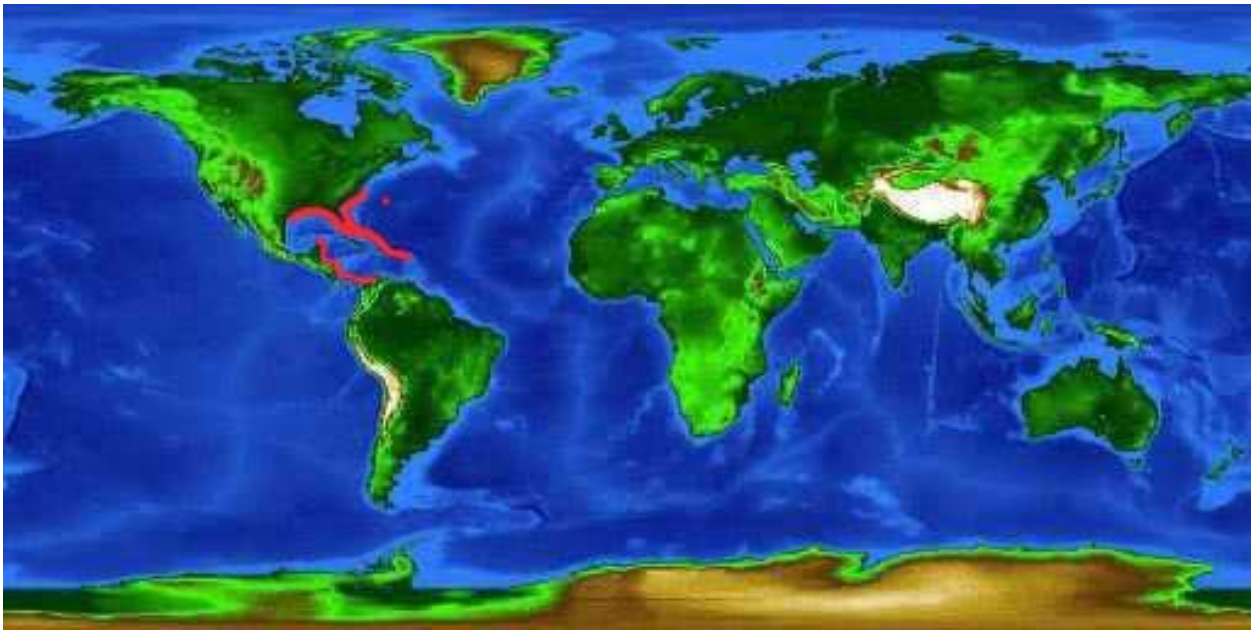


Figure 3.1.1. Distribution of hogfish. Source: Florida Museum of Natural History

Commercial harvest of hogfish is conducted primarily by spearfishing, hook-and-line, and prior to 2007, traps. Fish traps were prohibited from the Gulf exclusive economic zone (EEZ) in 2007, but occasional small amounts of trap landings may still occur from black sea bass pots, which are legal in selected areas of state waters. Between 2007 and 2012 in the Gulf, spearfishing accounted for 88% of the commercial harvest and hook-and-line accounted for 12% of the harvest (SEDAR 37 2014). Since 1986, commercial hogfish landings from the Gulf have ranged from a high of 94,073 lbs whole weight (ww) in 1993 to a low of 15,630 lbs ww in 2006. In the most recent five years landings have fluctuated between about 25,000 and 26,000 lbs ww, with a dockside value of between 99 thousand dollars and 173 thousand dollars (Table 3.1.1).

[5] http://www.flmnh.ufl.edu/fish/discover/species-profiles/lachnolaimus-maximus

Table 3.1.1. Hogfish commercial landings and dockside value 1986-2014. Landings are in pounds whole weight.

Year	Commercial Landings	Commercial Value
1986	25,437	$24,896
1987	28,713	$32,858
1988	27,478	$35,806
1989	55,301	$74,219
1990	61,481	$99,811
1991	53,974	$86,985
1992	64,789	$91,814
1993	94,073	$135,403
1994	58,935	$95,395
1995	25,408	$45,831
1996	20,650	$36,209
1997	23,401	$44,164
1998	15,942	$27,895
1999	23,111	$41,010
2000	21,108	$38,467
2001	27,059	$53,789
2002	30,387	$62,044
2003	28,036	$60,064
2004	25,254	$58,147
2005	20,110	$48,106
2006	15,630	$40,403
2007	18,112	$51,090
2008	24,150	$77,352
2009	32,316	$101,669
2010	34,926	$120,184
2011	45,995	$172,991
2012	42,989	$167,213
2013	24,874	$99,612
2014	34,533	$145,478

Source: NMFS Southeast Regional Office, ACL dataset (October 2015)

Recreational harvest of hogfish occurs primarily by spearfishing. Hogfish are one of the most targeted and caught species using spear. Between 2007 and 2012 in the Gulf, spearfishing accounted for 83% of the recreational harvest and hook-and-line accounted for 17% of the harvest. Recreational harvest of hogfish is mostly from private boats, with only a small proportion from either for-hire vessels or shore-based fishing (SEDAR 37 2014). Recreational landings of hogfish by mode in both numbers and pounds are shown in Table 3.1.2.

Table 3.1.2. Recreational landings (numbers of fish and pounds whole weight) of hogfish in the Gulf of Mexico, by mode.

	Headboat		Charter		Private		TOTAL	
Year	Landings (N)	Landings (lbs ww)	Landings (N)	Landings (lbs ww)	Landings (N)	Landings (lbs ww)	Landings (N)	Landings (lbs ww)
1986	117	191	10,527	17,444	56,560	98,593	67,204	116,228
1987	35	73	9,410	16,286	95,936	173,798	105,381	190,156
1988	201	383	0	0	66,280	150,849	66,481	151,232
1989	41	59	2,232	4,302	61,747	116,806	64,020	121,167
1990	148	450	0	0	19,480	38,146	19,628	38,596
1991	99	299	0	0	157,292	238,507	157,391	238,806
1992	213	477	0	0	96,333	231,717	96,546	232,194
1993	167	887	0	0	135,199	224,077	135,366	224,964
1994	654	2,868	0	0	75,890	132,394	76,544	135,262
1995	465	1,832	0	0	77,510	179,925	77,975	181,757
1996	13	53	0	0	33,665	65,924	33,678	65,977
1997	7	15	0	0	54,738	117,796	54,745	117,811
1998	25	102	3,704	7,000	48,614	92,594	52,343	99,697
1999	42	89	1,062	1,926	62,478	118,593	63,582	120,607
2000	66	493	0	0	36,299	71,081	36,365	71,574
2001	57	418	573	1,121	55,546	108,771	56,176	110,311
2002	61	393	854	1,976	31,979	73,981	32,894	76,350
2003	80	118	2,006	3,740	104,826	201,827	106,912	205,684
2004	53	103	191	339	42,688	76,410	42,932	76,852
2005	124	210	373	899	18,436	44,438	18,933	45,547
2006	41	244	98	192	22,425	43,913	22,564	44,349
2007	80	142	1,212	1,945	29,753	46,761	31,045	48,849
2008	61	94	409	824	80,282	166,513	80,752	167,431
2009	126	189	650	1,382	43,908	96,085	44,684	97,656
2010	431	665	28,010	53,281	61,912	141,411	90,353	195,357
2011	2,946	4,870	2,638	6,161	27,579	61,469	33,163	72,500
2012	4,139	8,563	6,485	14,790	48,272	121,238	58,897	144,591
2013	1,980	2,921	557	1,230	102,836	238,141	105,373	242,292
2014	2,032	2,869	4,242	8,459	38,512	71,649	44,786	82,977

Source: NMFS Southeast Regional Office, ACL dataset (October 2015) with Monroe County landings used in Gulf mean weight computations but excluded from Gulf landings, consistent with SEFSC Recreational ACL Datasets 2016-on)

There is currently no allocation of the hogfish annual catch limit (ACL) between the recreational and commercial sectors. During the period 1981-2014, the average proportion of recreational to commercial harvest (in pounds whole weight) was 79% recreational to 21% commercial. However, in any one year, the proportion of recreational to commercial harvest has fluctuated from 39%:61% in 1990 to 91%:9% in 2013, respectively (Table 2.3.2).

3.2 Description of the Physical Environment

The Gulf has a total area of approximately 600,000 square miles (1.5 million km^2), including state waters (Gore 1992). It is a semi-enclosed, oceanic basin connected to the Atlantic Ocean by the Straits of Florida and to the Caribbean Sea by the Yucatan Channel (Figure 3.2.1). Oceanographic conditions are affected by the Loop Current, discharge of freshwater into the northern Gulf, and a semi-permanent, anti-cyclonic gyre in the western Gulf. The Gulf includes both temperate and tropical waters (McEachran and Fechhelm 2005). Gulf water temperatures range from 54º F to 84º F (12º C to 29º C) depending on time of year and depth of water. Mean annual sea surface temperatures ranged from 73 º F through 83º F (23-28º C) including bays and bayous (Figure 3.2.1) between 1982 and 2009, according to satellite-derived measurements (NODC 2012: http://accession.nodc.noaa.gov/0072888). In general, mean sea surface temperature increases from north to south with large seasonal variations in shallow waters.

The physical environment for Gulf reef fish, including hogfish, is also detailed in the Generic Essential Fish Habitat (EFH) Amendment, the Generic ACL/Accountability Measure (AM) Amendment, and Reef Fish Amendment 40 (GMFMC 2004a; GMFMC 2011a; GMFMC 2014, respectively) and are incorporated by reference and further summarized below. In general, reef fish are widely distributed in the Gulf, occupying both pelagic and benthic habitats during their life cycle. A planktonic larval stage lives in the water column and feeds on zooplankton and phytoplankton (GMFMC 2004a). Juvenile and adult reef fish are typically demersal and usually associated with bottom topographies on the continental shelf (<100m) which have high relief, i.e., coral reefs, artificial reefs, rocky hard-bottom substrates, ledges and caves, sloping soft-bottom areas, and limestone outcroppings. However, several species are found over sand and soft-bottom substrates. For example, juvenile red snapper are common on mud bottoms in the northern Gulf, particularly off Texas through Alabama. Also, hogfish, some juvenile snapper (e.g. mutton, gray, red, dog, lane, and yellowtail snappers) and grouper (e.g. Goliath grouper, red, gag, and yellowfin groupers) have been documented in inshore seagrass beds, mangrove estuaries, lagoons, and larger bay systems.

In the Gulf, fish habitat for adult hogfish consists of reef and hard bottom habitats that provide structural cover, and hogfish have been observed at depths >60 m (GMFMC 2004a, SEDAR 37 2014). Juveniles are found in polyhaline estuarine seagrass beds or nearshore reef habitats. Detailed information pertaining to the Gulf area closures and marine reserves is provided in Amendment 32 (GMFMC 2011b).

With respect to the National Register of Historic Places, there is one site listed in the Gulf. This is the wreck of the *U.S.S. Hatteras*, located in federal waters off Texas. Historical research indicates that over 2,000 ships have sunk on the Federal Outer Continental Shelf between 1625 and 1951; thousands more have sunk closer to shore in state waters during the same period. Only a handful of these have been scientifically excavated by archaeologists for the benefit of generations to come. Further information can be found at: http://www.boem.gov/Environmental-Stewardship/Archaeology/Shipwrecks.aspx.

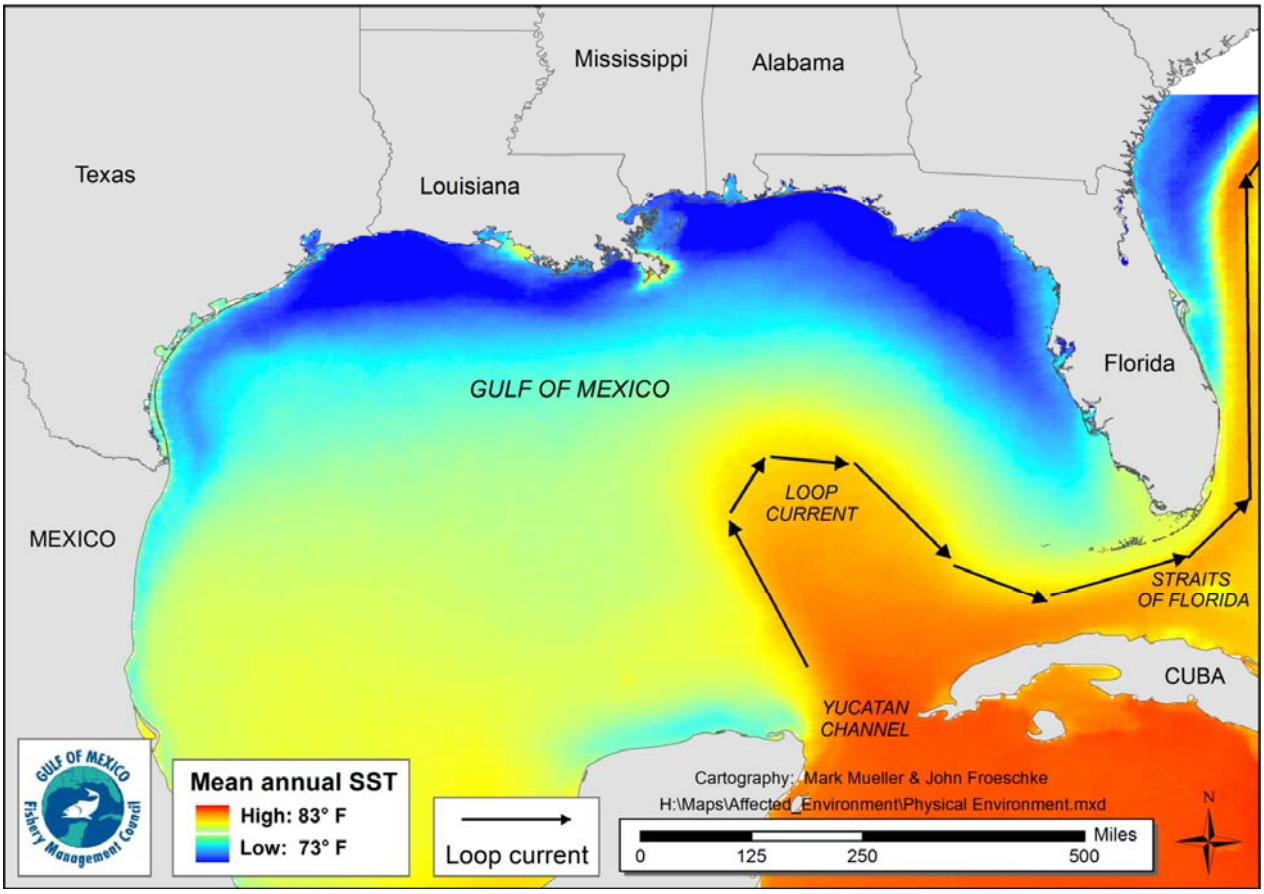


Figure 3.2.1. Physical environment of the Gulf including major feature names and mean annual sea surface temperature as derived from the Advanced Very High Resolution Radiometer Pathfinder Version 5 sea surface temperature data set (http://accession.nodc.noaa.gov/0072888)

3.3 Description of the Biological/Ecological Environment

The biological environment of the Gulf, including the species addressed in this amendment, is described in detail in the Generic EFH Amendment, the Generic ACL/AM Amendment, and Reef Fish Amendment 40 (GMFMC 2004a; GMFMC 2011a; GMFMC 2014, respectively) and is incorporated here by reference and further summarized below.

Hogfish Life History and Biology

Hogfish occur in warm temperate to tropical waters of the western Atlantic Ocean from Brazil to Bermuda and occur throughout the Caribbean and Gulf. Hogfish demonstrate the typical reef fish life history pattern (Appendix C). Eggs and larvae are pelagic while juveniles are found associated with shallow-water coastal habitats. Hogfish are protogynous hermaphrodites. Female size and age at 50% maturity to occur between 151.6 – 192.7 mm fork length (FL) and 0.9 – 1.6 years (SEDAR 37 2014). Females may transition into males as small as approximately 200 mm FL, however the size and age of 50% maturity for the west Florida Shelf stock is 426 mm FL and 6.5 years (SEDAR 37 2014). Spawning occurs

during the winter and spring months with larger fish in deeper waters having a longer spawning season (SEDAR 37 2014). Hogfish have been aged up to 23 years (McBride and Richardson 2007) with the oldest female being aged to 10 years (Collins and McBride 2011). A more complete description of hogfish life history can be found in the Generic EFH Amendment (GMFMC 2004a) and in SEDAR 37 (2014).

Recent genetic analyses by Seyoum et al. (2014) suggest three distinct stocks in the Gulf and South Atlantic waters. A suite of 24 microsatellite loci were used to examine the genetic structure of hogfish collected in the southeast. Although there were some gaps in sample coverage (primarily between the central east coast of Florida and South Carolina), three distinct groups emerged. The west Florida shelf stock included samples collected from the Panhandle of Florida south along the west Florida shelf, and converged with the Florida Keys/eastern Florida south of Naples. The Florida Keys/eastern Florida stock included samples collected south of Naples, through the Florida Keys and up the southeastern coast of Florida. The third group included hogfish collected off the coast of the Carolinas and was genetically distinct from the two Florida groups.

Status of the Hogfish Stock

The Southeast Data, Assessment, and Review (SEDAR) 37 for hogfish used the Stock Synthesis (Methot and Wetzel 2013). This is an integrated statistical catch-at-age model and is widely used for stock assessments in the United States. For more information on the model, see SEDAR 37 (2014). SEDAR 37 (2014) used data through 2012. Commercial and recreational landings for 2013 and 2014 were obtained from Florida Wildlife Research Institute Trip Tickets, the SEFSC's Accumulated Landings System database, the Marine Recreational Information Program (MRIP) and the Southeast Region Headboat Survey (SRHS). Catches for 2015 were assumed to be the average of 2013 and 2014 catches. Three stocks were considered in the assessment based on the genetic analysis described above. The stocks were west Florida, East Florida including the Florida Keys and Dry Tortugas, and the Carolinas (Georgia through North Carolina). Nearly all landings of hogfish from the Gulf came from Florida, so the stock was described as a west Florida shelf stock for the purpose of the assessment although the West Florida shelf stock included limited catch data from other Gulf states. A more detailed description of the assessment can be found at http://sedarweb.org/sedar-37.

The Gulf of Mexico Fishery Management Council's (Gulf Council) Scientific and Statistical Committee (SSC) evaluated the stock using a proxy for F_{MSY} of $F_{30\%SPR}$ where F is fishing mortality, MSY is maximum sustainable yield, and SPR is spawning potential ratio. For west Florida shelf, the stock was found not to be overfished or undergoing overfishing[6]; however, the East Florida/Florida Keys hogfish stock was considered overfished and undergoing overfishing by the South Atlantic Fishery Management Council's (South Atlantic Council) SSC. In evaluating the assessments output, the Gulf Council's SSC recommended an overfishing limit (OFL) and acceptable biological catch (ABC) yield streams for 2015-2018. The OFL yield stream was produced using a P* = 0.5 and using the Council's ABC control rule, an ABC yield stream was produced using a P* = 0.4 with a CV of 0.37. The OFL and ABC yield streams are shown in Table 1.1.1.

[6] Note that if an $F_{40\%SPR}$ proxy is used for F_{MSY}, the west Florida stock is considered overfished (SEDAR 37 2014)

General Information on Reef Fish Species

The National Ocean Service collaborated with NMFS and the Council to develop distributions of reef fish (and other species) in the Gulf (SEA 1998). The National Ocean Service obtained fishery-independent data sets for the Gulf, including SEAMAP, and state trawl surveys. Data from the Estuarine Living Marine Resources (ELMR) Program contain information on the relative abundance of specific species (highly abundant, abundant, common, rare, not found, and no data) for a series of estuaries, by five life stages (adult, spawning, egg, larvae, and juvenile) and month for five seasonal salinity zones (0-0.5, 0.5-5, 5-15, 15-25, and >25 parts per thousand). National Ocean Service staff analyzed these data to determine relative abundance of the mapped species by estuary, salinity zone, and month. For some species not in the ELMR Program database, distribution was classified as only observed or not observed for adult, juvenile, and spawning stages.

In general, reef fish are widely distributed in the Gulf, occupying both pelagic and benthic habitats during their life cycle. Habitat types and life history stages are summarized in Appendix C and can be found in more detail in GMFMC (2004a). In general, both eggs and larval stages are planktonic. Larvae feed on zooplankton and phytoplankton. Exceptions to these generalizations include the gray triggerfish that lay their eggs in depressions in the sandy bottom, and gray snapper whose larvae are found around submerged aquatic vegetation (SAV). Juvenile and adult reef fish are typically demersal, and are usually associated with bottom topographies on the continental shelf (<328 feet; <100 m) which have high relief, i.e., coral reefs, artificial reefs, rocky hard-bottom substrates, ledges and caves, sloping soft-bottom areas, and limestone outcroppings. However, several species are found over sand and soft-bottom substrates. Juvenile red snapper are common on mud bottoms in the northern Gulf, particularly from Texas to Alabama. Also, some juvenile snappers (e.g. mutton, gray, red, dog, lane, and yellowtail snappers) and groupers (e.g. goliath grouper, red, gag, and yellowfin groupers) have been documented in inshore seagrass beds, mangrove estuaries, lagoons, and larger bay systems (GMFMC 1981). More detail on hard bottom substrate and coral can be found in the Fishery Management Plan (FMP) for Corals and Coral Reefs (GMFMC and SAFMC 1982).

Many of these species co-occur with hogfish and can be incidentally caught during hogfish fishing. In some cases, these fish may be discarded for regulatory reasons and thus are considered bycatch. Appendix D (bycatch practicability analysis) examines the effects of fishing on these species. In general, this analysis coupled with previous analyses has found that reducing bycatch provides biological benefits to managed species as well as benefits to the fishery through less waste, higher yields, and less forgone yield. However, in some cases, actions are approved that can increase bycatch through regulatory discards such as increased minimum sizes and closed seasons. In these cases, there is some biological benefit to the managed species that outweighs any increases in discards.

Status of Reef Fish Stocks

The Reef Fish FMP currently encompasses 31 species (Table 3.3.1). Eleven other species were removed from the FMP in 2012 through the Generic ACL/AM Amendment (GMFMC 2011a). Stock assessments and stock assessment reviews have been conducted for 13 species and can be

found on the Council (www.gulfcouncil.org) and SEDAR (www.sefsc.noaa.gov/sedar) websites. The assessed species are:

- Red Snapper (SEDAR 7 2005; SEDAR 7 Update 2009; SEDAR 31 2013; SEDAR 31 Update 2015)
- Vermilion Snapper (Porch and Cass-Calay 2001; SEDAR 9 2006c; SEDAR 9 Update 2011a)
- Yellowtail Snapper (Muller et al. 2003; SEDAR 3 2003; O'Hop et al. 2012)
- Mutton Snapper (SEDAR 15A 2008)
- Gray Triggerfish (Valle et al. 2001; SEDAR 9 2006a; SEDAR 9 Update 2011b, SEDAR 43 2015)
- Greater Amberjack (Turner et al. 2000; SEDAR 9 2006b; SEDAR 9 Update 2010; SEDAR 33 2014a)
- Hogfish (Ault et al. 2003; SEDAR 6 2004b; Cooper et al. 2013; SEDAR 37 2014)
- Red Grouper (NMFS 2002; SEDAR 12 2007; SEDAR 12 Update 2009, SEDAR 42 2015)
- Gag (Turner et al. 2001; SEDAR 10 2006; SEDAR 10 Update 2009; SEDAR 33 2014b)
- Black Grouper (SEDAR 19 2010)
- Yellowedge Grouper (Cass-Calay and Bahnick 2002; SEDAR 22 2011b)
- Tilefish (Golden) (SEDAR 22 2011a)
- Atlantic Goliath Grouper (Porch et al. 2003; SEDAR 6 2004a; SEDAR 23 2011)

The NMFS Office of Sustainable Fisheries updates its Status of U.S. Fisheries Report to Congress on a quarterly basis utilizing the most current stock assessment information. The most recent update can be found at: http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/. The status of both assessed and unassessed stocks as of the writing of this report is shown in Table 3.3.1.

Table 3.3.1. Species of the Reef Fish FMP grouped by family.

Common Name	Scientific Name	Stock Status
Family Balistidae – Triggerfishes		
Gray Triggerfish	*Balistes capriscus*	Overfished, overfishing
Family Carangidae – Jacks		
Greater Amberjack	*Seriola dumerili*	Overfished, overfishing
Lesser Amberjack	*Seriola fasciata*	Unknown
Almaco Jack	*Seriola rivoliana*	Unknown
Banded Rudderfish	*Seriola zonata*	Unknown
Family Labridae - Wrasses		
*Hogfish	*Lachnolaimus maximus*	Not overfished, no overfishing
Family Malacanthidae - Tilefishes		
Tilefish (Golden)	*Lopholatilus chamaeleonticeps*	Not overfished, no overfishing
Blueline Tilefish	*Caulolatilus microps*	Unknown
Goldface Tilefish	*Caulolatilus chrysops*	Unknown
Family Serranidae - Groupers		
Gag	*Mycteroperca microlepis*	Not overfished, no overfishing
Red Grouper	*Epinephelus morio*	Not overfished, no overfishing
Scamp	*Mycteroperca phenax*	Unknown
Black Grouper	*Mycteroperca bonaci*	Not overfished, no overfishing
Yellowedge Grouper	**Hyporthodus flavolimbatus*	Not overfished, no overfishing
Snowy Grouper	**Hyporthodus niveatus*	Unknown
Speckled Hind	*Epinephelus drummondhayi*	Unknown
Yellowmouth Grouper	*Mycteroperca interstitialis*	Unknown
Yellowfin Grouper	*Mycteroperca venenosa*	Unknown
Warsaw Grouper	**Hyporthodus nigritus*	Unknown
***Atlantic Goliath Grouper	*Epinephelus itajara*	Unknown
Family Lutjanidae - Snappers		
Queen Snapper	*Etelis oculatus*	Unknown
Mutton Snapper	*Lutjanus analis*	Not overfished, no overfishing
Blackfin Snapper	*Lutjanus buccanella*	Unknown
Red Snapper	*Lutjanus campechanus*	Overfished, no overfishing
Cubera Snapper	*Lutjanus cyanopterus*	Unknown, no overfishing
Gray Snapper	*Lutjanus griseus*	Unknown, no overfishing
Lane Snapper	*Lutjanus synagris*	Unknown, no overfishing
Silk Snapper	*Lutjanus vivanus*	Unknown
Yellowtail Snapper	*Ocyurus chrysurus*	Not overfished, no overfishing
Vermilion Snapper	*Rhomboplites aurorubens*	Not overfished, no overfishing
Wenchman	*Pristipomoides aquilonaris*	Unknown

Notes: *The East Florida/Florida Keys hogfish stock is considered overfished and undergoing overfishing.
**In 2013 the genus for yellowedge grouper, snowy grouper, and warsaw grouper was changed by the American Fisheries Society from *Epinephelus* to *Hyporthodus* (American Fisheries Society 2013).
***Atlantic goliath grouper is a protected grouper and benchmarks do not reflect appropriate stock dynamics. In 2013 the common name was changed from goliath grouper to Atlantic goliath grouper by the American Fisheries Society to differentiate from the Pacific goliath grouper, a newly named species (American Fisheries Society 2013).

Protected Species

The Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) provide special protections to some species that occur in the Gulf. Appendix A includes a very brief summary of how these two laws, and more information is available on NMFS Office of Protected Resources website (http://www.nmfs.noaa.gov/pr/laws/). All 22 marine mammals in the Gulf are protected under the MMPA. Two marine mammals (sperm whales and manatees) are also protected under the Endangered Species Act (ESA). Other species protected under the ESA include five sea turtle species (Kemp's ridley, loggerhead, green, leatherback, and hawksbill), two fish species (Gulf sturgeon and smalltooth sawfish), and five coral species (elkhorn, staghorn, lobed star, mountainous star, and boulder star). Critical habitat designated under the ESA for smalltooth sawfish, Gulf sturgeon, and the Northwest Atlantic Ocean distinct population segment of loggerhead sea turtles also occur in the Gulf, though only loggerhead critical habitat occurs in federal waters.

The following sections provide a brief overview of the marine mammals, sea turtles, and fish that may be present in or near areas where Gulf reef fish fishing occurs and their general life history characteristics. Since none of the listed corals or designated critical habitats in the Gulf are likely to be adversely affected by the Gulf reef fish fishery, they are not discussed further.

Marine Mammals

The 22 species of marine mammals in the Gulf include one sirenian species (a manatee), which is under U.S. Fish and Wildlife Service's (USFWS) jurisdiction, and 21 cetacean species (dolphins and whales), all under NMFS' jurisdiction. Manatees primarily inhabit rivers, bays, canals, estuaries, and coastal waters rich in seagrass and other vegetation off Florida, but can occasionally be found in seagrass habitats as far west as Texas. Although most of the cetacean species reside in the oceanic habitat ($\geq$ 200 m), the Atlantic spotted dolphin is found in waters over the continental shelf (20-200 m), and the common bottlenose dolphin (hereafter referred to as bottlenose dolphins) is found throughout the Gulf, including within bays, sounds, and estuaries; coastal waters over the continental shelf; and in deeper oceanic waters.

Sperm whales are one of the cetacean species found in offshore waters of the Gulf of Mexico (>200m) and are listed endangered under the ESA. Sperm whales, are the largest toothed whales and are found year-round in the northern Gulf of Mexico along the continental slope and in oceanic waters (Waring et al. 2013). There are several areas between Mississippi Canyon and De Soto Canyon where sperm whales congregate at high densities, likely because of localized, highly productive habitats (Biggs et al. 2005; Jochens et al. 2008). There is a resident population of female sperm whales, and whales with calves frequently sighted there.

Bryde's whales are the only resident baleen whales in the Gulf and are currently being evaluated to determine if listing under the ESA is warranted. Bryde's whales (pronounced "BREW-days") in the Gulf are currently restricted to a small area in the northeastern Gulf near De Soto Canyon in waters between 100 – 400 m depth along the continental shelf break, though information in the southern Gulf of Mexico is sparse (Waring et al. 2013). On September 18, 2014, NMFS received a revised petition from the Natural Resource Defense Council to list the Gulf of Mexico

Bryde's whale as an endangered Distinct Population Segment. On April 6, 2015, NMFS found the petitioned action may be warranted and convened a Status Review Team to prepare a status review report. NMFS will rely on the information status review report to make a 12-month determination as to whether or not listing as endangered or threatened the species is warranted, and if so, a proposed rule will be published in the Federal Register.

Although they are all the same species, **bottlenose dolphins** in the Gulf can be separated into demographically independent populations called stocks. Bottlenose dolphins are currently managed by NMFS as 36 distinct stocks within the Gulf. These include 31 bay, sound and estuary stocks, three coastal stocks, one continental shelf stock, and one oceanic stock (Waring et al. 2013). Additional climatic and oceanographic boundaries delineate the three coastal stocks such that the Gulf of Mexico Eastern Coastal Stock ranges from 84ºW to Key West, FL, the Gulf of Mexico Northern Coastal Stock ranges from 84ºW to the Mississippi River Delta, and the Gulf of Mexico Western Coastal stock ranges from the Mississippi River Delta to the Texas/Mexico border. Marine Mammal Stock Assessment Reports and additional information on these species in the Gulf are available on the NMFS Office of Protected Species website: http://www.nmfs.noaa.gov/pr/sspecies/.

Bottlenose dolphin adults range from 6 to 9 feet (1.8 to 2.8 m) long and weigh typically between 300 to 600 pounds (136 to 272 kg). Females and males reach sexual maturity between ages 5 to 13 and 9 to 14, respectively. Once mature, females give birth once every 3 to 6 years. Maximum known lifespan can be 50 years for males and greater than 60 years for females (Reynolds 2000).

The MMPA requires that each commercial fishery be classified by the number of marine mammals they seriously injure or kill. NMFS's List of Fisheries (LOF) classifies U.S. commercial fisheries into three categories based on the number of incidental mortality or serious injury they cause to marine mammals. More information about the LOF and the classification process can be found at: http://www.nmfs.noaa.gov/pr/interactions/fisheries/lof.html.

NMFS classifies reef fish bottom longline/hook-and-line gear in the Marine Mammal Protection Act 2015 LOF as a Category III fishery (79 FR 77919). This classification indicates the annual mortality and serious injury of a marine mammal stock resulting from any fishery is less than or equal to 1% of the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. Dolphins are the only species documented as interacting with these fisheries. Bottlenose dolphins are a common predator around reef fish vessels. They prey upon on the bait, catch, and/or released discards of fish from the reef fish fishery.

Turtles

Green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles are all highly migratory and travel widely throughout the Gulf. Several volumes exist that cover the biology and ecology of these species (i.e., Lutz and Musick (eds.) 1997; Lutz et al. (eds.) 2003, Wynekan et al. (eds.) 2013).

Green sea turtle hatchlings are thought to occupy pelagic areas of the open ocean and are often associated with *Sargassum* rafts (Carr 1987; Walker 1994). Pelagic stage green sea turtles are thought to be carnivorous. Stomach samples of these animals found ctenophores and pelagic snails (Frick 1976; Hughes 1974). At approximately 20 to 25 cm carapace length, juveniles migrate from pelagic habitats to benthic foraging areas (Bjorndal 1997). As juveniles move into benthic foraging areas a diet shift towards herbivory occurs. They consume primarily seagrasses and algae, but are also known to consume jellyfish, salps, and sponges (Bjorndal 1980, 1997; Paredes 1969; Mortimer 1981, 1982). The diving abilities of all sea turtles species vary by their life stages. The maximum diving range of green sea turtles is estimated at 110 m (360 ft) (Frick 1976), but they are most frequently making dives of less than 20 m (65 ft.) (Walker 1994). The time of these dives also varies by life stage. The maximum dive length is estimated at 66 minutes with most dives lasting from 9 to 23 minutes (Walker 1994).

The **hawksbill's** pelagic stage lasts from the time they leave the nesting beach as hatchlings until they are approximately 22-25 cm in straight carapace length (Meylan 1988; Meylan and Donnelly 1999). The pelagic stage is followed by residency in developmental habitats (foraging areas where juveniles reside and grow) in coastal waters. Little is known about the diet of pelagic stage hawksbills. Adult foraging typically occurs over coral reefs, although other hard-bottom communities and mangrove-fringed areas are occupied occasionally. Hawksbills show fidelity to their foraging areas over several years (van Dam and Diéz 1998). The hawksbill's diet is highly specialized and consists primarily of sponges (Meylan 1988). Gravid females have been noted ingesting coralline substrate (Meylan 1984) and calcareous algae (Anderes Alvarez and Uchida 1994), which are believed to be possible sources of calcium to aid in eggshell production. The maximum diving depths of these animals are not known, but the maximum length of dives is estimated at 73.5 minutes. More routinely, dives last about 56 minutes (Hughes 1974).

Kemp's ridley hatchlings are also pelagic during the early stages of life and feed in surface waters (Carr 1987; Ogren 1989). After the juveniles reach approximately 20 cm carapace length they move to relatively shallow (less than 50m) benthic foraging habitat over unconsolidated substrates (Márquez-M. 1994). They have also been observed transiting long distances between foraging habitats (Ogren 1989). Kemp's ridleys feeding in these nearshore areas primarily prey on crabs, though they are also known to ingest mollusks, fish, marine vegetation, and shrimp (Shaver 1991). The fish and shrimp Kemp's ridleys ingest are not thought to be a primary prey item but instead may be scavenged opportunistically from bycatch discards or discarded bait (Shaver 1991). Given their predilection for shallower water, Kemp's ridleys most routinely make dives of 50 m or less (Soma 1985; Byles 1988). Their maximum diving range is unknown. Depending on the life stage a Kemp's ridleys may be able to stay submerged anywhere from 167 minutes to 300 minutes, though dives of 12.7 minutes to 16.7 minutes are much more common (Soma 1985; Mendonca and Pritchard 1986; Byles 1988). Kemp's ridleys may also spend as much as 96% of their time underwater (Soma 1985; Byles 1988).

Leatherbacks are the most pelagic of all ESA-listed sea turtles and spend most of their time in the open ocean. Although they will enter coastal waters and are seen over the continental shelf on a seasonal basis to feed in areas where jellyfish are concentrated. Leatherbacks feed primarily on cnidarians (medusae, siphonophores) and tunicates. Unlike other sea turtles, leatherbacks'

diets do not shift during their life cycles. Because leatherbacks' ability to capture and eat jellyfish is not constrained by size or age, they continue to feed on these species regardless of life stage (Bjorndal 1997). Leatherbacks are the deepest diving of all sea turtles. It is estimated that these species can dive in excess of 1000 m (Eckert et al. 1989) but more frequently dive to depths of 50 m to 84 m (Eckert et al. 1986). Dive times range from a maximum of 37 minutes to more routines dives of 4 to 14.5 minutes (Standora et al. 1984; Eckert et al. 1986; Eckert et al. 1989; Keinath and Musick 1993). Leatherbacks may spend 74% to 91% of their time submerged (Standora et al. 1984).

Loggerhead hatchlings forage in the open ocean and are often associated with *Sargassum* rafts (Hughes 1974; Carr 1987; Walker 1994; Bolten and Balazs 1995). The pelagic stage of these sea turtles are known to eat a wide range of things including salps, jellyfish, amphipods, crabs, syngnathid fish, squid, and pelagic snails (Brongersma 1972). Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm straight-line carapace length, they begin to live in coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic (Witzell 2002). Here they forage over hard- and soft-bottom habitats (Carr 1986). Benthic foraging loggerheads eat a variety of invertebrates with crabs and mollusks being an important prey source (Burke et al. 1993). Estimates of the maximum diving depths of loggerheads range from 211 m to 233 m (692-764ft.) (Thayer et al. 1984; Limpus and Nichols 1988). The lengths of loggerhead dives are frequently between 17 and 30 minutes (Thayer et al. 1984; Limpus and Nichols 1988; Limpus and Nichols 1994; Lanyon et al. 1989) and they may spend anywhere from 80 to 94% of their time submerged (Limpus and Nichols 1994; Lanyon et al. 1989).

All five species of sea turtles are adversely affected by the Gulf reef fish fishery. Incidental captures are- infrequent, but occur in all commercial and recreational hook-and-line and longline components of the reef fish fishery. Observer data indicate that the bottom longline component of the fishery interacts solely with loggerhead sea turtles. Captured loggerhead sea turtles can be released alive or can be found dead upon retrieval of bottom longline gear as a result of forced submergence. Sea turtles caught during other reef fish fishing with other gears are believed to all be released alive due to shorter gear soak. All sea turtles released alive may later succumb to injuries sustained at the time of capture or from exacerbated trauma from fishing hooks or lines that were ingested, entangled, or otherwise still attached when they were released. Sea turtle release gear and handling protocols are required in the commercial and for-hire reef fish fisheries to minimize post-release mortality.

NMFS has conducted specific analyses ("Section 7 consultations") evaluating potential effects from the Gulf reef fish fishery on sea turtles (as well as on other ESA-listed species and critical habitat) as required by the ESA. On September 30, 2011, Southeast Regional Office (SERO) completed a biological opinion (Opinion), which concluded that the continued authorization of the Gulf reef fish fishery is not likely to jeopardize the continued existence of any sea turtles (loggerhead, Kemp's ridley, green, hawksbill, and leatherback) (NMFS 2011). An incidental take statement was issued specifying the amount and extent of anticipated take, along with reasonable and prudent measures and associated terms and conditions deemed necessary and appropriate to minimize the impact of these takes.

Fish

Historically the **smalltooth sawfish** in the U.S. ranged from New York to the Mexico border. Their current range is poorly understood but believed to have contracted from these historical areas. Smalltooth sawfish primarily occur in the Gulf off peninsular Florida and are most common off Southwest Florida and the Florida Keys. Historical accounts and recent encounter data suggest that immature individuals are most common in shallow coastal waters less than 25 meters (Bigelow and Schroeder 1953; Adams and Wilson 1995), while mature animals occur in waters in excess of 100 meters (Simpfendorfer pers. comm. 2006). Smalltooth sawfish feed primarily on fish. Mullet, jacks, and ladyfish are believed to be their primary food resources (Simpfendorfer 2001). Smalltooth sawfish also prey on crustaceans (mostly shrimp and crabs) by disturbing bottom sediment with their saw (Norman and Fraser 1938; Bigelow and Schroeder 1953).

Smalltooth sawfish are also adversely affected by the Gulf reef fish fishery, but are interacted with to a much lesser extent than sea turtles. Although the long, toothed rostrum of the smalltooth sawfish causes this species to be particularly vulnerable to entanglement in fishing gear, incidental captures in the commercial and recreational hook-and-line components of the reef fish fishery are rare events. Only eight smalltooth sawfish are anticipated to be incidentally caught every three year in the entire ref fish fishery, and none are expected to result in mortality (NMFS 2011). In the September 30, 2011, Opinion, NMFS concluded that the continued authorization of the Gulf reef fish fishery is not likely to jeopardize the continued existence of smalltooth sawfish (NMFS 2011). An incidental take statement was issued specifying the amount and extent of anticipated take, along with reasonable and prudent measures and associated terms and conditions deemed necessary and appropriate to minimize the impact of these takes. Fishermen in this fishery are required to follow smalltooth sawfish safe handling guidelines.

Northern Gulf of Mexico Hypoxic Zone

Every summer in the northern Gulf, a large hypoxic zone forms. It is the result of allochthonous materials and runoff from agricultural lands by rivers to the Gulf increasing nutrient inputs from the Mississippi River and a seasonal layering of waters in the Gulf (see http://www.gulfhypoxia.net/). The layering of the water is temperature and salinity dependent and prevents the mixing of higher oxygen content surface water with oxygen-poor bottom water. For 2014, the extent of the hypoxic area was estimated to be 5,052 square miles and is similar to the running average for the past five years of 5,543 square miles Gulf (see http://www.gulfhypoxia.net/). However, hogfish are not commonly found in the northern Gulf, so any impact of the hypoxic zone on hogfish should be minimal.

Climate change

Climate change projections show increases in sea-surface temperature and sea level; decreases in sea-ice cover; and changes in salinity, wave climate, and ocean circulation [Intergovernmental Panel on Climate Change (IPCC) http://www.ipcc.ch/]. These changes are likely to affect plankton biomass and fish larvae abundance that could adversely impact fish, marine mammals, seabirds, and ocean biodiversity. Kennedy et al. (2002) and Osgood (2008) have suggested

global climate change could affect temperature changes in coastal and marine ecosystems that can influence organism metabolism and alter ecological processes such as productivity and species interactions; change precipitation patterns and cause a rise in sea level which could change the water balance of coastal ecosystems; altering patterns of wind and water circulation in the ocean environment; and influence the productivity of critical coastal ecosystems such as wetlands, estuaries, and coral reefs. NOAA's Climate Change Web Portal (http://www.esrl.noaa.gov/psd/ipcc/ocn/) indicates the average sea surface temperature in the Gulf will increase by 1.2-1.4ºC for 2006-2055 compared to the average over the years 1956-2005. For reef fishes, Burton (2008) speculated climate change could cause shifts in spawning seasons, changes in migration patterns, and changes to basic life history parameters such as growth rates. It is unclear if hogfish distribution in the Gulf has been effected. Hogfish have not been used in the OceanAdapt model (http://oceanadapt.rutgers.edu/regional_data/) that shows distributional trends both in latitude and depth over the time period 1985-1013. For some reef fish species such as the smooth puffer, there has been a distributional trend to the north in the Gulf. For other species such as red snapper and the dwarf sand perch, there has been a distributional trend towards deeper waters. Finally, for other reef fish species such as the dwarf goatfish, there has been a distributional trend both to the north and to deeper waters. These changes in distributions have been hypothesized as a response to environmental factors such as increases in temperature.

The distribution of native and exotic species may change with increased water temperature, as may the prevalence of disease in keystone animals such as corals and the occurrence and intensity of toxic algae blooms. Hollowed et al. (2013) provided a review of projected effects of climate change on the marine fisheries and dependent communities. Integrating the potential effects of climate change into the fisheries assessment is currently difficult due to the time scale differences (Hollowed et al. 2013). The fisheries stock assessments rarely project through a time span that would include detectable climate change effects.

Greenhouse gases

The IPCC (http://www.ipcc.ch/) has indicated greenhouse gas emissions are one of the most important drivers of recent changes in climate. Wilson et al. (2014) inventoried the sources of greenhouse gases in the Gulf from sources associated with oil platforms and those associated with other activities such as fishing. A summary of the results of the inventory are shown in Table 3.3.2 with respect to total emissions and from fishing. Commercial fishing and recreational vessels make up a small percentage of the total estimated greenhouse gas emissions from the Gulf (1.43% and 0.59%, respectively).

Table 3.3.2. Total Gulf of Mexico greenhouse gas emissions estimates (tons per year) from oil platform and non-oil platform sources, commercial fishing and recreational vessels, and percent greenhouse gas emissions from commercial fishing and recreational vessels of the total emissions*.

Emission source	Greenhouse Gas CO_2	CH_4	N_2O	Total CO_{2e}**
Oil platform	11,882,029	271,355	167	17,632,106
Non-platform	22,703,695	2,029	2,698	23,582,684
Total	34,585,724	273,384	2,865	41,214,790
Commercial fishing	585,204	2	17	590,516
Recreational vessels	244,483	N/A	N/A	244,483
Percent commercial fishing	1.69	>0.01	0.59	1.43
Percent recreational vessels	0.71	NA	NA	0.59

*Compiled from Tables 7.9 and 7.10 in Wilson et al. (2014).

**The CO_2 equivalent (CO_{2e}) emission estimates represent the number of tons of CO_2 emissions with the same global warming potential as one ton of another greenhouse gas (e.g., CH_4 and N_2O). Conversion factors to CO_{2e} are 21 for CH_4 and 310 for N_2O.

Deepwater Horizon MC252 Oil Spill

On April 20, 2010 an explosion occurred on the Deepwater Horizon MC252 oil rig approximately 36 nautical miles (41 statute miles) off the Louisiana coast. Two days later the rig sank. An uncontrolled oil leak from the damaged well continued for 87 days until the well was successfully capped by British Petroleum on July 15, 2010. The Deepwater Horizon MC252 oil spill affected at least one-third of the Gulf area from western Louisiana east to the Florida Panhandle and south to the Campeche Bank in Mexico (Figure 3.3.1).

As reported by the National Oceanic and Atmospheric Administration Office of Response and Restoration (NOAA 2010), the oil from the Deepwater Horizon MC252 spill is relatively high in alkanes, which can readily be used by microorganisms as a food source. As a result, the oil from this spill is likely to biodegrade more readily than crude oil in general. The Deepwater Horizon MC252 oil is also relatively much lower in polyaromatic hydrocarbons. Polyaromatic hydrocarbons are highly toxic chemicals that tend to persist in the environment for long periods of time, especially if the spilled oil penetrates into the substrate on beaches or shorelines. Like all crude oils, MC252 oil contains volatile organic compounds (VOCs) such as benzene, toluene, and xylene. Some VOCs are acutely toxic but because they evaporate readily, they are generally a concern only when oil is fresh.[7]

[7] Source: http://sero.nmfs.noaa.gov/deepwater_horizon/documents/pdfs/fact_sheets/oil_characteristics.pdf

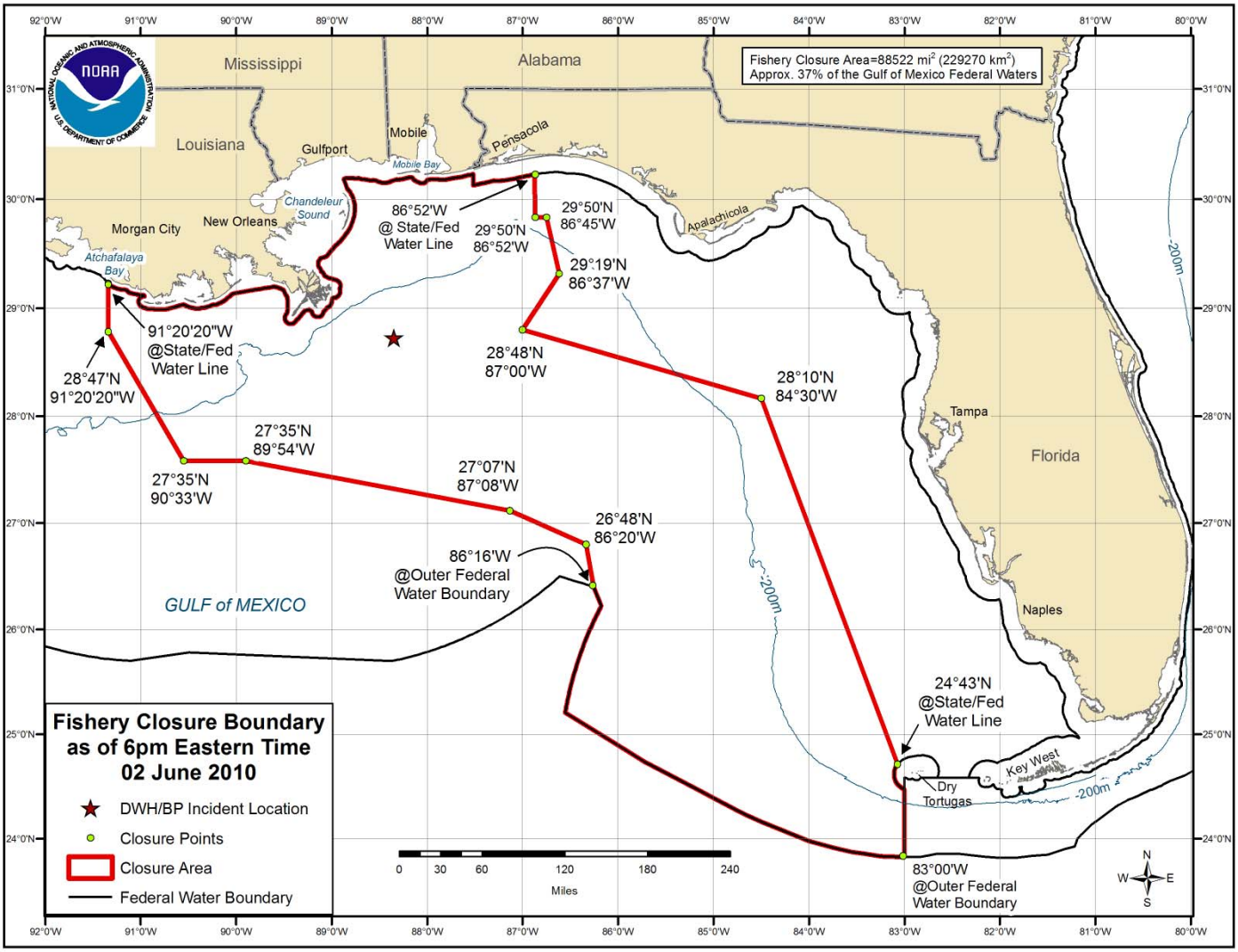


Figure 3.3.1. Fishery closure at the height of the Deepwater Horizon MC252 oil spill.

In addition to the crude oil, over a million gallons of the dispersant, Corexit 9500A®, was applied to the ocean surface and an additional hundreds of thousands of gallons of dispersant was pumped to the mile-deep well head (National Commission 2010). No large-scale applications of dispersants in deep water had been conducted until the Deepwater Horizon MC252 oil spill. Thus, no data exist on the environmental fate of dispersants in deep water. However, a study found that, while Corexit 9500A® and oil are similar in their toxicity, when Corexit 9500A® and oil were mixed in lab tests, toxicity to microscopic rotifers increased up to 52-fold (Rico-Martínez et al. 2013). This suggests that the toxicity of the oil and dispersant combined may be greater than anticipated.

Oil could exacerbate development of the hypoxic "dead" zone in the Gulf as could higher than normal input of water from the Mississippi River drainage. For example, oil on the surface of the water could restrict the normal process of atmospheric oxygen mixing into and replenishing

oxygen concentrations in the water column. In addition, microbes in the water that break down oil and dispersant also consume oxygen; this could lead to further oxygen depletion.

General Impacts on Fishery Resources

The presence of PAHs in marine environments can have detrimental impacts on marine finfish, especially during the more vulnerable larval stage of development (White et al. 2012). When exposed to realistic yet toxic levels of PAHs (1–15 µg/L), greater amberjack (*Seriola dumerili*) larvae develop cardiac abnormalities and physiological defects (Incardona et al. 2014). The future reproductive success of long-lived species, including red drum (*Sciaenops ocellatus*) and many reef fish species, may be negatively affected by episodic events resulting in high-mortality years or low recruitment. These episodic events could leave gaps in the age structure of the population, thereby affecting future reproductive output (Mendelssohn et al. 2012). Other studies have described the vulnerabilities of various marine finfish species, with morphological and/or life history characteristics similar to species found in the Gulf, to oil spills and dispersants (Hose et al. 1996; Carls et al. 1999; Heintz et al. 1999; Short 2003).

An increase in histopathological lesions were found in red snapper (*Lutjanus campechanus*) in the area affected by the oil, but Murawski et al. (2014) found that the incidence of lesions had declined between 2011 and 2012. The occurrence of such lesions in marine fish is not uncommon (Sindermann 1979; Haensly et al. 1982; Solangi and Overstreet 1982; Khan and Kiceniuk 1984, 1988; Kiceniuk and Khan 1987; Khan 1990). Red snapper diet was also affected after the spill. A decrease in zooplankton consumed, especially by adults (>400 mm TL) over natural and artificial substrates may have contributed to an increase in the consumption of fish and invertebrate prey- more so at artificial reefs than natural reefs (Tarnecki and Patterson 2015).

The effect of oil, dispersants, and the combination of oil and dispersants on fishes of the Gulf remains an area of concern. Marine fish species typically concentrate PAHs in the digestive tract, making stomach bile an appropriate testing medium. A study by Synder et al. (2015) assessed bile samples from golden tilefish (*Lopholatilus chamaeleonticeps*), king snake eel (*Ophichthus rex*), and red snapper for PAH accumulation over time, and reported concentrations were highest in golden tilefish during the same time period when compared to king snake eel, and red snapper. These results suggest that the more highly associated an organism is with the sediment in an oil spill area, the higher the likelihood of toxic PAH accumulation. Twenty-first century dispersant applications are thought to be less harmful than their predecessors. However, the combination of oil and dispersants have proven to be more toxic to marine fishes than either dispersants or crude oil alone. Marine fish which are more active (e.g., a pelagic species versus a demersal species) appear to be more susceptible to negative effects from interactions with weathered oil/dispersant emulsions. These effects can include mobility impairment and inhibited respiration (Swedmark et al. 1973). Another study found that while Corexit 9500A® and oil are similar in their toxicity, when Corexit 9500A® and oil were mixed in lab tests, toxicity to microscopic rotifers increased up to 52-fold (Rico-Martínez et al. 2013). These studies suggest that the toxicity of the oil and dispersant combined may be greater than anticipated.

Deepwater Coral Communities

Deepwater corals are particularly vulnerable to episodic mortality events such as oil spills, since corals are immobile. Severe health declines have been observed in three deepwater corals in response to dispersant alone (2.3–3.4 fold) and the oil–dispersant mixtures (1.1–4.4 fold) compared to oil-only treatments (DeLeo et al. 2015). Increased dispersant concentrations appeared to exacerbate these results. As hundreds of thousands of gallons of dispersant were applied near the wellhead during the *Deepwater Horizon* MC252 oil spill, the possibility exists that deepwater corals may have been negatively impacted by the oil spill and subsequent spill remediation activities.

Several studies have documented declines in coral health or coral death in the presence of oil from the *Deepwater Horizon* MC252 oil spill (White et al. 2012; Hsing et al. 2013; Fisher et al. 2014). Sites as far as 11 km southwest of the spill were documented to have >45% of the coral colonies affected by oil (White et al. 2012; Hsing et al. 2013), and, though less affected, a site 22 km in 1900 m of water had coral damage caused by oil (Fisher et al. 2014). Coral colonies from several areas around the wellhead had damage to colonies that seemed to be representative of microdroplets as all colonies were not affected, and colonies that were affected had patchy distributions of damaged areas (Fisher et al. 2014). Because locations of deep-sea corals are still being discovered, it is likely that the extent of damage to deep-sea communities will remain undefined.

Outstanding Effects

As a result of the *Deepwater Horizon* MC252 oil spill, a consultation pursuant to ESA Section 7(a)(2) was reinitiated. As discussed above, on September 30, 2011, the Protected Resources Division released a biological opinion, which after analyzing best available data, the current status of the species, environmental baseline (including the impacts of the recent *Deepwater Horizon* MC252 oil spill in the northern Gulf), effects of the proposed action, and cumulative effects, concluded that the continued operation of the Gulf reef fish fishery is not likely to jeopardize the continued existence of green, hawksbill, Kemp's ridley, leatherback, or loggerhead sea turtles, nor the continued existence of smalltooth sawfish (NMFS 2011). For additional information on the *Deepwater Horizon* MC252 oil spill and associated closures, see: http://sero.nmfs.noaa.gov/deepwater_horizon_oil_spill.htm.

3.4 Description of the Economic Environment

3.4.1 Commercial Sector

Vessel Activity

Tables 3.4.1.1 and 3.4.1.2 contain information on vessel performance for commercial vessels that harvested hogfish in the Gulf in 2010-2014. The tables contain vessel counts from the NMFS Southeast Fisheries Science Center (SEFSC) logbook (logbook) data (vessel count, trips, and landings). Dockside values were generated using landings information from logbook data and price information from the NMFS SEFSC Accumulated Landings System (ALS) data. These data only contain information on the harvest of finfish by these vessels and not the harvest from any non-finfish fisheries that these vessels may participate in.

On average, 61 commercial vessels per year landed hogfish in the Gulf (Table 3.4.1.1). These vessels, combined, averaged 318 trips per year in the Gulf on which hogfish was landed and 633 trips in the Gulf without hogfish or in the South Atlantic (Table 3.4.1.1). The average annual total dockside revenue (2014 dollars) was approximately $132,000 from hogfish, approximately $489,500 from other species co-harvested with hogfish (on the same trip), and approximately $1.53 million from other trips by these vessels (Table 3.4.1.2). Total average annual revenue from all finfish species harvested by vessels harvesting hogfish in the Gulf was approximately $2.15 million, or approximately $35,600 per vessel (Table 3.4.1.2).

Table 3.4.1.1. Summary of vessel counts, trips, and logbook landings (pounds gutted weight (lbs gw)) or vessels landing at least one pound of hogfish, 2010-2014.

Year	Number of Vessels	Number of Gulf Trips on which Hogfish were Caught	Hogfish Landings (lbs gw)	"Other Species" Landings Jointly Caught with Hogfish (lbs gw)	Number of Other Trips*	Landings on Other Trips (lbs gw)
2010	55	313	35,606	130,864	585	295,624
2011	57	336	41,384	140,861	999	595,420
2012	58	348	42,588	154,978	673	548,368
2013	59	235	19,854	112,333	768	638,025
2014	75	356	33,521	190,243	887	474,325
Average	61	318	34,591	145,856	633	510,352

Source: NMFS SEFSC Logbook data.
*Includes Gulf trips on which hogfish were not harvested and trips in the South Atlantic on which hogfish may have been harvested.

Table 3.4.1.2. Summary of vessel counts and revenue (thousand 2014 dollars) for vessels landing at least one pound of hogfish, 2010-2014.

Year	Number of Vessels	Dockside Revenue from Gulf Hogfish	Dockside Revenue from "Other Species" Jointly Caught with Hogfish	Dockside Revenue on Other Trips*	Total Dockside Revenue	Average Total Dockside Revenue per Vessel
2010	55	$122,969	$414,305	$801,035	$1,338,309	$24,333
2011	57	$156,792	$469,841	$1,802,306	$2,428,939	$42,613
2012	58	$164,975	$510,848	$1,593,436	$2,269,258	$39,125
2013	59	$78,171	$393,474	$1,908,415	$2,380,060	$40,340
2014	75	$137,045	$659,034	$1,560,099	$2,356,178	$31,416
Average	61	$131,990	$489,500	$1,533,058	$2,154,549	$35,565

Source: NMFS SEFSC Logbook and ALS data.
*Includes Gulf trips on which hogfish were not harvested and trips in the South Atlantic on which hogfish may have been harvested.

Ex-vessel Prices

The dockside or ex-vessel price is the price the vessel receives at the first sale of harvest. Over the period 2010-2014, the average annual ex-vessel price per lb for hogfish harvested in the Gulf was $3.82 (2014 dollars), and ranged from $3.45 in 2010 to $4.09 in 2014.

Commercial Sector Business Activity

Estimates of the business activity (economic impacts) in the U.S. associated with the Gulf hogfish commercial harvests were derived using the model developed for and applied in NMFS (2015) and are provided in Table 3.4.1.3. Business activity for the commercial sector is characterized in the form of full-time equivalent (FTE) jobs, income impacts (wages, salaries, and self-employed income), and output (sales) impacts (gross business sales). Income impacts should not be added to output (sales) impacts because this would result in double counting. The estimates of economic activity include the direct effects (effects in the sector where an expenditure is actually made), indirect effects (effects in sectors providing goods and services to directly affected sectors), and induced effects (effects induced by the personal consumption expenditures of employees in the direct and indirectly affected sectors).

Table 3.4.1.3. Average annual business activity associated with the harvests of vessels that harvest hogfish, 2010-2014.

Species	Average Annual Dockside Revenue[1]	Total Jobs	Harvester Jobs	Output (Sales) Impacts (thousands)[1]	Income Impacts (thousands)[1]
Hogfish	$131,990	17	4	$1,309	$481
All species[2]	$2,154,549	295	70	$21,366	$7,846

[1]2014 dollars.
[2]Includes dockside revenues and economic activity associated with the average annual harvests of all species, including hogfish, harvested by vessels that harvested hogfish in the Gulf.

As discussed above, vessels that harvested hogfish in the Gulf also harvested other species on trips where hogfish were harvested, took other trips in the Gulf on which no hogfish were harvested, and some vessels took trips in the South Atlantic. All revenues from all species harvested on all of these trips contributed towards making these vessels economically viable and contribute to the economic activity associated with these vessels. The average annual total ex-vessel revenues from all species (including hogfish) harvested during this period (2010-2014) by vessels that harvested hogfish in the Gulf was approximately $2.15 million (2014 dollars). The business activity associated with this revenue is estimated to support 295 FTE jobs (70 in the harvesting sector) and are associated with approximately $21.37 million in output (sales) impacts and approximately $7.84 million in income impacts.

Dealers

Commercial vessels landing hogfish can only sell their catch to federally permitted fish dealers. On November 4, 2015, 411 dealers possessed the necessary federal dealer permit to receive hogfish harvested in the Gulf. There are no income or sales requirements to acquire a federal dealer permit. As a result, the total number of dealers can vary over the course of the year and from year to year. Because the amount of hogfish average annual harvest in the Gulf is so low (see Tables 3.4.1.1 and 3.4.1.2), no dealers are expected to be dependent on hogfish sales.

Imports

Information on the imports of all snapper and grouper species, either fresh or frozen, are available at: http://www.st.nmfs.noaa.gov/st1/trade/cumulative_data/TradeDataProduct.html. Information on the imports of individual snapper or grouper species is not available. In 2012, imports of all snapper and grouper species (fresh and frozen) were approximately 44.51 million pounds valued at approximately $138.81 million (2014 dollars). More recent data is not currently available. These amounts are contrasted with the domestic harvest of all snapper and grouper in the U.S. in 2014 of approximately 20.32 mp valued at approximately $78.80 million (2014 dollars; data available at: http://www.st.nmfs.noaa.gov/commercial-fisheries/publications/index). Although the levels of domestic production and imports are not totally comparable for several reasons, including considerations of different product form such as fresh versus frozen, and possible product mislabeling, the difference in the magnitude of imports

relative to amount of domestic harvest is indicative of the dominance of imports in the domestic market.

3.4.2 Recreational Sector

Angler Effort

Recreational effort derived from the Marine Recreational Information Program (MRIP) database can be characterized in terms of the number of trips as follows:

- Target effort – The number of individual angler trips, regardless of duration, where the intercepted angler indicated that the species or a species in the species group was targeted as either the first or second primary target for the trip. The species did not have to be caught.
- Catch effort – The number of individual angler trips, regardless of duration and target intent, where the individual species or a species in the species group was caught. The fish did not have to be kept.
- Total recreational trips – The total estimated number of recreational trips in the Gulf, regardless of target intent or catch success.

Other measures of effort are possible, such as directed trips (the number of individual angler trips that either targeted or caught a particular species), among other measures. Estimates of the number of hogfish target trips and catch trips for the shore, charter, and private/rental boat modes in the Gulf for 2011-2014 are provided in Table 3.4.2.1 and Table 3.4.2.2. Because these estimates are survey-based, they may be more useful in demonstrating trends and ranking across modes rather than documenting absolute amounts of activity. For example, in the shore mode, the single positive value for target trips in 2011 (Table 3.4.2.1) may be better described as showing that some shore anglers target hogfish (i.e., targeting is not non-existent), but these anglers are less consistently encountered in the shore mode than in the other modes. For catch trips (Table 3.4.2.2), the shore mode estimates demonstrate an increasing trend in hogfish encounters, whereas the number of catch trips in the charter mode have been stable, despite the 2013 estimate, which may simply reflect a sampling anomaly.

Table 3.4.2.1. Number of hogfish recreational target trips, by mode, Florida, 2011-2014*.

	Shore Mode**	Charter Mode	Private/Rental Mode	All Modes
2010	0	5,346	29,023	34,369
2011	4,569	722	27,560	28,282
2012	0	2,574	65,344	67,918
2013	0	282	60,606	60,888
2014	0	477	64,441	64,918
Average	914	1,880	49,395	51,275

*Florida was the only Gulf state with recorded target effort for hogfish.
Source: MRIP database, NMFS, SERO.

Note: these effort estimates do not include hogfish effort recorded for Monroe County, FL, because hogfish harvest in this area is managed by the South Atlantic Fishery Management Council (SAFMC).

Table 3.4.2.2. Number of hogfish recreational catch trips, by mode, Florida, 2010-2014*.

	Shore Mode	Charter Mode	Private/Rental Mode	All Modes
2010	363	5,346	49,433	55,142
2011	722	2,026	44,814	47,562
2012	1,742	3,380	91,419	96,541
2013	6,507	412	99,011	105,930
2014	13,113	3,992	78,914	96,019
Average	4,489	3,031	72,718	80,239

*Florida was the only Gulf state with recorded target effort for hogfish.
Source: MRIP database, NMFS, SERO.
Note: these effort estimates do not include hogfish effort recorded for Monroe County, FL, because hogfish harvest in this area is managed by the SAFMC.

Similar analysis of recreational effort is not possible for the headboat mode because headboat data are not collected at the angler level. Estimates of effort by the headboat mode are provided in terms of angler days, or the number of standardized 12-hour fishing days that account for the different half-, three-quarter-, and full-day fishing trips by headboats. The stationary "fishing for demersal (bottom-dwelling) species" nature of headboat fishing, as opposed to trolling, suggests that most, if not all, headboat trips and, hence, angler days, are demersal or reef fish trips by intent.

The distribution of headboat effort (angler days) by geographic area is presented in Table 3.4.2.3. Headboat data is collected by the NMFS Southeast Region Headboat Survey (SRHS). Because hogfish target and catch effort for shore, private/rental, and charter anglers were only recorded in Florida, only estimates for headboat angler days from Florida are relevant to the hogfish analysis. However, the SRHS data collection program combines Alabama with north Florida for confidentiality purposes. As a result, estimates of the headboat angler days in Alabama are also included in Table 3.4.2.3. Also, similar to the target and catch effort estimates provided in Tables 3.4.2.1 and 3.4.2.2, the estimates of angler days exclude trips taken in Monroe County, FL (area designation "Dry Tortugas" in the SRHS). On average (2010 through 2014), 158,525 headboat angler days were taken in the area of focus per year.

Table 3.4.2.3. Headboat angler days and percent distribution, by state, 2010-2014.

	West Florida	Florida/Alabama*	Total
2010	69,113	40,594	109,707
2011	78,317	77,303	155,620
2012	83,365	77,770	161,135
2013	94,752	80,048	174,800
2014	102,841	88,524	191,365
Average	85,678	72,848	158,525

*Starting in 2013, SRHS data has been reported separately for NW Florida and Alabama, but has been combined in this table for consistency with previous years.
Source: NMFS Southeast Region Headboat Survey (SRHS).
FLW = Southwest Florida through the Florida Middle Grounds, FL-AL = northwest Florida and Alabama.

Permits

The for-hire sector is comprised of charter vessels and headboats (party boats). Although charter vessels tend to be smaller, on average, than headboats, the key distinction between the two types of operations is how the fee is determined. On a charter boat trip, the fee charged is for the entire vessel, regardless of how many passengers are carried, whereas the fee charged for a headboat trip is paid per individual angler.

A federal charter/headboat (for-hire) vessel permit is required for fishing in federal waters for Gulf reef fish (RF). On October 30, 2015, there were 1,306 vessels with a valid (non-expired) or renewable Gulf for-hire RF permit (including historical captain permits). A renewable permit is an expired limited access permit that may not be actively fished, but is renewable for up to one year after expiration. The Gulf RF for-hire permits are limited access permits. Most for-hire vessels possess more than one for-hire permit. Among the 1,306 vessels with a Gulf Reef Fish for-hire permit, 1,250 also had a Gulf Charter/Headboat permit for Coastal Migratory Pelagic species for-hire permit and 56 had only a RF for-hire permit. Additionally, 167 of these vessels (all vessels with Gulf RF for-hire permit) had a Gulf commercial reef fish permit and 353 vessels had at least one for-hire permit required to fish for species managed by the South Atlantic Fishery Management Council (Atlantic dolphin/wahoo, Atlantic CMP species, or snapper-grouper species).

Although the for-hire permit application collects information on the primary method of operation, the permit itself does not identify the permitted vessel as either a headboat or a charter vessel and vessels may operate in both capacities. However, if a vessel meets the selection criteria used by the NMFS Southeast Region Headboat Survey (SRHS) and is selected to report by the Science Research Director of the Southeast Fishery Science Center, it is determined to operate primarily as a headboat and is required to submit harvest and effort information to the SRHS. As of May 6, 2015, 69 Gulf headboats were registered in the SRHS (K. Fitzpatrick, NMFS SEFSC, pers. comm.).

Information on Gulf charter boat and headboat operating characteristics is included in Savolainen et al. (2012) and is incorporated herein by reference.

There are no specific federal permitting requirements for recreational anglers to fish for or harvest reef fish. Instead, anglers are required to possess either a state recreational fishing permit that authorizes saltwater fishing in general, or be registered in the federal National Saltwater Angler Registry system, subject to appropriate exemptions. For the for-hire sector, customers are authorized to fish under the charter or headboat vessel license and are not required to hold their own fishing licenses. As a result, it is not possible to identify with available data how many individual anglers would be expected to be affected by this proposed action.

Economic Value

Economic value can be measured in the form of consumer surplus (CS) per additional hogfish kept on a trip for anglers (the amount of money that an angler would be willing to pay for a fish in excess of the cost to harvest the fish). The value of the CS per fish for is unknown; however, a proxy value for an additional "snapper" kept on a trip is approximately $12.37 (Haab et al. 2012; values updated to 2014 dollars).

Economic value for for-hire vessels can be measured by producer surplus (PS) per passenger trip (the amount of money that a vessel owner earns in excess of the cost of providing the trip). Estimates of the PS per for-hire passenger trip are not available. Instead, net operating revenue (NOR), which is the return used to pay all labor wages, returns to capital, and owner profits, is used as a proxy for PS. For vessels in the Gulf, the estimated NOR value is $153 (2014 dollars) per charter angler trip (Liese and Carter 2011). The estimated NOR value per headboat angler trip is $53 (2014 dollars) (C. Liese, NMFS SEFSC, pers. comm.).

Business Activity

The desire for recreational fishing generates economic activity as consumers spend their income on various goods and services needed for recreational fishing. This spurs economic activity in the region where recreational fishing occurs. It should be clearly noted that, in the absence of the opportunity to fish, the income would presumably be spent on other goods and services and these expenditures would similarly generate economic activity in the region where the expenditure occurs. As such, the analysis below represents a distributional analysis only.

Estimates of the business activity (economic impacts) associated with recreational angling for hogfish were derived using average impact coefficients for recreational angling for all species, as derived from an add-on survey to the Marine Recreational Fisheries Statistics Survey (MRFSS) to collect economic expenditure information, as described and utilized in NMFS (2015). Estimates of the average expenditures by recreational anglers are also provided in NMFS (2015) and are incorporated herein by reference.

Recreational fishing generates business activity (economic impacts). Business activity for the recreational sector is characterized in the form of full-time equivalent jobs, output (sales) impacts (gross business sales), income impacts, and value-added impacts (difference between the value

of goods and the cost of materials or supplies). Estimates of the average hogfish target effort (2010-2014) and associated business activity (2014 dollars) are provided in Table 3.3.2.4. Because hogfish directed effort during this time period was only recorded in West Florida (see Table 3.4.2.1), estimates of business activity for the other Gulf States are not provided.

The estimates provided in Table 3.4.2.4 only apply at the state-level, i.e., they represent estimates of business activity in Florida and not to other states (for example, a good purchased in Florida may have been manufactured in a neighboring state) or the nation as a whole.

Estimates of the business activity associated with headboat effort are not available. Headboat vessels are not covered in the MRFSS/MRIP so, in addition to the absence of estimates of target effort, estimation of the appropriate business activity coefficients for headboat effort has not been conducted.

Table 3.4.2.4. Summary of hogfish target trips (2010-2014 average) and associated business activity (2014 dollars). Output, value added, and income impacts are not additive.

	West Florida*
	Shore Mode
Target Trips	914
Output Impact	$39,000
Value Added Impact	$25,000
Income Impact	$15,000
Jobs	0
	Private/Rental Mode
Target Trips	49,395
Output Impact	$2,466,000
Value Added Impact	$1,561,000
Income Impact	$944,000
Jobs	23
	Charter Mode
Target Trips	1,880
Output Impact	$1,261,000
Value Added Impact	$767,000
Income Impact	$534,000
Jobs	12
	All Modes
Target Trips	52,189
Output Impact	$3,767,000
Value Added Impact	$2,352,000
Income Impact	$1,493,000
Jobs	35

*No hogfish target trips were recorded in the other Gulf states.
Source: effort data from the MRIP, economic impact results calculated by NMFS SERO using the model developed for NMFS (2015).

3.5 Description of the Social Environment

Hogfish is harvested commercially and recreationally primarily off Florida. Hogfish are primarily caught by spear while diving and secondarily by hook-and-line. Recreational and commercial landings for the years 1986 through 2014 are provided in Table 2.3.2. Landings by sector and management measures are presented in Figure 3.5.1.

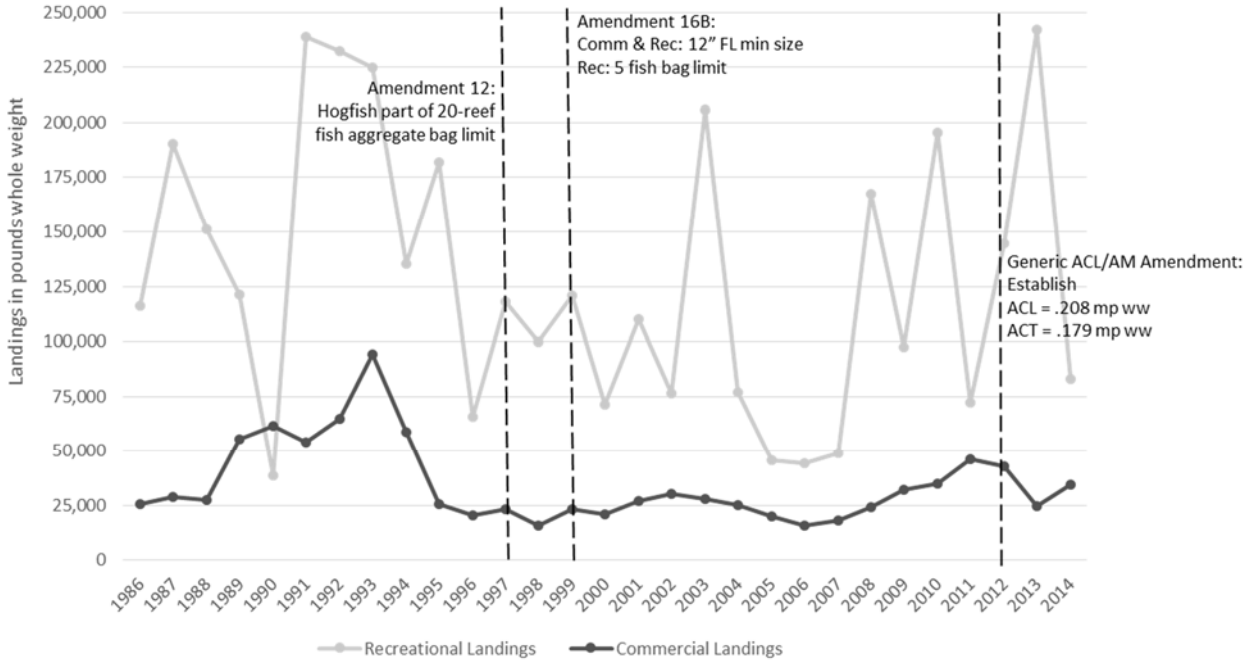


Figure 3.5.1. Commercial and recreational landings of hogfish (1986 – 2014) with management measures identified. Source: NMFS Southeast Regional Office, ACL dataset (October 2015). Recreational landings have Monroe County landings included in Gulf mean weight computations but are excluded from Gulf landings, consistent with SEFSC Recreational ACL Datasets 2016-on.

Commercial Fishing

Commercial landings of hogfish have averaged 28,037 lbs per year from 1999 (when hogfish was added to the reef fish management unit) through 2014, with a range of 15,630 lbs in 2006 to 45,995 lbs in 2011. Hogfish are primarily caught by spearfishing, although hogfish are targeted by hook-and-line, too (Table 3.5.1).

Table 3.5.1. Gear type used for commercial hogfish landings.

Year	Spear	Hook/Line	Unknown
1999	34.0%	32.2%	33.9%
2000	41.2%	48.3%	10.5%
2001	55.1%	26.4%	18.5%
2002	63.3%	18.8%	17.9%
2003	69.3%	24.6%	6.1%
2004	85.4%	10.5%	4.0%
2005	80.5%	16.0%	3.5%
2006	88.4%	9.3%	2.3%
2007	87.0%	10.5%	2.5%
2008	66.8%	9.1%	24.1%
2009	77.2%	7.2%	15.6%
2010	81.6%	16.0%	2.4%
2011	83.0%	12.2%	4.8%
2012	90.5%	9.5%	0.0%

Source: SEDAR 37, Table 6.2.2.3 (from the ALS-SEFSC dataset).

A regional quotient (RQ) measure was used to identify commercial engagement and reliance on hogfish. The RQ measures the relative importance of a given species across all communities in the region and represents the proportional distribution of commercial landings of a particular species. This proportional measure does not provide the number of pounds or the value of the catch; data that might be confidential at the community level for many places. The RQ is calculated by dividing the total pounds (or value) of a species landed in a given community, by the total pounds (or value) for that species for all communities in the region. The measure is a way to quantify the importance of hogfish to communities around the Gulf coast and suggest where impacts from management actions are more likely to be experienced. The data used for the RQ measure were assembled from the accumulated landings system (ALS), which includes commercial landings of all species from both state and federal waters and is based on dealers' reports. These data were converted to provide landings by (dealer's) address. Because of this, the address of a dealer may not be the coastal community where the dealer's facility is located.

As noted, commercial fishing for hogfish is prosecuted primarily in Florida. Based on the RQ measure, the top 15 communities with the greatest landings of hogfish in 2014 are identified in Figure 3.5.2. Of the top five communities, four are located in Pinellas County, Florida (Largo, St Petersburg, Tarpon Springs, and Redington Shores).

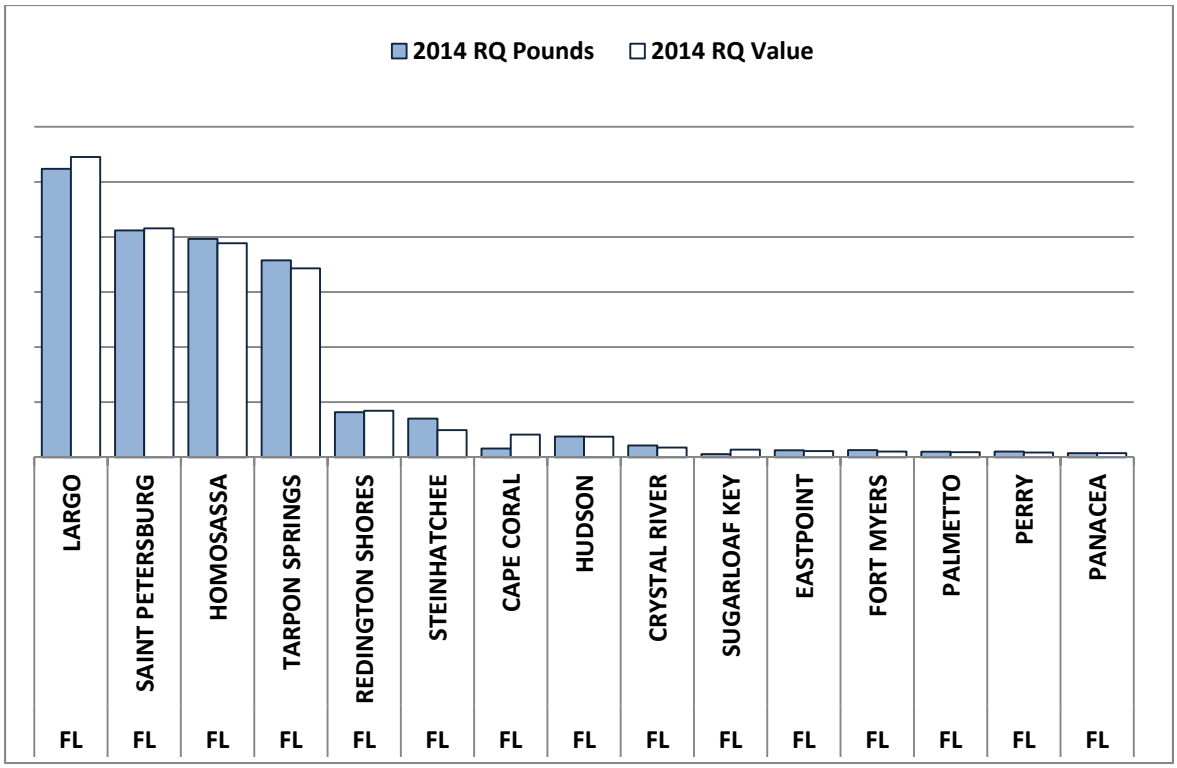


Figure 3.5.2. Top 15 commercial communities with the greatest landings of hogfish in 2014
Source: NMFS ALS 2014.

A community's proportion of total landings is not static and changes over time. Nevertheless, in recent years, Pinellas County communities have ranked highest for commercial hogfish landings. In 2013, three of the top five communities with the greatest landings were in Pinellas County, while in 2012, four out of the top five communities were in Pinellas County. Each year from 2010 through 2014, St Petersburg and Tarpon Springs, in Pinellas County have ranked within the top five communities, along with Homosassa in Citrus County (NMFS ALS data provided by M. Jepson, pers. comm.).

Recreational Fishing

Although landings of hogfish by hook-and-line are increasing, hogfish are primarily associated with spearfishing, being one of the most targeted and landed reef fish by spear (SEDAR 37 2014). Hogfish landings for the recreational sector are available by county, but not by community. This makes it difficult to identify communities as dependent or reliant on recreational fishing for hogfish. Furthermore, hogfish is generally part of a multi-species fishery making it difficult to isolate recreational dependence or reliance on hogfish separately from other reef fish species.

While there are no landings data at the community level for the recreational sector, Table 3.5.2 provides the number of charter/headboat permits for reef fish held in each Florida County. This is a crude measure of the reliance upon recreational reef fish fishing, is general in nature, and not specific to hogfish. Ideally, additional variables quantifying the importance of recreational

fishing to a community would be included (such as the amount of recreational landings in a community by species, availability of recreational fishing related businesses and infrastructure, etc.); however, these data are not available at this time. Further, an analysis based on discrete geo-political boundaries at the community level would result in both Panama City and Panama City Beach, in Bay County, ranking high enough to appear independently, while the numerous communities of Pinellas County, which has the most permits of any Florida County, would not appear. Thus, the aggregate number of permits by county is used to identify areas with a greater concentration of reef fish for-hire vessels.

Table 3.5.2. Number of valid and renewable charter/headboat reef fish permits in the Gulf of Mexico by Florida west coastal county as of May 28, 2015.

County	# of Permits
Pinellas	97
Okaloosa	93
Bay	77
Collier	51
Lee	37
Sarasota	36
Escambia	34
Hillsborough	18
Manatee	17
Santa Rosa	17
Franklin	16
Gulf	16
Citrus	15
Walton	12
Charlotte	11
Pasco	11
Hernando	7
Wakulla	6
Other Florida Counties	26
West Florida TOTAL	**597**

At this time it is not possible to examine the intensity of recreational fishing activity at the community level for a specific species, i.e., hogfish. However, it is likely that those communities that have a higher rank in terms of charter for-hire activity and have a dynamic commercial fishery for hogfish will likely have an engagement in recreational fishing for hogfish. Nevertheless, it cannot be assumed that the proportion of commercial hogfish landings among other species in a community (i.e., Figure 3.5.2) would be similar to its proportion among recreational landings within the same community because of sector differences in fishing practices and preferences. Nevertheless, an examination of where commercial and recreational landings are the greatest, and where these locations overlap could suggest areas of greater

dependence and reliance on the hogfish resource, and thus, where effects would most likely to be experienced.

Figure 3.5.3 presents the mean recreational landings of hogfish by county for the years 2010 – 2014. Recreational landings are greatest in Pinellas and Monroe County, followed by Pasco and Franklin Counties. Manatee, Sarasota, and Collier Counties have the next most abundant recreational landings of hogfish.

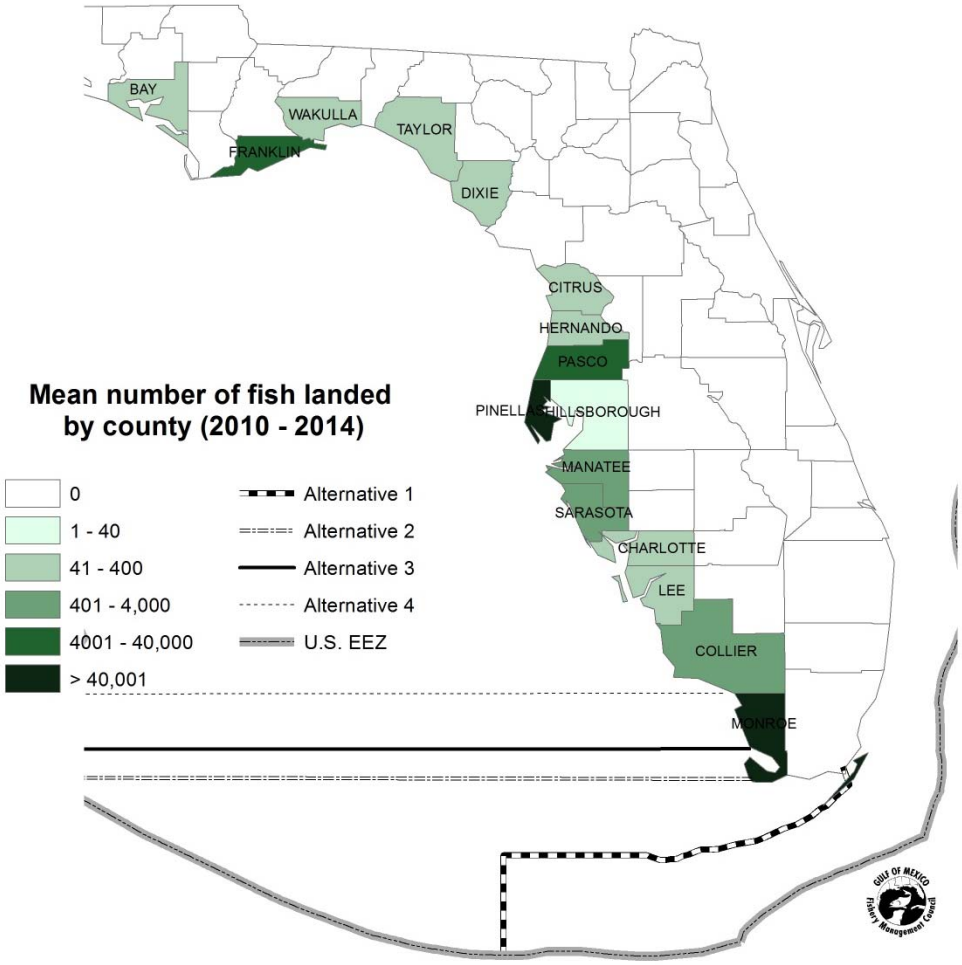


Figure 3.5.3. Mean recreational landings of hogfish by number of fish for west Florida Counties (2010 – 2014). An average of 12.4 lbs/year were landed in other Gulf States. Alternative 2 is the current preferred alternative in Action 1. Sources: MRIP and Southeast Region Headboat Survey, NMFS 2016.

At the county level, Pinellas ranks highest for the value and volume of commercial hogfish landings, the number of for-hire operators (Table 3.5.2), and recreational landings, suggesting that any social effects resulting from actions taken in this plan amendment would likely be greatest in Pinellas County communities. Secondarily, the abundance of commercial and recreational landings, and number of for-hire operators, in Pasco, Franklin, Citrus, and Manatee

Counties suggest that social effects resulting from actions in this plan amendment may be felt in communities within these counties, as well.

Hogfish is landed by both sectors in Monroe County. However, SEDAR 37 (2014) counted Monroe County landings as part of the east Florida/Florida Keys stock and the landings are assigned to the South Atlantic. If the current preferred alternative of Action 1 is approved, all of Monroe County hogfish landings will be under the jurisdictional boundaries of the South Atlantic Council. Because the east Florida/Florida Keys stock has been determined to be overfished and undergoing overfishing while also representing a large portion of Gulf landings, it is likely that indirect effects resulting from the actions in this amendment will be felt in Monroe County. It is likely that these effects would be negative as the east Florida/Florida Keys stock of hogfish is placed under a rebuilding plan.

3.5.1 Environmental Justice Considerations

Executive Order 12898 requires federal agencies conduct their programs, policies, and activities in a manner to ensure individuals or populations are not excluded from participation in, or denied the benefits of, or subjected to discrimination because of their race, color, or national origin. In addition, and specifically with respect to subsistence consumption of fish and wildlife, federal agencies are required to collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence. The main focus of Executive Order 12898 is to consider "the disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories…" This executive order is generally referred to as environmental justice (EJ).

Information on race, ethnicity, and income status for groups at the different participation levels (private anglers, for-hire captains, crew, and customers, and employees of recreational fishing businesses, etc.) is not available, because these types of data are not collected by NMFS or other agencies. Recreational and commercial fishermen and associated businesses and communities along the coast may be affected by the actions in this amendment (Chapter 4). However, the actions in this amendment would not affect individuals differently based on race, ethnicity, or income status. Thus, disproportionate impacts to EJ populations are not expected to result from any of the actions in this amendment. Nevertheless, the lack of impacts on EJ populations cannot be assumed. Finally, there are no known claims for customary usage or subsistence consumption of hogfish by any population including tribes or indigenous groups in the Gulf.

3.6 Description of the Administrative Environment

3.6.1 Federal Fishery Management

Federal fishery management is conducted under the authority of the Magnuson-Stevens Act (16 U.S.C. 1801 *et seq*.), originally enacted in 1976 as the Fishery Conservation and Management Act. The Magnuson-Stevens Act claims sovereign rights and exclusive fishery management authority over most fishery resources within the exclusive economic zone, an area extending 200

nautical miles from the seaward boundary of each of the coastal states, and authority over U.S. anadromous species and continental shelf resources that occur beyond the exclusive economic zone.

Responsibility for federal fishery management is shared by the Secretary of Commerce (Secretary) and eight regional fishery management councils that represent the expertise and interests of constituent states. Regional councils are responsible for preparing, monitoring, and revising management plans for fisheries needing management within their jurisdiction. The Secretary is responsible for promulgating regulations to implement proposed plans and amendments after ensuring management measures are consistent with the Magnuson-Stevens Act and with other applicable laws summarized in Appendix A. In most cases, the Secretary has delegated this authority to NMFS.

The Council is responsible for fishery resources in federal waters of the Gulf. These waters extend to 200 nautical miles offshore from the nine-mile seaward boundary of the states of Florida and Texas. Note that for reef fish management, the seaward boundary of the states of Alabama, Mississippi, and Louisiana was three miles. However, a provision was added in the Congressional Omnibus Appropriations Bill signed into law on December 18, 2015, that extended Alabama, Mississippi, and Louisiana state waters out nine miles into the Gulf of Mexico for the purpose of reef fish management. This measure will be in place for one year unless Congress takes additional action. The length of the Gulf coastline is approximately 1,631 miles. Florida has the longest coastline of 770 miles along its Gulf coast, followed by Louisiana (397 miles), Texas (361 miles), Alabama (53 miles), and Mississippi (44 miles). Action 1 of this action proposes to cede regulatory authority of hogfish in the southernmost region (Florida Keys and off the Everglades) to the South Atlantic Council. The South Atlantic Council is responsible for reef fish fishery resources in federal waters off North Carolina, South Carolina, Georgia and east Florida to Key West (http://www.safmc.net/).

The Council consists of seventeen voting members: 11 public members appointed by the Secretary; one each from the fishery agencies of Texas, Louisiana, Mississippi, Alabama, and Florida; and one from NMFS. The public is also involved in the fishery management process through participation on advisory panels and through Council meetings that, with few exceptions for discussing personnel matters, are open to the public. The regulatory process is also in accordance with the Administrative Procedures Act, in the form of "notice and comment" rulemaking, which provides extensive opportunity for public scrutiny and comment, and requires consideration of and response to those comments.

Regulations contained within FMPs are enforced through actions of the National Oceanic and Atmospheric Administration's Office of Law Enforcement, the United States Coast Guard, and various state authorities. To better coordinate enforcement activities, federal and state enforcement agencies have developed cooperative agreements to enforce the Magnuson-Stevens Act. These activities are being coordinated by the Council's Law Enforcement Advisory Panel and the Gulf States Marine Fisheries Commission's Law Enforcement Committee, which have developed joint enforcement agreements and cooperative enforcement programs (www.gsmfc.org).

The hogfish stock in the Gulf is classified as not overfished and not undergoing overfishing. Various hogfish management measures have been implemented and are outlined in Section 1.3. Periodic adjustments to the stock's ACL and other management measures needed to prevent overfishing and are implemented through plan or regulatory amendments.

3.6.2 State Fishery Management

The purpose of state representation at the Council level is to ensure state participation in federal fishery management decision-making and to promote the development of compatible regulations in state and federal waters. The state governments of Texas, Louisiana, Mississippi, Alabama, and Florida have the authority to manage their respective state fisheries. Each of the five Gulf States exercises legislative and regulatory authority over their respective state's natural resources through discrete administrative units. Although each agency is the primary administrative body with respect to the states' natural resources, all states cooperate with numerous state and federal regulatory agencies when managing marine resources. A more detailed description of each state's primary regulatory agency for marine resources is provided on their respective Web pages (Table 3.6.2.1).

Table 3.6.2.1 Gulf of Mexico state marine resource agencies and Web pages.

State marine resource agency	Web page
Alabama Marine Resources Division	http://www.outdooralabama.com/
Florida Fish and Wildlife Conservation Commission	http://myfwc.com/
Louisiana Department of Wildlife and Fisheries	http://www.wlf.louisiana.gov/
Mississippi Department of Marine Resources	http://www.dmr.ms.gov/
Texas Parks and Wildlife Department	http://tpwd.texas.gov/

CHAPTER 4. ENVIRONMENTAL CONSEQUENCES

4.1 Action 1: Definition of the Management Unit

4.1.1 Direct and Indirect Effects on the Physical Environment

With respect to Action 1, fishery management actions that affect the physical environment mostly relate to the interactions of fishing with bottom habitat, either through gear impacts to bottom habitat or through the incidental harvest of bottom habitat as described in Section 3.1.1. For commercial harvest, the primary gears used for harvest of hogfish are spearfishing, hook-and-line, and prior to 2007, traps. Traps were prohibited in 2007. Between 2007 and 2012 in the Gulf of Mexico (Gulf), spearfishing accounted for 88% of the commercial harvest and hook-and-line accounted for 12% of the harvest (SEDAR 37 2014).

For recreational harvest, hogfish are taken primarily by spearfishing, being one of the most targeted and caught species using spear. Between 2007 and 2012 in the Gulf, spearfishing accounted for 83% of the recreational harvest and hook-and-line accounted for 17% of the harvest. Recreational harvest of hogfish is primarily from private boats, with only a small proportion from charter vessels and shore-based fishing (SEDAR 37 2014).

Fishing gear can damage or disturb bottom structures and occasionally incidentally harvest such habitat. The degree a habitat is affected by fishing gear depends largely on the vulnerability of the affected habitat to disturbance, and on the rate that the habitat can recover from disturbance (Barnette 2001). For example, the complex structure and vertical growth pattern of coral reef species makes reef habitat more vulnerable to adverse impacts from fishing gear and slower to recover from such impacts than is sand and mud bottom habitat (Barnette 2001).

Vertical lines

Concentrations of many managed reef fish species are higher on hard bottom areas than on sand or mud bottoms, thus vertical line gear fishing generally occurs over hard bottom areas (GMFMC 2004a). Vertical lines include multi-hook lines known as bandit gear, handlines, and rod-and-reels. Vertical-line gear has the potential to snag and entangle bottom structures and cause tear-offs or abrasions (Barnette 2001). In using bandit gear, a weighted line is lowered to the bottom, and then the lead is raised slightly off the bottom (Siebenaler and Brady 1952). The gear is in direct contact with the bottom for only a short period of time. Barnette (2001) suggests that physical impacts may include entanglement and minor degradation of benthic species from line abrasion and the use of weights (sinkers). Commercial or recreational fishing with rod-and-reel and handlines also puts gear on the bottom. The terminal part of the gear is either lifted off the bottom like fishing with bandit gear, or left contacting the bottom. Sometimes the fishing line can become entangled on coral and hard bottom outcroppings. The subsequent algal growth can foul and eventually kill the underlying coral (Barnette 2001). Researchers conducting studies in the restricted fishing area at Madison-Swanson reported seeing lost fishing line on the bottom, much of which appeared to be fairly old and covered with growth (A. David, pers. comm.), a clear indication that bottom fishing has had an impact on the physical environment

prior to fishing being prohibited in the area (GMFMC 2003). The National Fish and Wildlife Foundation, in issuing grants to remove marine debris, established monofilament fishing line is a priority marine debris issue.

Anchor damage is also associated with vertical-line fishing vessels, particularly by the recreational sector where fishermen may repeatedly visit well marked fishing locations. Bohnsack (in Hamilton 2000) showed that "favorite" fishing areas such as reefs are targeted and revisited multiple times, particularly with the advent of global positioning technology. The cumulative effects of repeated anchoring could damage hard bottom areas where fishing for hogfish occurs.

Spearfishing

Although spearfishing is a relatively minor component of harvest for other reef fish such as grouper, it is the dominant gear for both commercial and recreational harvest of hogfish. Barnette (2001) cited a study by Gomez (1987) concluding that spearfishing on reef habitat may result in some coral breakage, but damage is probably negligible. In addition, there could be some impacts from divers touching coral with hands or from resuspension of sediment by fins (Barnette 2001). Such impacts should be negligible to non-existent for well-trained and experienced spearfishers who stay in the water column and avoid contact with the bottom.

Powerheads

Powerheads are devices attached to the ends of a spear or stick that, when struck with sufficient force against a fish, fire a cartridge. Damage to the fish is caused primarily by the percussion from the expanding gasses rather than from a projectile. Stressed areas for reef fish begin at the shoreward boundary of federal waters and generally follow the 10-fathom contour from the Dry Tortugas to Sanibel Island; the 20-fathom contour to Tarpon Springs; the 10-fathom contour to Cape San Blas; the 25-fathom contour to south of Mobile Bay; the 13-fathom contour to Ship Island, Mississippi; the 10-fathom contour off Louisiana; and the 30-fathom contour off Texas. Within the stressed area, the use of powerheads against stocks in the reef fish management unit is prohibited. However, hogfish are exempt from the powerhead prohibition (§ 622.35(a)(1)). At one time, hogfish were included in the Reef Fish Fishery Management Plan (FMP) in the list of "species in the fishery but not the management unit", and the stressed area restrictions did not apply to that list. In 1999, Amendment 16B (GMFMC 1999a) eliminated the distinction between reef fish species in the management unit and those in the fishery but not in the management unit. At the time, hogfish, sand perch, dwarf sand perch, and Queen triggerfish were the only species left on the "in the fishery" list. Even though the "species in the fishery but not the management unit" no longer existed, these species continued to be listed as exempt from the stressed area restrictions. Queen triggerfish was removed from the FMP in Amendment 16B (GMFMC 1999a), and sand perch and dwarf sand perch were removed in the Generic Annual Catch Limits/Accountability Measures (ACL/AM) Amendment (GMFMC 2011a), leaving only hogfish from the old list. Powerheads are generally used against larger fish such as sharks and greater amberjack. It is unlikely that hogfish are harvested with powerheads.

The alternatives in this action establish the management boundary for hogfish between the west Florida shelf stock and the east Florida/Florida Keys stock and should not directly affect the physical environment. The east Florida/Florida Keys stock has been determined to be overfished and is in need of a rebuilding plan, whereas the west Florida shelf stock is neither overfished nor experiencing overfishing. Hogfish managed under the rebuilding plan established by the South Atlantic Fishery Management Council (South Atlantic Council) are likely to be subject to greater fishing restrictions than hogfish management by the Gulf of Mexico Fishery Management Council (Gulf Council), and therefore will be subject to less fishing activity directed toward the stock. The larger the area under the Gulf Council's jurisdiction that is reassigned to the South Atlantic Council for management of hogfish, the more positive the benefit will be to the physical environment in terms of gear interactions (an indirect effect). In this respect, **Alternative 1** (**No Action**) will continue to allow the greatest amount of fishing and gear interactions in the south Florida region. **Preferred Alternative 2** will have slightly less adverse gear interactions since a small part of the area in the Gulf Council's jurisdiction will be designated for hogfish management by the South Atlantic Council. **Alternative 3** will result in slightly less adverse impacts than **Preferred Alternative 2**, and **Alternative 4** will result in the least adverse impacts. It should be noted, however, that fishing for other stocks will continue to occur using the same gear types. Consequently, while small relative differences can be identified between the alternatives, such differences are likely to be insignificant within the context of all fishing activities.

4.1.2 Direct and Indirect Effects on the Biological/Ecological Environment

Hogfish occur in warm temperate to tropical waters of the western Atlantic Ocean, and are observed from Brazil to Bermuda, as well as throughout the Caribbean and Gulf. In the Gulf, they are caught primarily off the coast of Florida, with the majority of the landings coming from South/Southeastern and Western Florida. Only a small number of landings are reported west of Florida. Recent genetic analysis indicates that there are two distinct stocks of hogfish off the Florida coast that converge south of Naples (SEDAR 37 2014). In addition, there is a third distinct stock in the Atlantic off the Carolinas, but this third stock does not occur in Gulf waters and is not affected by actions in the Reef Fish FMP. Commercial, recreational, and fishery-independent trips where hogfish are caught are associated with mutton snapper, and yellowtail snapper, although not strongly (Farmer et al. 2010). The primary method for catching hogfish is spearfishing (Tables 2.4.2 and 2.4.3). Spearfishing is a line-of-sight method of fishing, so incidental bycatch of other species while targeting hogfish is likely minimal. In previous years, hogfish were considered a species that rarely takes a hook. However, as annual catch limits have resulted in closures of other species, hook-and-line targeting of hogfish has become more common[8]. Therefore, while some of the hook-and-line caught hogfish may be bycatch from fishermen targeting other species, an increasing portion of the catch is likely to be from fishermen specifically targeting the species. Bycatch of hogfish from fishermen targeting other species, and vice-versa, is unlikely to change significantly under any of the alternatives in this action.

[8] http://www.bradenton.com/sports/outdoors/fishing-boating/article34753368.html

The SEDAR 37 hogfish stock assessment used the Monroe/Collier county line (**Alternative 4**) as the dividing point between the west Florida stock and the east Florida/Florida Keys stock. All of the alternatives set the boundary for the hogfish management unit at the Monroe/Collier county line or farther south. Therefore, all of the alternatives keep the entire west Florida stock as defined in SEDAR 37 under Gulf Council management. Consequently, there will be no change in the biological and ecological effects on the west Florida stock regardless of which alternative is adopted. However, **Alternative 1, Preferred Alternative 2, and Alternative 3** each include a portion of the stock that is defined in the assessment as east Florida/Florida Keys stock. The two stocks will be subject to different management regimes because the east Florida/Florida Keys stock is overfished and in need of a rebuilding plan while the west Florida stock is not overfished. Hogfish caught south of the Monroe/Collier county line will be counted towards the South Atlantic catch limit even if they are caught under Gulf Council regulations. The larger the portion of the Atlantic/Florida Keys stock included under Gulf Council management, the more difficult it will be for the Atlantic/Florida Keys rebuilding plan to be effective.

Alternative 1 (No Action) leaves the demarcation for management of the two stocks as the jurisdictional boundary between the South Atlantic and Gulf Councils. This is 73 nautical miles (nm) south of the Monroe/Collier County line. Catch data cannot be resolved below the county level, so the amount of hogfish from the Atlantic/Florida Keys stock that is caught under Gulf Council management cannot be quantitatively estimated. However, qualitatively, **Alternative 1** will allow the largest portion of the Atlantic/Florida Keys stock to be caught under Gulf Council management, and therefore will have the greatest adverse impact on the effectiveness of the Atlantic/Florida Keys stock rebuilding plan.

Under **Preferred Alternative 2, Alternative 3,** and **Alternative 4**, it is the Gulf Council's intent to request that management of hogfish south of the demarcation line be transferred to the South Atlantic Council. This analysis assumes that this transfer of management authority will occur.

Preferred Alternative 2 sets the demarcation line for hogfish management at 25º 09' north latitude (south of Cape Sable), which is 38 nm south of the Monroe Collier county line and 35 nm north of the **Alternative 1** jurisdictional boundary. This demarcation line is currently used by Florida Fish and Wildlife Conservation Commission (FWC) for some state managed species such as permit. In addition, it is far enough north of the Keys and far enough south of Naples and Marco Island that it does not simply shift regulatory issues north to Collier County. This will allow almost half of Monroe County's Gulf coast to come under South Atlantic Council jurisdiction for purposes of hogfish management, and will allow the east Florida/Florida Keys stock rebuilding plan to control a larger proportion of the stock. However, it will still leave a portion of the east Florida/Florida Keys stock under Gulf Council management, which may hinder the rebuilding plan. Increased enforceability from using a known, pre-existing boundary may offset the adverse impacts from leaving a portion of the east Florida/Florida Keys stock under Gulf Council management, but from a purely biological perspective, **Preferred Alternative 2** will have less adverse biological/ecological impacts than **Alternative 1**, but more than **Alternatives 3** and **4**.

Alternative 3 sets the demarcation line for hogfish management at 25º 23' north latitude (Shark Point), which is 25 nm south of the Monroe Collier county line and 48 nm north of the

Alternative 1 jurisdictional boundary. Fishing trips originating south of this line rarely travel north of the boundary, and trips originating north of the boundary rarely travel south. This line allows more of the hogfish occurring off Monroe County to be managed under the east Florida/Florida Keys stock rebuilding plan than either **Alternative 1** or **Preferred Alternative 2**, and therefore has less adverse impacts than those alternatives. However, a portion of the east Florida/Florida Keys stock will remain under Gulf Council management, which may hinder the rebuilding plan. Therefore, **Alternative 3** will have less adverse biological/ecological impacts than **Alternative 1** or **Preferred Alternative 2**, but more than **Alternative 4**.

Alternative 4 sets the demarcation line at the Monroe/Collier county line, which is consistent with the boundary used by the SEDAR 37 (2014) stock assessment. Although the assessment used this as the demarcation line, it stated that convergence of the two stocks occurs south of Naples. Naples is north of the county line, so it is still possible that a small portion of the east Florida/Florida Keys stock will come under Gulf Council management. Nevertheless, **Alternative 4** places the largest amount of the east Florida/Florida Keys stock under South Atlantic Council management and provides the least adverse impacts to the rebuilding plan relative to **Alternative 1, Preferred Alternative 2,** and **Alternative 3**.

4.1.3 Direct and Indirect Effects on the Economic Environment

Defining the management unit is an administrative action that establishes the bounds, in terms of the species included and the geographic range of the affected species and associated fishing industry, on which subsequent management action is taken, when necessary. No direct effect on customary fishing practices, or associated economic costs or benefits, would occur as a result of defining the management unit. However, direct economic effects would result from the subsequent management actions that specify, for example, who may harvest the resource, how much of the resource may be harvested, when harvest may occur, etc. Because these effects would be a direct effect of subsequent action, enabled by the current proposed action, they would be indirect effects of the current action. Therefore, in the following discussion, all of the economic effects described are indirect effects of defining the management unit.

In theory, the greater the number of species included in a management unit and the larger the geographic range of the unit, the greater the allowable harvest and associated economic benefits that could accrue to that resource and associated fishing industry. For the current proposed action, only one species, hogfish, is included in the management unit, and the alternatives vary only in the specification of the geographic range of the unit. As a result, the following discussion will be limited to the economic effects of the alternative specifications of the geographic range of the hogfish management unit.

As previously stated, the larger the geographic area of the management unit (assuming hogfish are found in all of the area included in the alternative expanded ranges), the larger the potential harvest and associated economic effects on the fishing industry of management of the resource. **Alternative 1** would result in the largest management unit, followed by **Preferred Alternative 2**, **Alternative 3**, and **Alternative 4**. Thus, from this narrow perspective, i.e., geographic size of the management unit, the alternatives would be ranked in that order in terms of potential economic effects.

For hogfish, however, an additional consideration arises beyond the simple geographic size of the management unit. In SEDAR 37 (SEDAR 37 2013), three hogfish stocks were identified (Georgia/North Carolina, east Florida/Florida Keys, and west Florida shelf) and the division between the east Florida/Florida Keys and west Florida shelf stocks was identified as being located somewhere between Naples, Florida and the Florida Keys. Additionally, the east Florida/Florida Keys stock was identified as overfished and undergoing overfishing, and in need of a rebuilding plan (see Section 2.1), with management expected by the SAFMC (the other two stocks were identified as not overfished or undergoing overfishing).

All of the proposed alternatives would keep the entire west Florida shelf stock, as defined in SEDAR 37, in the hogfish management unit and under GMFMC management. Therefore, the west Florida stock would not be expected to be affected by any of the alternatives proposed in this action and no economic effects associated with the inclusion of the west Florida stock in the management unit would be expected to occur. However, the larger the area included in the proposed alternatives, beyond the area encompassed by the range of the west Florida stock, the greater the portion of the east Florida/Florida Keys stock that would be included under the GMFMC jurisdiction. As the portion of the east Florida/Florida Keys stock included in the management unit is increased, various problems with adverse economic consequences would be expected to arise. For example, if portions of the east Florida/Florida Keys stock are not managed by the GMFMC consistent with the needs of rebuilding, as included in the rebuilding plan adopted by the SAFMC, the rebuilding plan for the entire east Florida/Florida Keys stock would be expected to be unsuccessful, resulting in a failure to rebuild and loss of the associated economic benefits. If the rebuilding plan is unsuccessful, although Gulf fishermen would not have to bear the short-term effects of the rebuilding plan, any spill-over benefits that might arise from a recovered east Florida/Florida Keys stock into their fishing would not be realized. If the SAFMC has reduced control over the east Florida/Florida Keys stock, it could be forced to impose rebuilding restrictions on their area of jurisdiction that may be more severe, with associated increased adverse economic effects, than otherwise required if they had control over the larger area where the east Florida/Florida Keys stock is found. Although Gulf fishermen may benefit in the short term if not subjected to the restrictions necessary to achieve rebuilding, the total adverse economic effects across the south Florida region could exceed those incurred under more uniform adoption and implementation of a rebuilding plan. Alternatively, if compatible regulations in the Gulf are adopted, unless the regulations vary by area fished (i.e., more restrictive regulations in the southern portion of the management unit, and less restrictive measures elsewhere, where rebuilding in unnecessary), this would impose unnecessarily restrictive harvest measures, with associated economic losses, outside the range of the east Florida/Florida Keys stock. Adopting different regulations, however, increases management costs and increases the complexity of the management regime fishermen must follow.

Thus, the greater the portion of the east Florida/Florida Keys stock left under the authority of the GMFMC, the greater the expected adverse economic effects. Because **Alternative 1** would leave the largest portion of the Atlantic/Florida Keys stock under GMFMC management, it would be expected to result in the greatest adverse economic effects. **Preferred Alternative 2** would be expected to result in smaller adverse economic effects than **Alternative 1** because it would leave a smaller portion of the east Florida/Florida Keys stock under GMFMC

management, but more than **Alternative 3** and **Alternative 4**. **Alternative 4** would be expected to result in the least adverse economic effects because it would leave the largest portion the east Florida/Florida Keys stock under the jurisdiction of the South Atlantic Council management.

One additional point of consideration may deserve note. Hogfish is included in the Reef Fish (RF) Fishery Management Unit (FMU) in the Gulf and the Snapper-Grouper (SG) FMU in the South Atlantic. Respective federal commercial and for-hire permits are required by both councils to harvest species in the respective RF and SG FMUs. Because hogfish are expected to be harvested by fishermen who generally fish for, and harvest, multiple reef fish or snapper-grouper species, all said fishermen are expected to already possess the respective necessary federal permits. As a result, altering the geographic area for the hogfish management unit would not be expected to cause any fishermen to need to acquire any federal permits they do not already possess and no additional costs to acquire such permits should be required under any of the proposed alternatives.

4.1.4 Direct and Indirect Effects on the Social Environment

Potential social effects that may result from this action would primarily relate to 1) the progress of the rebuilding plan under development by the South Atlantic Fishery Management Council (SAFMC) for the east Florida/Florida Keys hogfish stock, and 2) compliance and enforcement issues by creating a region off of southwest Florida where different management measures may be established from those of the Gulf following implementation of the rebuilding plan.

Additional effects would not usually be expected from retaining **Alternative 1** (No Action), as the management boundary of hogfish would remain unchanged. However, among **Alternatives 1 – 4**, **Alternative 1** includes the largest portion of the stock that was identified in the stock assessment (SEDAR 37 2014) as part of the east Florida/Florida Keys stock. While the west Florida stock was determined as neither overfished nor undergoing overfishing, the east Florida/Florida Keys stock is overfished and undergoing overfishing and is in need of a rebuilding plan. The larger the portion of the east Florida/Florida Keys stock that is placed under Gulf management, the greater the potential for negative effects on the progress of the rebuilding plan to be developed for the east Florida/Florida Keys stock.

At 73 nm south of the demarcation line used in the stock assessment, **Alternative 1** would be most likely to result in adverse effects following establishment of the east Florida/Florida Keys stock's rebuilding plan. The demarcation line proposed under the remaining alternatives would result in fewer potential negative effects as they are located closer to the demarcation line used in the stock assessment. **Preferred Alternative 2**, at 38 nm south of the demarcation line, would be expected to result in fewer potential negative effects than **Alternative 1**, but slightly greater potential effects than **Alternative 3**, which would establish the stock boundary line 25 nm south of the line used in the stock assessment. **Alternative 4** would be expected to result in the least potential negative effects by falling on the Monroe/Collier county line, the demarcation line used in the stock assessment.

Currently, regulations are consistent for hogfish throughout the Gulf Council's management jurisdiction, as well as the Florida Keys and the east coast of Florida. No negative effects would

be expected from **Alternative 1**, as management would remain consistent for the harvest of hogfish throughout the Gulf Council's management jurisdiction for reef fish species. Under **Alternatives 2 – 4**, a region within the Gulf Council's management jurisdiction would be created for which the harvest of hogfish would likely be subject to more restrictive regulations while undergoing the rebuilding plan under development by SAFMC. This region would be largest under **Alternative 4**, and progressively smaller under **Alternative 3** and **Preferred Alternative 2**. Having different regulations for a single species within an area of Gulf management jurisdiction while regulations for other reef fish species remain consistent can be confusing for fishermen and make compliance and enforcement more complicated.

In addition to effects arising from the size of the area that would be put under SAFMC management jurisdiction, the proposed demarcation lines may be compared based on the likelihood of fishing activity occurring on both sides of the new management boundary. Fishermen are known to travel north and south of the demarcation line under **Alternative 4** to fish, which means fishermen would need to be mindful of potentially different regulations on either side of the demarcation line. On the other hand, fishing trips originating either north or south of the demarcation line under **Alternative 3** are most likely to fish only on the side of the demarcation line from which the trip departed, making compliance and enforcement less complicated than under **Alternative 4**. Under **Preferred Alternative 2**, the demarcation line is 13 nm further south than the line proposed under **Alternative 3**, and is also used by the Florida Fish and Wildlife Commission as a regulatory boundary for state managed species such as permit. Because local fishermen are likely to be familiar with the demarcation line under **Preferred Alternative 2**, fewer negative effects on compliance and enforcement would be expected compared to **Alternatives 3** and **4**.

4.1.5 Direct and Indirect Effects on the Administrative Environment

The setting of a geographic boundary separate from the South Atlantic Council/Gulf Council jurisdictional boundary to define the hogfish management unit in the Reef Fish FMP is an administrative action and will have direct and indirect effects on the administrative environment through additional rulemaking to establish the boundary and designation of the South Atlantic Council as the responsible Council for hogfish south of the boundary. **Alternative 1** would retain the South Atlantic Council/Gulf Council jurisdictional boundary for hogfish management and would result in no direct change to the administrative environment. However, it would leave a portion of the overfished east Florida/Florida Keys hogfish stock, as defined in the SEDAR 37 assessment, subject to Gulf Council management which may indirectly affect the administrative environment by hindering attempts by the South Atlantic Council to effectively implement a rebuilding plan for the overfished stock. The remaining alternatives place more of the east Florida/Florida Keys stock under South Atlantic jurisdiction. Therefore, the indirect impacts on the rebuilding plan would be less for **Preferred Alternative 2**, even less for **Alternative 3**, and would be eliminated for **Alternative 4** since **Alternative 4** uses the same boundary line as the SEDAR 37 assessment.

Preferred Alternative 2 and **Alternative 3** would both set the hogfish management boundary between the South Atlantic Council/Gulf Council jurisdictional boundary and the Monroe/Collier county line, which was used by SEDAR 37 to separate west Florida stock landings from east

Florida/Florida Keys stock landings. These alternatives would have adverse impacts on the administrative environment compared to **Alternative 1** by creating additional boundaries in the EEZ requiring additional federal enforcement. They would also complicate the regulatory environment by creating a region off of southwest Florida where some hogfish are subject to South Atlantic regulations, while the remaining reef fish would continue to be subject to Gulf regulations. The **Preferred Alternative 2** boundary is an extension of an existing boundary for some state managed species into federal waters. Since it uses an existing boundary, the adverse administrative impacts of **Preferred Alternative 2** relative to **Alternative 1** are expected to be small. The **Alternative 3** boundary occurs at a location where vessels the leave from north of the boundary generally stay north of the boundary, and vessels that leave from south of the boundary generally stay south of the boundary. Although it creates an entirely new boundary, enforceability is unlikely to be a major concern. Therefore, the relative adverse administrative impacts of **Alternative 3** relative to **Alternative 1** and **Preferred Alternative 2**, while slightly greater due to the creation of a new boundary, are also expected to be small.

Alternative 4 would set the hogfish management boundary at the Monroe/Collier County line, which was used by SEDAR 37 to separate west Florida stock landings from east Florida/Florida Keys stock landings. As discussed above, this would eliminate indirect adverse impacts on the east Florida/Florida Keys stock rebuilding plan by placing the entire stock, as defined in SEDAR 37, under South Atlantic Council jurisdiction. However, as with **Alternative 3**, it would create an entirely new management boundary, and unlike **Alternative 3**, there is no natural separation of fishermen north and south of the line. Therefore, **Alternative 4** would create the greatest enforcement issues and would have the greatest adverse impacts on the administrative environment.

4.2 Action 2: Status Determination Criteria for Hogfish

4.2.1 Direct and Indirect Effects on the Physical Environment

Hogfish status determination criteria do not directly affect the physical environment. However, specifying these criteria may indirectly affect the physical environment by defining the future level of fishing effort that would 1) end overfishing in the short term should it occur and 2) sustain the stock over the long term. As mentioned in Section 4.1.1, effects on the physical environment from fishing are associated with gear coming into contact with the bottom. Different gears have different levels of impact. Spearfishing and hook-and-line gear, the primary gears used to harvest hogfish, have minimal adverse effects on the physical environment, although anchoring while engaged in fishing activity does have adverse effects as described in Section 4.1.1 In general, the alternatives that allow fishing effort to increase (more gear being used) would have greater effects.

Of the different status determination criteria, the MFMT would help to determine management measures to reduce fishing effort to a level designed to prevent overfishing. Therefore, the lower the MFMT value, the less fishing effort. **Alternative 2** is expected to have the most adverse effect on the physical environment because it has the highest MFMT value (0.150; Table 2.2.1), followed by **Alternative 1** and **Preferred Alternative 3**, which have equal MFMT values (0.95).

Alternative 4, with the lowest MFMT value (0.62), is expected to have the least adverse effect on the physical environment. Note that any reduction in fishing effort as a result of tailoring fishery management measures to these status determination criteria would likely be minimal. The reef fish fishery is a multispecies fishery. If fishermen are not able to retain one species, they often shift their effort to other species, maintaining fishing effort on reef fish.

With respect to the options for MSST, the SSB values from which the MSST is calculated are highest for **Alternative 4,** followed by **Preferred Alternative 3**, then **Alternative 2**. The higher the MSST, the more restrictive fishing measures (least adverse to the physical environment) need to be to prevent the stock from being fished below the overfished threshold. Within each alternative, **Option a** would require more restrictive management measures, followed by **Preferred Option b**, then **Option c** (Table 2.2.1). Between alternatives, **Option 4a** would require more restrictive management measures, then **Option 3a**, then **Option 2a**. The same trend would also apply to **Options b** and **c** between alternatives (i.e., **Option 4b**>**Preferred Option 3b**>**Option 2b** and **Option 4c**>**3c**>**2c**). **Alternative 1** would not have an overfished threshold, so management measures to restrict fishing would be based on MFMT and not consider MFMT.

4.2.2 Direct and Indirect Effects on the Biological/Ecological Environment

Establishing status determination criteria for hogfish should not directly affect the biological/ecological environment because they simply provide fishery managers with defined harvest thresholds to consider in developing fishery management measures. Managers use these measures in part to evaluate whether the stock removal (fishing) and fishing mortality rates are within desirable ranges. Therefore, **Alternatives 1-4** should have no direct effect on the biological/ecological environment. However, specifying these values would indirectly affect the biological/ecological environment by defining the future level of harvest that would 1) reduce the likelihood of overfishing occurring and 2) sustain the stock over the long term in accordance with the national standard guidelines.

Alternative 1, if selected as preferred would still require management measures to minimize the likelihood of overfishing of the hogfish stock with the current MFMT; however, MSY and MSST would not be established. No criterion for an overfished level for the stock (MSST) could lead to the stock becoming depleted. If this depletion caused the stock to be reduced to a very low level, stock recovery could be lengthy.

Alternative 4 would set the MFMT, MSY, and MSST at the most conservative levels of the considered alternatives using an MSY proxy of the yield of fishing at $F_{40\%SPR}$. Because the stock is at a level below 40% SPR and management goals under this alternative would be associated with fishing at $F_{40\%SPR}$ and $SSB_{40\%SPR}$, harvests would need to limited to achieving a greater stock size. This would provide a biological benefit to the stock by allowing the stock to grow.

Alternative 2 would set the MFMT, MSY, and MSST to the most liberal level of the alternatives. This alternative, which is based on fishing at MSY and not a proxy, assumes a more productive stock that can sustain higher levels of fishing effort. However, if the estimate of MSY is optimistic compared to the actual productivity of the stock, selecting this alternative

compared to the other alternatives would have an increased likelihood of overfishing and ultimately lead to an overfished stock.

Preferred Alternative 3 would set the MFMT, MSY, and MSST using the MSY proxy based on the yield of fishing at $F_{30\%SPR}$. This is the proxy recommended by the Council's Scientific and Statistical Committee (SSC) and it is intermediate to **Alternatives 2** and **4**. Thus, in terms of ranking the alternatives from having the least to most adverse effects on the hogfish stock, they would be **Alternative 4**, **Preferred Alternative 3**, **Alternative 2**, and **Alternative 1**. Although the MFMT for **Alternative 1** and **Preferred Alternative 3** are the same, **Alternative 1** does not provide an overfished threshold and would not provide a basis for establishing a rebuilding plan.

With respect to the options to set MSST (**Options a-c**), once the stock achieves equilibrium, the overfished threshold provides a buffer to the stock and its ability to sustain MSY. Because **Option a** has the MSST biomass level closest to SSB under each alternative, the trigger to establish a rebuilding plan is more likely to be tripped than **Preferred Option b** or **Option c**. As long as the SSB does not fall too far below MSST, the stock can be rebuilt more quickly than if the stock biomass were to fall below the thresholds set by **Preferred Option b** or **Option c**. Therefore, **Option a** for each alternative provides greater assurances the stock can be rebuilt should the stock biomass be reduced below B_{MSY}. The tradeoff associated with this assurance is that natural variation in recruitment could cause the hogfish stock to more frequently alternate between an overfished and rebuilt condition, even if the fishing mortality rate applied to the stocks was within the limits specified by the MFMT. However, the likelihood of this occurring could be reduced if the hogfish stock were managed at a more conservative ACL (see Action 3). Because **Preferred Option b** for each alternative would provide a buffer between **Option c** and **Option a**, the effects from **Preferred Option b** would be expected to be intermediate.

The relationships among species in marine ecosystems are complex and poorly understood, making the nature and magnitude of ecological effects difficult to predict with any accuracy. The most recent hogfish stock assessment (SEDAR 37 2014) indicated the west Florida shelf stock is not overfished and not experiencing overfishing. It is possible that forage species and competitor species could increase or decrease in abundance in response to a decrease or increase in hogfish abundance. This action, regardless of the alternative, should not directly affect hogfish abundance, thus any effects on forage species and competitor species would not likely be different from no action. Although birds, dolphins, and other predators may feed on hogfish discards, there is no evidence that any of these species rely on hogfish discards for food. Changes in the prosecution of the reef fish fishery are not expected from this action, so no additional effects to protected resources (see Section 3.3.1) are anticipated.

4.2.3 Direct and Indirect Effects on the Economic Environment

This action considers the establishment or revision of multiple status determination criteria for the west Florida hogfish stock. Establishing or revising status determination criteria is an administrative action that establishes the foundation and bounds, on which subsequent stock health determinations, allowable harvest, and other management actions are based. No direct effect on customary fishing practices, or associated economic costs or benefits, would be expected to occur as a result of establishing or revising status determination criteria. However,

direct economic effects would result from the subsequent management measures adopted in response to stock assessments, i.e., what is the MSY and is the stock overfished or undergoing overfishing. If the resource is determined to be overfished or undergoing overfishing, the management actions implemented, as necessary, to end overfishing and/or rebuild the resource would be expected to result in direct economic effects on fishermen, and the associated fishing industry and communities. Because these effects would be a direct consequence of these subsequent actions, enabled by the specifications of the current proposed action, they would be indirect effects of the current action. Therefore, in the following discussion, all of the economic effects discussed are indirect effects of establishing or revising the status determination criteria for the hogfish management unit.

Status determination criteria are required components of Fishery Management Plans. When examining the expected economic effects of alternative specifications, two key considerations arise, i.e., are the specifications biologically appropriate for the resource and the extent to which alternative specifications may be insufficiently or overly conservative. With respect to the biological appropriateness of the alternative specifications, see Sections 2.2 and 4.2.2. With respect to the issue of appropriate conservatism, the economic perspective is more harvest should not be allowed than that necessary to protect and maintain (or rebuild, as necessary) a healthy resource; however, fish should not unnecessarily be left unharvested if the biology of the resource does not require their survival, otherwise, foregone economic benefits would occur. In general, the less conservative the status determination criteria are, the greater the likelihood the resource will be harmed, necessitating economically harmful regulatory corrections, and the more conservative the status determination criteria are, the greater the likelihood fish will be needlessly left unharvested and associated economic benefits foregone.

With the exception of **Alternative 1**, the proposed alternatives and associated options vary in their conservatism. **Alternative 1** differs from the other alternatives in that under **Alternative 1**, the MSY and MSST would continue to be undefined, while MFMT would continue to be defined as equal to $F_{30\% \text{ SPR}}$. Thus, separate from the adequacy of the MFMT specification, the most obvious economic effects of **Alternative 1** would be that additional management attention, with associated costs, would be required at some future date to specify the required management criteria and, while these parameters remain undefined, the health of the resource may be jeopardized because the management measures in place may not be consistent with the (unknown) condition of the resource.

Because of the deficiencies of **Alternative 1**, i.e., the absence of definition of the two required status determination criteria, in the following discussion, **Alternatives 2-4** will primarily be compared with each other rather than **Alternative 1. Alternatives 2** and **4** (absent the associated options) would set the most liberal and most conservative set of status determination criteria, respectively, while **Preferred Alternative 3** would set status determination criteria at intermediate levels. Assuming the allowable harvest, as specified by the Annual Catch Limit (ACL) and/or Annual Catch Target (ACT) (see Sections 2.3 and 4.3) would change in tandem with the MSY (i.e., the larger the MSY, the larger the ACL and ACT), **Alternative 2** would allow the largest harvest of hogfish, **Alternative 4** the smallest, and **Preferred Alternative 3** more harvest than **Alternative 4** but less than **Alternative 2** (the allowable harvest for **Alternative 1** is discussed in section 4.3.3). Assuming all of the proposed MSY values are

biologically sustainable, **Alternative 2** would, therefore, be expected to result in the most economic benefits, followed by **Preferred Alternative 3** and **Alternative 4**. Stated a different way, assuming all three specifications are sustainable, **Alternative 4** would be expected to leave more foregone economic benefits in the water (because of lower harvest) than **Preferred Alternative 3** compared to **Alternative 2**. Alternatively, if the likelihood that the MSY is incorrectly specified (i.e., is set too high) increases as the MSY increases, **Alternative 2** would have the highest likelihood that excessive harvest occurs, harming the resource and necessitating costly corrective action, followed by **Preferred Alternative 3** and **Alternative 4**. In contrast, if the lower the MSY, the higher the likelihood that the MSY is mis-specified low, then the lower the MSY the greater the likelihood that biologically allowable harvest will be left unharvested, resulting in foregone economic benefits. Thus, the likelihood of foregone economic benefits would be the highest under **Alternative 4**, followed by **Preferred Alternative 3**, and **Alternative 2**. As should be obvious, the expected economic consequences, whether gains or losses, of **Preferred Alternative 2** would be expected to be intermediate to those of **Alternative 2** and **Alternative 4**.

With respect to the options under **Alternatives 2-4**, they vary in conservatism such that they would, progressively, **Option a** through **Option c**, require a higher (**Option a**) through lower (**Option c**) MSST before a determination that the stock is overfished and a requirement for corrective stock rebuilding would be triggered. If the MSST is breached as a result of fishing and not other biological or ecological conditions (in retrospect, if an environmental event collapses a stock, it could be argued excessive fishing likely occurred prior to the event; however, reducing the harvest rate to that necessary to anticipate the environmental event is likely unrealistic), although fishing a stock to the point it becomes overfished would mean fishermen received more economic benefits prior to the determination than they should have received (i.e., fishermen harvested too many fish, for which they received economic value), the general wisdom is that reducing a stock to an overfished state should be avoided because of the economic severity of the subsequent necessary corrective management. The lower the MSST, the greater the expected allowable harvest (you can fish the resource down to a lower level) and associated annual economic benefits and the less likely corrective action would be required (assumed more difficult and/or less likely to fish the resource down to that point), and conversely, the higher the MSST, the lower likely annual harvests and associated benefits, but the more likely the resource would become overfished and corrective action required (it may be easier to fish "down to" a higher biomass level than a lower biomass level). Thus, among the options considered, **Option a** would establish the highest MSST, affording the greatest protection to the stock, while likely resulting in the lowest allowable harvest and having the highest likelihood that the resource may become overfished, absent potentially excessively restrictive management measures. Alternatively, **Option c** would establish the lowest MSST, resulting in the lowest protection of the stock, potentially the highest allowable harvest and least likelihood the resource may become overfished. The effects of **Preferred Option b** would be intermediate to those of **Option a** and **Option c**. Available data, however, does not support quantification of the economic effects and subsequent ranking of these options.

4.2.4 Direct and Indirect Effects on the Social Environment

The establishment of status determination criteria for hogfish does not result in direct effects to the social environment. Rather, indirect effects may arise as the setting of the status determination criteria defines the future level of fishing effort that, if exceeded, would require management measures to end overfishing in the short term, should it occur, and to sustain the stock over the long term. Specifically, this action defines the range of future fishing levels from which an ACL (and possibly ACT) will be selected in the next action.

Generally, indirect effects would not be expected as long as the selected values result in yield levels that are greater than current landings, thereby avoiding disruptions to current fishing activity through new restrictions. For example, if the selected MSY, referring to the largest long-term average catch, If the selected values result in yield levels that are lower than current landings, triggering the need for new harvest restrictions, indirect negative effects would be expected.

Alternative 1 (No Action) would leave MSY and MSST undefined. NS1 guidelines require these status determination criteria be defined for each managed stock, although this requirement could be satisfied in a concurrent document under development (Reef Fish Amendment 44).

In setting the most conservative levels for MFMT, MSY, and MSST, indirect negative effects would be most likely to occur under **Alternative 4** among the alternatives. In the short term, these effects would manifest from an in-season closure, which would occur should NMFS estimate the ACT has been met. Further retention of hogfish would be prohibited for the duration of the year. The current fishing mortality rate for hogfish (SEDAR 37) exceeds the MSY proxy provided under **Alternative 4**, and hogfish would be considered as experiencing overfishing. Because the Magnuson Stevens Act requires NMFS to end overfishing as soon as possible, it is likely that effort and harvest levels would need to be restricted through new management measures if **Alternative 4** is selected as preferred.

The values for setting MFMT, MSY, and MSST under **Alternative 2** would allow for the highest levels of fishing effort by assuming a more productive stock. **Alternative 2** would be expected to be the least likely alternative to result in negative indirect effects in the short-term, by enabling the highest levels of fishing effort to be set. However, if the assumption of a more productive stock is not accurate, this alternative would have an increased likelihood of allowing overfishing to occur compared to the other alternatives, which could lead to an overfished stock and potential for negative long-term effects.

The potential for indirect effects from **Preferred Alternative 3** would be intermediary between **Alternatives 2** and **4**. **Preferred Alternative 3** would be more likely than **Alternative 2** to result in negative short-term effects as a lower level of fishing effort could be set; however, **Preferred Alternative 3** would be less likely than **Alternative 2** to result in negative long-term effects by setting more conservative levels for MFMT, MSY, and MSST. Inversely, **Preferred Alternative 3** would be less likely than **Alternative 4** to result in negative short-term effects by setting less conservative levels for MFMT, MSY, and MSST, and more likely than **Alternative 4**

to result in negative long-term effects if the fishing levels set from the **Preferred Alternative 3** levels for MFMT, MSY, and MSST allow overfishing to occur.

Options a – c would set MSST, a threshold for the stock that should the biomass fall below, the stock would be declared overfished, triggering the need for a rebuilding plan. Social effects would be indirect and only result in the event the threshold for determining the stock as overfished is triggered. There is a tradeoff in indirect effects in setting MSST, such that **Option a** would be most likely to be triggered in the short-term, the stock would be declared overfished, and a rebuilding plan would be needed, which would likely include more restrictive harvest regulations. At the same time, should the stock status become overfished under **Option a**, the stock could be rebuilt more quickly than if the stock biomass is allowed to fall lower, such as under **Preferred Option b** or **Option c**. **Option c** would be the least likely to be trigger an overfished declaration, but should this occur, the stock's biomass would be lower and the rebuilding plan would be expected to take longer than under **Option a**, and potentially require more restrictive harvest regulations to rebuild the stock than **Option a**. The effects of **Preferred Option b** would be intermediary between **Options a** and **c**.

4.2.5 Direct and Indirect Effects on the Administrative Environment

The setting of status determination criteria is an administrative action and will have effects on the administrative environment through additional rulemaking (direct effect), addressing overfished and overfishing conditions (direct effect), and monitoring the harvest (indirect effect). Because **Alternatives 1-4** would not require rulemaking, there would not be any immediate effect on the administrative environment from rulemaking. However, the Magnuson-Stevens Act requires NMFS to end overfishing as soon as possible and develop rebuilding plans for stocks considered overfished. Alternatives that have a higher degree of likelihood determining the hogfish stock to be overfished or undergoing overfishing are more likely to result in further action to correct these conditions. Because **Alternative 4** has a very conservative MSY proxy, the probability of F exceeding the MFMT and the SSB falling below the MSST are greater than the other alternatives (Table 2.2.1). Therefore, this alternative would adversely affect the administrative environment more than the other alternatives as the likelihood of needing to take corrective action is greater. In addition, this alternative's MSST is more likely to be triggered because of natural fluctuations in SSB (see the discussion in Section 2.2) and lead to the implementation of a rebuilding plan when one may not be needed. **Alternative 2**, which is based on MSY rather than a proxy, has the highest MFMT and lowest respective MSST values (**Options a-c**; Table 2.2.1). Therefore, the likelihood of the stock being declared undergoing overfishing or overfished is lower and would have the least adverse effect on the administrative environment. With respect to overfishing, both **Alternative 1** and **Preferred Alternative 3** have MFMT values that are in-between **Alternatives 2** and **4**. Therefore, these alternatives would have intermediate adverse effects on the administrative environment relative to **Alternatives 2** and **4**. **Alternative 1** would not set an MSY or MSST value and so is in violation of the Magnuson-Stevens Act. As a result, if action is not taken in this amendment to rectify this need, another action would need to be initiated of provide the missing status determination criteria. The respective **Preferred Alternative 3** MSST values (**Options a-c**) are in-between **Alternatives 2** and **4**, and therefore the effects from this alternative would be intermediate to **Alternatives 2** and **4**.

With respect to the MSST options, within an alternative, **Option a** would set the highest MSST value and **Option c** the lowest MSST value for **Alternatives 2-4**. Thus the likelihood of the stock being reduced from overfishing to an overfished condition and in need of a rebuilding plan is greater than **Preferred Option b** or **Option c** (Table 2.2.1). **Preferred Option b** is intermediate to **Options a** and **c**. In order, **Option a** would have the greatest chance of adversely affecting the administrative environment through additional management measures, followed by **Preferred Option b**, and then **Option c**.

Indirect effects of status determination criteria require monitoring of the harvests and evaluating the stock condition through stock assessments. Regardless of which alternative is selected as preferred, these management activities need to continue. Therefore, the indirect effects from each alternative should be similar.

4.3 Action 3: Annual Catch Limit and Annual Catch Target

4.3.1 Direct and Indirect Effects on the Physical Environment

Setting a hogfish ACL or ACT does not directly affect the physical environment. However, specifying these values may indirectly affect the physical environment by defining the future level of fishing effort needed to harvest either value. As mentioned in Section 4.1.1, effects on the physical environment from fishing are associated with gear coming into contact with bottom. Different gears have different levels of impact. Spearfishing and hook-and-line gear, the primary gears used to harvest hogfish, have minimal adverse effects on the physical environment. In general, the alternatives that allow greater levels of fishing effort (more gear being used) would have greater affects. Note that any reduction in fishing effort as a result of tailoring fishery management measures to limit the harvest to not exceed the ACL would likely be minimal. The reef fish fishery is a multispecies fishery. If fishermen are not able to retain one species, they often shift their effort to other species, maintaining over all reef fish fishing effort.

Alternative 4 would set the lowest ACL of the alternatives (Table 4.3.1.1; ACL = 159,300 lbs ww). Therefore, management measures to constrain the harvest to this level (e.g., fishing season and bag limit) would limit fishing effort the most and have the least adverse effect on the physical environment over the 2016-2018 time period. **Alternatives 1 (No Action)** and **2** would set similar cumulative ACLs that are higher than **Alternative 4** (Table 4.3.1.1). Therefore, management measures to constrain harvest would be less restrictive than under **Alternative 4**. This in turn could lead to higher fishing effort and greater adverse effects on the physical environment than **Alternative 4**. **Preferred Alternative 3** would have the highest cumulative harvest over the 2016-2019 time period (Table 4.3.1.1) and would therefore have the highest fishing effort and greatest adverse effects on the physical environment.

If no additional management action is taken prior to 2019, **Alternatives 2** and **4** would have the same ACL (159,300 lbs ww) after 2018, which is less than **Alternative 1** (208,000 lbs ww) or **Preferred Alternative 3** (219,000 lbs ww). Therefore, management actions to constrain the harvest to the ACL after 2018 under **Alternatives 2** and **4** would result in the greatest effort

restrictions, and correspondingly, the least adverse effect on the physical environment. **Preferred Alternative 3** would have the least effort restrictions after 2018 and therefore the greatest adverse effect on the physical environment. **Alternative 1** would be intermediate between the other alternatives both in terms of effort limitations and adverse effects on the physical environment. However, Florida FWC has indicated that they tentatively plan to conduct a new hogfish stock assessment in 2018. Therefore, it is likely that the ACL will be modified by the 2019 fishing season and operating under new ABC projections.

Table 4.3.1.1. Proposed hogfish annual catch limits (pounds whole weight) for 2015-2019 as well as the sum of the 2016-2018 annual catch limits for each Action 3 alternative.

Year	Alternative 1	Alternative 2	Preferred Alternative 3	Alternative 4
2016	208,000	240,400	219,000	159,300
2017	208,000	216,800	219,000	159,300
2018	208,000	200,800	219,000	159,300
2019	208,000	159,300	219,000	159,300
Sum 2016-2018	624,000	658,000	876,000	477,900

Options a and **b** determine whether or not an ACT should be established for **Alternatives 2-4**. Whether to set an ACT or not should have no additional effects on how **Alternatives 1-4** influence the physical environment. This is because the current ACT (**Alternative 1**) is not being used to manage hogfish and no management measures constraining the hogfish harvest based on an ACT are being proposed in Amendment 43.

4.3.2 Direct and Indirect Effects on the Biological/Ecological Environment

Establishing ACLs and ACTs for hogfish should not directly affect the biological/ecological environment because they simply provide fishery managers with defined harvest levels to consider in developing fishery management measures. Managers use ACLs and ACTs in part to evaluate whether the harvest within a year is below or above recommended limits. Therefore, **Alternatives 1-4** should have no direct effect on the biological/ecological environment. However, specifying these values would indirectly affect the biological/ecological environment by defining the future level of harvest that is not to be exceeded.

Over the 2016-2019 time period, **Alternative 4** would provide the lowest harvest limit (Table 4.3.1.1; summed ACL = 477,900 lbs ww). This lower limit should reduce the removals of hogfish from the stock more than the other alternatives. **Alternatives 1** and **2** would result in similar but intermediate summed ACLs over the 2016-2019 time period (summed ACL of 624,000 and 658,000 lbs ww, respectively). Thus, **Alternatives 1 (No Action) and 2** would have a greater adverse effect on the hogfish stock than **Alternative 4** through greater removals over this time period. **Preferred Alternative 3** would result in the highest summed ACLs over the 2016-2019 time period (876,000 lbs ww), and therefore the highest likelihood of overfishing if the ACL were exceeded (i.e., most adverse to the stock). However, this ACL is still below the average overfishing limit shown in Table 1.1.2. The likelihood of overfishing if the ACL were

exceeded would be lowest under **Alternative 4**, and intermediate under **Alternatives 1** and **2** (Table 4.3.1.1).

As explained in Section 4.3.2.1, **Preferred Option a** and **Option b** determine whether or not an ACT should be established for **Alternatives 2-4**. Whether to set an ACT or not should have no additional effects on how **Alternatives 1-4** influence the biological environment. This is because the current ACT (**Alternative 1**) is not being used to manage hogfish and no management measures constraining the hogfish harvest based on an ACT are being proposed in Amendment 43.

The relationships among species in marine ecosystems are complex and poorly understood, making the nature and magnitude of ecological effects difficult to predict with any accuracy. The most recent hogfish stock assessment (SEDAR 37 2014) indicated the west Florida shelf stock is not overfished and not experiencing overfishing. It is possible that forage species and competitor species could increase or decrease in abundance in response to a decrease or increase in hogfish abundance. This action, regardless of the alternative, should not directly affect hogfish abundance, thus any effects on forage species and competitor species would not likely be different from no action. Although birds, dolphins, and other predators may feed on hogfish discards, there is no evidence that any of these species rely on hogfish discards for food. Changes in the prosecution of the reef fish fishery are not expected from this action, so no additional effects to protected resources (see Section 3.3.1) are anticipated. Additionally, because of the multispecies nature of this fishery (as discussed in Section 3.2) and that the primary gear used to harvest hogfish is spearfishing (as discussed in Section 4.1.1), this action should have minimal impacts in terms of bycatch.

4.3.3 Direct and Indirect Effects on the Economic Environment

Alternative 1 would maintain the current hogfish ACL at 208,000 lbs and the current ACT at 179,000 lbs between 2016 and 2018 and 159,000 lbs thereafter. As a result, because **Alternative 1** would not change the ACL or ACT, current hogfish harvests and other customary uses of the resource would not be expected to be directly affected. However, **Alternative 2** and **Preferred Alternative 3** would allow more hogfish harvest over the 3-year period (2016-2018) than **Alternative 1**, while **Alternative 4** would allow less harvest. If the higher harvests are not detrimental to the resource, then maintaining **Alternative 1** would be expected to result in foregone economic benefits to fishermen and the associated fishing industry. On the other hand, if lower harvests are necessary to protect the health of the resource, then maintaining **Alternative 1** would be expected to result in subsequent declines in allowable harvest and associated economic benefits. The following discussion will describe and quantify, where possible, the expected differences in economic effects of the proposed alternatives from the perspective of whether the associated allowable harvest would be higher or lower compared to **Alternative 1** during the period 2016-2018. Available data does not allow quantitative consideration of the economic effects of the biological consequences of the higher or lower rates of harvest (e.g., what the effect of a more or less aggressive extraction rate may have on the allowable harvest beyond 2018). These biological considerations may be discussed elsewhere in the biological consequences discussion.

Alternative 2 would establish varying ACLs between 2016 and 2018 ranging from 240,000 lbs in 2016 to 200,800 lbs by 2018. Both **Preferred Alternative 3** and **Alternative 4** would establish constant hogfish ACLs for 2016-2018, with **Alternative 3** establishing an ACL of 219,000 lbs and **Alternative 4** establishing the lowest ACL among the alternatives, 159,000 lbs. Each of **Alternatives 2-4** could also establish companion ACTs as either not defined (i.e., no ACT) or a value determined by the ACL/ACT control rule at 87% of the ACL. Otherwise, **Preferred Alternative 3** and **Alternatives 2** and **4** differ from **Alternative 1** in that each would establish a new (relative to the 2018 ACL and ACT) ACL and ACT for the years after 2018, whereas under **Alternative 1** the current ACL and ACT would be maintained.

Based on Table 2.3.2, on average, the recreational and commercial sectors accounted for 78.9% and 21.1% of hogfish landings between 1986 and 2014, respectively. Hogfish harvests expected to result from ACLs proposed in **Preferred Alternative 3** and **Alternatives 2** and **4** are apportioned between the recreational and commercial sectors based on these percentages. For each sector, hogfish harvests that are expected to result from the proposed ACLs are provided in Table 4.3.3.1. The estimates and analysis presented here are based on **Option a** for **Preferred Alternative 3** and **Alternatives 2** and **4**, which would not establish an ACT. If an ACT is implemented as proposed in **Option b** in **Preferred Alternative 3** and **Alternatives 2** and **4**, then estimates provided would have to be prorated to reflect harvest levels. Although the ACTs would be set at 87% of the corresponding ACLs, harvests would be expected to fall somewhere between the ACL and the ACT. The ranking of the alternatives would remain the same, whether estimated economic effects are based on ACL or ACT changes.

Table 4.3.3.1. Estimated commercial and recreational hogfish harvests (2016-2019+) by alternative.

Commercial				
	2016	**2017**	**2018**	**2019+**
Alternative 1	43,888	43,888	43,888	43,888
Alternative 2	50,724	45,745	42,369	33,612
Preferred Alternative 3	46,209	46,209	46,209	46,209
Alternative 4	33,612	33,612	33,612	33,612
Recreational				
	2016	**2017**	**2018**	**2019+**
Alternative 1	164,112	164,112	164,112	164,112
Alternative 2	189,676	171,055	158,431	125,688
Preferred Alternative 3	172,791	172,791	172,791	172,791
Alternative 4	125,688	125,688	125,688	125,688

For the commercial sector, the economic effects expected to result from proposed changes in ACLs were estimated based on an average annual ex-vessel price per pound of hogfish harvested in the Gulf. Between 2010 and 2014, the average ex-vessel price is estimated at $3.82 per pound

(2014 dollars). The estimated changes in commercial landings and associated ex-vessel revenue for the proposed alternatives are provided in Table 4.3.3.2. It should be noted that these results are not equivalent to changes in economic value, similar to the analysis of the recreational sector provided below.

Table 4.3.3.2. Differences between expected commercial hogfish harvests under **Alternatives 2-4** and commercial status quo harvests (in pounds) and estimated changes in ex-vessel revenues (in $2014)

	2016		2017		2018		2019+	
	lbs	**$**	**lbs**	**$**	**lbs**	**$**	**lbs**	**$**
Alternative 2	6,836	$26,114	1,857	$7,094	-1,519	-$5,803	-10,276	-$39,254
Preferred Alternative 3	2,321	$8,866	2,321	$8,866	2,321	$8,866	2,321	$8,866
Alternative 4	-10,276	-$39,254	-10,276	-$39,254	-10,276	-$39,254	-10,276	-$39,254

For a given year, changes in ACL that would result in expected commercial hogfish harvests greater than the commercial status quo harvests would be expected to result in positive economic effects. If follows that if the expected commercial hogfish harvests are less than the commercial status quo harvests, negative economic effects, i.e., losses in ex-vessel revenues would result. For example, in 2017, **Alternative 2** would be expected to result in positive economic effects estimated at $7,094 because the expected commercial hogfish harvests are estimated to exceed the commercial status quo harvests by 1,857 lbs.

For the recreational sector, the expected economic effects of the proposed alternatives were measured in changes in economic value, i.e., changes in consumer surplus (CS) for anglers. The expected changes in CS were based on the estimated CS per hogfish and on the change in the number of hogfish harvested. See section 3.4 for a definition of CS. Estimates of the CS per fish for most individual species are not available and this includes hogfish. Because the value of the CS per hogfish is not known, the proxy value used in this analysis is the CS value for an additional "snapper" (not specific to the species) kept on a trip, i.e., $12.37 (Haab et al. 2012; values updated to 2014 dollars). Estimates of the expected changes in the number of hogfish harvested were obtained by dividing the expected changes in ACLs by the estimated average weight of a hogfish, 2.1 lbs, as derived from the information in Table 4.4.2.1. This analysis does not include changes in producer surplus (PS) to for-hire operators because ACL changes are not expected to affect the number of for-hire trips targeting hogfish. Hogfish are seldom targeted and are typically harvested with other reef fish. The percentage of for-hire trips targeting hogfish is estimated at 0.3% (S. Holiman, NMFS SERO, personal communication). The exclusion of PS estimates would not impact the ranking of the proposed alternatives. For **Alternatives 2-4**, expected changes in recreational hogfish harvests (in pounds and in number of fish) and associated changes in CS are provided in Table 4.3.3.3.

Table 4.3.3.3. Differences between expected recreational hogfish harvests under **Alternatives 2-4** and recreational status quo harvests and (in pounds and number of fish) and estimated changes in consumer surplus (CS) (in $2014).

		Alternative		
		2	**Preferred 3**	**4**
2016	Pounds	25,564	8,679	-38,424
	Number	12,173	4,133	-18,297
	CS	$150,584	$51,123	-$226,336
2017	Pounds	6,943	8,679	-38,424
	Number	3,306	4,133	-18,297
	CS	$40,898	$51,123	-$226,336
2018	Pounds	-5,681	8,679	-38,424
	Number	-2,705	4,133	-18,297
	CS	-$33,464	$51,123	-$226,336
2019+	Pounds	-38,424	8,679	-38,424
	Number	-18,297	4,133	-18,297
	CS	-$226,336	$51,123	-$226,336

Compared to the status quo, **Alternative 4** would set the lowest ACL among the alternatives and would be expected to result in the largest change in CS.

For both sectors, the economic effects expected to result from **Preferred Alternative 3** and **Alternatives 2** and **4** are summarized in Table 4.3.3.4. It should be noted that the effects on the commercial sector should not be added to the effects on the recreational sector because the commercial effects are changes in ex-vessel revenue whereas the recreational effects are changes in economic value. As shown in Table 4.3.3.4, **Alternative 2** would be expected to result in the greatest increase in economic effects (revenues and CS) relative to **Alternative 1**, followed by **Preferred Alternative 3**. Because **Alternative 4** would result in a decrease in allowable harvest compared to **Alternative 1**, it would be expected to result in a reduction in revenue to the commercial sector and losses in value to the recreational sector.

Table 4.3.3.4. Changes in commercial revenue and recreational consumer surplus (CS) for Alternatives 2-4 (in $2014)

	2016	2017	2018	2019+
Alternative 2				
Commercial (Revenue)	$26,114	$7,094	-$5,803	-$39,254
Recreational (CS)	$150,584	$40,898	-$33,464	-$226,336
Preferred Alternative 3				
Commercial (Revenue)	$8,866	$8,866	$8,866	$8,866
Recreational (CS)	$51,123	$51,123	$51,123	$51,123
Alternative 4				
Commercial (Revenue)	-$39,254	-$39,254	-$39,254	-$39,254
Recreational (CS)	-$226,336	-$226,336	-$226,336	-$226,336

It should be noted that the analysis provided above does not include consideration of the expected effects of the proposed changes in the hogfish minimum size limit, which are discussed in Section 4.4.3. As can be seen in Section 4.4.3, the proposed alternatives to the status quo minimum size limit would be expected to reduce the number of hogfish harvested. The discussion of the interaction of the expected effects of Actions 3 (ACL and ACT) and 4 (minimum size limit) will be provided in Chapter 5.

4.3.4 Direct and Indirect Effects on the Social Environment

The range of fishing levels is derived from the selected status determination criteria selected in Action 2. Thus, the effects from this action extend from the indirect effects of Action 2, as Action 2 specifies the range of fishing levels within which the ACL (and possibly ACT) may be set. Similar to the effects in Action 2, setting an ACL and ACT for hogfish would not result in direct effects. Rather, indirect effects would occur should there be a difference between the allowable fishing levels of the ACL and ACT, and the harvest levels from current fishing activity. The risk of negative effects occurring are greater when the ACL/ACT catch levels are lower than current harvest levels, while negative effects would not be expected should the ACL/ACT catch levels be greater than current harvest levels.

An in-season fishing closure on hogfish occurred for the first time on December 2, 2013. In-season fishing closures are disruptive to fishing activity, and the closure was widely unexpected before it was announced by NMFS on November 27, 2013. The lower the ACL (and possibly ACT) is set, the more likely it is to be reached and the more likely for an in-season closure to occur, resulting in negative social effects.

Table 4.3.1.1 provides the ACLs under **Alternatives 1 – 4** for 2016 – 2019. Setting the lowest ACL among the alternatives, **Alternative 4** would be most likely to result in negative effects through an in-season fishing closure. For the last ten years of available landings data (2005 – 2014), total hogfish landings exceeded the proposed ACL under **Alternative 4** four times. The 2016 landings are projected to exceed the **Alternative 4** ACL by approximately 31,500 lbs. In comparison, for the last ten years of landings data, total hogfish landings exceeded the ACL under **Alternative 1** twice, and 2016 landings are not projected to exceed the **Alternative 1** ACL.

In contrast to **Alternatives 1** and **4**, **Alternative 2** and **Preferred Alternative 3** propose larger ACLs for the years 2016 – 2018, and would be less likely to be exceeded triggering negative effects. **Preferred Alternative 3** provides a constant ACL for each year (2016 – 2018), while **Alternative 2** provides a decreasing ACL. However, the combined ACL for the three years is 1,000 lbs greater under **Alternative 2** than **Preferred Alternative 3**. Thus, the effects from these alternatives would be expected to be similar; it would be more likely for an in-season closure to be triggered in 2016 under **Preferred Alternative 3**, but in 2018, an in-season closure would be more likely under **Alternative 2**, assuming stable harvest activity.

Compared to **Alternative 1**, **Preferred Alternative 3** would provide a larger ACL for 2019 (219,000 lbs), while **Alternatives 2** and **4** provide a smaller ACL for 2019 (159,300 lbs). If management action is not taken, as is expected, before 2019 to modify the ACL, greater negative effects would result under **Alternatives 2** and **4** in 2019, compared to **Preferred Alternative 3**.

Both an ACL and ACT are currently defined for hogfish (**Alternative 1**), however the ACT is not being used for management. The 2013 in-season closure was triggered when NMFS determined the ACL had been met, not the ACT. Thus, the ACT under **Alternative 1** serves no purpose. The options under **Alternatives 2 – 4** would determine whether an ACT would be established (**Options b**) or not established (**Preferred Options a**). There is no proposed action in this amendment to manage the harvest of hogfish towards an ACT, thus there would be no difference in social effects between adopting an ACT (**Options b**) and not adopting an ACT (**Preferred Options a**).

This effects analysis assumes that harvest activity will continue at relatively stable levels. It is possible for unintentional effects to occur depending on the management measures adopted by SAFMC. For example, should SAFMC approve its current preferred alternative of a 25-lb commercial trip limit, it is possible that some commercial fishing effort could shift to Gulf waters by vessels possessing a commercial reef fish permit. This would be expected to increase the amount of commercial landings. On the other hand, the Gulf Council's current preferred alternative in Action 4 would increase the minimum size limit to 16-inches fork length (FL). This increase in the minimum size limit is expected to decrease the recreational harvest by 46% and the commercial harvest by 40% (Table 2.4.5 and Section 4.4.4). Thus, the effects of this action will depend on other management actions both within this amendment and in the South Atlantic region.

4.3.5 Direct and Indirect Effects on the Administrative Environment

Setting ACLs and ACTs is an administrative action and would have effects on the administrative environment through additional rulemaking (direct effect), addressing overfished and overfishing conditions (direct effect), and monitoring harvests (indirect effect). Because **Alternative 1**, the no-action alternative, would not require rulemaking, there would not be any immediate effect on the administrative environment from rulemaking. For **Alternatives 2-4**, rulemaking would be required to codify a new hogfish ACL and potentially ACT (**Option b**).

ACLs can have direct effects on the administrative environment should they be exceeded. Currently, if the sum of the commercial and recreational landings exceeds the stock ACL, then during the following fishing year, if the sum of commercial and recreational landings reaches or is projected to reach the stock ACL, a notification will be filed by NMFS with the Office of the Federal Register to close the commercial and recreational sectors for the remainder of that fishing year. Therefore, the higher the ACL, the probability of it being exceeded and the need to close the commercial and recreational sectors to hogfish fishing is lower. Thus, alternatives with lower ACLs would likely adversely affect the administrative environment more than alternatives with higher ACLs.

Alternative 4 has the lowest constant catch ACL (159,300 lbs ww) and, unless management measures are stringent enough, has the greatest probably being exceeded (Table 4.3.1.1). Thus, this alternative could adversely affect the administrative environment more than any of the other alternatives. **Alternative 1**, with the next highest constant catch ACL (208,000 lbs ww), would be next, followed by **Preferred Alternative 3** (219,000 lbs ww). It is difficult to assess how **Alternative 2** compares to **Alternative 1** and **Preferred Alternative 3** as **Alternative 2**, with its declining yield stream, has the highest ACL of all the alternatives in 2016 (240,400 lbs ww) and is lower than **Alternative 1** and **Preferred Alternative 3** in 2018 (200,800 lbs ww and 219,000 lbs ww, respectively). It is likely intermediate in its effects to **Alternative 1** and **Preferred Alternative 3**. Unless further action is taken prior to 2019, the effects from **Alternatives 2 and 4** would be similar as the ACLs become equal at 159,300 lbs ww onward (Table 4.3.1). This ACL is less than **Alternative 1** for these years.

Currently, there are no actions associated with using ACTs to manage hogfish. Therefore, whether to set an ACT (**Option b**) or not set an ACT (**Preferred Option a**) should not affect the administrative environment other than codifying a new ACT under **Alternatives 2-4** if **Option b** were selected as preferred. Alternative 1 would maintain the current ACT established in the Generic ACL/AM Amendment (GMFMC 2011a). Should accountability measures based on an ACT be developed in the future (e.g., basing season closures on the ACT rather than ACL), there could be administrative effects. However, until these actions are defined, it is difficult to assess how these measures would affect this environment.

Indirect effects of ACLs and ACTs require monitoring of the harvests and evaluating annual harvests relative to these values. Regardless of which alternative is selected as preferred, these management activities need to continue. Therefore, the indirect effects from each alternative should be similar.

4.4 Action 4: Hogfish Minimum Size Limit

4.4.1 Direct and Indirect Effects on the Physical Environment

In general, direct effects on the physical environment occur when fishing gear and anchors interact with the substrate and attached organisms. As discussed in Section 4.1.1, the dominant gear for both recreational and commercial harvest is spearfishing. Barnette (2001) cited a study by Gomez (1987) concluding that spearfishing on reef habitat may result in some coral breakage, but damage is probably negligible. In addition, there could be some impacts from divers touching coral with hands or from resuspension of sediment by fins (Barnette 2001). Such impacts should be negligible to non-existent for well-trained and experienced spearfishers who stay in the water column and avoid contact with the bottom. No direct effects from fishing on the physical environment are expected to occur from alternatives in Action 4.

Alternative 1 (No Action) would retain the current minimum size limit of 12 inches fork length (FL) for both commercial and recreational sectors and is not expected to result in any direct or indirect impacts to the physical environment. **Alternatives 2**, **3**, and **Preferred Alternative 4** would increase the minimum size limit for hogfish to 14, 15, and 16 inches FL, respectively. Compared to **Alternative 1** increasing the minimum size limit to **Alternatives 2**, **3**, or **Preferred Alternative 4** is expected to result in minimum adverse impacts to the physical environment. For example, a small number of anglers use hook-and-line gear to harvest hogfish which may result in fishermen staying at various fishing sites longer or move their fishing vessel several times over one area potentially resetting the anchoring in an effort to land a legal size hogfish. If this type of fishing behavior occurs, gear interactions with the bottom substrate could increase, including resetting the anchor several times or changing fishing locations. However, most anglers that target hogfish use spearguns, which is the primarily gear used and are not anticipated to result in any significant negative impacts on the physical environment.

Generally, increasing the minimum size limit is expected to slow the harvest rate initially that could result in recreational and commercial anglers fishing harder to land legal sized hogfish. However, since hogfish is part of the reef fish aggregate and they are not the only reef fish harvested on most trips increasing the minimum size limit is expected to have minimal to no indirect negative impacts on the physical environment compared to **Alternative 1 (No Action)**.

4.4.2 Direct and Indirect Effects on the Biological/Ecological Environment

Action 4 is expected to have minimum positive indirect effects on the biological/ecological environment. These effects are described in Section 4.1.2 and summarized here. Increasing the minimum size limit of hogfish for the recreational and commercial sector could allow hogfish to reproduce a longer period of time before being removed from the population thereby increasing the reproductive potential of the stock. However, the tradeoff could be an increase in regulatory discards and discard mortality at least in the short term. Hogfish are primarily landed by spearfishers so little information is available on discard mortality. In SEDAR 37 (2014) a 10% discard mortality rate was assumed for commercial and recreational hook-and-line gear and 100% for spearfishing. The quantity of undersized fish that are shot by spearfishing is unknown. Further, the impacts of increasing the minimum size limit and whether regulatory discards by

spearfishing are exacerbated until fishers are educated on the management changes are also unknown. Generally, lower minimum size limits result in a more rapid harvest of higher numbers of smaller fish, potentially filling the quota more quickly. Therefore, increasing the minimum size limit is expected to slow recreational and commercial landings; however, regulatory discards and discard mortality are anticipated to increase (see Table 2.4.5 and discussion in section 2).

Based on the length-weight relationship of hogfish used during SEDAR 37 (2014), a 12-inch FL hogfish (**Alternative 1**) is estimated to weigh 1.4 pounds whole weight (lbs ww). In the last three years the recreational sector has landed hogfish that are heavier and therefore estimated to be larger fish than the current 12-inch FL minimum size limit (Table 4.4.2.1). Based on recent recreational landings the average size of hogfish landed is closer to the 14 and 15-inch FL minimum size limit estimated in SEDAR 37 (2014) (Figure 4.4.2.1). For example, a 14-inch FL (**Alternative 2**) hogfish is estimated to weigh 2.1 lbs ww; a 15 inch FL hogfish (**Alternative 3**) is estimated to weigh 2.5 lbs ww; and a 16-inch FL (**Preferred Alternative 4**) hogfish is estimated to weigh 3 lbs ww (Figure 4.4.2.1). The mean weight of a commercial hogfish during 2012-2014 was 5.11 lbs ww.

Table 4.4.2.1. Average weight (lbs ww) of hogfish landed by the recreational and commercial sector from 2013-2015.

Year	Recreational Landings	Commercial Landings
2013	2.30	5.46
2014	1.85	5.76
2015	2.11	Not available

Source: SERO January 2016

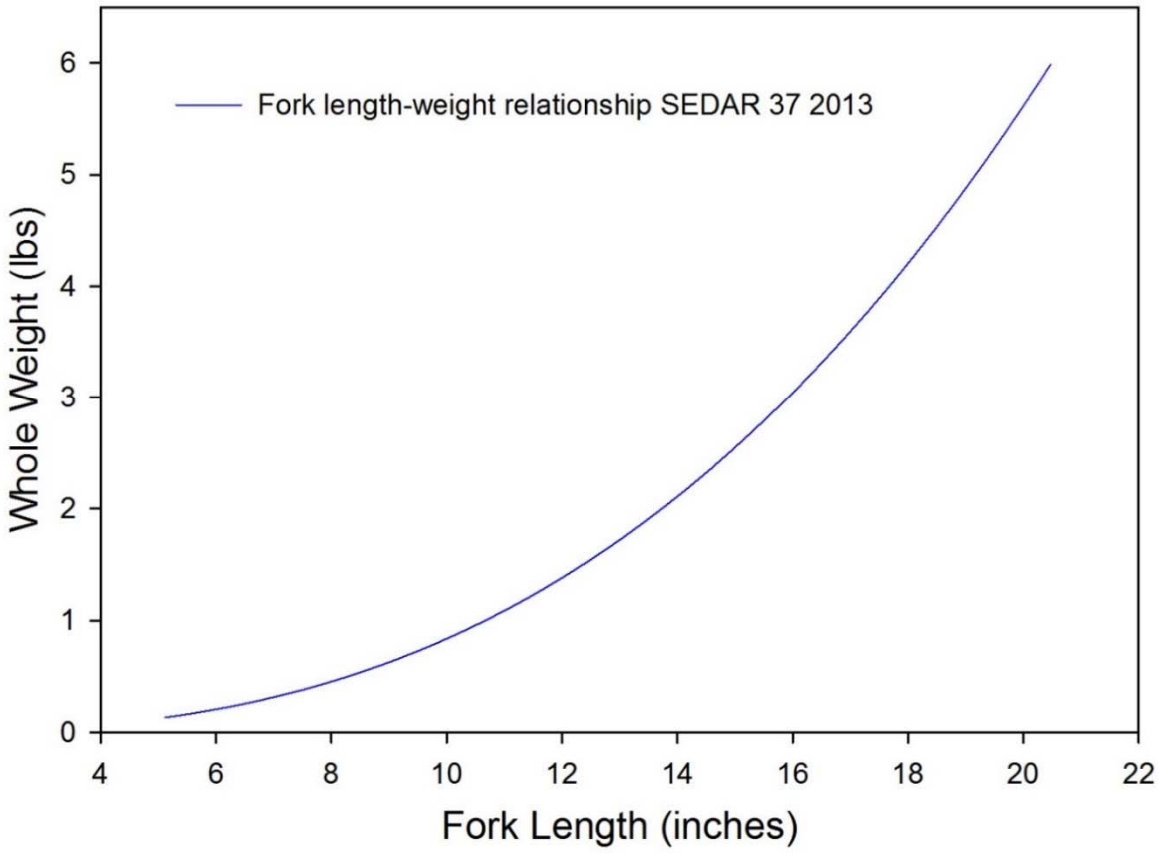


Figure 4.4.2.1. Hogfish length-weight relationship. Source: Conversion factors from SEDAR 37 (2014): weight (g) = 0.000095*FL(mm)2.74522.

All of the minimum size limit alternatives considered in this action are above the mean size of female reproductive maturity (7.5 inches FL). However, hogfish are protogynous hermaphrodites meaning they transition from females to males at approximately 16.8 inches FL. Therefore, all of the alternatives considered in this action are below the mean size of transition from female to male, although **Preferred Alternative 4** is very close to the mean transition size. For protogynous stocks such as hogfish, this means that most of the females will be protected from harvest. Disproportionate fishing on males in the population could increase the possibility of reduced fertilization rates; however, there is a little information on the importance of sperm limitation, if any for hogfish (Brooks et al. 2008).

Preferred Alternative 4 (16 inches FL) is very close to the mean size of transition. Based on the von Bertalanffy growth curve in SEDAR 37 (2014) hogfish take approximately six months to grow 1 inch (Figure 4.4.2.2). Based on the growth curve conversion factor in SEDAR 37 (2014) the estimated size at ages for **Alternatives 1-4** are shown in Table 4.4.2.2. This suggests if the Council increases the minimum size limit from **Alternative 1** (12 inches FL) to **Preferred Alternative 4** (16 inches FL) it could take a hogfish up to 2 years to reach this minimum size limit, which could increase regulatory discards for a couple of years. Release mortality rates used in SEDAR 37 were 10% for hook-and-line gear and 100% for spearfishing.

Table 4.4.2.2. Estimated size (fork length inches) and age (years) for Alternatives 1-4.

Alternative	Fork Length (inches)	Age (years)
1	12	3
2	14	4
3	15	4.3
4	16	5

Source: Conversion factors from SEDAR 37 (2014): FL (cm) = 84.89885132*(1-e-$^{0.1057678*(t+1.3290378)}$).

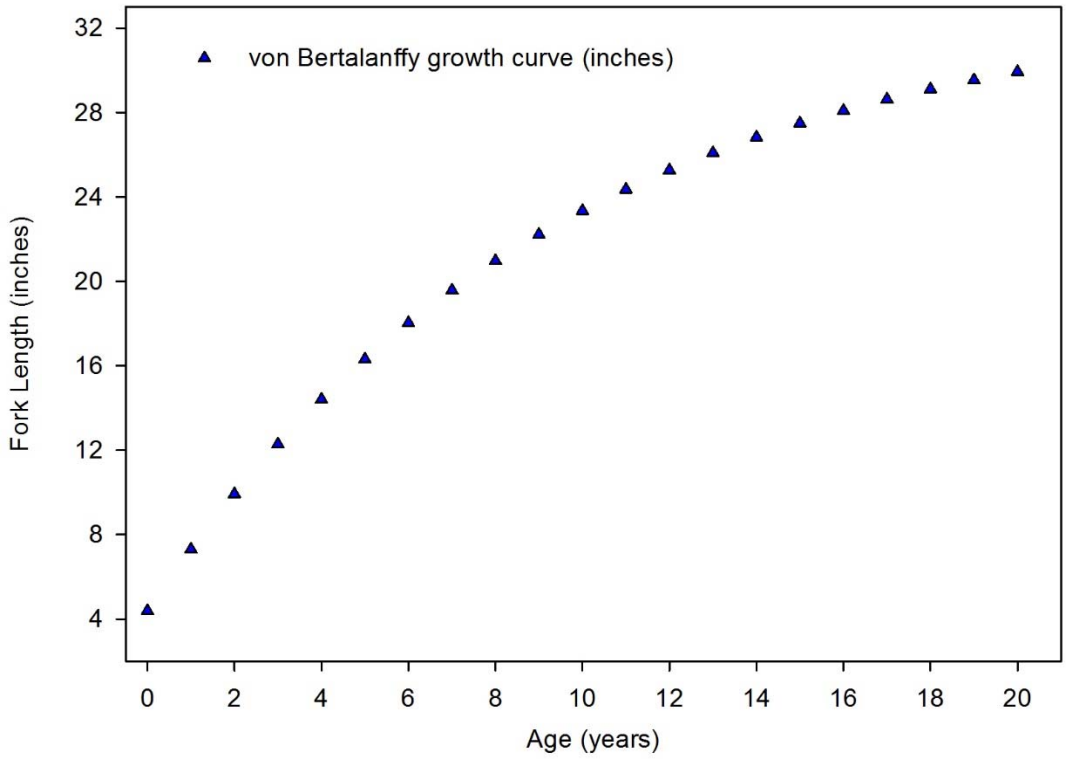


Figure 4.4.2.2. Hogfish von Bertalanffy growth curve converted to inches. Source: Conversion factors from SEDAR 37 (2014): FL (cm) = 84.89885132*(1-e-0.1057678*(t+1.3290378)).

The size-at-age and average weight information summarized above suggests that any minimum size limit modification for hogfish the Council considers in **Alternatives 2-4** compared to **Alternative 1 (No Action)** would likely have minimal effects on the biological/ecological environment. There would likely be short-term minimum negative impacts on discards and discard mortality for the stock with increasing minimum size limits, but in the long-term there could be a positive tradeoffs. For example, as the minimum size limit is increased there would be a greater number of larger females, and potentially some females that had transitioned to males in the population. These larger females and smaller males are anticipated to contribute to reproductive potential and provide positive impacts on the biological/ecological environment.

4.4.3 Direct and Indirect Effects on the Economic Environment

This action considers increases in the commercial and recreational minimum size limit for hogfish. **Alternatives 2, 3,** and **Preferred 4** would increase the minimum size limit to 14, 15, and 16 inches FL, respectively. **Alternative 1**, which would maintain the current 12-inch FL minimum size limit, would not be expected to affect fishing for hogfish and would therefore not be expected to result in any direct economic effects. For the commercial sector, the expected economic effects of the proposed alternatives are measured in changes in ex-vessel revenue based on an average ex-vessel price of $3.82 per pound (2014 dollars). For the recreational sector, the expected economic effects of the proposed alternatives are measured in changes in CS. Similar to the analysis provided in Section 4.3.3, the expected changes in CS utilize a CS value of $12.37 (2014 dollars) per hogfish and are based on the estimated changes in the number of fish expected to be harvested. This analysis does not include changes in PS or NOR to for-hire operators because it is assumed that increases to the hogfish size limit would reduce the likelihood to catch and keep a legal-size hogfish but would not affect the number of for-hire trips targeting hogfish. As discussed in Section 4.3.3, the exclusion of PS estimates would not impact the ranking of the alternatives.

Based on Table 2.3.2, on average, the recreational and commercial sectors accounted for 78.9% and 21.1% of hogfish landings between 1986 and 2014, respectively. Based on Table 3.1.2, headboats, charter for-hire, and private recreational anglers accounted, on average, for 0.81%, 3.86%, and 95.34% of recreational hogfish landings between 1986 and 2014, respectively. The average annual hogfish landings between 1986 and 2014 and the estimated annual reductions in hogfish harvests by sector and mode under the proposed size limit increases are provided in Table 4.4.3.1. The estimates and analysis presented here are based on hogfish ACLs. If an ACT is implemented as proposed in Action 3 (**Option b)**, then the estimates provided would have to be adjusted to reflect the revised allowable harvest level. Although the ACTs would be set at 87% of the corresponding ACLs, harvests would be expected to fall somewhere between the ACL and the ACT. The ranking of the alternatives would remain the same, whether the estimated economic effects are based on the ACL or ACT changes.

Table 4.4.3.1. Average annual hogfish landings in pounds (1986-2014) and expected annual changes in hogfish harvests (in percent and lbs) by sector and mode for Alternatives 2-4.

Sector	Average Landings	Alternative 2		Alternative 3		Preferred Alternative 4	
		Percent	Pounds	Percent	Pounds	Percent	Pounds
Commercial	43,888	-17	-7,461	-24	-10,533	-40	-17,555
Private	156,457	-17	-20,772	-26	-31,768	-45	-54,984
Charter	6,327	-30	-1,482	-57	-2,817	-75	-3,706
Headboats	1,328	-35	-363	-56	-581	-66	-684
Recreational (lbs)	164,112		-22,617		-35,166		-59,374
Recreational (Fish)	78,149		-10,770		-16,746		-28,273

The estimated changes in commercial ex-vessel revenue and recreational CS expected to result from the proposed changes in the minimum size limit are provided in Table 4.4.3.2. Because each of the proposed alternatives would be expected to result in a reduction in harvest relative to **Alternative 1**, each would be expected to result in a reduction in economic benefits. For a given sector, greater increases in the minimum size limit relative to status quo would be expected to result in greater reductions in harvest and associated economic effects. **Preferred Alternative 4**, which would set a 16-inch size limit, would be expected to result in the greatest reduction in harvests and associated economic effects to the commercial and recreational sectors.

Table 4.4.3.2. Expected annual changes in commercial ex-vessel revenue and recreational CS (2014 dollars).

Sector	Alternative 2 (14" FL)	Alternative 3 (15" FL)	Preferred Alternative 4 (16" FL)
Commercial (ex-vessel revenue)	-$28,501	-$40,237	-$67,061
Recreational (CS)	-$133,225	-$207,143	-$349,742

It should be noted that the analysis provided above does not include consideration of the expected effects of the proposed changes in the hogfish ACL and ACT, which are discussed in Section 4.3.3. As can be seen in Section 4.3.3, the proposed alternatives to the status quo ACL and ACT would be expected to change the amount of hogfish harvested (two alternatives would allow increased harvest and one would decrease the allowable harvest). The discussion of the interaction of the expected effects of Actions 3 (ACL and ACT) and 4 (minimum size limit) is provided in Chapter 5.

4.4.4 Direct and Indirect Effects on the Social Environment

In general, increasing the minimum size limit would be expected to result in negative effects relative to the difficulty for fishermen to land a legal size hogfish. Negative effects would also result from an increase in dead discards, as fishermen find it wasteful if they are prohibited from retaining a fish that is already dead. The majority of hogfish are caught by recreational fishermen while spearfishing in the Gulf (SEDAR 37 2014). Due to the 100% discard mortality for recreational spearfishing (Section 2.4), increasing the minimum size limit would be expected to result in an increase in dead discards if it is difficult for spearfishers to identify a legal size hogfish under an increased minimum size while underwater. On the other hand, indirect benefits could result if the increased minimum size limit slows the rate of harvest enough to avoid an in-season closure, triggered by reaching the ACL. Additional effects would not be expected from retaining the current minimum size limit of 12 inches FL (**Alternative 1**). However, an in-season closure would be most likely to occur under **Alternative 1**, as the most hogfish would be retainable (all hogfish 12 inches FL and greater).

Negative effects would be expected to increase as the minimum size limit increases. Thus, a 16-inch FL minimum size limit (**Preferred Alternative 4**) would be expected to result in the

greatest negative effects among the alternatives. These effects would decrease in intensity under **Alternative 3** followed by **Alternative 2**. In terms of indirect effects, the potential for negative effects would be reversed; an in-season ACL closure would be least likely under the largest minimum size limit (**Preferred Alternative 4**), followed by **Alternative 3** then **Alternative 2**. However, due to the expected reductions in landings under each of **Alternatives 2-4** (Table 2.4.5) and the current preferred alternative in Action 3 to increase the ACL to 219,000 lbs ww, it is likely that a substantial quota underage could occur from a greater increase to the minimum size limit, compared to **Alternative 1**.

Although a larger minimum size limit would also provide greater biological benefits for the stock, potentially resulting in increased long-term social benefits from a healthier stock, increasing the minimum size limit to 16 inches FL (**Preferred Alternative 4**) is the greatest increase among the alternatives and is expected to reduce the recreational harvest by 46% and the commercial harvest by 40% (Table 2.4.5). Given the status of the West Florida stock as neither overfished nor undergoing overfishing (SEDAR 37 2014), additional negative effects may be expected from increasing the minimum size limit by four inches, especially from the recreational sector. These negative effects would be manifested by further dissatisfaction with fishery management and would most likely occur off the central west Florida coast, especially among anglers fishing from Pinellas County (Figure 3.5.3).

On the other hand, adopting a 16-inch FL minimum size limit would allow the minimum size limit to be consistent in all Florida waters, as this is the current preferred alternative for the east Florida/Florida Keys stock in the rebuilding plan being developed by SAFMC. The SAFMC rebuilding plan proposes to reduce the bag limit from five fish per person per day to one fish per person per day in east Florida and the Florida Keys, and to adopt a fishing season of July through October. This means that a different bag limit and fishing season would be in place on either side of the new jurisdictional boundary (Action 1). Nevertheless, it would be less complicating to enforce different seasons and bag limits across the jurisdictional boundary than a minimum size limit, which would require officers to physically measure the fish.

4.4.5 Direct and Indirect Effects on the Administrative Environment

The alternatives in Action 4 are expected to have minimal impacts to the administrative environment compared to no action. **Alternative 1** maintains the 12-inch FL minimum size limit, which is enforced by NMFS, the U.S. Coast Guard, and state enforcement along with other reef fish minimum size limits. **Alternatives 2**, **3** and **Preferred Alternative 4** increase the minimum size limit to 14 inches FL, 15 inches FL, and 16 inches FL respectively. Increasing the minimum size limit could extend the fishing season and possibly avoid an ACL closure, which would be a beneficial effect on the administrative environment. From this perspective, **Preferred Alternative 4** would provide the greatest administrative benefit because it would have the highest likelihood of avoiding an ACL closure, followed by **Alternative 3** and **Alternative 2**. **Alternative 1** would have the least benefit because it would result in the greatest likelihood of an ACL closure. Florida currently has a 12-inch FL minimum size limit, and as of the writing of this section, the South Atlantic Council is proposing a 16-inch minimum size limit for hogfish in the east Florida/Florida Keys stock. A portion of the east Florida/Florida Keys stock occurs off south Florida in Gulf waters, but would be designated for management by the South Atlantic

under the Action 1 alternatives (other than no action). If Florida, the South Atlantic Council, and the Gulf Council adopt inconsistent size limits, there could be some adverse effects to enforceability due to the complexity of the size limit regulations. This adverse effect would be avoided if the three management agencies adopt consistent minimum size limit regulations.

4.5 Action 5: Use of Powerheads to Harvest Hogfish in the Stressed Area

4.5.1 Direct and Indirect Effects on the Physical Environment

Spearfishing on coral habitat may result in some coral breakage. Damage from a spear striking the hard bottom with a powerhead would be greater than from a non-powerhead spear if the powerhead discharges. However, unless the powerhead is shot directly into the hard bottom, which is unlikely, the powerhead is not likely to discharge, and would therefore cause no greater damage than a non-powerhead spear. Other adverse impacts could result not only from the spear hitting the coral, but also from divers touching the coral or from resuspension of sediment by fins (Barnette 2001). However, these impacts would occur regardless of whether the diver is using a powerhead or not. Other than the slight possibility of a powerhead discharging into the coral or hard bottom under **Alternative 1**, there is no difference in the adverse impacts to the physical environment between **Alternative 1** and **Preferred Alternative 2**.

4.5.2 Direct and Indirect Effects on the Biological/Ecological Environment

Spearfishing is highly selective, both in terms of species and size, and thus has minimal direct impact on non-target species (Frisch et al. 2012). However, because of its capability to be selective, spearfishing is able to target larger fish relative to other fishing gears and can significantly alter abundance and size structure of target species toward fewer and smaller fish (Chapman and Kramer 1999, Matos-Caraballo et al. 2006, National Marine Sanctuaries 2012). Hogfish are protogynous hermaphrodites (meaning that they mature as females and transition to males later in life). They form harems for spawning consisting of a single male and 5 – 15 females (SEDAR 37 2014). Powerheads are impracticable for use with smaller fish, so to the extent that powerhead spearfishing might occur in the stressed area, divers would selectively target the largest individuals, which are generally the males. Removal of the dominant male has the potential to significantly affect harem stability and decrease reproductive potential (Munoz et al., 2010). Therefore, **Alternative 1**, which allows harvest of hogfish using powerheads has greater potential adverse impacts on the hogfish stock than **Preferred Alternative 2**, which prohibits the use of powerheads in the stressed area.

4.5.3 Direct and Indirect Effects on the Economic Environment

This action considers the removal of a provision that exempts hogfish from the prohibition on the use of powerheads to take Gulf reef fish in the stressed area. **Alternative 1** would allow current hogfish fishing practices to continue and, as a result, would not be expected to result in any direct or indirect economic effects. No adverse economic effects associated with the allowance

of harvest of hogfish using powerheads in the stressed area have been identified other than the potential of regulatory confusion because of the current powerhead exemption. Although **Preferred Alternative 2** would reestablish the powerhead prohibition in the stressed area, it would not be expected to have measurable effects on the harvest of hogfish and associated economic benefits. Therefore, no direct economic effects would be expected to result from **Preferred Alternative 2**. However, indirect economic effects may result from **Preferred Alternative 2** because the reinstatement of the prohibition may improve the enforcement of fishing regulations in the stressed area by applying the prohibition of the use of powerheads to all reef fish in the stressed area.

4.5.4 Direct and Indirect Effects on the Social Environment

The use of powerheads is prohibited in the stressed area for the harvest of all Gulf reef fish species except hogfish (**Alternative 1,** No Action). That hogfish are exempt from the prohibition on the use of powerheads for reef fish is an artifact of hogfish's status as the last remaining species in the "list of species in the fishery but not the management unit." Powerheads are primarily used while spearfishing for underwater defense from predators such as sharks, and may occasionally be used for large, strong fish like greater amberjack. It is unlikely that spearfishers use powerheads to target hogfish due to the physical damage inflicted on the fish and because hogfish are not particularly difficult to harvest by speargun.

Additional effects would not be expected from retaining **Alternative 1 (**No Action**)**, although there is no known biological or social benefits for allowing the powerhead exception for hogfish. Negative effects on fishing behavior would not be expected under **Preferred Alternative 2**, as spearfishers are not likely using powerheads to take hogfish. Thus, there is no difference in social effects between the alternatives. Making the powerhead prohibition apply to hogfish in the stressed area (**Preferred Alternative 2**) would make the prohibition consistent for all reef fish; this could have some minor indirect benefits by simplifying fishing regulations.

4.5.5 Direct and Indirect Effects on the Administrative Environment

Preferred Alternative 2 is expected to have minor beneficial effects to the administrative environment compared to **Alternative 1 (No Action)**. **Alternative 1** maintains the exception to the stressed area's prohibition on the use of powerheads for taking hogfish. This allows a diver to possess a powerhead spear in the stressed area, which may complicate enforcement of the prohibition on its use for other reef fish. Some divers carry a device called a bangstick for protection against sharks. This is a metal shaft or wooden pole (not a spear) with a powerhead mounted on the end. Bangsticks are carried for self-defense, and are not generally used to harvest fish. **Preferred Alternative 2** is not intended to prohibit the carrying of bangsticks for self-defense. **Preferred Alternative 2** benefits the administrative environment by simplifying the regulations and enforcement, and by applying the stressed area powerhead prohibition consistently to all reef fish.

4.6 Cumulative Effects Analysis

The cumulative effects from managing the reef fish fishery have been analyzed in Amendments 30A (GMFMC 2008a), 30B (GMFMC 2008b), 31 (GMFMC 2009), 32 (GMFMC 2011b), 40 (GMFMC 2014), and 28 (GMFMC 2015) and are incorporated here by reference. Additional pertinent actions are summarized in the history of management (Section 1.3). Currently, there are two reef fish (Gulf Council) and one snapper-grouper (South Atlantic Council) reasonably foreseeable future actions (RFFAs) that are being considered, which could affect the Gulf hogfish stock. These are: Amendment 44, which would set the 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; an amendment to require electronic reporting for charter vessels to improve the quality and timeliness of landings data for this component of the recreational sector; and South Atlantic Snapper Grouper Amendment 37, which would modify the management unit for hogfish, specify fishing levels based on the South Atlantic Council's SSC recommendations for the Georgia-North Carolina and Florida Keys/East Florida stocks of hogfish, and modify or establish management measures.

The affected area of this proposed action encompasses the state and federal waters of the Gulf as well as Gulf communities that are dependent on reef fish fishing. However, most hogfish are landed in Florida, so Florida communities would be expected to be affected the most. The proposed action would re-define the hogfish management unit; establish status determination criteria, annual catch limits, and annual catch targets; modify the hogfish minimum size limit; and restrict the use of powerheads for harvesting hogfish. These actions are not expected to have significant beneficial or adverse cumulative effects on the physical and biological/ecological environments as it would minimally affect fishing practices (see Sections 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.4.1, 4.4.2, 4.5.1, and 4.5.2). If the recreational and commercial harvests are constrained to the stock ACL, then the effects to these environments would likely be beneficial compared to the no action alternatives. However, for the social and economic environments, short-term adverse effects are likely (see Sections 4.1.3, 4.1.4, 4.2.3, 4.2.4, 4.3.3, 4.3.4, 4.4.3, 4.4.4, 4.5.3, and 4.5.4) and could result in economic losses to fishing communities. These short-term effects are expected to be compensated for by long-term management goals to maintain the stock at healthy levels. This action, combined with past and RFFAs is not expected to have substantial adverse effects on public health or safety. Because the reef fish fishery is a multispecies fishery, there are always fish to target throughout the year for the commercial and recreational sectors such that the proposed actions, along with past and RFFAs, are not expected to substantially alter the manner in which the fishery is prosecuted.

Non-FMP actions affecting the reef fish fishery have been described in previous cumulative effect analyses (e.g., Amendment 40). Two important events include impacts of the Deepwater Horizon MC252 oil spill and climate change. Impacts from the Deepwater Horizon MC252 oil spill are still being examined; however, some peer-reviewed studies have been published. Because hogfish are not found in great numbers in the areas most heavily impacted by the oil spill, little research directed at hogfish. Any effects from the spill were likely minimal to the hogfish stock.

There is a large and growing body of literature on past, present, and future impacts of global climate change induced by human activities. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. The Environmental Protection Agency's climate change web page provides basic background information on these and other measured or anticipated effects. In addition, the Intergovernmental Panel on Climate Change has numerous reports addressing their assessments of climate change (http://www.ipcc.ch/publications_and_data/publications_and_data.shtml). Global climate changes could affect the Gulf fisheries as discussed in Section 3.3. However, the extent of these effects cannot be quantified at this time. The proposed actions are not expected to significantly contribute to climate change through the increase or decrease in the carbon footprint from fishing as these actions should not change how the fishery is prosecuted. As described in Section 3.3, the contribution to greenhouse gas emissions from fishing is minor compared to other emission sources (e.g., oil platforms).

The effects of the proposed action are, and will continue to be, monitored through collection of landings data by NMFS, stock assessments and stock assessment updates, life history studies, economic and social analyses, and other scientific observations. Landings data for the recreational sector in the Gulf are collected through MRIP, the Southeast Region Headboat Survey (SRHS), and the Texas Marine Recreational Fishing Survey. In addition, the Louisiana Department of Wildlife and Fisheries and the Alabama Department of Conservation and Natural Resources have instituted programs to collect red snapper recreational landings information in their respective states. Commercial data are collected through trip ticket programs, port samplers, and logbook programs, as well as dealer reporting through the individual fishing quota program.

CHAPTER 5. REGULATORY IMPACT REVIEW

CHAPTER 6. REGULATORY FLEXIBILITY ACT ANALYSIS

CHAPTER 7. LIST OF PREPARERS

PREPARERS

Name	Expertise	Responsibility	Agency
Steven Atran	Fishery biologist	Co-Team Lead – Amendment development, biological analyses	GMFMC
Peter Hood	Fishery biologist	Co-Team Lead – Amendment development, biological analyses, cumulative effects analysis	SERO
Assane Diagne	Economist	Economic analyses	GMFMC
Stephen Holiman	Economist	Economic analyses	SERO
Ava Lasseter	Anthropologist	Social analyses	GMFMC
Nick Farmer	Fishery biologist	Biological analyses	SERO
Carrie Simmons	Fishery biologist	Biological analyses	GMFMC
Ryan Rindone	Fishery biologist	Biological analyses	GMFMC

REVIEWERS (Preparers also serve as reviewers)

Name	Expertise	Responsibility	Agency
Noah Silverman	Environmental Protection Specialist	National Environmental Policy Act review	SERO
Mara Levy	Attorney	Legal review	NOAA GC
Steve Branstetter	Biologist	Review	SERO
Adam Bailey	Technical writer and editor	Regulatory writer	SERO
Jennifer Lee	Biologist	Protected Resources review	SERO
David Dale	Biologist	Essential Fish Habitat review	SERO
Adyan Rios	Biologist	Review	SEFSC
Akbar Marvasti	Economist	Review	SEFSC
David Carter	Economist	Review	SEFSC

GMFMC = Gulf of Mexico Fishery Management Council; NOAA GC = National Oceanic and Atmospheric Administration General Counsel; SEFSC = Southeast Fisheries Science Center; SERO = Southeast Regional Office of the National Marine Fisheries Service

CHAPTER 8. LIST OF AGENCIES CONSULTED

National Marine Fisheries Service
- Southeast Fisheries Science Center
- Southeast Regional Office
- Office for Law Enforcement

NOAA General Counsel

Environmental Protection Agency
United States Coast Guard
United States Fish and Wildlife Services
Texas Parks and Wildlife Department
Alabama Department of Conservation and Natural Resources/Marine Resources Division
Louisiana Department of Wildlife and Fisheries
Mississippi Department of Marine Resources
Florida Fish and Wildlife Conservation Commission

CHAPTER 9. REFERENCES

Adams, W.F., and C. Wilson. 1995. The status of the smalltooth sawfish, *Pristis pectinata* Latham 1794 (Pristiformes: Pristidae) in the United States. Chondros 6(4):1-5.

Ault, J. S., S. G. Smith, G. A. Diaz, and E. Franklin. 2003. Florida hogfish fishery stock assessment. University of Miami, Rosenstiel School of Marine Science. Contract No. 7701 617573 for Florida Marine Research Institute, St. Petersburg, Florida.

American Fisheries Society. 2013. Common and Scientific Names of Fishes from the United States, Canada, and Mexico. Seventh Edition. Special Publication 34. Bethesda, MD.

Anderes Alvarez, B. L., and I. Uchida. 1994. Study of hawksbill turtle (*Eretmochelys imbricata*) stomach content in Cuban waters. Pages 27-40 *in* Study of the Hawksbill Turtle in Cuba (I). Ministry of Fishing Industry, CUBA. Ministry of Fishing Industry, Cuba.

Barnette, M. C. 2001. A review of the fishing gear utilized within the Southeast Region and their potential impacts on essential fish habitat. NOAA Technical. Memorandum. NMFS-SEFSC-449. National Marine Fisheries Service. St. Petersburg, Florida.

Bigelow, H.B., and W.C. Schroeder. 1953. Sawfishes, guitarfishes, skates and rays, pp. 1-514. *In:* Tee-Van, J., C.M Breder, A.E. Parr, W.C. Schroeder and L.P. Schultz (eds). Fishes of the Western North Atlantic, Part Two. Mem. Sears Found. Mar. Res. I.

Biggs, D.C., Jochens, A.E., Howard, M.K., DiMarco, S.F., Mullin, K.D., Leben, R.R., Muller-Karger, F.E., & Hu, C. (2005). Eddy forced variations in on- and off-margin summertime circulation along the 1000-m isobath of the northern Gulf of Mexico, 2000–2003, and links with sperm whale distributions along the middle slope. In: W. Sturges & A. Lugo-Fernandez (Eds.), Circulation in the Gulf of Mexico: Observations and models. (Vol. 161). Washington, D.C.: American Geophysical Union.

Bjorndal, K. A. 1997. Foraging ecology and nutrition of sea turtles. P. L. Lutz, and J. A. Musick, editors. The Biology of Sea Turtles. CRC Press, Boca Raton.

Bjorndal, K. A. 1980. Nutrition and grazing behavior of the green turtle, Chelonia mydas. Marine Biology 56:147-154.

Bolten, A. B., and G. H. Balazs. 1995. Biology of the early pelagic stage - the 'lost year'. Pages 579-581 *in* K. A. Bjorndal, editor. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, DC.

Brongersma, L. D. 1972. European Atlantic turtles. Zoologische Verhandelingen (121):1-318.

Burke, V. J., S. J. Morreale, and A. G. J. Rhodin. 1993. *Lepidochelys kempii* (Kemp's ridley sea turtle) and *Caretta caretta* (loggerhead sea turtle): diet. Herpetological Review 24(1):31-32.

Burns, K. M., and J. T. Froeschke. 2012. Survival of red grouper (*Epinephalus morio*) and red snapper (*Lutjanus campechanus*) caught on J-hooks and circle hooks in the Florida recreational and recreational-for-hire fisheries. Bull. Mar. Sci. 88(3):633-646.

Burton, M. 2008. Southeast U.S. Continental Shelf, Gulf of Mexico, and U.S. Caribbean. *In* Osgood, K. E. (ed). Climate Impacts on U.S. Living Marine Resources: National Marine Fisheries Service Concerns, Activities and Needs. U.S. Dep. Commerce, NOAA Tech. Memo. NMFSF/ SPO-89, pp 31-43.

Byles, R. 1988. Satellite Telemetry of Kemp's Ridley Sea Turtle, *Lepidochelys kempi*, in the Gulf of Mexico. Report to the National Fish and Wildlife Foundation:40 pp.

Carls, M.G., S.D. Rice, and J.E. Hose. 1999. Sensitivity of Fish Embryos to Weathered Crude Oil: Part I. Low-level Exposure during Incubation Causes Malformations, Genetic Damage, and Mortality in Larval Pacific Herring (*Clupea pallasi*). Environmental Toxicology and Chemistry 18(3): 481–493.

Carr, A. F. 1986. RIPS, FADS, and little loggerheads. BioScience 36(2):92-100.

Carr, A. 1987. New perspectives on the pelagic stage of sea turtle development. Conservation Biology 1(2):103-121.

Cass-Calay, S. L., and M. Bahnick. 2002. Status of the yellowedge grouper fishery in the Gulf of Mexico. Contribution SFD 02/03 – 172. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. Miami, Florida.

Chapman, M.R. and D.L. Kramer. 1999. Gradients in coral reef fish density and size across the Barbados Marine Reserve boundary: Effects of reserve protection and habitat characteristics. Marine Ecology Progress Series 181:81-96.
http://www.int-res.com/articles/meps/181/m181p081.pdf

Clapp, R. B., R. C. Banks, D. Morgan-Jacobs, and W. A. Hoffman. 1982. Marine birds of the southeastern United States and Gulf of Mexico. U.S. Dept. of Interior, Fish and Wildlife Service, Office of Biological Services, Washington D.C. FWS/OBS-82/01. 3 vols.

Colin, P. L. 1982. Spawning and larval development of the hogfish, *Lachnolaimus maximus* (Pisces: Labridae). Fishery Bulletin, U. S. 80 (4): 853-862.
http://fishbull.noaa.gov/80-4/colin.pdf

Collins A. and R. McBride. 2008. Final report for integrating life history, mating system, fishing effects, and habitat of hogfish, *Lachnolaimus maximus*, a harem spawning fish in the southeast U.S. FWRI File Code F2541-05-07-F.
http://www.sefsc.noaa.gov/P_QryLDS/download/CR125_NA05NMF4540040F2540.pdf?id=LDS

Collins, A.B. and R.S. McBride. 2011. SEDAR37-RD-02. Demographics by depth: spatially explicit life-history dynamics of a protogynous reef fish. Fish. Bull. 109:232–242

Cooper, W., A.Collins, J. O'Hop, and D. Addis. 2013. The 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, FL. 295 p. with App.

Davis, J. C. 1976. Biology of the hogfish, *Lachnolaimus maximus* (Walbaum), in the Florida Keys. M. S. Thesis. University of Miami. Coral Gables, FL. pp: 86.

DeLeo, D.M., D.V. Ruiz-Ramos, I.B. Baums, and E.E. Cordes. 2015. Response of deep-water corals to oil and chemical dispersant exposure. Deep-Sea Research II. In press.

Eckert, S. A., K. L. Eckert, P. Ponganis, and G. L. Kooyman. 1989. Diving and foraging behavior of leatherback sea turtles (*Dermochelys coriacea*). Canadian Journal of Zoology 67(11):2834-2840.

Eckert, S. A., D. W. Nellis, K. L. Eckert, and G. L. Kooyman. 1986. Diving patterns of two leatherback sea turtles (*Dermochelys coriacea*) during internesting intervals at Sandy Point, St. Croix, U.S. Virgin Islands. Herpetologica 42(3):381-388.

Farmer, N. A., R. P. Malinowski, and M.F. McGovern. 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 p.

Fisher, C.R., P. Hsing, C.L. Kaiser, D.R., Yoerger, H.H. Roberts, W.W. Shedd, E.E. Cordes, T.M. Shank, S.P. Berlet, M.G. Saunders, E.A. Larcom, J.M. Brooks. 2014. Footprint of *Deepwater Horizon* blowout impact to deep-water coral communities. Proceedings of the National Academy of Sciences 111: 11744-11749. doi: 10.1073/pnas.1403492111

Frick, J. 1976. Orientation and behavior of hatchling green turtles *Chelonia mydas* in the sea. Animal Behavior 24(4):849-857.

FSAP. 1998a. Report of the first ad hoc finfish stock assessment panel. Gulf of Mexico Fishery Management Council, Tampa, FL. 12 p.

FSAP. 1998b. Report of the second ad hoc finfish stock assessment panel. Gulf of Mexico Fishery Management Council, Tampa, FL. 21 p.

GMFMC. 1981. Environmental impact statement and fishery management plan for the reef fish resources of the Gulf of Mexico and environmental impact statement. Gulf of Mexico Fishery Management Council, Tampa, Florida. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/RF%20FMP%20and%20EIS%201981-08.pdf

GMFMC. 1997a. Amendment 14 to the fishery management plan for the reef fish fishery of the Gulf of Mexico, includes regulatory impact review, initial regulatory flexibility analysis, and environmental assessment. Gulf of Mexico Fishery Management Council. Tampa, Florida. http://gulfcouncil.org/Beta/GMFMCWeb/downloads/RF%20Amend-14%20Final%201996-08.pdf

GMFMC. 1997b. Amendment 15 to the fishery management plan for the reef fish resources of the Gulf of Mexico, includes regulatory impact review, initial regulatory flexibility analysis, and environmental assessment. Gulf of Mexico Fishery Management Council. Tampa, Florida. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/AMEND15.pdf

GMFMC. 1999a. Amendment 16B to the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida.

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

GMFMC. 1999c. Regulatory amendment to the reef fish fishery management plan to set 1999 gag/black grouper management measures (revised), includes environmental assessment, regulatory impact review, and initial regulatory flexibility analysis. Gulf of Mexico Fishery Management Council, Tampa, Florida. 84 p. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/RF%20RegAmend%20-%201999-08.pdf

GMFMC. 2003. Corrected amendment for a charter/vessel headboat permit moratorium amending the fishery management plans for: reef fish (Amendment 20) and coastal migratory pelagics (Amendment 14) including environmental assessment, regulatory impact review, and initial regulatory flexibility act. Gulf of Mexico Fishery Management Council, Tampa, Florida. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/CBAmendmentFINAL-corrected.pdf

GMFMC. 2004a. Final environmental impact statement for the generic essential fish habitat amendment to the following fishery management plans of the Gulf of Mexico: shrimp fishery of the Gulf of Mexico, red drum fishery of the Gulf of Mexico, reef fish fishery of the Gulf of Mexico, stone crab fishery of the Gulf of Mexico, coral and coral reef fishery of the Gulf of Mexico, spiny lobster fishery of the Gulf of Mexico and South Atlantic, coastal migratory pelagic resources of the Gulf of Mexico and South Atlantic. Gulf of Mexico Fishery Management Council. Tampa, Florida. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Final%20EFH%20EIS.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. 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. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/VS%2023%20Oct%20Final%2010-21-04%20with%20Appendix%20E.pdf

GMFMC. 2005. Final amendment 18A to the fishery management plan for the reef fish resources of the Gulf of Mexico, including environmental assessment, regulatory impact review, and initial regulatory flexibility analyses. Gulf of Mexico Fishery Management Council. Tampa, Florida. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Amendment_18A_Final.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. 2008. 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. http://www.gulfcouncil.org/docs/amendments/Amend-30A-Final%20208.pdf

GMFMC. 2009. Final amendment 31 to the fishery management plan for reef fish resources in the Gulf of Mexico addresses bycatch of sea turtles in the bottom longline component of the Gulf of Mexico reef fish fishery, includes draft environmental impact statement and regulatory impact review. Gulf of Mexico Fishery Management Council. Tampa, Florida. 261 pp with appendices. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Final%20Draft%20RF%20Amend%2031%206-11-09.pdf

GMFMC. 2011a. 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.

http://www.gulfcouncil.org/docs/amendments/Final%20Generic%20ACL_AM_Amendment-September%209%202011%20v.pdf

GMFMC. 2011b. Final reef fish amendment 32 – gag grouper – rebuilding plan, annual catch limits, management measures, red grouper – annual catch limits, management measures, and grouper accountability measures. Gulf of Mexico Fishery Management Council. Tampa, Florida. http://www.gulfcouncil.org/docs/amendments/Final%20RF32_EIS_October_21_2011%5b2%5d.pdf

GMFMC. 2012a. Final amendment 35 to the reef fish fishery management plan for the reef fish resources of the Gulf of Mexico – modifications to the greater amberjack rebuilding plan and adjustments to the recreational and commercial management measures, including an environmental assessment, fishery impact statement, regulatory impact review, and regulatory flexibility act analysis. Gulf of Mexico Fishery Management Council. Tampa, Florida. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Final_Amendment_35_Greater_Amberjack_Rebuilding_8_May_2012.pdf

GMFMC. 2012b. Final amendment 37 to the reef fish fishery management plan for the reef fish resources of the Gulf of Mexico – Modifications to the gray triggerfish rebuilding plan including adjustments to the annual catch limits and annual catch targets for the commercial and recreational sectors. Gulf of Mexico Fishery Management Council. Tampa, Florida. http://www.gulfcouncil.org/docs/amendments/Final_Reef_Fish_Amend_37_Gray_Triggerfish_12_06_12[1].pdf

GMFMC. 2012c. Final amendment 38 to the reef fish fishery management plan for the reef fish resources of the Gulf of Mexico – modifications to the shallow-water grouper accountability measures, including an environmental assessment, fishery impact statement, regulatory impact review, and regulatory flexibility act analysis. Gulf of Mexico Fishery Management Council. Tampa, Florida. http://www.gulfcouncil.org/docs/amendments/Final%20Amendment%2038%2009-12-2012.pdf

GMFMC. 2014. Amendment 40 to the Reef Fish Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico - Recreational Red Snapper Sector Separation. Gulf of Mexico Fishery Management Council. Tampa, Florida. http://www.gulfcouncil.org/fishery_management_plans/reef_fish_management.php

GMFMC. 2015. Final amendment 28 to the reef fish fishery management plan for the reef fish resources of the Gulf of Mexico – red snapper allocation. Gulf of Mexico Fishery Management Council, Tampa, Florida. 302 p. http://gulfcouncil.org/docs/amendments/Final%20Red%20Snapper%20Allocation%20-RF%20Amendment%2028.pdf

GMFMC. 2016 (in progress). Draft 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.

GMFMC and SAFMC. 1982. Fishery management plan final environmental impact statement for coral and coral reefs. Gulf of Mexico Fishery Management Council. Tampa, Florida; and South Atlantic Fishery Management Council. Charleston, South Carolina. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Coral%20FMP.pdf

Gomez, E.D., A.C. Alcala, and H.T. Yap. 1987. Other fishing methods destructive to coral. pp. 65-75 in Human Impacts on Coral Reefs: Facts and Recommendations. Antenne Museum, French Polynesia.

Gore, R. H. 1992. The Gulf of Mexico: A treasury of resources in the American Mediterranean. Pineapple Press. Sarasota, Florida.

Frisch A.J., A.J. Cole, J-P.A. Hobbs, J.R. Rizzari, and K.P. Munkres. 2012. Effects of spearfishing on reef fish populations in a multi-use conservation area. PLoS ONE 7(12): e51938. doi:10.1371/journal.pone.0051938 http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0051938

Haab, T., R. L. Hicks, K. Schnier, and J.C. Whitehead. 2012. Angler heterogeneity and the species specific demand for marine recreational fishing. Working Paper No. 10-02. Appalachian State University, Department of Economics. Available at: http://econ.appstate.edu.marfin/

Haensly, W.E., J.M. Neff, J.R. Sharp, A.C. Morris, M.F. Bedgood, and P.D. Beom 1982. Histopathology of *Pleuronectes platessa* from Aber Wrac'h and Aber Benoit, Brittany, France: long-term effects of the Amoco Cadiz crude oil spill. Journal of Fish Disease 5: 365-391.

Hamilton, A. N., Jr. 2000. Gear impacts on essential fish habitat in the Southeastern Region. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. Pascagoula, Mississippi.

Harrison, P. 1983. Seabirds: an identification guide. Houghton Mifflin Company, Boston, Massachusetts. Field Notes 48: 976-978.

Heintz, R.A., J.W. Short, and S.D. Rice. 1999. Sensitivity of fish embryos to weathered crude oil: Part II. Increased mortality of pink salmon (*Oncorhynchus gorbuscha*) embryos incubating downstream from weathered Exxon *Valdez* crude oil. Environmental Toxicology and Chemistry 18(3): 494–503.

Hollowed, A. B., Barange, M., Beamish, R., Brander, K., Cochrane, K., Drinkwater, K., Foreman, M., Hare, J., Holt, J., Ito, S-I., Kim, S., King, J., Loeng, H., MacKenzie, B., Mueter, F., Okey, T., Peck, M. A., Radchenko, V., Rice, J., Schirripa, M., Yatsu, A., and Yamanaka, Y. 2013. Projected impacts of climate change on marine fish and fisheries. ICES Journal of Marine Science 70: 1023–1037.

Hose, J.E., M.D. McGurk, G.D. Marty, D.E. Hinton, E.D Brown, and T.T. Baker. 1996. Sublethal effects of the (Exxon *Valdez*) oil spill on herring embryos and larvae: morphological, cytogenetic, and histopathological assessments, 1989–1991. Canadian Journal of Fisheries and Aquatic Sciences 53: 2355-2365.

Hsing, P., B. Fu, E.A. Larcom, S.P. Berlet, T.M. Shank, A.F. Govindarajan, A.J. Lukasiewicz, P.M. Dixon, C.R. Fisher. 2013. Evidence of lasting impact of the *Deepwater Horizon* oil spill on a deep Gulf of Mexico coral community Elementa: Science of the Anthropocene 1: 1-15.

Hughes, G. R. 1974. Is a sea turtle no more than an armored stomach? Bulletin of the South African Association for Marine Biological Research 11:12-14.

Incardona, J.P, L.D. Gardner, T.L. Linbo, T.L. Brown, A.J. Esbaugh, E.M. Mager, J.D. Stieglitz, B.L. French, J.S. Labenia, C.A. Laetz, M. Tagal, C.A. Sloan, A. Elizur, D.D. Benetti, M. Grosell, B.A. Block, and N.L. Scholz. 2014. *Deepwater Horizon* crude oil impacts the developing hearts of large predatory pelagic fish. Proceedings of the National Academy of Sciences 111(15): E1510–E1518.

Jochens, A., Biggs, D., Benoit-Bird, K., Engelhaupt, D., Gordon, J., Hu, C., Jaquet, N., Johnson, M., Leben, R., Mate, B., Miller, P., Ortega-Ortiz, J., Thode, A., Tyack, P., & Würsig, B. (2008). Sperm whale seismic study in the Gulf of Mexico: Synthesis report. (OCS Study MMS 2008-006). New Orleans, LA: U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region.

Keinath, J. A., and J. A. Musick. 1993. Movements and diving behavior of leatherback turtle. Copeia 1993(4):1010-1017.

Kennedy, V. S., R. R. Twilley, J. A. Kleypas, J. H. Cowan, Jr., S. R. Hare. 2002. Coastal and Marine Ecosystems and Global Climate Change: Potential Effects on U.S. Resources. Pew Center on Global Climate Change.

Khan, R.A. and J.W. Kiceniuk. 1984. Histopathological effects of crude oil on Atlantic cod following chronic exposure. Canadian Journal of Zoology 62: 2038-2043.

Khan R.A. and J.W. Kiceniuk. 1988. Effect of petroleum aromatic hydrocarbons on monogeneids parasitizing Atlantic cod, *Gadus morhua*. Bulletin of Environmental Contamination and Toxicology 41: 94-100.

Khan, R.A. 1990. Parasitism in Marine Fish after Chronic Exposure to Petroleum Hydrocarbons in the Laboratory and to the Exxon *Valdez* Oil Spill. Bulletin of Environmental Contamination and Toxicology 44: 759-763.

Kiceniuk J.W. and R.A. Khan. 1987. Effect of petroleum hydrocarbons on Atlantic cod, *Gadus morhua*, following chronic exposure. Canadian Journal of Zoology 65: 490-494.

Lanyon, J.M., C.J. Limpus, and H., Marsh. 1989. Dugongs and turtles: grazers in the seagrass system. *In:* Larkum, A.W.D, A.J., McComb and S.A., Shepard (eds.) Biology of Seagrasses. Elsevier, Amsterdam, 610.

Liese, C. and D.W. Carter. 2011. Collecting Economic Data from the For-Hire Fishing Sector: Lessons from a Cost and Earnings Survey of the Southeast U.S. Charter Boat Industry. 14 p. In Beard, T. D., Jr., A. J. Loftus, and R. Arlinghaus (editors). The Angler and the Environment. American Fisheries Society, Bethesda, MD.

Limpus, C.J., and N., Nichols. 1988. The southern oscillation regulates the annual numbers of green turtles (*Chelonia mydas*) breeding around northern Australia. Australian Journal of Wildlife Research 15:157.

Limpus, C.J., and N., Nichols. 1994. Progress report on the study of the interaction of El Niño Southern Oscillation on annual *Chelonia mydas* numbers at the southern Great Barrier Reef rookeries. *In:* Proceedings of the Australian Marine Turtle Conservation Workshop, Queensland Australia.

Lutz, P. L., and J. A. Musick, editors. 1997. The biology of sea turtles. CRC Press, Boca Raton, Florida.

Lutz, P. L., J. A. Musick, and J. Wyneken. 2003. The Biology of Sea Turtles. Volume II. CRC Press, Inc., Washington, D.C.

Márquez M, R. 1994. Synopsis of biological data on the Kemp's ridley turtle, *Lepidochelys kempii* (Garman 1880). U. S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida.

Matos-Caraballo, D., J.M. Posada and B.E. Luckhurst. 2006. Fishery-dependent evaluation of a spawning aggregation of tiger grouper (*Mycteroperca tigris*) at Vieques Island, Puerto Rico. Bulletin of Marine Science, Volume 79, Number 1, July 2006, pp. 1-16. http://www.ingentaconnect.com/content/umrsmas/bullmar/2006/00000079/00000001/art00001

McBride, R.S. and Johnson, M. R. 2007. Sexual development and reproductive seasonality of hogfish (Labridae: *Lachnolaimus maximus*), an hermaphroditic reef fish. Journal of Fish Biology 71:1270-1292.

McBride, R.S. and A.K. Richardson. 2007. Evidence of size-selective fishing mortality from an age and growth study of hogfish (Labridae: *Lachnolaimus maximus*), a hermaphroditic reef fish. Bulletin of Marine Science 80:401-417.

McBride, R.S.; Thurman, P.E.; Bullock, L.H. 2008. SEDAR37-RD-05. Regional variations of hogfish (Lachnolaimus maximus) life history: consequences for spawning biomass and egg production models. J. Northw. Atl. Fish. Sci., Vol. 41: 1–12

McEachran, J.D. and J.D. Fechhelm. 2005. Fishes of the Gulf of Mexico, Vol. 2. University of Texas Press. Austin, Texas.

Mendelssohn, I.A., G.L. Andersen, D.M. Baltz, R.H. Caffey, K.R. Carman, J.W. Fleeger, S.B. Joye, Q. Lin, E. Maltby, E.B. Overton, and L.P. Rozas. 2012. Oil Impacts on Coastal Wetlands: Implications for the Mississippi River Delta Ecosystem after the *Deepwater Horizon* Oil Spill. BioScience 62: 562–574.

Mendonca, M. T., and P. C. H. Pritchard. 1986. Offshore movements of post-nesting Kemp's ridley sea turtles (*Lepidochelys kempii*). Herpetologica 42:373-380.

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

Meylan, A. 1984. Feeding ecology of the hawksbill turtle *Eretmochetys imbricata*: Spongivory as a feeding niche in the coral reef community. Unpublished Ph.D. Dissertation. University of Florida; Gainesville, Florida.

Meylan, A. 1988. Spongivory in hawksbill turtles: a diet of glass. Science 239:393-395.

Meylan, A. B., and M. Donnelly. 1999. Status justification for listing the hawksbill turtle (Eretmochelys imbricata) as critically endangered on the 1996 IUCN Red List of Threatened Animals. Chelonian Conservation and Biology 3(2):200-204.

Mortimer, J. A. 1981. The feeding ecology of the west Caribbean green turtle (*Chelonia mydas*) in Nicaragua. Biotropica 13(1):49-58.

Mortimer, J. A. 1982. Feeding ecology of sea turtles. Pages 103-109 *in* K. A. Bjorndal, editor. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington D.C.

Muller, R. G., M. D. Murphy, J. de Silva, and L. R. Barbieri. 2003. Final report submitted to the National Marine Fisheries Service, the Gulf of Mexico fishery management council, and the South Atlantic fishery management council as part of the southeast data, assessment, and review (SEDAR) iii. Florida Fish and Wildlife Conservation Commission, FWC-FMRI Report: IHR 2003-10. Florida Fish and Wildlife Research Institute. St. Petersburg, Florida.

Muñoz, R. C., M. L. Burton, K. J. Brennan, and R. O. Parker. 2010. Reproduction, habitat utilization, and movements of hogfish (*Lachnolaimus maximus*) in the Florida Keys, U.S.A.: comparisons from fished versus unfished habitats. Bull. Mar. Sci. 86:93–116. http://www.ingentaconnect.com/content/umrsmas/bullmar/2010/00000086/00000001/art00007

Murawski, S.A., W.T. Hogarth, E.B. Peebles, and L. Barbieri. 2014. Prevalence of External Skin Lesions and Polycyclic Aromatic Hydrocarbon Concentrations in Gulf of Mexico Fishes, Post-*Deepwater Horizon*. Transactions of the American Fisheries Society 143(4): 1084-1097.

National Commission. 2010. The use of surface and subsea dispersants during the BP *Deepwater Horizon* oil spill. National Commission on the BP *Deepwater Horizon* Oil Spill and Offshore Drilling (National Commission). Staff Working Paper No. 4. http://www.oilspillcommission.gov/sites/default/files/documents/Updated%20Dispersants%20Working%20Paper.pdf

National Marine Sanctuaries. 2012. Biological considerations of the effects of spearfishing. Office of National Marine Sanctuaries, National Oceanic and Atmospheric Association, Flower Garden Banks National Marine Sanctuary. 2 p. http://flowergarden.noaa.gov/document_library/mgmtdocs/spearfishingresearch.pdf

NMFS. 2002. Status of red grouper in United States waters of the Gulf of Mexico during 1986-2001, revised. Contribution No. SFD-01/02-175rev. National Marine Fisheries Service, Southeast Fisheries Science Center. Miami, Florida.

NMFS. 2011. Biological opinion on the continued authorization of Reef Fish fishing under the Gulf of Mexico Reef Fish Fishery Management Plan. September 30, 2011. Available at: http://sero.nmfs.noaa.gov/pr/esa/Fishery%20Biops/03584%20GOM%20Reef%20Fish%20BiOp%202011%20final.pdf

NODC. 2012. 4 km NODC/RSMAS AVHRR Pathfinder v5 Seasonal and Annual Day-Night Sea Surface Temperature Climatologies for 1982-2009 for the Gulf of Mexico (NODC Accession 0072888). http://accession.nodc.noaa.gov/0072888

NMFS. 2015. Fisheries Economics of the United States, 2009. U.S. Department of Commerce, NOAA Technical Memorandum. National Marine Fisheries Service-F/SPO-118. http://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2013

NOAA. 2010. Deepwater Horizon Oil: Characteristics and Concerns. NOAA Office of Response and Restoration, Emergency Response Division. 2 p. http://sero.nmfs.noaa.gov/deepwater_horizon/documents/pdfs/fact_sheets/oil_characteristics.pdf
Norman, J. R., and F. C. Fraser. 1938. Giant Fishes, Whales and Dolphins. W. W. Norton and Company, Inc., New York, NY. 361 pp.

Ogren, L. H. 1989. Distribution of juvenile and subadult Kemp's ridley sea turtles: preliminary results from 1984-1987 surveys. Pages 116-123 *in* C. W. Caillouet Jr., and J. A.M. Landry, editors. Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation, and Management. Texas A&M University Sea Grant College, Galveston, Texas.

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.

Osgood, K. E. (editor). 2008. Climate Impacts on U.S. Living Marine Resources: National Marine Fisheries Service Concerns, Activities and Needs. U.S. Dep. Commerce, NOAA Tech. Memo. NMFSF/SPO-89, 118 pp.

Paredes, R.P. 1969. Introduccion al Estudio Biologico de *Chelonia mydas agassizi* en el Perfil de Pisco, Master's thesis, Universidad Nacional Federico Villareal, Lima, Peru.

Porch, C. E., and S. L. Cass-Calay. 2001. Status of the vermilion snapper fishery in the Gulf of Mexico – assessment 5.0. Sustainable Fisheries Division Contribution No. SFD-01/01-129. National Marine Fisheries Service, Southeast Fisheries Science Center. Miami, Florida.

Porch, C. E., A. M. Eklund, and G. P. Scott. 2003. An assessment of rebuilding times for goliath grouper. Contribution: SFD 2003-0018. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. Miami, Florida.

Reynolds, J.E. III, R.S. Wells, and S.D Eide. 2000. The Bottlenose Dolphin: Biology and Conservation. University Press of Florida. 289 pp.

Rico-Martinez, R., T.W. Snell, and T.L. Shearer. 2013. Synergistic toxicity of Macondo crude oil and dispersant Corexit 9500A ((R)) to the *Brachionus plicatilis* species complex (Rotifera). Environmental Pollution 173: 5–10.

Savolainen, M.A., R.H. Caffey, and R.F. Kazmierczak, Jr. 2012. Economic and Attitudinal Perspectives of the Recreational For-hire Fishing Industry in the U.S. Gulf of Mexico. Center for Natural Resource Economics and Policy, LSU AgCenter and Louisiana Sea Grant College Program, Department of Agricultural Economics and Agribusiness, Louisiana State University, Baton Rouge, LA. 171 p.
http://www.laseagrant.org/pdfs/Gulf-RFH-Survey-Final-Report-2012.pdf

SEA (Strategic Environmental Assessment Division, NOS). 1998. Product overview: Products and services for the identification of essential fish habitat in the Gulf of Mexico. NOS, Page 7-62 DEIS for EFH for the Gulf of Mexico FMPs July 2003 Silver Spring MD; National Marine Fisheries Service, Galveston, Texas; and Gulf of Mexico Fishery Management Council. Tampa, Florida.

SEDAR 3. 2003. Complete stock assessment report of yellowtail snapper in the southeastern United States – SEDAR 3, Assessment report 1. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 6. 2004a. SEDAR report 1 the goliath grouper in southern Florida: Assessment review and advisory report. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 6. 2004b. SEDAR report 2 the hogfish in Florida: Assessment review and advisory report. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 7. 2005. Stock assessment report of SEDAR 7 Gulf of Mexico red snapper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 7 Update. 2009. Update stock assessment report of SEDAR 7 Gulf of Mexico red snapper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 9. 2006a. Stock assessment report 1 of SEDAR 9: Gulf of Mexico gray triggerfish. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 9. 2006b. Stock assessment report 2 of SEDAR 9: Gulf of Mexico greater amberjack. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 9. 2006c. Stock assessment report 3 of SEDAR 9: Gulf of Mexico vermilion snapper assessment report 3. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 9 Update. 2010. SEDAR 9 stock assessment update report, Gulf of Mexico greater amberjack. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 9 Update. 2011a. SEDAR update stock assessment of vermilion snapper in the Gulf of Mexico. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 9 Update. 2011b. SEDAR update stock assessment of gray triggerfish in the Gulf of Mexico. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 10. 2006. Gulf of Mexico Gag Grouper Stock Assessment Report 2. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.
SEDAR 10 Update. 2009. Stock assessment of gag in the Gulf of Mexico. – SEDAR update assessment. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 12. 2007. SEDAR12-Complete Stock Assessment Report 1: Gulf of Mexico Red Grouper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 12 Update. 2009. Stock assessment of red grouper in the Gulf of Mexico – SEDAR update assessment. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 15A. 2008. Stock assessment report 3 (SAR 3) South Atlantic and Gulf of Mexico mutton snapper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 19. 2010. Stock assessment report Gulf of Mexico and South Atlantic black grouper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 22. 2011a. Stock assessment report Gulf of Mexico tilefish. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 22. 2011b. Stock assessment report Gulf of Mexico yellowedge grouper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 23. 2011. Stock assessment report South Atlantic and Gulf of Mexico goliath grouper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 31. 2013. Stock assessment report Gulf of Mexico red snapper. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 31 Update. 2015. Stock assessment of red snapper in the Gulf of Mexico 1872 – 2013 - with provisional 2014 landings. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/.

SEDAR 33. 2014a. Gulf of Mexico greater amberjack stock assessment report. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/

SEDAR 33. 2014b. Gulf of Mexico gag stock assessment report. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/

SEDAR 37. 2014. The 2013 stock assessment report for hogfish in the south Atlantic and Gulf of Mexico. Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida. 241 p. + appendices. Available from http://www.sefsc.noaa.gov/sedar/.

SEDAR 42. 2015. Gulf of Mexico red grouper stock assessment report. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/

SEDAR 43. 2015. Gulf of Mexico gray triggerfish stock assessment report. Southeast Data, Assessment, and Review. North Charleston, South Carolina. http://www.sefsc.noaa.gov/sedar/

Seyoum S, Collins AB, Puchulutegue C, McBride RS, Tringali MD. 2014. Genetic population structure of Hogfish (Labridae: *Lachnolaimus maximus*) in the southeastern United States. SEDAR 37-DW01. Available from http://www.sefsc.noaa.gov/sedar/.

Shaver, D. J. 1991. Feeding Ecology of Wild and Head-Started Kemp's Ridley Sea Turtles in South Texas Waters. Journal of Herpetology 25(3):327-334.

Short, J. 2003. Long-Term Effects of Crude Oil on Developing Fish: Lessons from the Exxon *Valdez* Oil Spill. Energy Sources 25(6): 509-517.

Siebenaler, J.B., and W. Brady. 1952. A high speed manual commercial fishing reel. Florida Board of Conservation Tech. Series No. 4.

Simpfendorfer, CA. 2001. Essential habitat of the smalltooth sawfish, *Pristis pectinata*. Report to the National Fisheries Service's Protected Resources Division. Mote Marine Laboratory, Technical Report (786) 21pp.

Sindermann, C.J. 1979. Pollution-associated diseases and abnormalities of fish and shellfish: a review. Fisheries Bulletin 76: 717-749.

Solangi, M.A. and R.M. Overstreet. 1982. Histopathological changes in two estuarine fishes, Menidia beryllina (Cope) and Trinectes maculatus (Bloch and Schneider), exposed to crude oil and its water-soluble fractions. Journal of Fish Disease 5: 13-35.

Soma, M. 1985. Radio biotelemetry system applied to migratory study of turtle. Journal of the Faculty of Marine Science and Technology, Tokai University, Japan, 21:47.

Standora, E. A., J. R. Spotila, J. A. Keinath, and C. R. Shoop. 1984. Body temperatures, diving cycles, and movement of a subadult leatherback turtle, *Dermochelys coriacea*. Herpetologica 40:169-176.

Swedmark, M., A. Granmo, and S. Kollberg. 1973. Effects of oil dispersants and oil emulsions on marine animals. Water Research 7(11): 1649-1672.

Tarnecki, J.H. and W.F. Patterson III. 2015. Changes in Red Snapper Diet and Trophic Ecology. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 7: 135–147.

Thayer, G.W., K.A., Bjorndal, J.C., Ogden, S.L., Williams, and J.C., Zieman. 1984. Role of large herbivores in seagrass communities. Estuaries 7:351.

Turner, S. C., N. J. Cummings, and C. P. Porch. 2000. Stock assessment of Gulf of Mexico greater amberjack using data through 1998. SFD-99/00-100. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. Miami, Florida.

Turner, S. C., C. E. Porch, D. Heinemann, G. P. Scott, and M. Ortiz. 2001. Status of the gag stocks of the Gulf of Mexico: assessment 3.0. August 2001. Contribution: SFD-01/02-134. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. Miami, Florida.

Valle, M., C. Legault, and M. Ortiz. 2001. A stock assessment for gray triggerfish, *Balistes capriscus*, in the Gulf of Mexico. Contribution: SFD-01/02-124. National Oceanic and

Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center. Miami, Florida.

van Dam, R. P., and C. E. Díez. 1998. Home range of immature hawksbill turtles (Eretmochelys imbricata (Linnaeus) at two Caribbean islands. Journal of Experimental Marine Biology and Ecology 220(1):15-24.

Walker, T. 1994. Post-hatchling dispersal of sea turtles. Proceedings of the Australian Marine Turtle Conservation Workshop 1994:79-94.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel. 2013. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2012, Volume 1. 425 pp.

White, H.K., P. Hsing, W. Cho, T.M. Shank, E.E. Cordes, A.M. Quattrini, R.K. Nelson, R. Camili, A.W.J. Demopoulos, C.R. German, J.M. Brooks, H.H. Roberst, W. Shedd, C.M. Reddy, C.R. Fisher. 2012. Impact of the *Deepwater Horizon* oil spill on a deep-water coral community in the Gulf of Mexico. Proceedings of the National Academy of Sciences 109:20303-20308.

Wilson, D., R. Billings, R. Chang, H. Perez, and J. Sellers. 2014. Year 2011 Gulfwide emissions inventory study. US Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-666.

Witzell, W. N. 2002. Immature Atlantic loggerhead turtles (*Caretta caretta*): suggested changes to the life history model. Herpetological Review 33(4):266-269.

Wyneken, J., K. J. Lohmann, J. A. Musick (Eds). 2013. The Biology of Sea Turtles, Volume III Boca Raton, London, New York: CRC Press. 457 pp.

APPENDIX A – OTHER APPLICABLE LAW

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (16 U.S.C. 1801 et seq.) provides the authority for fishery management in federal waters of the exclusive economic zone. However, fishery management decision-making is also affected by a number of other federal statutes designed to protect the biological and human components of U.S. fisheries, as well as the ecosystems that support those fisheries. Major laws affecting federal fishery management decision-making are summarized below.

Administrative Procedures Act

All federal rulemaking is governed under the provisions of the Administrative Procedure Act (APA) (5 U.S.C. Subchapter II), which establishes a "notice and comment" procedure to enable public participation in the rulemaking process. Under the APA, the National Marine Fisheries Service (NMFS) is required to publish notification of proposed rules in the *Federal Register* and to solicit, consider, and respond to public comment on those rules before they are finalized. The APA also establishes a 30-day waiting period from the time a final rule is published until it takes effect.

Coastal Zone Management Act

Section 307(c)(1) of the federal Coastal Zone Management Act of 1972 (CZMA), as amended, requires federal activities that affect any land or water use or natural resource of a state's coastal zone be conducted in a manner consistent, to the maximum extent practicable, with approved state coastal management programs. The requirements for such a consistency determination are set forth in NMFS regulations at 15 C.F.R. part 930, subpart C. According to these regulations and CZMA Section 307(c)(1), when taking an action that affects any land or water use or natural resource of a state's coastal zone, NMFS is required to provide a consistency determination to the relevant state agency at least 90 days before taking final action.

Upon submission to the Secretary, NMFS will determine if this plan amendment is consistent with the Coastal Zone Management programs of the states of Alabama, Florida, Louisiana, Mississippi, and Texas to the maximum extent possible. Their determination will then be submitted to the responsible state agencies under Section 307 of the CZMA administering approved Coastal Zone Management programs for these states.

Data Quality Act

The Data Quality Act (DQA) (Public Law 106-443) effective October 1, 2002, requires the government to set standards for the quality of scientific information and statistics used and disseminated by federal agencies. Information includes any communication or representation of knowledge such as facts or data, in any medium or form, including textual, numerical, cartographic, narrative, or audiovisual forms (includes web dissemination, but not hyperlinks to information that others disseminate; does not include clearly stated opinions).

Specifically, the DQA directs the Office of Management and Budget (OMB) to issue government wide guidelines that "provide policy and procedural guidance to federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information disseminated by federal agencies." Such guidelines have been issued, directing all federal agencies to create and disseminate agency-specific standards to: 1) ensure information quality and develop a pre-dissemination review process; 2) establish administrative mechanisms allowing affected persons to seek and obtain correction of information; and 3) report periodically to Office of Management and Budget on the number and nature of complaints received.

Scientific information and data are key components of fishery management plans (FMPs) and amendments and the use of best available information is the second national standard under the Magnuson-Stevens Act. To be consistent with the Act, FMPs and amendments must be based on the best information available. They should also properly reference all supporting materials and data, and be reviewed by technically competent individuals. With respect to original data generated for FMPs and amendments, it is important to ensure that the data are collected according to documented procedures or in a manner that reflects standard practices accepted by the relevant scientific and technical communities. Data will also undergo quality control prior to being used by the agency and a pre-dissemination review.

Endangered Species Act

The Endangered Species Act (ESA) of 1973, as amended, (16 U.S.C. Section 1531 et seq.) requires federal agencies use their authorities to conserve endangered and threatened species. The ESA requires NMFS, when proposing a fishery action that "may affect" critical habitat or endangered or threatened species, to consult with the appropriate administrative agency (itself for most marine species, the U.S. Fish and Wildlife Service for all remaining species) to determine the potential impacts of the proposed action. Consultations are concluded informally when proposed actions may affect but are "not likely to adversely affect" endangered or threatened species or designated critical habitat. Formal consultations, including a biological opinion, are required when proposed actions may affect and are "likely to adversely affect" endangered or threatened species or adversely modify designated critical habitat. If jeopardy or adverse modification is found, the consulting agency is required to suggest reasonable and prudent alternatives.

On September 30, 2011, the Protected Resources Division released a biological opinion which, after analyzing best available data, the current status of the species, environmental baseline (including the impacts of the recent Deepwater Horizon MC 252 oil release event in the northern Gulf of Mexico), effects of the proposed action, and cumulative effects, concluded that the continued operation of the Gulf of Mexico reef fish fishery is also not likely to jeopardize the continued existence of green, hawksbill, Kemp's ridley, leatherback, or loggerhead sea turtles, nor the continued existence of smalltooth sawfish (NMFS 2011). On December 7, 2012, NMFS published a proposed rule to list 66 coral species under the ESA and reclassify *Acropora* from threatened to endangered (77 FR 73220). In a memorandum dated February 13, 2013, NMFS determined the reef fish fishery was not likely to adversely affect *Acropora* because of where the fishery operates, the types of gear used in the fishery, and that other regulations protect *Acropora* where they are most likely to occur.

Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, and on the importing of marine mammals and marine mammal products into the United States. Under the MMPA, the Secretary of Commerce (authority delegated to NMFS) is responsible for the conservation and management of cetaceans and pinnipeds (other than walruses). The Secretary of the Interior is responsible for walruses, sea and marine otters, polar bears, manatees, and dugongs.

Part of the responsibility that NMFS has under the MMPA involves monitoring populations of marine mammals to make sure that they stay at optimum levels. If a population falls below its optimum level, it is designated as "depleted," and a conservation plan is developed to guide research and management actions to restore the population to healthy levels.

In 1994, Congress amended the MMPA, to govern the taking of marine mammals incidental to commercial fishing operations. This amendment required the preparation of stock assessments for all marine mammal stocks in waters under U.S. jurisdiction, development and implementation of take-reduction plans for stocks that may be reduced or are being maintained below their optimum sustainable population levels due to interactions with commercial fisheries, and studies of pinniped-fishery interactions.

Under Section 118 of the MMPA, NMFS must publish, at least annually, a List of Fisheries (LOF) that places all U.S. commercial fisheries into one of three categories based on the level of incidental serious injury and mortality of marine mammals that occurs in each fishery. The categorization of a fishery in the LOF determines whether participants in that fishery may be required to comply with certain provisions of the MMPA, such as registration, observer coverage, and take reduction plan requirements. The primary gears used in the Gulf of Mexico reef fish fishery are still classified in the proposed 2014 MMPA LOF as Category III fishery (December 6, 2013; 78 FR 73477). The conclusions of the most recent LOF for gear used by the reef fish fishery can be found in Section 3.3.

Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (PRA) (44 U.S.C. 3501 et seq.) regulates the collection of public information by federal agencies to ensure the public is not overburdened with information requests, the federal government's information collection procedures are efficient, and federal agencies adhere to appropriate rules governing the confidentiality of such information. The PRA requires NMFS to obtain approval from the Office of Management and Budget before requesting most types of fishery information from the public. Revising the definition of the hogfish management unit, setting status determination criteria and annual catch limits, and revising the hogfish minimum size limit would likely not have PRA consequences.

Executive Orders

E.O. 12630: Takings

The Executive Order on Government Actions and Interference with Constitutionally Protected Property Rights that became effective March 18, 1988, requires each federal agency prepare a Takings Implication Assessment for any of its administrative, regulatory, and legislative policies and actions that affect, or may affect, the use of any real or personal property. Clearance of a regulatory action must include a takings statement and, if appropriate, a Takings Implication Assessment. The National Oceanic and Atmospheric Administration Office of General Counsel will determine whether a Taking Implication Assessment is necessary for this amendment.

E.O. 12866: Regulatory Planning and Review

Executive Order 12866: Regulatory Planning and Review, signed in 1993, requires federal agencies to assess the costs and benefits of their proposed regulations, including distributional impacts, and to select alternatives that maximize net benefits to society. To comply with E.O. 12866, NMFS prepares a Regulatory Impact Review (RIR) for all fishery regulatory actions that either implement a new fishery management plan or significantly amend an existing plan (See Chapter 5). RIRs provide a comprehensive analysis of the costs and benefits to society of proposed regulatory actions, the problems and policy objectives prompting the regulatory proposals, and the major alternatives that could be used to solve the problems. The reviews also serve as the basis for the agency's determinations as to whether proposed regulations are a "significant regulatory action" under the criteria provided in E.O. 12866 and whether proposed regulations will have a significant economic impact on a substantial number of small entities in compliance with the Regulatory Flexibility Analysis. A regulation is significant if it a) has an annual effect on the economy of $100 million or more or adversely affects in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments and communities; b) creates a serious inconsistency or otherwise interferes with an action taken or planned by another agency; c) materially alters the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or d) raises novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive Order.

E.O. 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations

This Executive Order mandates that each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions. The Executive Order is described in more detail relative to fisheries actions in Section 3.5.1.

E.O. 12962: Recreational Fisheries

This Executive Order requires federal agencies, in cooperation with states and tribes, to improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities through a variety of methods including, but not limited to, developing joint partnerships; promoting the restoration of recreational fishing areas that are limited by water quality and habitat degradation; fostering sound aquatic conservation and restoration endeavors; and evaluating the effects of federally-funded, permitted, or authorized actions on aquatic systems and recreational fisheries, and documenting those effects. Additionally, it establishes a seven-member National Recreational Fisheries Coordination Council (Council) responsible for, among other things, ensuring that social and economic values of healthy aquatic systems that support recreational fisheries are considered by federal agencies in the course of their actions, sharing the latest resource information and management technologies, and reducing duplicative and cost-inefficient programs among federal agencies involved in conserving or managing recreational fisheries. The Council also is responsible for developing, in cooperation with federal agencies, States and Tribes, a Recreational Fishery Resource Conservation Plan - to include a five-year agenda. Finally, the Order requires NMFS and the U.S. Fish and Wildlife Service to develop a joint agency policy for administering the ESA.

E.O. 13132: Federalism

The Executive Order on Federalism requires agencies in formulating and implementing policies, to be guided by the fundamental Federalism principles. The Order serves to guarantee the division of governmental responsibilities between the national government and the states that was intended by the framers of the Constitution. Federalism is rooted in the belief that issues not national in scope or significance are most appropriately addressed by the level of government closest to the people. This Order is relevant to FMPs and amendments given the overlapping authorities of NMFS, the states, and local authorities in managing coastal resources, including fisheries, and the need for a clear definition of responsibilities. It is important to recognize those components of the ecosystem over which fishery managers have no direct control and to develop strategies to address them in conjunction with appropriate state, tribes, and local entities (international, too).

E.O. 13158: Marine Protected Areas

This Executive Order requires federal agencies to consider whether their proposed action(s) will affect any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural or cultural resource within the protected area. There are several marine protected areas, habitat areas of particular concern, and gear-restricted areas in the eastern and northwestern Gulf of Mexico.

Essential Fish Habitat

The amended Magnuson-Stevens Act included a new habitat conservation provision known as essential fish habitat (EFH) that requires each existing and any new FMPs to describe and identify EFH for each federally managed species, minimize to the extent practicable impacts from fishing activities on EFH that are more than minimal and not temporary in nature, and identify other actions to encourage the conservation and enhancement of that EFH. To address these requirements the Council has, under separate action, approved an Environmental Impact Statement (GMFMC 2004a) to address the new EFH requirements contained within the Magnuson-Stevens Act. Section 305(b)(2) requires federal agencies to obtain a consultation for any action that may adversely affect EFH. An EFH consultation will be conducted for this action.

References

GMFMC. 2004. Final environmental impact statement for the generic essential fish habitat amendment to the following fishery management plans of the Gulf of Mexico: shrimp fishery of the Gulf of Mexico, red drum fishery of the Gulf of Mexico, reef fish fishery of the Gulf of Mexico, stone crab fishery of the Gulf of Mexico, coral and coral reef fishery of the Gulf of Mexico, spiny lobster fishery of the Gulf of Mexico and South Atlantic, coastal migratory pelagic resources of the Gulf of Mexico and South Atlantic. Gulf of Mexico Fishery Management Council. Tampa, Florida. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Final%20EFH%20EIS.pdf

NMFS. 2011. Biological opinion on the continued authorization of Reef Fish fishing under the Gulf of Mexico Reef Fish Fishery Management Plan. September 30, 2011. Available at: http://sero.nmfs.noaa.gov/pr/esa/Fishery%20Biops/03584%20GOM%20Reef%20Fish%20BiOp%202011%20final.pdf

APPENDIX B – BYCATCH PRACTICABILITY ANALYSIS

Introduction

Bycatch is defined as fish harvested in a fishery, but not sold or retained for personal use. This definition includes both economic and regulatory discards, and excludes fish released alive under a recreational catch-and-release fishery management program. Economic discards are generally undesirable from a market perspective because of their species, size, sex, and/or other characteristics. Regulatory discards are fish required by regulation to be discarded, but also include fish that may be retained but not sold.

Agency guidance provided at 50 CFR 600.350(d)(3) identifies ten factors to consider in determining whether a management measure minimizes bycatch or bycatch mortality to the extent practicable. These are:

1. Population effects for the bycatch species;
2. Ecological effects due to changes in the bycatch of that species (effects on other species in the ecosystem);
3. Changes in the bycatch of other species of fish and the resulting population and ecosystem effects;
4. Effects on marine mammals and birds;
5. Changes in fishing, processing, disposal, and marketing costs;
6. Changes in fishing practices and behavior of fishermen;
7. Changes in research, administration, and enforcement costs and management effectiveness;
8. Changes in the economic, social, or cultural value of fishing activities and non-consumptive uses of fishery resources;
9. Changes in the distribution of benefits and costs; and
10. Social effects.

The Regional Fishery Management Councils are encouraged to adhere to the precautionary approach outlined in Article 6.5 of the Food and Agriculture Organization of the United Nations Code of Conduct for Responsible Fisheries when uncertain about these factors.

Bycatch practicability analyses of the reef fish fishery have been provided in several reef fish amendments to the Fishery Management Plan (FMP) for the Reef Fish Resources of the Gulf of Mexico and focused to some degree on the component of the fishery affected by the actions covered in the amendment. Bycatch practicability analyses have been completed for red snapper (GMFMC 2004b, GMFMC 2007, GMFMC 2014, GMFMC 2015), grouper (GMFMC 2008b, GMFMC 2009, GMFMC 2011a, GMFMC 2012c), vermilion snapper (GMFMC 2004c), greater amberjack (GMFMC 2008, GMFMC 2012a), gray triggerfish (GMFMC 2012b). In addition, a bycatch practicability analysis was conducted for the Generic Annual Catch Limits/Accountability Measures Amendment (GMFMC 2011a) that covered the Reef Fish, Coastal Migratory Pelagics, Red Drum, and Coral FMPs. In general, these analyses found that reducing bycatch provides biological benefits to managed species as well as benefits to the

fishery through less waste, higher yields, and less forgone yield. However, in some cases, actions are approved that can increase bycatch through regulatory discards such as increased minimum sizes and closed seasons. In these cases, there is some biological benefit to the managed species that outweighs any increases in discards.

Hogfish Bycatch

Hogfish bycatch is thought to be minimal. Hogfish are primarily caught in both the commercial and recreational reef fish fisheries by spearfishing. Some hogfish are caught with hook-and-line. In SEDAR 37 (2014), the discard mortality rate for spearfishing was set at 100%. However, even though the extent of fishermen spearing undersized hogfish is unknown, the consensus was it was minimal as fishermen are able to directly observe fish before capture and can avoid spearing undersized fish. The discard mortality rate assigned to hook-and-line gear in SEDAR 37 (2014) was set at 10% in the assessment. Collins and McBride (2011) suggested discard mortality was minimal because fish taken in deeper waters where barotrauma can be a factor are likely to be of legal size (greater than the minimum size limit of 12 inches FL), and so would be kept rather than discarded.

Discards in the recreational sector are low. Annual discard estimates, while low, were highly variable in SEDAR 37 (2014) and many years did not have any estimates of discarded fish. Additionally, no discards were recorded from spearfishing from the west Florida stock and only a few from the Florida Keys/ east Florida stock. Calibrated annual discards from 1981 to 2014 where data was available ranged from 314-5,099 fish for the west Florida stock using MRIP. The same data source provided annual discard estimates from Florida Keys/ east Florida stock at 1,585-68,492 fish from hook-and-line gear and 182-2456 fish from spearfishing. Using MRIP and SEFSC Headboat data, the percentage of discarded hogfish compared to harvested fish was 5-11% depending on the recreational subsector for what are likely hook-and-line caught fish over the 2009-2013 time period (Table B-1). Because the extent of divers spearing undersized hogfish is unknown and that most hogfish are caught with spearguns, the total number and percent of discards relative to the harvest is likely higher. However, these added discards are likely low given spear fishermen are better able to avoid targeting fish under the minimum size limit and not target hogfish after they have achieved their daily bag limit.

Discards in the commercial sector are also low. The estimated number of discards from spearfishing from 1993-2013for the west Florida stock and Florida Keys/ east Florida stock ranged from 40 to 141 fish and 133 to 289, respectively (Table 6.3.1.1 in SEDAR 37 2014). The estimated weight of dead discards from spearfishing, assuming a 10% discard mortality rate, ranged from 126 to 444 pounds and 515 to 1,119 pounds, respectively, from 1993 to 2013 (Table 6.3.1.3 from SEDAR 37 2014). The assessment was not able to determine the number of discards from hook-and-line gear and set the value at zero for the west Florida stock, but the number (weight) from the Florida Keys/ east Florida stock ranged from 74 (64) to 255 (232). Discards using the SEFSC Commercial Logbook and Commercial Discard Logbook data estimated an average of 23 fish discarded annually for the Gulf as a whole between 2009 and 2013 (Table B-1; note that estimates of discards in the commercial sector are highly uncertain).

Hogfish are a bycatch in the Florida lobster fishery where they have been observed in traps. However, the occurrence of hogfish is minimal. Matthews et al. (2005) only observed 77 hogfish in over 21,000 traps in the Florida Keys. They noted all of the fish were discarded alive.

Table B-1. Mean headboat, charter, private, and commercial estimates of landings and discards (2009-2013) in numbers (recreational) and pounds whole weight (commercial) in the U. S. Gulf of Mexico.

	HEADBOAT			CHARTER			PRIVATE			COMMERCIAL	
Species	**Landings (N)**	**Discards (N)**	**Discards (%)**	**Landings (N)**	**Discards (N)**	**Discards (%)**	**Landings (N)**	**Discards (N)**	**Discards (%)**	**Landings (lbs)**	**Discards (N)**
Almaco jack	2,005	43	2%	4,587	1,987	43%	5,100	1,619	32%	36,277	14
Banded rudderfish	6,094	1,066	17%	25,473	1,401	6%	5,606	31,125	555%	17,549	130
Black grouper	42	81	193%	5	44	963%	811	4,548	561%	46,855	7,119
Blackfin snapper	138	4	3%	0	0		0	0		4,698	0
Blueline tilefish	195	1	0%	43	0	0%	0	0		67,901	296
Cubera snapper	197	7	3%	11	21	185%	505	189	37%	1,307	0
Gag	7,241	43,528	601%	38,260	235,195	615%	141,368	1,370,337	969%	620,534	120,066
Golden tilefish	323,148	0	0%	260,021	6,694	3%	209,910	76,804	37%	376,649	2,320
Goldface tilefish	7	0	0%	0	0		0	0		9,056	0
Goliath grouper	0	3		0	0		0	0		0	300
Gray snapper	22,948	1,724	8%	159,145	156,204	98%	883,280	3,076,032	348%	155,194	14,093
Gray triggerfish	10,739	19,943	186%	36,955	71,514	194%	80,159	145,683	182%	74,997	7,533
Greater amberjack	3,554	3,906	110%	27,535	40,982	149%	30,965	165,409	534%	481,954	13,525
Hogfish	***1,924***	***216***	***11%***	***8,262***	***439***	***5%***	***116,183***	***6,246***	***5%***	***36,203***	***23***
Lane snapper	54,143	4,845	9%	37,495	12,432	33%	100,272	185,651	185%	23,923	1,947
Lesser amberjack	286	77	27%	142	0	0%	167	281	168%	21,190	239
Mutton snapper	409	9	2%	0	426		426	2,686	630%	77,736	68
Queen snapper	33	0	0%	0	33		0	0		12,427	0
Red grouper	8,928	127,589	1429%	70,392	486,830	692%	152,818	1,810,702	1185%	4,992,180	817,288
Red snapper	112,215	96,011	86%	166,736	363,451	218%	566,754	1,506,960	266%	3,773,741	226,966
Scamp	2,515	2,000	80%	11,832	3,787	32%	14,248	36,072	253%	246,538	1,126
Silk Snapper	53	0	0%	2,684	811	30%	22,834	0	0%	38,597	3
Snowy grouper	100	1,897	1905%	723	25	3%	5,896	462	8%	153,962	224

Speckled Hind	77	56	73%	220	89	40%	330	539	163%	41,720	56
Vermilion snapper	0	10,084		0	0		0	0		2,581,867	5,973
Warsaw grouper	113	161	143%	176	10	6%	484	0	0%	97,402	8
Wenchman	0	0		0	0		0	0		30,465	0
Yellowedge grouper	45	1	1%	330	8	2%	273	0	0%	742,028	218
Yellowfin grouper	0	0	0%	19	0	0%	0	781		1,511	0
Yellowmouth grouper	22	1	3%	46	0	0%	0	125		421	0
Yellowtail snapper	2,837	950	33%	518	9	2%	3,780	2,789	74%	718,060	91,072

Sources: MRIP data from SEFSC Recreational ACL Dataset (Jan 2015), Headboat data from SEFSC Headboat Logbook CRNF files (expanded; July 2014), Commercial landings data from SEFSC Commercial ACL Dataset (July 2014) with discard estimates from expanded SEFSC Commercial Logbook (Nov 2014) and Commercial Discard Logbook (Nov 2014). Note commercial discard estimates are for vertical line gear only.

Other Bycatch

Species incidentally encountered by the reef fish fishery include sea turtles, sea birds, and reef fishes. The primary gears of the Gulf reef fish fishery (longline and handline) are classified in the List of Fisheries (LOF) for 2015 (79 FR 77919, December 29, 2014) as Category III gear. This classification indicates the annual mortality and serious injury of a marine mammal stock resulting from any fishery is less than or equal to one percent of the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock, while allowing that stock to reach or maintain its optimum sustainable population. Spearfishing is not a listed gear type for the Gulf of Mexico. However, spearfishing is listed for the commercial fisheries in the Pacific Ocean and no marine mammal species were incidentally killed or injured with this gear. It is likely similar for the Gulf.

The most recent biological opinion for the Reef Fish FMP was completed on September 30, 2011 (NMFS 2011). The opinion determined the continued authorization of the Gulf reef fish fishery managed under this FMP is not likely to adversely affect Endangered Species Act-listed marine mammals or coral, and would not likely jeopardize the continued existence of sea turtles (loggerhead, Kemp's ridley, green, hawksbill, and leatherback), or smalltooth sawfish. However, in the past, actions have been taken by the Council and NMFS to increase the survival of incidentally caught sea turtle and smalltooth sawfish by the commercial and recreational sectors of the fishery. These include the requirements for permitted vessels to carry specific gear and protocols for the safe release in incidentally caught endangered sea turtle species and smalltooth sawfish (GMFMC 2005) as well as restrictions on the longline portion of the commercial sector. Restrictions for longlines in the reef fish fishery include a season-area closure, an endorsement to use longline gear, and a restriction on the total number of hooks that can be carried on a vessel (GMFMC 2009).

Three primary orders of seabirds are represented in the Gulf, Procellariiformes (petrels, albatrosses, and shearwaters), Pelecaniformes (pelicans, gannets and boobies, cormorants, tropic birds, and frigate birds), and Charadriiformes (phalaropes, gulls, terns, noddies, and skimmers) (Clapp et al., 1982; Harrison, 1983) and several species, including: piping plover, least tern, roseate tern, bald eagle, and brown pelican (the brown pelican is endangered in Mississippi and Louisiana and delisted in Florida and Alabama) are listed by the U.S. Fish and Wildlife Service as either endangered or threatened. Human disturbance of nesting colonies and mortalities from birds being caught on fishhooks and subsequently entangled in monofilament line are primary factors affecting sea birds. Oil or chemical spills, erosion, plant succession, hurricanes, storms, heavy tick infestations, and unpredictable food availability are other threats. There is no evidence that the reef fish fishery is adversely affecting seabirds. However, interactions, especially with brown pelicans consuming reef fish discards and fish before they are landed, are known to occur (SEDAR 7 2005).

Other species of reef fish are also incidentally caught when targeting hogfish. Discarded fish are only available for the commercial sector (SEDAR 37 2014). For commercial spearfishing between 2011 and 2014, the most common species discarded on such trips were scamp, red grouper, red snapper, gag, and triggerfish. For commercial hook-and-line gear, the most common species were red grouper, red snapper, gag, yellowtail snapper, and greater amberjack.

Practicability of current management measures in the directed hogfish fishery relative to their impact on bycatch and bycatch mortality.

A bycatch practicability analysis has not been conducted for hogfish, but as a species it has been included in more general analyses for reef fish in the Generic Annual Catch Limits/Accountability Measures Amendment (GMFMC 2011a). Hogfish are regulated by a 12-inch fork length (FL) minimum size limit for both the commercial and recreational sectors, and a 5-fish recreational bag limit. There is no allocation between the commercial and recreational sectors. Hogfish are also managed under an annual catch limit (ACL) and have an annual catch target (ACT). The accountability measure for hogfish is that if landings exceed the ACL in a given year, then in the subsequent year the season will be closed at such time as is projected to prevent the ACL from being exceeded again. The ACT (a target set below the ACL and a measure of management uncertainty) is not used in hogfish management. Other reef fish fishery management measures that affect hogfish fishing include reef fish permit requirements for the commercial and for-hire sectors.

Closed Seasons

To date, hogfish have not been closed in the Gulf. Landings for 2015 have preliminarily been estimated to be 90.2 percent of the ACL, thus no closure is anticipated for 2016.

Bag Limits

The recreational sector is regulated by a 5-hogfish daily bag limit per person. For spearfishing, hogfish discards because of the bag limit are likely to be rare. After a fisherman catches their bag limit, they will stop targeting hogfish and search for other species because of the line-of-sight capture method associated with this gear. Hogfish discards while hook-and-line fishing because of the bag limit is likely to occur as a result of incidental capture of undersized fish prior to reaching the bag limit, or from targeting of other reef fish residing in similar habitat after the hogfish bag limit has been reached. However, as indicated above, hook-and-line gear captures few fish. As mentioned in Section 3.1 of Amendment 43 (GMFMC 2016), Gulf spearfishing accounted for 83% of the recreational harvest and hook-and-line accounted for 17% of the harvest between 2007 and 2012.

Size limits

The 12-inch FL minimum size limit is an important factor when considering bycatch in the directed fishery. Size limits are intended to protect immature fish and reduce fishing mortality. For hogfish, this size limit does allow most females to become sexually mature (see Sections 2.4 and 3.3 of Amendment 43 [GMFMC 2016]). However, hogfish are protogynous heremaphrodites that form harems. The size at which 50% of the hogfish have transitioned from females to males has been estimated at 16.8 inches FL. Thus, the 12-inch minimum size limit may have effects on hogfish social structures through the removal of males.

McBride and Richardson (2007) noted that having spearfishing as the major mode of capture can be advantageous to managing hogfish. Because divers can accurately judge fish size prior to

harvest, their compliance with an increased minimum size limit could reduce population mortality rates with little or no bycatch of illegal, undersized fish.

Area closures

Although the Council has not developed area closures specifically for hogfish, the Council has created areas to protect other species. For example, two restricted fishing areas were developed to specifically protect spawning aggregations of gag in 2000 (GMFMC 1999c). The Madison-Swanson and Steamboat Lumps marine restricted fishing areas are located in the northeastern Gulf at a depth of 40 to 60 fathoms. Both areas prohibit bottom fishing. Bottom fishing is also prohibited in the Tortugas North and South marine reserves in the southern Gulf near the Dry Tortugas. Marine reserves and time/area closures benefit fish residing within reserve boundaries by prohibiting their capture during part or all of the year. Within marine reserves, fish that are undersized potentially have an opportunity to grow to legal size and are no longer caught as bycatch. If these fish emigrate from the marine reserve (i.e., spillover effect), then they may be caught as legal fish outside the reserve, thereby reducing bycatch. However, anglers and commercial fishermen may redistribute their effort to areas surrounding the area closure. If fishing pressure in these areas is increased, then any benefits of reduced bycatch of fish in the marine reserve will likely be offset by increases in bycatch of fish residing outside the marine reserve. Within restricted fishing areas or time/area closures, fishing is allowed under restrictions that are intended to protect certain components of the populations within the area (e.g., prohibitions on bottom fishing gear), or to protect populations during a critical phase of their life history, such as during spawning.

The Council did develop a season area closure to reduce bycatch of sea turtles for the longline component of the commercial sector. The use of longlines had been prohibited from waters less than 20 fathoms east of Cape San Blas, Florida, and 50 fathoms west of Cape San Blas; however, due to higher estimates of sea turtles caught in longline gear, measures were put in place through Amendment 31 (GMFMC 2009) to reduce this bycatch. One of these measures was the prohibition of the use of bottom longline gear in the Gulf reef fish fishery, shoreward of a line approximating the 35-fathom contour east of Cape San Blas, Florida from June through August. Most sea turtle takes by longline occur during the summer months.

Allowable gear

Discard mortality associated with spearfishing, the primary gear to harvest hogfish, is estimated at 100%. However, only undersized hogfish mistakenly killed while spearfishing would contribute to the number of dead discards and fish falling into this category is considered to be very low (SEDAR 37 2014). Vertical hook-and-line gear (bandit rigs, manual handlines) is also used to harvest this species, but at a reduced level compared to spearfishing. Discards for this gear are primarily due to the minimum size limit, but given the low discard mortality rate (10%), the number of dead discards is thought to be low for this gear.

To minimize discard mortality from hook-and-line gear, reef fish fishermen in both the commercial and recreational sectors are required to use non-stainless steel circle hooks, if using natural baits, to reduce discard mortality. The size of circle hooks used in the fishery varies by

manufacturer, gear type, and species targeted (i.e., if targeting vermilion snapper, smaller circle hooks may be used). Although circle hooks may not work as well to reduce discard mortality for some species (e.g., red snapper), they are effective in reducing mortality in other species such as red grouper (Burns and Froeschke 2012). Burns and Froeschke (2012) did not look at hogfish.

In addition to the circle hook requirement, Amendment 27 (GMFMC 2007) also put in place requirements for both commercial and recreational fishermen in the reef fish fishery to carry onboard dehooking devices. This gear is intended to reduce bycatch and discard mortality. A dehooking device is a tool intended to remove a hook embedded in a fish. It reduces the handling time releasing a fish from a hook and allows a fish to be released with minimum damage. The Council also encourages fishermen to use devices to reduce barotrauma such as venting tools and fish descenders. These gears have been shown in some instances to reduce discard mortality in fish showing signs of barotrauma. However, this is less of an issue for hogfish because most fish brought up from depth are of a legal size (SEDAR 37 2014).

Alternatives being considered and bycatch minimization

The measures to define the management unit, set the status determination criteria, and set the ACL and ACT discussed in Amendment 43 (GMFMC 2016) can indirectly affect bycatch in the Gulf reef fish fishery. These actions are primarily administrative. They would change the apportionment of fish between the Gulf and South Atlantic Councils and affect how many hogfish can be caught. Depending on which alternative is selected for each action, it could either reduce or increase bycatch in the reef fish fishery. The action to change the size limit would directly affect bycatch for hogfish. Generally, increasing the minimum size limit leads to an increase in undersized fish being discarded. As mentioned above, this may be less of an issue for hogfish because most of the harvest is by spearfishermen who are likely able to distinguish undersized from legal fish. The powerhead measure is unlikely to directly affect hogfish bycatch as this gear is not used to harvest hogfish. These measures are not expected to change how the reef fish fishery is prosecuted and so should not change bycatch of other species including reef fish, sea turtles, marine mammals, or seabirds.

Practicability Analysis

Criterion 1: Population effects for the bycatch species

With the exception of revising the size limit, the other actions in Amendment 43 (GMFMC 2016) are not expected to directly affect bycatch minimization. As discussed in Section 2.4 of Amendment 43 (GMFMC 2016), although larger size limits are expected to increase discards and discard mortality in the hook-and-line fisheries, the additional numbers of dead discards are expected to be small due to the low discard mortality rate. Additional discard mortality from recreational spearfishing, which is the predominant method of capture, should be negligible because there are currently no reported discards, and spearfishing is sight fishing (Section 2.4 of Amendment 43 [2016]). As a result, regardless of which alternative is selected for Action 4 (hogfish minimum size limit for commercial and recreational sectors), it is difficult to assess whether this action, in terms of dead discards, would be beneficial, adverse, or have no effect on the hogfish stock.

As described earlier in this bycatch practicability analysis, the Council and NMFS have developed a variety of management measures to reduce reef fish (including hogfish) bycatch and these measures are thought to benefit the status of the stock. These include the gear requirements as discussed above, such as dehooking devices and the use of circle hooks by the reef fish fishery, as well as the encouragement for fishermen to use devices that reduce barotrauma. In addition, any increases in bycatch resulting from proposed management actions are accounted for when reducing directed fishing mortality. Any reductions in bycatch not achieved must be accounted for when setting the ACLs; the less bycatch is reduced, the more the ACLs must be reduced.

Criterion 2: Ecological effects due to changes in the bycatch of hogfish (effects on other species in the ecosystem)

The relationships among species in marine ecosystems are complex and poorly understood, making the nature and magnitude of ecological effects difficult to predict with any accuracy. The most recent hogfish stock assessment (SEDAR 37 2014) indicated the stock is not overfished or undergoing overfishing in the Gulf; however, the eastern Florida/Florida Keys stock is overfished and undergoing overfishing. Consequently, it is possible that forage species and competitor species in the Gulf portion of the Florida Keys could decrease in abundance in response to an increase in hogfish abundance through stock rebuilding. Changes in the bycatch of hogfish are not expected to directly affect other species in the ecosystem. Although birds, dolphins, and other predators may feed on hogfish discards, there is no evidence that any of these species rely on hogfish discards for food.

Criterion 3: Changes in the bycatch of other species of fish and invertebrates and the resulting population and ecosystem effects

Population and ecosystem effects resulting from changes in the bycatch of other species of fish and invertebrates are difficult to predict. As discussed above, scamp, red grouper, red snapper, gag, gray triggerfish, yellowtail snapper, and greater amberjack are commonly caught in association with hogfish. Many of these species are in rebuilding plans (gag, gray triggerfish, and greater amberjack) with the stocks improving. Regulatory discards significantly contribute to fishing mortality for all of these reef fish species, with the exception of gray triggerfish.

No measures are proposed in this amendment to directly reduce the bycatch of other reef fish species. As mentioned, this action would define the management unit, set the status determination criteria, set the ACL and ACT, revise the minimum size limit, and prohibit the use of powerheads in the stressed area. Bycatch minimization measures implemented through Amendment 18A (GMFMC 2005), Amendment 27 (GMFMC 2007), and Amendment 31 (GMFMC 2009) are expected to benefit reef fish stocks, sea turtles, and smalltooth sawfish.

Criterion 4: Effects on marine mammals and birds

The effects of current management measures on marine mammals and birds are described above. Bycatch minimization measures evaluated in this amendment are not expected to significantly

affect marine mammals and birds. There is no information to indicate marine mammals and birds rely on hogfish for food, and the measure in this amendment is not anticipated to alter the existing prosecution of the fishery, and thus interactions with marine mammals or birds.

Criterion 5: Changes in fishing, processing, disposal, and marketing costs

Reducing the ACL in Action 3, Alternatives 2-3 after 2018 and Alternative 4 would result in fewer fish being landed and certainly affect fishing, processing, disposal, and marketing costs relative to no action. However, because hogfish is a part of a multispecies fishery, other species could be targeted to fill any loses from reduced hogfish ACLs. This action would not be expected to result in any changes in fishing, processing, disposal, or marketing costs of recreationally harvested hogfish because these fish may not be sold.

Criterion 6: Changes in fishing practices and behavior of fishermen

Actions proposed in Amendment 43 (2016) could result in a modification of fishing practices by commercial and recreational fishermen based on a change in size limit. However, as discussed earlier in this BPA, the number of discards is not expected to be affected by the proposed actions because of the gears used to harvest this species. It is difficult to quantify any of the measures in terms of reducing discards until bycatch has been monitored over several years. Commercial and recreational bycatch information is collected by NMFS, and that information will continue to be analyzed to determine what changes, if any, have taken place in terms of fishing practices and fishing behavior as a result of the actions implemented through this amendment.

Social effects of actions proposed in Amendment 43 (2016) are addressed in Chapter 4 and information on environmental justice can be found in Section 3.5.1.

Criterion 7: Changes in research, administration, and enforcement costs and management effectiveness

The proposed management measures are not expected to significantly impact administrative costs. ACLs and ACTs are based on stock assessments used to regulate the commercial and recreational sectors harvesting hogfish. None of the resultant measures from this action are expected to diminish regulatory effectiveness. All of these measures will require additional research to determine the magnitude and extent of impacts to bycatch and bycatch mortality. Administrative activities such as ACL monitoring and enforcement should not be affected by the proposed management measures.

Criterion 8: Changes in the economic, social, or cultural value of fishing activities and non-consumptive uses of fishery resources

Hogfish is a highly desirable target species, particularly for spearfishermen. The proposed increase in the ACL in Alternatives 2 and 3 is intended to increase the hogfish harvest in the Gulf. This would be expected to improve fishing opportunities for the reef fish fishery, thereby increasing the economic and social benefits for fishermen and associated coastal businesses and

communities. No effects would be expected on the non-consumptive uses of the fishery resources.

Criterion 9: Changes in the distribution of benefits and costs

The net effects of the proposed management measures in this amendment on bycatch are unknown because the resultant management measures could increase dead discards as a result of increasing the minimum size limit. The proposed management measures would not be expected to affect the total amount of hogfish normally harvested by anglers and commercial fishermen. However, increases in the hogfish ACL (Action 2, Alternatives 2 and 3) are expected to result in economic benefits for both sectors compared to no action.

Criterion 10: Social effects

Bycatch is considered wasteful by fishermen and it reduces overall yield obtained from the fishery. Minimizing bycatch to the extent practicable will increase efficiency, reduce waste, and benefit stock sustainablility, thereby resulting in net social benefits. It is expected that these actions would result in benefits for the recreational and commercial sectors.

Conclusion

Analysis of the ten bycatch practicability factors indicates there would be positive biological impacts associated with further reducing bycatch in the reef fish fishery. The main benefits of reducing hogfish bycatch are less waste and increased yield in the directed fishery. Reducing discards and discard mortality rates would result in less forgone yield.

When determining reductions associated with various management measures, discard mortality is factored into the analyses to adjust the estimated reductions for losses due to dead discards. Changes in discards associated with each of these management measures are contingent on assumptions about how fishermen's behavior and fishing practices will adjust. In these actions, defining the management unit, setting the status determination criteria, setting the ACL and ACT, and prohibiting the use of powerheads in the stressed area discussed in Amendment 43 (GMFMC 2016) can indirectly affect bycatch in the Gulf reef fish fishery. Action 4, which would revise the hogfish minimum size limit, could increase the number of hogfish discards. However, as discussed above, this effect is likely minimal given that most hogfish are harvested by spearfishing and the discard mortality associated for fish caught by hook and line is low.

The Council needed to consider the practicability of implementing the bycatch minimization measures discussed above with respect to the overall objectives of the Reef Fish FMP and Magnuson-Stevens Fishery Conservation and Management Act. Therefore, given actions in this amendment combined with previous actions, management measures, to the extent practicable, minimize bycatch and to the extent bycatch cannot be avoided, minimize the mortality of that bycatch.

APPENDIX C – SUMMARY OF COMMENTS RECEIVED

APPENDIX D – ACL/ACT CONTROL RULE FOR HOGFISH ACT BUFFER

ACL/ACT Buffer Spreadsheet			version 4.1 - April 2011	Combined Hogfish	
sum of points	6.5				
max points	9.5		Buffer between ACLand ACT (or ABC and ACL)	Unweighted	13
Min. Buffer	**0**	**min. buffer**	User adjustable	Weighted	**13**
Max Unw.Buff	19	max unwt. Buff			
Max Wtd Buff	**25**	**max wtd. buffer**	User adjustable		
	Component	Element score	Element	Selection	Element result
	Stock assemblage	0	This ACL/ACT is for a single stock.	x	0
		1	This ACL/ACT is for a stock assemblage, or an indicator species for a stock assemblage		
	Ability to Constrain Catch	0	Catch limit has been exceeded 0 or 1 times in last 4 years		3.5
		1	Catch limit has been exceeded 2 or more times in last 4 years	x	
			For the year with max. overage, add 0.5 pts. For every 10 percentage points (rounded up) above ACL	2.5	
			Not applicable (there is no catch limit)		
			Apply this component to recreational fisheries, not commercial or IFQ fisheries		
		0	Method of absolute counting		2
	Precision of Landings Data Recreational	1	MRIP proportional standard error (PSE) <= 20		
		2	MRIP proportional standard error (PSE) > 20	x	
			Not applicable (will not be included in buffer calculation)		
			Apply this component to commercial fisheries or any fishery under an IFQ program		
	Precision of Landings Data Commercial	0	Landings from IFQ program		1
		1	Landings based on dealer reporting	x	
		2	Landings based on other		
			Not applicable (will not be included in buffer calculation)		
	Timeliness	0	In-season accountability measures used or fishery is under an IFQ	x	0
		1	In-season accountability measures not used		
				Sum	6.5
	Weighting factor				
		Element weight	Element	Selection	Weighting
	Overfished status	0	1. Stock biomass is at or above B_{OY} (or proxy).	x	0
		0.1	2. Stock biomass is below B_{OY} (or proxy) but at or above B_{MSY} (or proxy).		
		0.2	3. Stock biomass is below B_{MSY} (or proxy) but at or above minimum stock size threshold (MSST).		
		0.3	4. Stock is overfished, below MSST.		
		0.3	5. Status criterion is unknown.		

Hogfish landings percent over/under ACL in last 4 years
2011 n/a
2012 41% = 2.5 penalty points (maximum overage)
2013 17% (overage)
2014 -6%

Hogfish recreational PSE (total Gulf landings) in last 4 years
2011 26%
2012 32%
2013 35%
2014 18%
Average 27%