Monterey Bay Aquarium

Seafood Watch®

Stone crab

Menippe mercenaria
Menippe adina

©Florida Dept. of Agriculture

United States of America: Gulf of Mexico & Western Central Atlantic

Pots

September 4, 2019

Seafood Watch Consulting Researcher

Seafood Watch Standard used in this assessment: Standard for Fisheries vF3

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Watch Assessment. Each assessment synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, Seafood Watch seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying assessments will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Watch assessments in any way they find useful.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard. Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

Best Choice/Green: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught.

Avoid/Red Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report provides recommendations for the US commerical fishery for stone crab (*Menippe mercenaria*, *Menippe adina*, and hybrids of the two species) using crab pots in the US Atlantic and Gulf of Mexico. Because the fishery primarily operates in Florida waters and is managed by the Florida Fish and Wildlife Conservation Commission (FWC), this report focuses on the Florida fishery.

Criterion 1
Stock assessment models indicate "high" concern for the stone crab stock, based on fishing mortality impacts.

Criterion 2
Bycatch in the traps is thought to be low and primarily consists of undersized stone crab, which are returned to the water alive with high survival rates. The main concern is with the fishery's impacts on marine mammals.

Criterion 3
The fishery is formally managed by the FWC and uses a limited-entry system, restricted season, and minimum size limits. There are no quotas or catch limits, and therefore no direct control of fishing mortality. Fishery-dependent and -independent data are collected and used in stock assessments, but the current assessment is somewhat outdated. Robust stakeholder engagement and enforcement measures are in place for the fishery.

Criterion 4
Stone crab traps are used primarily on soft sediment habitat and are considered to have moderate impact on the substrate. There are no specific spatial management or ecosystem-based management measures in place, but detrimental ecosystem/food web impacts are not likely.

Final Seafood Recommendations

SPECIES/FISHERY	CRITERION 1: IMPACTS ON THE SPECIES	CRITERION 2: IMPACTS ON OTHER SPECIES	CRITERION 3: MANAGEMENT EFFECTIVENESS	CRITERION 4: HABITAT AND ECOSYSTEM	OVERALL RECOMMENDATION
Florida stone crab United States of America Gulf of Mexico, Pots, United States of America	Red (1.526)	Red (1.732)	Red (1.000)	Yellow (2.449)	**Avoid (1.595)**
Florida stone crab United States of America Western Central Atlantic, Pots, United States of America	Red (1.526)	Red (1.732)	Red (1.000)	Yellow (2.449)	**Avoid (1.595)**
Gulf stone crab United States of America Gulf of Mexico, Pots, United States of America	Red (1.526)	Red (1.732)	Red (1.000)	Yellow (2.449)	**Avoid (1.595)**
Gulf stone crab United States of America Western Central Atlantic, Pots, United States of America	Red (1.526)	Red (1.732)	Red (1.000)	Yellow (2.449)	**Avoid (1.595)**

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

- **Best Choice/Green** = Final Score >3.2, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores
- **Avoid/Red** = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This report provides recommendations for the commercial stone crab (*Menippe mercenaria*, *Menippe adina*, and hybrids of the two species) fishery using crab pots in the US Atlantic and Gulf of Mexico. Although stone crabs occur along the entire southeastern US coast from North Carolina through Texas, the fishery primarily operates in Florida waters (NOAA 2011). Therefore, this report focuses on the Florida fishery, which manages both species (and hybrids) as a single fishery stock.

Species Overview

Stone crabs occur from approximately North Carolina to Panama, including the entire Gulf of Mexico, the Bahamas, and the Greater Antilles (FFWCC 2017). Two species occur in US waters: *Menippe mercenaria* occurs along the Atlantic and Gulf coasts of peninsular Florida and up to North Carolina. *Menippe adina* is found from the Florida panhandle through Texas. Hybrids of the two species exist between Tampa Bay and peninsular Florida, and from Jacksonville, FL to South Carolina, although the extent of these hybrid ranges are still under debate. (Bert and Harrison 1988) (Duermit 2016). Both species and their hybrids are caught by the fishery. This is a unique fishery in which the claws are removed and the crabs are returned alive to the water.

The state of Florida has managed stone crabs in its waters since 1929, and a Fishery Management Plan (FMP) for the Gulf of Mexico stock was implemented in 1979 to manage the fishery. However, because most commercially caught stone crabs are landed in Florida state waters, the FMP was redundant with existing state regulations and was repealed in 2011 (NOAA 2011). The Florida Fish and Wildlife Conservation Commission (FWC) currently manages the stone crab fishery in Florida, including vessels using the limited fishing grounds outside state waters.

Production Statistics

Nearly all commercially landed stone crabs are landed in Florida, and almost all of Florida's catch occurs along the Gulf coast (Fig. 1). Overall landings fluctuate among years (Fig. 2), and catch per unit effort has declined dramatically since the 1980s as the number of traps has increased exponentially.

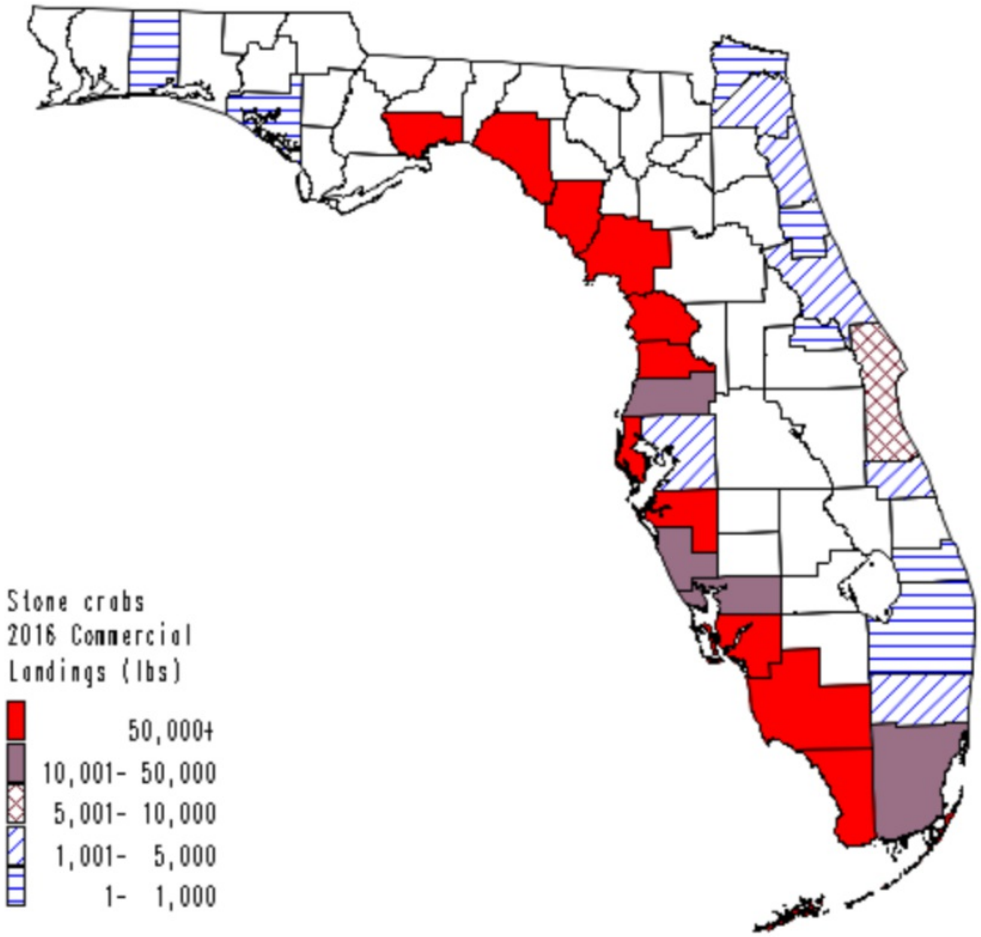

Figure 1 Geographic distribution of the commercial landings (pounds) of Stone Crab claws during 2016. Figure from FFWCC (2017).

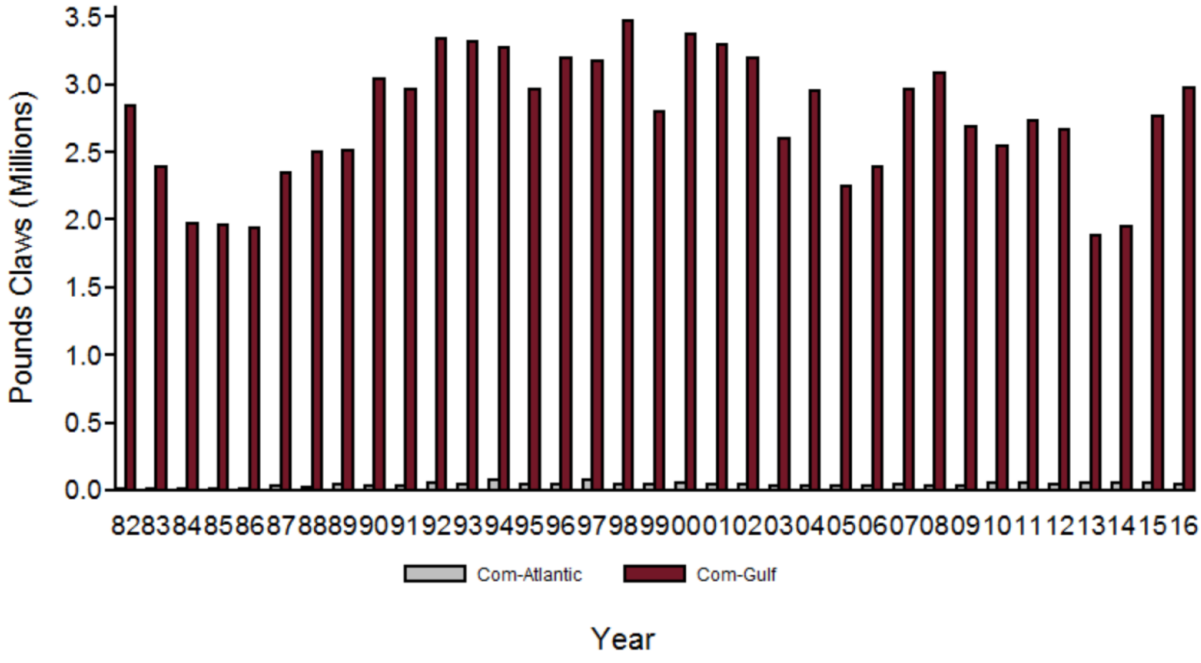

Figure 2 Commercial annual landings (pounds) of Stone Crab claws on the Atlantic and Gulf coasts of Florida, 1982–2016. Figure from FFWCC (2017).

Importance to the US/North American market.

Stone crab has limited availability outside of the southeastern US and Gulf coast and is considered a minor species in the national crab market. However, it is an important species locally in regions where it is caught, particularly Florida. Almost all stone crab sold in the US is caught here, and there is a negligible export market to Asia for the species.

Common and market names.

Gulf stone crab, Florida stone crab.

Primary product forms

Claws, either fresh-cooked or frozen.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the Species Under Assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical

Guiding Principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*

Criterion 1 Summary

FLORIDA STONE CRAB			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
United States of America/Gulf of Mexico | Pots | United States of America	2.33: Moderate Concern	1.00: High Concern	Red (1.526)
United States of America/Western Central Atlantic | Pots | United States of America	2.33: Moderate Concern	1.00: High Concern	Red (1.526)

GULF STONE CRAB			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
United States of America/Gulf of Mexico | Pots | United States of America	2.33: Moderate Concern	1.00: High Concern	Red (1.526)

United States of America/Western Central Atlantic | Pots | United States of America	2.33: Moderate Concern	1.00: High Concern	Red (1.526)

Criterion 1 Assessment

SCORING GUIDELINES

Factor 1.1 - Abundance

Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

FLORIDA STONE CRAB

Factor 1.1 - Abundance

UNITED STATES OF AMERICA/GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA/WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

Moderate Concern

The fishery manages the two species of stone crab (Florida stone crabs, *Menippe mercenaria*, and Gulf stone crabs, *Menippe adina*) as a single stock, so their abundance here is assessed as a single stock. The two species have partially overlapping distributions and can interbreed to produce hybrids.

The most recent stock assessment was published in 2011 (Muller et al. 2011). Because the crabs are returned alive to the water after harvesting their claws, there is no direct link between landings and stone crab population biomass, and biomass-based abundance reference points (e.g., equilibrium biomass at F_{MSY})

are not informative for this fishery. However, claw removal is associated with higher mortality rates and reduced feeding, which limits the energy for crab growth and reproduction (Duermit et al 2015) (Hogan and Griffen 2014). Recent exposures to red tides may also have impacts on population abundance (Gravinese 2019).

Surplus production models indicated that the fishery was experiencing overfishing (fishing mortality ratio F >1; see criterion 1.2) and has been since 1996–1997, but DeLury depletion models show no trend of decline in recruitment (i.e., recruitment overfishing). Annual landings have been decreasing since 2000 (FWC 2019).

Stone crabs are not considered highly vulnerable under the Productivity-Susceptibility Assessment framework $V = \sqrt{(1.5^2+1.875^2)} = 2.40$ (low vulnerability). Because there is insufficient information about stock status relative to reference points and the species is not highly vulnerable, abundance is scored as "moderate" concern.

Justification:

Productivity Attribute Table

PRODUCTIVITY ATTRIBUTE	RELEVANT INFO	REFERENCE	SCORE
Average age at maturity	<5 years	(Crowley 2018)	1
Average maximum	<10 year	(Gerhart and Bert 2008)	1
Fecundity	>100,000 eggs/yr	(Crowley 2019)	2
Reproductive strategy	Demersal egg brooder	(Crowley 2019)	2
Trophic level	2.75 to 3.25	(Abeels et al 2012) (Thera et al 2014)	2
Density dependence	No depensatory or compensatory dynamics demonstrated or likely		2
Productivity Score (P)			**1.5**

Susceptibility Attribute Table

SUSCEPTIBILITY ATTRIBUTE	RELEVANT INFO	SCORE
Areal overlap	Unknown, so default score is used (>30% across their geographic range, considering all fisheries).	3
Vertical overlap	Stone crabs are a targeted species, so default score is used (*High degree of overlap between fishing depths and depth range of species*)	3

Selectivity of fishery	Stone crabs are a targeted species, but size limits reduce general susceptibility (Gandy 2018) so default score is used (species is targeted but conditions under "high risk" do not apply)	2
Post-capture mortality	Stone crabs are targeted but released alive after removal of the claws. Post-capture (post-declawing) survival range are likely between 33 and 66%, and vary with water temperature (Duermit et al 2015) (Gandy 2016)	2
Susceptibility score (S)	S = [(s1*s2*s3*s4-1)/40]+1	1.875

Factor 1.2 - Fishing Mortality

UNITED STATES OF AMERICA/GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA/WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

High Concern

The fishery manages the two species of stone crab (Florida stone crabs, *Menippe mercenaria*, and Gulf stone crabs, *Menippe adina*) as a single stock, and their fishing mortality is assessed as a single stock.

The stone crab fishery releases crabs back to the water alive, so in theory there is no direct fishing mortality. In practice, there can be significant mortality associated with the removal of one or both claws, particularly if claws are removed incorrectly or with large wound sizes, if crabs are exposed to air for long periods, or under warm conditions (Davis et al 1978) (Duermit et al 2015) (Gandy 2016).

Because the crabs are returned alive to the water after harvesting their claws, there is no direct link between landings and stone crab population biomass, and biomass-based abundance reference points (e.g., equilibrium biomass at F_{MSY}) are not informative for this fishery. Surplus production models show a high likelihood that fishing mortality rate, F >F_{MSY} for the decade leading up to 2009, the final model year (Muller et al. 2011). Commercial landings have also shown a decrease since 2000 (FWC 2019).

Because the most recent available model suggests that overfishing is occurring for the stock, fishing mortality is scored as "high" concern.

Justification:

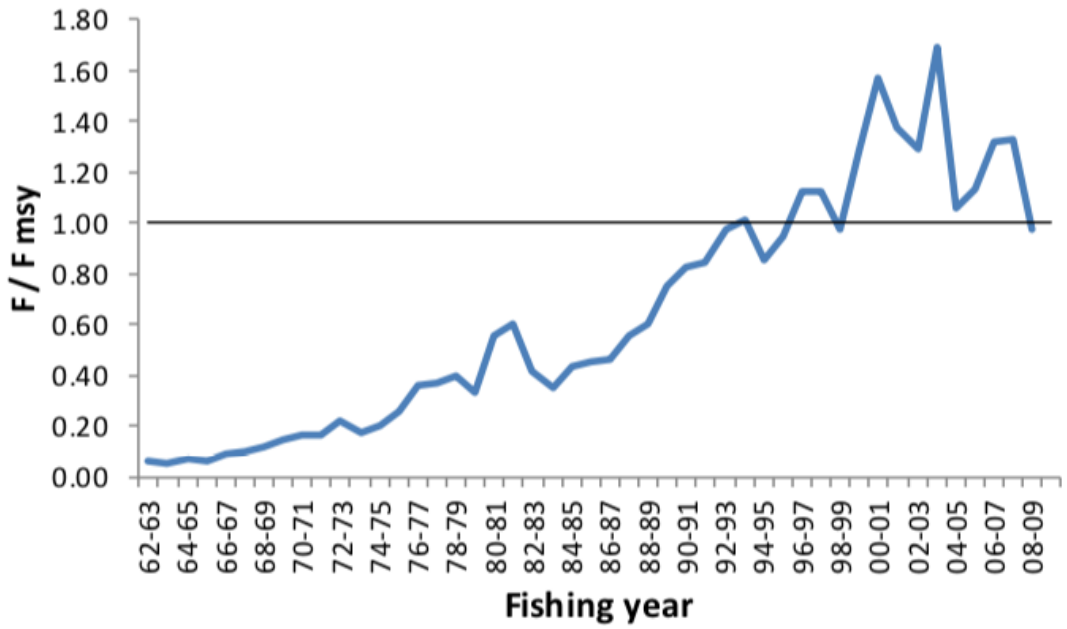

Figure 3 F/Fmsy ratios for stone crab as estimated by the surplus production model.

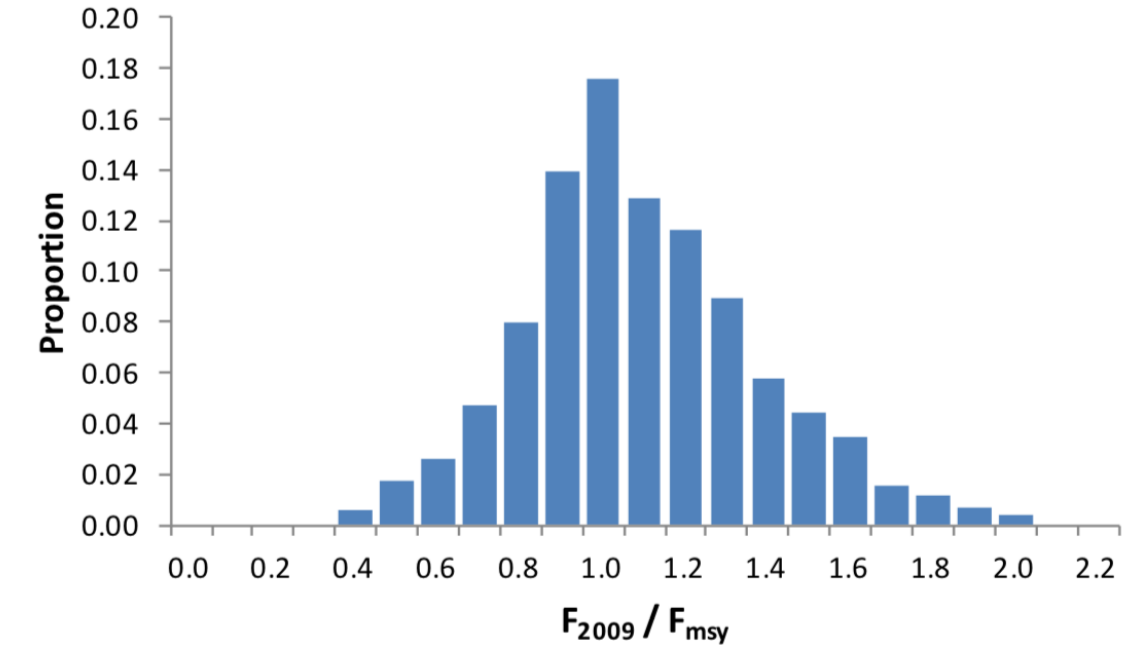

Figure 4 Distribution of bootstrapped F/Fmsy ratios for the final model year (2009) of the surplus production model. Fishing mortality F exceeded Fmsy in >50% of model outcomes.

GULF STONE CRAB

Factor 1.1 - Abundance

UNITED STATES OF AMERICA/GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA/WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

Moderate Concern

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The most recent stock assessment was published in 2011 (Muller et al. 2011). Because the crabs are returned alive to the water after harvesting their claws, there is no direct link between landings and stone crab population biomass, and biomass-based abundance reference points (e.g., equilibrium biomass at F_{MSY}) are not informative for this fishery. However, claw removal is associated with higher mortality rates and reduced feeding, which limits the energy for crab growth and reproduction (Duermit et al 2015) (Hogan and Griffen 2014). Recent exposures to red tides may also have impacts on population abundance (Gravinese 2019).

Surplus production models indicated that the fishery was experiencing overfishing (fishing mortality ratio F >1; see criterion 1.2) and has been since 1996–1997, but DeLury depletion models show no trend of decline in recruitment (i.e., recruitment overfishing). Annual landings have been decreasing since 2000 (FWC 2019).

Stone crabs are not considered highly vulnerable under the Productivity-Susceptibility Assessment framework $V = \sqrt{(1.5^2+1.875^2)} = 2.40$ (low vulnerability). Because there is insufficient information about stock status relative to reference points and the species is not highly vulnerable, abundance is scored as "moderate" concern.

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Susceptibility Attribute Table

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Selectivity of fishery	Stone crabs are a targeted species, but size limits reduce general susceptibility (Gandy 2018) so default score is used (species is targeted but conditions under "high risk" do not apply)	2
Post-capture mortality	Stone crabs are targeted but released alive after removal of the claws. Post-capture (post-declawing) survival range are likely between 33 and 66%, and vary with water temperature (Duermit et al 2015) (Gandy 2016)	2
Susceptibility score (S)	S = [(s1*s2*s3*s4-1)/40]+1	1.875

Factor 1.2 - Fishing Mortality

UNITED STATES OF AMERICA/GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA/WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

High Concern

The fishery manages the two species of stone crab (Florida stone crabs, *Menippe mercenaria*, and Gulf stone crabs, *Menippe adina*) as a single stock, and their fishing mortality is assessed as a single stock.

The stone crab fishery releases crabs back to the water alive, so in theory there is no direct fishing mortality. In practice, there can be significant mortality associated with the removal of one or both claws, particularly if claws are removed incorrectly or with large wound sizes, if crabs are exposed to air for long periods, or under warm conditions (Davis et al 1978) (Duermit et al 2015) (Gandy 2016).

Because the crabs are returned alive to the water after harvesting their claws, there is no direct link between landings and stone crab population biomass, and biomass-based abundance reference points (e.g., equilibrium biomass at F_{MSY}) are not informative for this fishery. Surplus production models show a high likelihood that fishing mortality rate, $F > F_{MSY}$ for the decade leading up to 2009, the final model year (Muller et al. 2011). Commercial landings have also shown a decrease since 2000 (FWC 2019).

Because the most recent available model suggests that overfishing is occurring for the stock, fishing mortality is scored as "high" concern.

Justification:

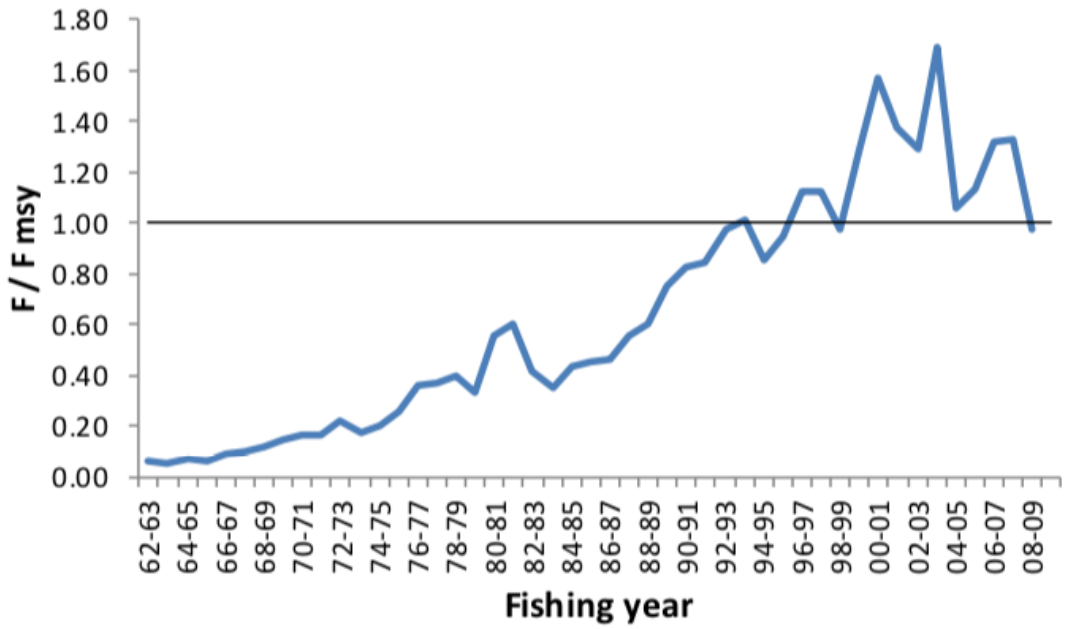

Figure 5 F/Fmsy ratios for stone crab as estimated by the surplus production model.

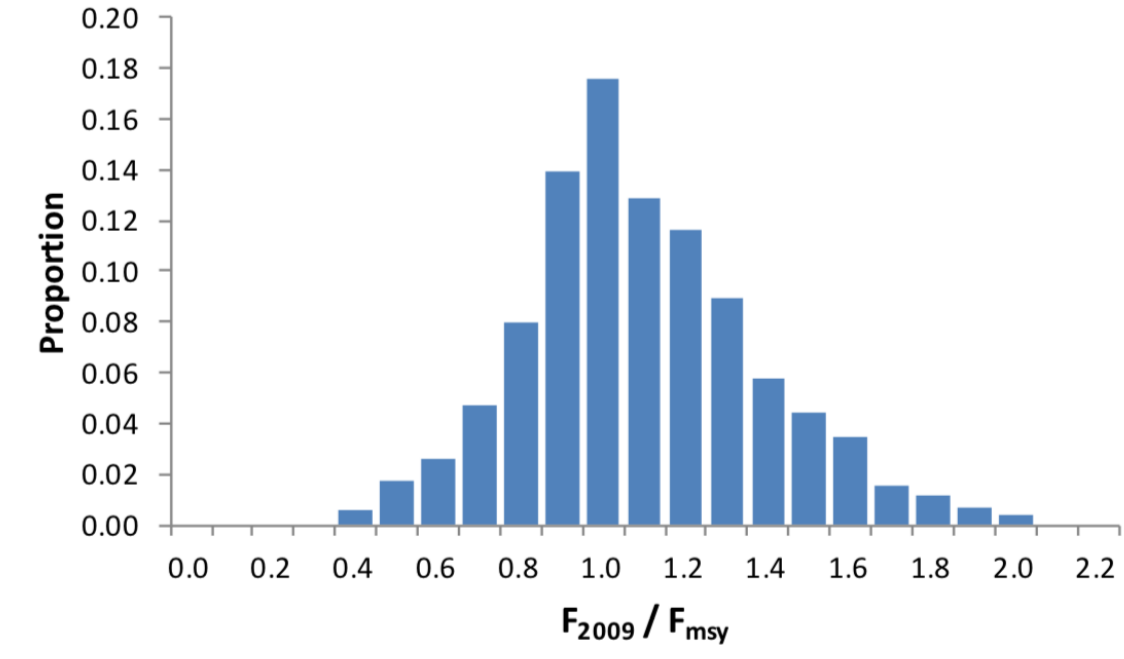

Figure 6 Distribution of bootstrapped F/Fmsy ratios for the final model year (2009) of the surplus production model. Fishing mortality F exceeded Fmsy in >50% of model outcomes.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤=3.2=Yellow or Moderate Concern*
- *Score ≤=2.2=Red or High Concern*

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding Principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix A.

FLORIDA STONE CRAB - UNITED STATES OF AMERICA/GULF OF MEXICO - POTS - UNITED STATES OF AMERICA					
Subscore:	**1.732**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.732**
Species	**Abundance**		**Fishing Mortality**	**Subscore**	
Bottlenose dolphin	1.00:High Concern		3.00:Moderate Concern	Red (1.732)	
Calico box crab	2.33:Moderate Concern		3.00:Moderate Concern	Yellow (2.644)	

FLORIDA STONE CRAB - UNITED STATES OF AMERICA/WESTERN CENTRAL ATLANTIC - POTS - UNITED STATES OF AMERICA					
Subscore:	**1.732**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.732**
Species	**Abundance**		**Fishing Mortality**	**Subscore**	
Bottlenose dolphin	1.00:High Concern		3.00:Moderate Concern	Red (1.732)	
Calico box crab	2.33:Moderate Concern		3.00:Moderate Concern	Yellow (2.644)	

GULF STONE CRAB - UNITED STATES OF AMERICA/GULF OF MEXICO - POTS - UNITED STATES OF AMERICA					
Subscore:	**1.732**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.732**

Species	Abundance	Fishing Mortality	Subscore
Bottlenose dolphin	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Calico box crab	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

GULF STONE CRAB - UNITED STATES OF AMERICA/WESTERN CENTRAL ATLANTIC - POTS - UNITED STATES OF AMERICA					
Subscore:	**1.732**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.732**

Species	Abundance	Fishing Mortality	Subscore
Bottlenose dolphin	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Calico box crab	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

A study of trap bycatch across representative stone crab fishing areas (Gandy 2018) found bycatch nontarget species to be highly spatially variable, and included other noncommercial crab species (calico, spider, and hermit crabs), some benthic molluscs, and small fishes. These results were consistent with unpublished bycatch data from other monitoring programs (R. Gandy, personal communication). With the exception of calico box crabs (*Hepatus epheliticus*), these species make up <5% of landings and are not included in the assessment. Calico box crabs constituted 9.4% of the catch and are assessed as a bycatch species.

The fishery is listed as a Category II fishery (occasional incidental death or serious injury) for bottlenose dolphins by NOAA Fisheries. This includes the Eastern Coastal, Northern Coastal, and Bay, Sound, and Estuary (BSE) stocks for the Gulf of Mexico fishery, and the Biscayne Bay, Florida Bay, Indian River Lagoon estuarine, and Jacksonville estuarine stocks for the Western Central Atlantic fishery (NOAA 2018).

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance

(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality

(same as Factor 1.2 above)

BOTTLENOSE DOLPHIN

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

High Concern

The bottlenose dolphin stocks that interact with the stone crab fishery are of unknown abundance (NOAA 2015) (NOAA 2013) (NOAA 2018), but are considered to have high inherent vulnerability based on Seafood Watch criteria for marine mammals. Therefore, they are scored as "high" concern.

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

Moderate Concern

The contribution of the stone crab fishery to potential biological removal (PBR) is generally unknown for all the bottlenose dolphin stocks that potentially interact with the fishery because observer data are limited or absent. The fishery is considered a Category II fishery for bottlenose dolphin stocks.

For the Gulf of Mexico region, NOAA considers the Bay, Sound, and Estuary (BSE) stocks and the Northern Coastal stock as strategic stocks, while the Eastern Coastal stock is not a strategic stock (NOAA 2015) (NOAA 2018).

For the Western Central Atlantic region, NOAA considers the Biscayne Bay, Indian River Lagoon estuarine, and Jacksonville estuarine stocks as strategic stocks, while the Florida Bay stock is not a strategic stock (NOAA 2015) (NOAA 2013).

Assessing bottlenose dolphin stocks on a regional basis, both Gulf of Mexico and Western Central Atlantic stone crab fisheries are scored as "moderate" concern, based on the lowest performing stock in each body of water.

Factor 2.3 - Modifying Factor: Discards and Bait Use

Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

RATIO OF BAIT + DISCARDS/LANDINGS	FACTOR 2.3 SCORE
<100%	1
>=100	0.75

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

< 100%

The vast majority of incidental catch in the stone crab fishery consists of undersized stone crabs, which are returned alive to the sea (T. Bert, personal communication) and these are expected to have a high (99%) post-discard survival rate when returned intact (Kronstadt et al. 2018). Stone crab fishermen primarily use waste products from slaughterhouses (such as pig's feet) or fish houses (such as fish heads) as bait in their traps (T. Bert, personal communication). Therefore, the discard and bait-to-landings ratio is expected to be

<100%.

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective,' 'moderately effective,' 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

The Criterion 3 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2 = Red or High Concern*

Rating is Critical if Management Strategy and Implementation is Critical.

GUIDING PRINCIPLE

- The fishery is managed to sustain the long-term productivity of all impacted species.

Criterion 3 Summary

Fishery	Management Strategy	Bycatch Strategy	Research and Monitoring	Enforcement	Stakeholder Inclusion	Score
Fishery 1: United States of America / Gulf of Mexico | Pots | United States of America	Ineffective	Moderately Effective	NA	NA	NA	Red (1.000)
Fishery 2: United States of America / Gulf of Mexico | Pots | United States of America	Ineffective	Moderately Effective	NA	NA	NA	Red (1.000)
Fishery 3: United States of America / Western Central Atlantic | Pots | United States of America	Ineffective	Moderately Effective	NA	NA	NA	Red (1.000)

Fishery 4: United States of America / Western Central Atlantic | Pots | United States of America	Ineffective	Moderately Effective	NA	NA	NA	Red (1.000)

Criterion 3 Assessment

Factor 3.1 - Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

Ineffective

The fishery manages the two species of stone crab (Florida stone crabs, *Menippe mercenaria*, and Gulf stone crabs, *Menippe adina*) as a single stock. This is a limited-entry commercial fishery (based on trap certificates) and is managed through a limited harvest season (October to May) and a minimum claw size limit (2.75 in) (FL Admin Code 2018).

Because the fishery only harvests crab claws and returns live animals to the water, it does not cause direct fishing mortality. However, indirect mortality can still be significant, and tends to be greater when water temperatures are high (Davis et al. 1978) (Duermit et al. 2015) (Gandy 2016). There is a trap limitation program in place that aims to reduce traps in the fishery by reducing the number of trap certificates when there is a transfer of ownership. However, this is a passive reduction strategy, and there are currently no harvest limits for certificate holders (FL Admin Code 2018) (Muller et al. 2011). Therefore, there are no measures that directly control fishing mortality. The most recent stock assessment for the fishery from 2011 suggests that the stock is experiencing overfishing (F >Fmsy, Criterion 1.2). There have been suggestions from Florida scientists for improving management based on existing spawning potential models and the known relationship between water temperature and fishing mortality (Crowley 2018), but these have not been implemented. Because the fishery lacks measures that are expected to be effective in controlling fishing mortality, and it is likely that the stock is overexploited, management strategy is scored as "ineffective."

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

Moderately Effective

Traps are required to have a degradable panel to prevent ghost fishing (FL Admin Code 2018). Cull rings to reduce bycatch are voluntarily used by some fishers, and the fishery is moving to implement them as standard on all new traps. These cull rings have been shown to successfully reduce bycatch of nontarget species and of undersized stone crabs (Gandy 2018).

The fishery is listed as Category II for marine mammal bycatch (NOAA 2018). Because an effective bycatch measure is not yet in place, the stone crab fishery currently scores as "moderately effective" for bycatch strategy.

Factor 3.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

GUIDING PRINCIPLES

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
United States of America / Gulf of Mexico / Pots / United States of America	2	0	Moderate Concern	Yellow (2.449)
United States of America / Gulf of Mexico / Pots / United States of America	2	0	Moderate Concern	Yellow (2.449)
United States of America / Western Central Atlantic / Pots / United States of America	2	0	Moderate Concern	Yellow (2.449)
United States of America / Western Central Atlantic / Pots / United States of America	2	0	Moderate Concern	Yellow (2.449)

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate

Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management

Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive*

scientific evidence is not available for this fishery.

- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

2

Stone crab traps are set on a mixture of emergent rock and soft substrates such as mud, sand, and seagrass meadows. Traps on hardbottom substrate are considered to have an impact score of "2" by Seafood Watch.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

0

There are no measures in place to reduce gear impacts.

Factor 4.3 - Ecosystem-Based Fisheries Management

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

Moderate Concern

No spatial management measures are in place and existing management strategies do not directly account for stone crabs' ecological roles. The removal of claws can lead to changes in crabs' trophic roles, such as a shift away from larger hard-shelled bivalve prey (Duermit et al 2015) (Hogan and Griffen 2014), but it is unclear how these changes may impact food webs on a broader scale. Because the fishery does not specifically account for ecosystem functioning, but detrimental food web impacts are not likely, it is scored as "moderate" concern for ecosystem-based fishery management.

Acknowledgements

Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch would like to thank the consulting researcher and author of this report, Natalie Low, as well as Theresa Bert of the Florida Fish and Wildlife Conservation Commission, Liz Duermit of the South Carolina Department of Natural Resources, Phillip Gravinese of the Mote Marine Laboratory and one anonymous reviewers for graciously reviewing this report for scientific accuracy.

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Appendix A: Extra By Catch Species

CALICO BOX CRAB

Factor 2.1 - Abundance

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

Moderate Concern

The calico box crab is not a targeted fisheries species and there is no stock assessment for the species. Because there are almost no available information on key biological parameters for this species, a productivity-susceptibility analysis (PSA) was conducted using productivity parameters from a better-studied congener, the flecked box crab *Hepatus pundibundus*. Based on this PSA V = $\sqrt{(1.33^2+2.33^2)}$ = 2.68 (medium vulnerability), the species is not expected to be highly vulnerable.

Because there is insufficient information about stock status relative to reference points and the species is not highly vulnerable, abundance is scored as "moderate" concern.

Justification:

PRODUCTIVITY ATTRIBUTE	RELEVANT INFO	REFERENCE	SCORE
Productivity Attribute Table			
Average age at maturity	<5 years	(Keunecke 2007)	1
Average maximum age	<10 years	(Keunecke 2007)	1
Fecundity	>20,000 eggs per year	(Reigada 1995)	1
Reproductive strategy	Broadcast spawner (brooder)	(de Lima 2014) (Hebling 2003)	1
Trophic level	2.75 to 3.25	(Mantelatto 1997)	2
Density dependence	No evidence for compensatory or depensatory dynamics		2
Productivity Score (P)			1.33

SUSCEPTIBILITY ATTRIBUTE	RELEVANT INFO	SCORE
Susceptibility Attribute Table		

Area overlap	Unknown, and the species appears to be a common bycatch species in multiple parts of its range (Gandy 2018) (Hernáez 2012). Default score of 3 is used.	3
Vertical overlap	Unknown, but species is not targeted. Default score of 3 is used.	3
Selectivity of fishery	Species is not targeted, but is caught incidentally. "High risk" conditions do not apply.	2
Post-capture mortality	Post-capture mortality is unknown, so the default score of 3 is used.	3
Susceptibility score (S)		2.33

Factor 2.2 - Fishing Mortality

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

Moderate Concern

Fishing mortality for calico crabs is unknown and receives the default score.

Factor 2.3 - Discard Rate

UNITED STATES OF AMERICA / GULF OF MEXICO, POTS, UNITED STATES OF AMERICA
UNITED STATES OF AMERICA / WESTERN CENTRAL ATLANTIC, POTS, UNITED STATES OF AMERICA

< 100%

The vast majority of incidental catch in the stone crab fishery consists of undersized stone crabs, which are returned alive to the sea (T. Bert, personal communication) and these are expected to have a high (99%) post-discard survival rate when returned intact (Kronstadt et al. 2018). Stone crab fishermen primarily use waste products from slaughterhouses (such as pig's feet) or fish houses (such as fish heads) as bait in their traps (T. Bert, personal communication). Therefore, the discard and bait-to-landings ratio is expected to be <100%.