Monterey Bay Aquarium Seafood Watch®

Lionfish

Pterois volitans and *Pterois miles*

United States of America: Atlantic and Gulf of Mexico

Traps (unspecified), Hand implements

Seafood Watch Consulting Researcher

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Disclaimer
Seafood Watch strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture.Scientific review, however, does not constitute an endorsement of the Seafood Watch program or its recommendations on the part of the reviewing scientists. Seafood Watch is solely responsible for the conclusions reached in this report.
Seafood Watch Standard used in this assessment: Fisheries Standard v2

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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 includes recommendations for Red lionfish (*Pterois volitans*) and Devil firefish (*Pterois miles*) caught by spear and as incidental bycatch in the Florida Caribbean spiny lobster pot/trap fishery. The lionfish fishery occurs in western Atlantic Ocean, Caribbean Sea and Gulf of Mexico.

Lionfish have medium inherent vulnerability to fishing pressure. They grow quickly, and can reach a maximum size of 47 cm and live for 15 years or more. Lionfish are sexually mature around 10-18 cm and females produce up to 2 million eggs per year, which are secreted up to every 4 days in two gelatinous egg masses of approximately 12,000-15,000 eggs. There is low conservation concern, as lionfish are an invasive species outside of the Indo-Pacific and are detrimentally affecting native species through predation and resource competition. As a result, managers are focusing on ways to reduce and prevent further spread of the lionfish population.

There are no bycatch species for the spearfish fishery since lionfish are targeted. In the Caribbean spiny lobster pot/trap fishery, the most common non-targeted species caught include white grunts (*Haemulon plumierii*) and stone crabs (*Menippe* spp.). Various other finfish and invertebrates, such as grouper, hogfish, snapper, hermit crabs, arrow crabs and spider crabs comprise no more than 5% of the catch. White grunts and stone crabs are assessed under criterion 2, but have low inherent vulnerability and are not overfished or undergoing overfishing. Common bottlenose dolphins are impacted by spiny lobster pot/trap fisheries but mortality from the gear is of low concern.

There is currently no fishery management plan for lionfish aimed at conserving stock size, but multiple control plans are available and in the process of being developed amongst local, state, federal, and international partners. There are no regulations in place for the lionfish fishery in Atlantic or Gulf state waters, but it is illegal to transport and release live lionfish. There is uncertainty in the effectiveness of management strategies for Caribbean spiny lobster.

Lionfish are fished with spears and traps. These gear types tend to cause moderate to no impact on benthic habitats. Spiny lobster traps are deployed in a variety of habitats including on rocky reefs and coral, as well as in sand and seagrass areas, so gear impact on substrate will vary with habitat. Finally, lionfish are both competitors with and apex predators on ecologically, commercially and recreationally important species; hence their reduction or removal from the Atlantic, Caribbean and Gulf of Mexico will greatly benefit the native species.

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1 TARGET SPECIES	CRITERION 2 OTHER SPECIES	CRITERION 3 MANAGEMENT	CRITERION 4 HABITAT	OVERALL RECOMMENDATION
Devil firefish | Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States	5.000	5.000	4.000	4.000	**Best Choice (4.472)**
Devil firefish | Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States	5.000	2.511	3.000	3.162	**Best Choice (3.303)**
Devil firefish | Gulf of Mexico | Atlantic, Western Central | Hand implements | United States	5.000	5.000	4.000	4.000	**Best Choice (4.472)**
Devil firefish | Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States	5.000	2.511	3.000	3.162	**Best Choice (3.303)**
Red lionfish | Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States	5.000	5.000	4.000	4.000	**Best Choice (4.472)**
Red lionfish | Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States	5.000	2.511	3.000	3.162	**Best Choice (3.303)**
Red lionfish | Gulf of Mexico | Atlantic, Western Central | Hand implements | United States	5.000	5.000	4.000	4.000	**Best Choice (4.472)**
Red lionfish | Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States	5.000	2.511	3.000	3.162	**Best Choice (3.303)**

Summary

Red lionfish (*Pterois volitans*) and Devil firefish (*Pterois miles*) are found in the western Atlantic Ocean, Caribbean Sea and Gulf of Mexico. This report covers the United States lionfish fishery, where lionfish are targeted by spearing and are caught as incidental bycatch in the Florida Caribbean spiny lobster pot/trap fishery, and accounts for 93% of all U.S. landings.

The **Best choice** rank for Red lionfish and Devil firefish is driven by the fact that it is an invasive species fishery, which is managed towards removing or eradicating the species, in combination with the fishery's minor impacts on bycatch and habitat impacts.

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 Concern[2], 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.

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[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 includes recommendations for Red lionfish (*Pterois volitans*) and Devil firefish (*Pterois miles*), targeted by spearing and caught as incidental bycatch in the Florida Caribbean spiny lobster trap fishery. The fishery occurs in the western Atlantic, Caribbean Sea, and Gulf of Mexico.

Species Overview

Lionfish, of the genus *Pterois*, in which there are 12 species, are venomous marine fish that are native to the Indo-Pacific (FFWCC 2015)(Eschmeyer and Fricke 2015). They are conspicuous fish with red white, cream/black bands, large pectoral fins, and 18 venomous spines (NOAA 2011b). *Pterois* spp. are a popular marine ornamental aquarium fish, which has led to their release and/or escape into the Atlantic Ocean, and the current invasive status in the western Atlantic ocean, Caribbean Sea and the Gulf of Mexico (NOAA 2014)

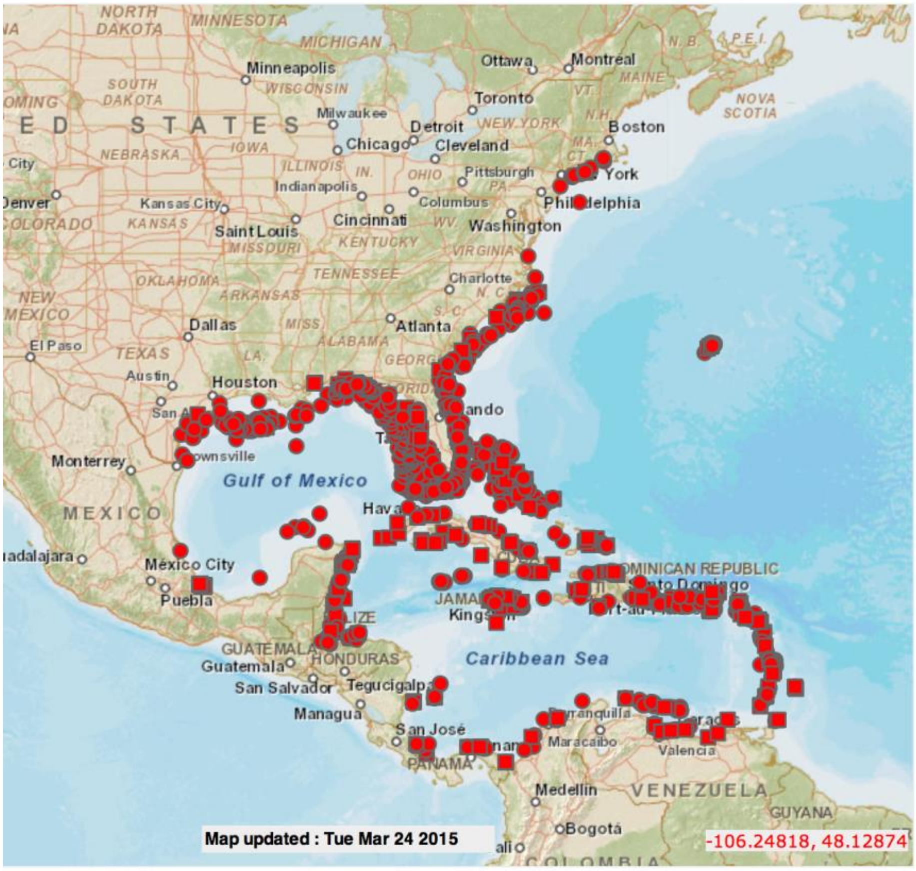

Figure 1. Distribution of Red lionfish and Devil firefish (from USGS 2015).

. The lionfish invasion represents one of the most rapid and devestating marine invasions in history.

In their natural habitat, lionfish exhibit high site fidelity and inhabit warm water reefs and artificial structures such as wrecks, from a few inches of water to over 300 meters, and grow typically to about 30-35cm total length, with some individuals reaching over 45cm. In their invaded range, lionfish can be found in numerous habitats, including reefs, wrecks, bridge pilings, seagrass, mangroves and natural hardbottom, in temperatures as cold as 48 degrees Farenheit, and in excess of 18 inches (Schofield et al. 2015)(FFWCC 2015).

Lionfish become sexually mature at less than a year old, males at 10 cm and females at 18 cm (Ahrenholz and Morris 2010), and can live for up to 15 years (NCCOS 2014). Female lionfish can spawn every 4 days, releasing two gelatinous egg masses of approximately 12,000-15,000 eggs each that drift around for up to 25 days, allowing them to be dispersed in great numbers over potentially great distances (Morris 2009). These life-history characteristics have allowed lionfish to reach densities of up to 300-650 fish ha-1 in certain invaded areas (Green and Cote 2009)(Frazer et al. 2012). Because of their ability to reach high densities, lionfish can drastically reduce native fish populations (by both predation and competition), by as much as 90% (Albins and Hixon 2008) (Albins 2013)(Albins 2015). The species included in this report, Red lionfish, *Pterois* volitans, and Devil firefish, *Pterois* miles, are two distinct, but visually identical species (Morris 2009), with *P. volitans* occuring throughout the invaded range, and *P. miles*, less abundant in the Caribbean region compared to the southeast U.S. (Freshwater et al. 2009)(James Morris, personal communication, 9/4/15).

Presently, lionfish are targeted by spearing and are caught as incidental bycatch in the Caribbean spiny lobster trap fishery. There is no formal fishery management plan for lionfish as of yet, but multiple control management plans are currently being developed, and there is cooperation and communication amongst local, state, federal, and international partners for their proper management. A National Invasive Lionfish Prevention and Management Plan was developed by the Aquatic Nusiance Species Task Force, an intergovernmental organization that is co-chaired by NOAA (Morris 2012)(NOAA 2014). NOAA's National Marine Sanctuaries Program and the National Park Service have developed lionfish response plans that will guide lionfish management in affected U.S. sanctuaries and part of the Gulf, Caribbean and southeastern United States (Johnston et al. 2015). These two plans will guide the management of invasive lionfish and ensure that all partners are working toward common objectives (NOAA 2014)(NOAA 2015).

Production Statistics

Lionfish landings in Florida have only recently been recorded (128 lbs in 2011) and have increased every year since then with a total of 12,227 lbs caught in 2013 (NMFS 2015), with the majority of lionfish caught in traps.

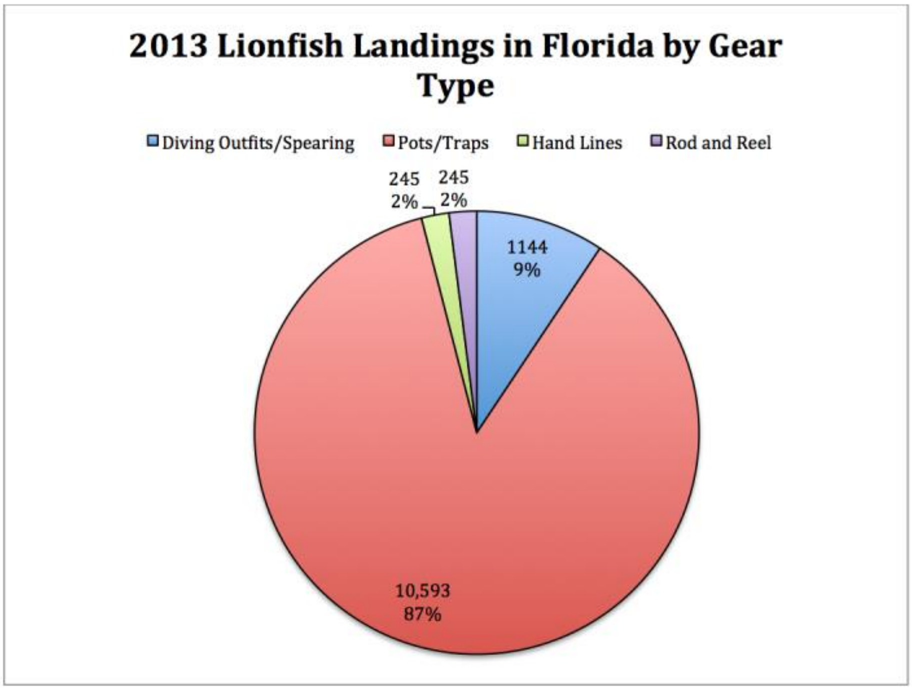

Figure 2. 2013 Lionfish landings in Florida by gear type

The Florida Fish and Wildlife Commission (FWC) recorded lionfish landings as 2,381 lbs in 2011, 12,946 in 2013 and 21,799 in 2014 (FFWCC 2015a). By 2000, lionfish were established in North Carolina (Morris and Whitfield 2009), but commercial landings were only first recorded in 2013 at 835 lbs (NMFS 2015).

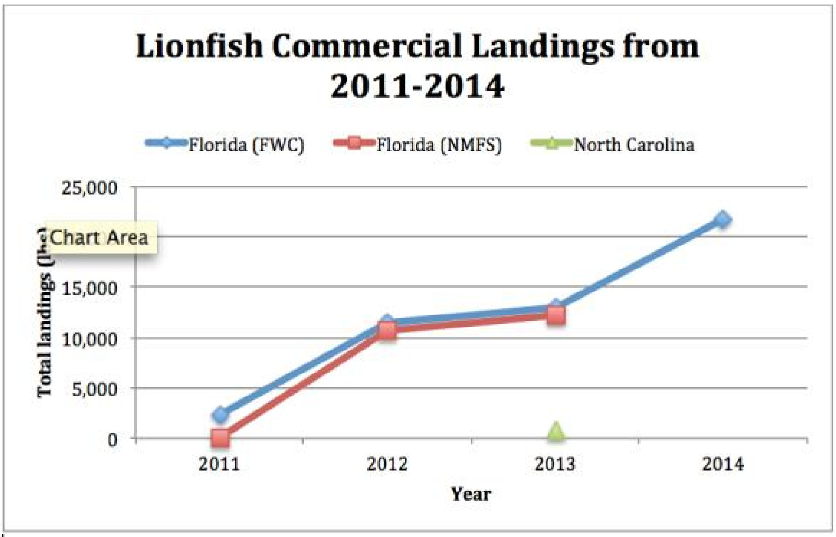

Figure 3. Annual lionfish commercial landings from 2011-2014 (data from NOAA 2015 and FWC 2015).

These landings information, however, do not include the significantly large amounts of lionfish killed during culls and derbies (which are not recorded through NIMS commerical landings).

Importance to the US/North American market.

In 2010, NOAA began a campaign to promote the consumption of lionfish and to encourage human hunting as the only form of population control (NOAA 2014). The Reef Environmental Education Foundation (REEF) has also promoted consumption by releasing a lionfish cookbook, and by sponsoring numerous safe handling workshops for prospective chefs. Marketing for lionfish has been developed, and at present, the market demand for lionfish drastically exceeds supply by 400% (Bill Kelly pers. comm.)(Blue Ventures 2015).

Common and market names.

Red lionfish and Devil firefish are also known as lionfish (FDA 2015), zebrafish, firefish, turkeyfish, butterfly cod, ornate butterfly cod, red firefish, and peacock lionfish (NOAA 2011b)(ITIS 2015).

Primary product forms

Red lionfish and Devil firefish are sold as whole gutted fish and fillets, both fresh and 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

DEVIL FIREFISH

REGION / METHOD	INHERENT VULNERABILITY	ABUNDANCE	FISHING MORTALITY	SCORE
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Best Choice (5.000)
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Best Choice (5.000)
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Best Choice (5.000)
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Best Choice (5.000)

RED LIONFISH

REGION / METHOD	INHERENT VULNERABILITY	ABUNDANCE	FISHING MORTALITY	SCORE
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Best Choice (5.000)
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Best Choice (5.000)
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Best Choice (5.000)
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Best Choice (5.000)

Criterion 1 Assessments

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.*

Devil firefish

Factor 1.1 - Inherent Vulnerability

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Low

The Fishbase score for Devil firefish is 61, which is considered high vulnerability (Froese and Pauly 2014), but using the productivity analysis tool in the Seafood Watch criteria, Devil firefish have low inherent vulnerability with a score of 2.5, due to their young age at sexual maturity, their reproductive strategy and their moderate lifespan.

Justification:

Life History Attribute	Score	Rationale	Source
Average Age at Maturity	3	1 year	Ahrenholz and Morris 2010
Average Maximum Age	2	15 years	National Centers for Coastal Ocean Science webpage 2015
Fecundity	N/A	Females produce over 2 million eggs per year	Morris 2009
Average Maximum Size	3	47 cm	National Centers for Coastal Ocean Science webpage 2015
Average Size at Maturity	3	15 cm	Morris 2009
Reproductive Strategy	3	Broadcast spawner	National Centers for Coastal Ocean Science webpage 2015
Trophic Strategy	1	3.7	Froese and Pauly 2014
Total Score	**2.5**	**Low Vulnerability**	

Figure 1: **Table 1.** Life history characteristics for the Devil firefish, *Pterois miles.*

Factor 1.2 - Abundance

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Very Low Concern

Since a population assessment for lionfish has not been conducted, there is no formal metric for abundance. However, lionfish are considered an invasive species in the western Atlantic Ocean, Caribbean Sea and Gulf of Mexico. Lionfish are native to the South Pacific and Indian Oceans, but were introduced into Florida coastal waters during the mid 1980s (Morris and Whitfield 2009) either as releases or escapes from marine aquaria (Hare and Whitfield 2003)(Semmens et al. 2004)(Ruiz-Carus et al. 2006). They have quickly spread across a large portion of the tropical and subtropical western Atlantic and Caribbean (Schofield 2009), with densities in the Bahamas of up to 300–650 fish ha−1, which are the highest reported densities for this species in both its invaded and native ranges (Green and Cote 2009)(Frazer et al. 2012). Red lionfish, *Pterois* volitans, occur throughout the invaded range, while Devil firefish, *Pterois* miles, is restricted to the U.S. mainland (Freshwater et al. 2009).

Due to their expanding range and rapidly increasing populations, fishery managers are concerned that the negative impacts lionfish may have on native species and the ecology of coral reefs will be irreversible if not addressed soon (Morris and Whitfield 2009)(Albins and Hixon 2013)(Frazer et al. 2012). Because lionfish are invasive in the region, and fishing can serve to reduce negative impacts by reducing its abundance, we have rated this factor a very low concern.

Justification:

The success of lionfish in persisting in and expanding their range can be due to a number of reasons. Lionfish are habitat generalists and efficient and broad predators with a high competitive ability, rapid growth, high reproductive rates and low parasite loads (Morris 2009)(Morris and Akins 2009)(Albins and Hixon 2013)(Cote et al. 2013)(Sikkel et al. 2014). They have defensive venomous spines, and therefore few natural predators, in addition to cryptic coloring and behavior (Bernadsky and Goulet 1991)(Morris 2009)(Morris and Whitfield 2009)(Barbour et al. 2010)(Albins and Hixon 2013).

Factor 1.3 - Fishing Mortality

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Very Low Concern

A stock assessment for lionfish has not yet been conducted, and as such, there is no formal metric for fishing mortality. However, lionfish are invasive in the western Atlantic Ocean, Caribbean Sea and Gulf of Mexico, therefore fishery managers want to reduce their abundance. Because of this, we have rated this factor very low concern.

Red lionfish

Factor 1.1 - Inherent Vulnerability

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Low

The Fishbase score for Red lionfish is 54, which is considered moderate to high vulnerablity (Froese and Pauly 2014), but using the productivity analysis tool in the Seafood Watch criteria, Red lionfish have low inherent vulnerability with a score of 2.5, due to their young age at sexual maturity, their reproductive strategy and their moderate lifespan.

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Justification:

Life History Attribute	Score	Rationale	Source
Average Age at Maturity	3	1 year	Ahrenholz and Morris 2010
Average Maximum Age	2	15 years	National Centers for Coastal Ocean Science webpage 2015
Fecundity	N/A	Females produce over 2 million eggs per year	Morris 2009
Average Maximum Size	3	47 cm	National Centers for Coastal Ocean Science webpage 2015
Average Size at Maturity	3	15 cm	Morris 2009
Reproductive Strategy	3	Broadcast spawner	National Centers for Coastal Ocean Science webpage 2015
Trophic Strategy	1	4.4	Froese and Pauly 2014
Total Score	**2.5**	**Low Vulnerability**	

Figure 2: **Table 2.** Life history characteristics for the Red lionfish, *Pterois volitans.*

Factor 1.2 - Abundance

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Very Low Concern

Since a population assessment for lionfish has not been conducted, there is no formal metric for abundance. However, lionfish are considered an invasive species in the western Atlantic Ocean, Caribbean Sea and Gulf of Mexico. Lionfish are native to the South Pacific and Indian Oceans, but were introduced into Florida coastal waters during the mid 1980s (Morris and Whitfield 2009) either as releases or escapes from marine aquaria (Hare and Whitfield 2003)(Semmens et al. 2004)(Ruiz-Carus et al. 2006). They have quickly spread across a large portion of the tropical and subtropical western Atlantic and Caribbean (Schofield 2009), with densities in the Bahamas of up to 300–650 fish ha−1, which are the highest reported densities for this species in both its invaded and native ranges (Green and Cote 2009)(Frazer et al. 2012). Red lionfish, *Pterois* volitans, occur throughout the invaded range, while Devil firefish, *Pterois* miles, is restricted to the U.S. mainland (Freshwater et al. 2009).

Due to their expanding range and rapidly increasing populations, fishery managers are concerned that the negative impacts lionfish may have on native species and the ecology of coral reefs will be irreversible if not addressed soon (Morris and Whitfield 2009)(Albins and Hixon 2013)(Frazer et al. 2012). Because lionfish are invasive in the region, and fishing can serve to reduce negative impacts by reducing its abundance, we have rated this factor a very low concern.

Justification:

The success of lionfish in persisting in and expanding their range can be due to a number of reasons. Lionfish are habitat generalists and efficient and broad predators with a high competitive ability, rapid growth, high reproductive rates and low parasite loads (Morris 2009)(Morris and Akins 2009)(Albins and Hixon 2013)(Cote et al. 2013)(Sikkel et al. 2014). They have defensive venomous spines, and therefore few natural predators, in addition to cryptic coloring and behavior (Bernadsky and Goulet 1991)(Morris 2009)(Morris and Whitfield 2009)(Barbour et al. 2010)(Albins and Hixon 2013).

Factor 1.3 - Fishing Mortality

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Very Low Concern

A stock assessment for lionfish has not yet been conducted, and as such, there is no formal metric for fishing mortality. However, lionfish are invasive in the western Atlantic Ocean, Caribbean Sea and Gulf of Mexico, therefore fishery managers want to reduce their abundance. Because of this, we have rated this factor very low concern.

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

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

DEVIL FIREFISH			
REGION / METHOD	SUB SCORE	DISCARDS+BAIT / LANDINGS	SCORE
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States	5.000	1.000: < 20%	Green (5.000)
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States	2.644	0.950: 20-40%	Yellow (2.511)
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States	5.000	1.000: < 20%	Green (5.000)
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States	2.644	0.950: 20-40%	Yellow (2.511)

RED LIONFISH			
REGION / METHOD	SUB SCORE	DISCARDS+BAIT / LANDINGS	SCORE
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States	5.000	1.000: < 20%	Green (5.000)
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States	2.644	0.950: 20-40%	Yellow (2.511)
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States	5.000	1.000: < 20%	Green (5.000)
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States	2.644	0.950: 20-40%	Yellow (2.511)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

ATLANTIC AND ADJACENT AREAS | ATLANTIC, NORTHWEST | HAND IMPLEMENTS | UNITED STATES				
SUB SCORE: 5.000	DISCARD RATE: 1.000		**SCORE: 5.000**	
SPECIES	**INHERENT VULNERABILITY**	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Devil firefish	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)
Red lionfish	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)

ATLANTIC AND ADJACENT AREAS | ATLANTIC, NORTHWEST | TRAPS (UNSPECIFIED) | UNITED STATES				
SUB SCORE: 2.644	DISCARD RATE: 0.950		**SCORE: 2.511**	
SPECIES	**INHERENT VULNERABILITY**	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Caribbean spiny lobster	2.000: Medium	3.000: Moderate Concern	2.330: Moderate Concern	Yellow (2.644)
Bottlenose dolphin	1.000: High	2.000: High Concern	3.670: Low Concern	Yellow (2.709)
Stone crabs (unspecified)	3.000: Low	3.000: Moderate Concern	3.670: Low Concern	Green (3.318)
White grunt	3.000: Low	3.000: Moderate Concern	3.670: Low Concern	Green (3.318)
Devil firefish	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)
Red lionfish	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)

GULF OF MEXICO | ATLANTIC, WESTERN CENTRAL | HAND IMPLEMENTS | UNITED STATES				
SUB SCORE: 5.000	DISCARD RATE: 1.000		**SCORE: 5.000**	
SPECIES	**INHERENT VULNERABILITY**	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Devil firefish	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)
Red lionfish	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)

GULF OF MEXICO | ATLANTIC, WESTERN CENTRAL | TRAPS (UNSPECIFIED) | UNITED STATES				
SUB SCORE: 2.644	DISCARD RATE: 0.950		**SCORE: 2.511**	
SPECIES	**INHERENT VULNERABILITY**	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Caribbean spiny lobster	2.000: Medium	3.000: Moderate Concern	2.330: Moderate Concern	Yellow (2.644)
Bottlenose dolphin	1.000: High	2.000: High Concern	3.670: Low Concern	Yellow (2.709)
Stone crabs (unspecified)	3.000: Low	3.000: Moderate Concern	3.670: Low Concern	Green (3.318)
White grunt	3.000: Low	3.000: Moderate Concern	3.670: Low Concern	Green (3.318)
Devil firefish	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)
Red lionfish	3.000: Low	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)

Lionfish are caught either by targeted spearfishing or as incidental bycatch in the Caribbean spiny lobster fishery. Other common non-targeted species caught in the spiny lobster fishery include crabs, such as stone crabs, and additional finfish, such as white grunts. According to Matthews and Donaghue (1997), white grunts and stone crabs dominated bycatch in spiny lobster traps. While turtles are entangled occasionally in trap lines, there are very few interactions between turtles and the lobster fishery; a biological opinion on those interactions found that the spiny lobster fishery has no population level effect on Loggerhead, Green, Hawksbill, Leatherback, or Kemp's ridley sea turtles. Therefore, turtles are not included in this assessment. Other bycatch species make up less than 5% of the catch and are not considered species of concern. The total discard rate for lobster fisheries is generally between 8-15%.

The Florida spiny lobster trap/pot fishery is classified as a Category III fishery in the 2017 Marine Mammal Protection Act (MMPA) List of Fisheries (82 FR 3655, 12 January 2017). Therefore, it is unlikely that the fishery will jeopardize marine mammal stocks (NOAA 2018a). The National Marine Fisheries Service (NMFS) has recently added the Florida Keys stock of bottlenose dolphin to the list of stocks incidentally killed or injured in the Category III Florida spiny lobster trap/pot fishery based on one capture in 2013 (NOAA 2018a). Therefore, bottlenose dolphins have been considered in this report.

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)

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

Bottlenose dolphin

Factor 2.1 - Inherent Vulnerability

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

High
Common bottlenose dolphin has high inherent vulnerability (SFW Criteria document p. 9).

Factor 2.2 - Abundance

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

High Concern
Lionfish are caught in the Florida spiny lobster fishery; this fishery has been selected as a category III species for injuring or killing five bottlenose dolphin stocks detailed in the table below (NOAA 2018a). They are not considered as endangered or threatened, though the Western North Atlantic Central Florida Coastal stock is deemed "depleted" {NOAA 2017a}. The Florida Bay stock is considered to be most at-risk because they are a resident population (Waring et al. 2014) which overlaps with the lobster trap/pot. However, the status of this stock relative to the optimum sustainable population (OSP) is unknown and there are insufficient data to determine the population trends for this stock (Waring et al. 2014). Most of the stocks have unknown populations with unknown trends (Table 1). Marine mammals are assumed to be a highly vulnerability species and therefore, Seafood Watch deems abundance as a “high” concern

Justification:

Stock status of common bottlenose dolphins which interact with Florida spiny lobster pot fishery

Stock	Strategic Stock	Min. Population Estimate	Trend Known?	OSP Known?	Source
Biscayne Bay estuarine	Yes	Unknown	No	No	Waring et al. 2014, NMFS 2017a
Central FL coastal	Yes	913	No	No	Waring et al. 2016, NMFS 2019
Eastern GMX coastal	No	11,110	No	No	Ware et al. 2016, NMFS 2019
FL Bay estuarine	No	Unknown but abundance of 514	No	No	Waring et al. 2014, Litz et al. 2008
Florida Keys	Unknown				

Factor 2.3 - Fishing Mortality

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Low Concern
Florida Bay and Biscayne Bay stocks

In the Florida Bay estuarine and Biscayne Bay estuarine stock, the Potential Biological Removal (PBR) is undetermined (Table 2). Therefore fishing mortality is unknown relative to PBR. The Florida Bay stock is considered to be most at-risk (pers. comm., J. Powell 20 July 2018), but level of fishing effort in the pot/trap fishery in this area, is considered low (Waring et al. 2014). There were no documented human-caused mortalities in the last stock assessment report based on 2007 to 2011 data (Waring et al. 2014), but there was one reported entanglement in 2013 (Hayes et al. 2018a). The Biscayne Bay estuarine stock is listed as a strategic stock (Table 2).

Central Florida Coastal and Eastern Gulf of Mexico stocks

The Central Florida coastal stock's annual pot/trap fishery-caused mortality and total annual fishery-related mortality/serious injury are <1% of PBR (Table 2). In the Gulf of Mexico eastern coastal stock, annual pot/trap fishery-caused mortality is <1% of PBR and total fishing mortality is below the PBR (Table 2).

The Florida spiny lobster fishery is categorized as a Category III fishery. The Central Florida coastal and eastern Gulf of Mexico stocks are automatically scored a "low" concern, since the percent of PBR taken by fishery is very low (<1%). The fishing mortality relative to PBR of the Florida Bay and Biscayne Bay stocks is unknown; therefore, a more conservative score is required. However, the most recent stock assessment suggested that there were no recorded interactions with the lobster trap fishery between 2007 and 2011 (Waring et al. 2014); therefore, Seafood Watch deems fishing mortality as "low" concern.
Justification:

Fishing mortality of common bottlenose dolphins relative to PBR

Stock	Total Entanglements	Total Annual Fishing Mortality	PBR	Source
Biscayne Bay Estuarine	None (2007 to 2011)	Unknown	Unknown	Waring et al. 2014
Central FL coastal	1 (2009 to 2013)	0.4	9.1	NMFS 2019, Waring et al. 2014
Eastern GMX coastal	5 (2012 to 2016)	1.6	111	Waring et al. 2016, Hayes et al. 2018
FL Bay estuarine	1 (in 2013)	Unknown	Unknown	NMFS 2019, Waring et al. 2014
Florida Keys	Not available			

Caribbean spiny lobster

Factor 2.1 - Inherent Vulnerability

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Medium

According to the Seafood Watch PSA analysis, Caribbean spiny lobster appears to be of medium vulnerability.

Justification:

Life History Attribute	Score	Rationale	Source
Average Age at Maturity	2	1-2 years Lengths at 70-80 mm	Maxwell et al. 2009
Average Maximum Age	2	10-30 years	Ehrhardt 2005
Reproductive Strategy	2	Brooder	Ehrhardt 2005 SEDAR 2010
Density Dependence	2	No density dependence suggested, but unknown	Behringer and Butler 2006
Total Score	**2**	**Medium Vulnerability**	

Figure 3: **Table 3.** Life history characteristics for the Caribbean spiny lobster, *Panulirus argus.*

Factor 2.2 - Abundance

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Moderate Concern

The biomass for spiny lobster in Florida is considered fairly stable, but due to recent reviews of existing models the stock is considered unknown. It is likely the entire Caribbean spiny lobster population is unknown due to the recruitment variability in the region and that populations may be locally overfished/depleted in other areas of the Caribbean (Ehrhardt 2000). As a result, we have rated this factor moderate concern.

Justification:

Recent reviews of the stock assessments for spiny lobster in the Southeastern United States have shown a decreasing biomass but have ultimately rejected the latest model results and declared the stock status as unknown due to the uncertainties related to dependence upon external recruitment from the Caribbean populations (SEDAR 2010)

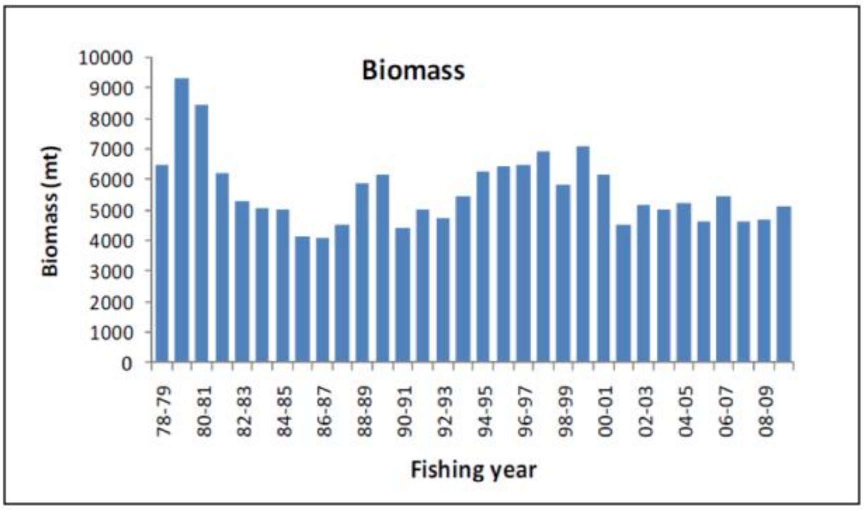

Figure 4. Biomass of Caribbean spiny lobster in southeastern U.S. (figure from SEDAR 2010).

. Although catch data is available, stock assessments have not been performed for Honduras or Nicaragua since 1999 {pers. comm. Phillips 2012}. The 2006 assessment for the Brazilian stock indicated that biomass has decreased {Ehrhardt and Negreiros Aragão 2006}. There are also reports that local Florida spawning stock biomass, estimated from an age-structured sequential population analysis, has decreased since 1988 (Ehrhardt and Fitchett 2010). The overall uncertainties which have led regional management to reject the latest stock assessment results in an unknown stock status.

Factor 2.3 - Fishing Mortality

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Moderate Concern

The latest review of the spiny lobster stock assessment for the southeastern U.S. has established the F_{MSY} as unknown because long-term productivity cannot be estimated without further understanding of recruitment levels of spawning stock (SEDAR 2010). There is also a lack of data for the spiny lobster fisheries in other countries (FAO 2003). As a result, we have rated this factor moderate concern.

Stone crabs (unspecified)

Factor 2.1 - Inherent Vulnerability

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Low

Using the productivity analysis tool in the Seafood Watch criteria, Stone crabs have low inherent vulnerability with a score of 2.5, due to their young age at sexual maturity, their reproductive strategy and their moderate lifespan.

Justification:

Life History Attribute	Score	Rationale	Source
Average Age at Maturity	3	2 years	Fleuch 2015
Average Maximum Age	3	7-9 years	Fleuch 2015
Fecundity	N/A	Up to 1 million eggs per breeding season	Fleuch 2015
Reproductive Strategy	2	Brooder	Fleuch 2015
Density Dependence	2	No depensatory or compensatory dynamics demonstrated or likely	Miller 2013
Total Score	**2.5**	**Low Vulnerability**	

Figure 4: **Table 4.** Life history characteristics for stone crab, *Menippe spp.*

Factor 2.2 - Abundance

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Moderate Concern

There are no biological reference points to determine the overfished status of stone crabs. Since there is no recent stock assessment for the species, abundance is scored according to inherent vulnerability.

The stock assessment is between five and ten years old, adding uncertainty to the results of the stock assessment. Fishery-independent surveys show that relative abundance generally has remained stable over time (with fluctuations) or have been decreasing (FFWCC 2017a).

Since the species has "low" vulnerability and there is some conflicting information about stock status (abundance is considered unknown), Seafood Watch deems abundance as a “moderate” concern.

Justification:

The most recent assessment of stone crab stocks (Muller et al. 2011) used two models to evaluate the stock status: the surplus production model and the DeLury model. The DeLury model demonstrated that recruitment varies without trend. The last stock assessment for the stone crab fishery concluded that the resource is fished at a maximum level (Muller et al. 2011). Since the most recent assessment, there has been little to no change in the fishery or its population (pers. comm., FFWCC 2017).

Fishery-independent surveys measured abundance using two indicators: young-of the-year (YOY) and post-YOY throughout two areas, the Atlantic and the Gulf (FFWCC 2017a).

There is some concern relating to the low numbers of large, mature males (Muller et al. 2011). Gerhart and Bert (2008) suggested that few males are likely to have mated before entering the fishery. Since females mature at a smaller size than males, and their claws are proportionally smaller towards male crab claws, female crabs are expected to spawn once or more before reaching the minimal harvest claw size. Male stone crabs have a size-related mating hierarchy, hence few males have mated before they attain legal size (Gerhart and Bert 2008).

Factor 2.3 - Fishing Mortality

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Low Concern

The last stock assessment for stone crabs was published in 2011 and generally showed that the stock is undergoing overfishing (Muller et al. 2011) (FFWCC 2017a). The assessment concluded that stone crabs are the target of a highly over-capitalized trap fishery (where the number of traps is excessive and their stock status "is best indicated by the lack of an increase in landings when the number of traps more than doubled") (Muller et al. 2011). Though the stock assessment is between five and ten years old, low catch-per-trap rates have been recorded, indicating that there are too many traps in the fishery (FFWCC 2017a).

Spiny lobster traps account for less than 10% of stone crab landings (FFWCC 2017a). Stone crabs are not expected to exceed 5% of bycatch in the spiny lobster catch, and in recent ghost fishing studies, non-lobster invertebrates were observed in fewer than 10% of trap observations (Butler and Matthews 2015). However, stone crab claws are retained in the spiny lobster fishery (and the rest of the clawed crab is discarded back into the water). The mortality rates of the clawed crabs is highly dependent on the method in which they are harvested (see Justification for further explanation). When stone crabs are declawed, their mortality ranges between 25 to 71% (when one claw is removed) and 14 to 80% (when both claws are removed) (Duermit et al. 2015). Another study suggests that most stone crabs die when both claws are removed (Gandy et al. 2016). The frequency of clawed crabs re-entering the fishery is uncommon (Duermit et al. 2015) (Muller et al. 2011): Duermit et al. (2017) showed that only 3% of legal-sized crabs caught in the study had regenerated claws (Duermit et al. 2017).

While the mortality rate of stone crabs can be high, catch rates of stone crabs and overall mortality caused by the lobster fishery is assumed to be relatively low compared to that from the direct stone crab fishery; therefore, Seafood Watch deems fishing mortality as a “low” concern.

Justification:

Two models were used to estimate fishing mortality: the surplus production model and DeLury model. In the surplus production model, over 50% of model runs suggests that overfishing may be occurring (F_{2009} /F_{MSY} = 1.11) (Muller et al. 2011). The DeLury model was used to estimate if recruitment has changed over time given the high levels of mortality. The model found that recruitment is variable but without trend. Recruitment in the fishery occurs from two sources: 1) where crabs with their original claws reach minimum size, and 2) where crabs have new claws that meet the minimum size (i.e., the crab was declawed and grew a new one). Therefore, this method cannot fully be trusted to evaluate fishing mortality (Muller et al. 2011).

The catch-per-trip data series showed declines until the 2007–08 season but subsequently showed increases. The report suggested that the lack of an increase in landings — concurrent with a doubling in the number of traps — indicated catch potential has reached an upper limit. Between 1986 and 1987 through 2004–05, there have been no observed declines in recruitment (FFWCC 2017a).

The stock assessment mentions that there is a lack of data regarding fishing mortality in the recreational fishery, increasing uncertainty in total fishing mortality estimates (Muller et al. 2011). Additionally, the stock assessment is between five and ten years old (Muller et al. 2011). Another assessment is expected to be published in 2019.

Although discard mortality rates varies significantly with the number of claws removed, the size of the wound (produced by claw removal) is considered a more significant factor. The indirect effects of claw removal (including altered feeding abilities) are deemed substantial (Duermit et al. 2015). Depending upon the size of the crab and when in the intermolt cycle the crab is declawed, it can take one to two years for a crab to regenerate a claw to legal size (Muller et al. 2011). It is legal to remove both claws of legal crabs; however, fishery managers do not encourage this practice as it significantly reduces discard survival rates (FFWCC 2017d). Other factors that may increase mortality rates specifically include being dropped from large heights, but also sex, carapace width, degree of injury, which claw was removed (Kronstadt et al. 2018), and increasing handling times and temperature (Duermit et al. 2015).

White grunt

Factor 2.1 - Inherent Vulnerability

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Low

The Fishbase score for White grunt is 62, which is considered high vulnerability (Froese and Pauly 2014), but using the productivity analysis tool in the Seafood Watch criteria, White grunt have low inherent vulnerability with a score of 2.5, due to their young age at sexual maturity, their reproductive strategy and their moderate lifespan.

Justification:

Life History Attribute	Score	Rationale	Source
Average Age at Maturity	3	3 years	Florida Museum of Natural History Ichthyology webpage
Average Maximum Age	2	18 years	Murie and Parkyn 2005
Fecundity	N/A	19,873-535,039 eggs per female per breeding cycle	Palazón-Fernández 2007
Average Maximum Size	3	53 cm	Froese and Pauly 2014
Average Size at Maturity	3	17 cm	Padgett 1997
Reproductive Strategy	3	Broadcast spawner	Froese and Pauly 2014
Trophic Strategy	1	3.8	Froese and Pauly 2014
Total Score	**2.5**	**Low Vulnerability**	

Figure 5: **Table 5.** Life history characteristics for the White grunt, *Haemulon plumierii*.

Factor 2.2 - Abundance

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Moderate Concern

In the 1999 stock assessment, Murphy et al. (Murphy et al. 1999) estimated B/B_{MSY} to be above 1 between 1994 and 1998, indicating a stable population size. Due to the lack of an updated assessment of biomass relative to reference points, we have rated this factor moderate concern.

Factor 2.3 - Fishing Mortality

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Low Concern

There is no formal metric for fishing mortality, however, observed fishing practices in the Spiny lobster fishery are shown to have minimal impact on bycatch (Matthews and Donaghue 1997). In addition, divers have observed that 90% of fish escape within 24 hours, therefore we have rated this factor low concern.

Factor 2.3 - Modifying Factor: Discards and Bait Use

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

< 20%

Since spearing efforts only target lionfish (hence, there are no discards) and there is no bait used, the discard rate/landings is nil. As a result, we have rated this factor < 20%.

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

20-40%

Lionfish are caught primarily as incidental bycatch in Caribbean spiny lobster traps in the Florida Keys (John Hunt, Bill Kelly, pers. comm.).

Total discard rates given in Shester and Micheli (Shester and Micheli 2011) for spiny lobster trap fisheries are presented as 15%. Although this study refers to the California spiny lobster (*P. interruptus*) fishery, rather than the Caribbean spiny lobster (*Panulirus argus),* it is possible the rates are quite similar. There is little information about the total discard rate in the Caribbean spiny lobster fishery. Most studies to date have been focused on comparing percentages of bycatch in various types of traps and not the impact to the ecosystem as a whole. However, Matthews *et al.* (Matthews et al. 2005) did note that the number of fish that died in traps during observations over one season was quite small.

Data from Shester and Micheli (2011) includes the invertebrates that are most often returned to the water alive, but does not include the bait used. Studies from other lobster fisheries globally have shown that volumes of bait used regularly exceed the volume of the target species landed {Harnish & Martin Willison 2009}(Waddington and Meeuwig 2009), but that is not the case in the Florida lobster fishery. The Florida fishery permits the use of undersized lobsters (or "shorts") as attractants in traps {GMFMC & SAFMC 2011b}. Strips of salted cowhide are used as bait secondarily and fish carcasses may be used at times, but is not preferred for bait use due to the rapid disintegration within the traps (personal communication (Gregory 2013). Studies have shown that traps baited with short lobsters catch more lobster than traps baited with any other method (Heatwole et al. 1988). Although there are measures in place to reduce mortality, the impacts of confinement may result in up to 10% mortality (Matthews 2001)(Matthews 2013, pers. comm.). Combined with a conservative estimate of 15% discards from the Shester & Micheli (2011), a total bait use and discard rate of 25% is given.

Criterion 3: Management Effectiveness

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.'

- *5 (Very Low Concern)—Rated as 'highly effective' for all seven subfactors considered*
- *4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*
- *3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'*
- *2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective.'*
- *1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated 'ineffective.'*
- *0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of Illegal, unregulated, and unreported fishing occurring.*

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***

Criterion 3 Summary

FISHERY	HARVEST STRATEGY	BYCATCH MANAGEMENT STRATEGY	SCORE
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States	4.000	0.000	**Green (4.000)**
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States	3.000	3.000	**Yellow (3.000)**
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States	4.000	0.000	**Green (4.000)**
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States	3.000	3.000	**Yellow (3.000)**

Factor 3.1 Summary

FISHERY	STRATEGY	RECOVERY	RESEARCH	ADVICE	ENFORCE	TRACK	INCLUSION
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States	Highly effective	N/A	Highly effective	Highly effective	Highly effective	Moderately Effective	Highly effective
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States	Moderately Effective	N/A	Highly effective	Highly effective	Highly effective	Moderately Effective	Highly effective
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States	Highly effective	N/A	Highly effective	Highly effective	Highly effective	Moderately Effective	Highly effective
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States	Moderately Effective	N/A	Highly effective	Highly effective	Highly effective	Moderately Effective	Highly effective

Factor 3.2 Summary

FISHERY	ALL SPECIES RETAINED?	CRITICAL?	STRATEGY	RESEARCH	ADVICE	ENFORCE
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States	Yes					
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States	No	No	Moderately Effective	Moderately Effective	Highly effective	Highly effective

FISHERY	ALL SPECIES RETAINED?	CRITICAL?	STRATEGY	RESEARCH	ADVICE	ENFORCE
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States	Yes					
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States	No	No	Moderately Effective	Moderately Effective	Highly effective	Highly effective

Criterion 3 Assessment

SCORING GUIDELINES

Subfactor 3.1.1 – 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? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Subfactor 3.1.2 – Recovery of Species of Concern
Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery's impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

Subfactor 3.1.3 – Scientific Research and Monitoring
Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery's impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

Subfactor 3.1.4 – Management Record of Following Scientific Advice
Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

Subfactor 3.1.5 – 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.

Subfactor 3.1.6 – Management Track Record
Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

Subfactor 3.1.7 – 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 and includes stakeholder input.

Subfactor 3.2.2 – Management Strategy and Implementation
Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.)

Subfactor 3.2.3 – Scientific Research and Monitoring
Considerations: Is bycatch in the fishery recorded/documented and is there adequate monitoring of bycatch to measure fishery's impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met

Subfactor 3.2.4 – Management Record of Following Scientific Advice
Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do

they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

Subfactor 3.2.5 – Enforcement of Management Regulations
Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen's compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.

Factor 3.1.1 - Critical?

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States

No

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States

No

Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

No

Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

No

Factor 3.1.2 - Mgmt Strategy / Implement

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

Highly effective
There is no formal fishery management plan for lionfish to date, but multiple management plans are currently being developed, and there is cooperation and communication amongst local, state, federal, and international partners for their proper management.

Using the strategies and practices developed during the 2010 International Coral Reef Initiative–Caribbean Regional Lionfish Workshop in Cancun, a National Invasive Lionfish Prevention and Management Plan was developed by the Aquatic Nusiance Species Task Force, an intergovernmental organization that is co-chaired by NOAA, and will be publicly available in spring 2015 (Morris 2012)(NOAA 2014). NOAA's Office of National Marine Sanctuaries recently completed their own lionfish plan that will guide lionfish management in affected sanctuaries in the Gulf and southeast United States (Johnston et al. 2015). These two plans together will guide the management of invasive lionfish and ensure that all partners are working toward common objectives (NOAA 2014)(NOAA 2015).

Lionfish populations are increasing and spreading throughout the western Atlantic Ocean, Caribbean Sea, and Gulf of Mexico (NOAA 2014). Lionfish are invasive and managers are concerned that their high abundance is having a negative and irreversible impact (due to predation and competition) on many of the native and ecologically important species (Albins and Hixon 2008)(Morris and Whitfield 2009)(Albins and Hixon 2013)(Arias-Gonzalez et al. 2011). As a result, managers are actively focusing on ways to reduce the abundance of lionfish, prevent their expansion into new areas, and limit any negative ecological impacts (Morris 2012)(NOAA 2015). Therefore, we have rated this factor "highly" effective.
Justification:
The Florida Fish and Wildlife Conservation Commission (FWC) lionfish team held a meeting in August 2012 to develop an agency approach on lionfish control. In this meeting, the working group drafted future conditions and decided to hold a lionfish summit with stakeholders to receive input and identify collaborative opportunities with respect to research needs and management

strategies for lionfish population control. The FWC hosted a Lionfish Summit in Cocoa Beach, Florida in October 2013, with the goal of developing a collaborative framework for partnering on future lionfish management that included identification of research priorities, management actions and outreach initiatives (FFWCC 2013).

In August 2010, the International Coral Reef Initiative (ICRI) set up a Regional Lionfish Committee (RLC) and held a region-wide workshop on the lionfish invasion in the Wider Caribbean. This committee is tasked with developing a strategy for lionfish control and management. To date, the RLC has released their regional-strategy document, supported Costa Rica in developing a National Strategy for the Control of Invasive Lionfish in Costa Rica, released an advisory statement and manual in three languages which aims to draw international attention to the invasive lionfish issue, developed a lionfish webportal to facilitate regional communication, compiled scientific information and provided access to best management practices and manager-training tools, and presented at regional and international conferences and fora on the lionfish invasion in the Caribbean (Morris 2012)(ICRI 2015).

At present, organizations are focusing on small-scale manual removal of lionfish throughout these invaded areas. For example, REEF's Lionfish Research Program hosts lionfish derbies and tournaments and Lionfish Removal and Awareness Day in order to help control lionfish populations. They have a Reef Ranger program where one adopts a reef and pledges to remove lionfish from it. REEF also holds workshops on safe collecting and handling techniques of lionfish, how to prepare them to eat, and how to easily obtain collection permits. The FWC encourages divers, anglers and commercial harvesters to remove lionfish in Florida waters to limit negative impacts to native marine life and ecosystems. There are no Florida state or federal regulations (in Gulf state or Atlantic waters) on minimum size limit or daily bag limit. It is illegal to transport and release live lionfish."

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Moderately Effective
Lionfish

There is no formal fishery management plan for lionfish to date, but multiple management plans are currently being developed, and there is cooperation and communication amongst local, state, federal, and international partners for their proper management.

Using the strategies and practices developed during the 2010 International Coral Reef Initiative–Caribbean Regional Lionfish Workshop in Cancun, a National Invasive Lionfish Prevention and Management Plan was developed by the Aquatic Nusiance Species Task Force, an intergovernmental organization that is co-chaired by NOAA, and will be publicly available in spring 2015 (Morris 2012)(NOAA 2014). NOAA's Office of National Marine Sanctuaries recently completed their own lionfish plan that will guide lionfish management in affected sanctuaries in the Gulf and southeast United States (Johnston et al. 2015). These two plans together will guide the management of invasive lionfish and ensure that all partners are working toward common objectives (NOAA 2014)(NOAA 2015).

Caribbean Spiny Lobster

Since the 1800s, there has been a commercial spiny lobster trap fishery along the Florida coast. Regulations and laws regulating the spiny lobster in the state of Florida have been in place since the early 1900s, namely minimum size limits, a closed season, and the prohibition of taking berried females (Buesa 2018). The lobster fishery takes place in state and federal waters. It is managed by the Florida state agency (Florida Fish and Wildlife Conservation Commission) and federal councils (SAFMC and GMFMC) through a FMP in the South Atlantic and the Gulf of Mexico Management Council regions since 1982 (GMFMC and SAFMC 1982). The FMP has been amended 12 times over the years (GMFMC 2017a). In 1992, Florida adopted regulations instituting the Lobster Trap Certificate Program to reduce the number of traps in the fishery (Matthews and Williams 2000). FMP Amendment 10 (2011) established a combined recreational and commercial fishery Annual Catch Limit (ACL) of 10.46 million lb whole weight and an Annual Catch Target (ACT) for the combined recreational and commercial fishery of 6.59 million lb (GMFMC 2017a). The amendment also modified regulations regarding the use of undersized lobsters as bait (Federal Register 2011). Amendment 11, implemented in April 2012, closed 60 specific areas to protect Acropora coral species. Amendment 12 was implemented in 2014 and consolidated the existing federal dealer permits and increased the frequency of federal dealer reporting from a monthly to weekly basis. More recently, modifications to Amendment 4 respecified the OFL and ABC by using a longer time series of landings data (GMFMC 2017a).

There is a lack of evidence to prove that the management strategy is being implemented successfully. The most recent stock assessment was rejected by the Review Panel and current reference points are not deemed suitable for the stock. The stock is not believed to be undergoing overfishing and landings have been stable in recent years (GMFMC 2017a). However, a large proportion of recruitment to the US spiny lobster fishery comes from outside the US EEZ. US catches probably have little, if any, effect on the productivity or sustainability of the biomass in US waters (SAFMC 2016a). This makes it difficult to determine if the management within the US EEZ is effective at managing the stock.

Stone crab

Lobster and stone crab seasons have some overlap and stone crabs are caught and retained in the spiny lobster fishery (pers. comm., FFWCC 25 May 2018). Stone crab are subject to management through the FFWCC, which includes the limited fishing grounds outside state waters (FFWCC 2011a) (FFWCC 2016c).

Lionfish populations are increasing and spreading throughout the western Atlantic Ocean, Caribbean Sea, and Gulf of Mexico (NOAA 2014). Lionfish are invasive and managers are concerned that their high abundance is having a negative and irreversible impact (due to predation and competition) on many of the native and ecologically important species (Albins and Hixon 2008)(Morris and Whitfield 2009)(Albins and Hixon 2013)(Arias-Gonzalez et al. 2011). As a result, managers are actively focusing on ways to reduce the abundance of lionfish, prevent their expansion into new areas, and limit any negative ecological impacts (Morris 2012)(NOAA 2015).

Although management strategies for lionfish are considered "highly" effective, the effectiveness of current management measures for Caribbean spiny lobster is uncertain. Therefore, Seafood Watch deems management strategy as "moderately" effective.
Justification:
The Florida Fish and Wildlife Conservation Commission (FWC) lionfish team held a meeting in August 2012 to develop an agency approach on lionfish control. In this meeting, the working group drafted future conditions and decided to hold a lionfish summit with stakeholders to receive input and identify collaborative opportunities with respect to research needs and management strategies for lionfish population control. The FWC hosted a Lionfish Summit in Cocoa Beach, Florida in October 2013, with the goal of developing a collaborative framework for partnering on future lionfish management that included identification of research priorities, management actions and outreach initiatives (FFWCC 2013).

In August 2010, the International Coral Reef Initiative (ICRI) set up a Regional Lionfish Committee (RLC) and held a region-wide workshop on the lionfish invasion in the Wider Caribbean. This committee is tasked with developing a strategy for lionfish control and management. To date, the RLC has released their regional-strategy document, supported Costa Rica in developing a National Strategy for the Control of Invasive Lionfish in Costa Rica, released an advisory statement and manual in three languages which aims to draw international attention to the invasive lionfish issue, developed a lionfish webportal to facilitate regional communication, compiled scientific information and provided access to best management practices and manager-training tools, and presented at regional and international conferences and fora on the lionfish invasion in the Caribbean (Morris 2012)(ICRI 2015).

At present, organizations are focusing on small-scale manual removal of lionfish throughout these invaded areas. For example, REEF's Lionfish Research Program hosts lionfish derbies and tournaments and Lionfish Removal and Awareness Day in order to help control lionfish populations. They have a Reef Ranger program where one adopts a reef and pledges to remove lionfish from it. REEF also holds workshops on safe collecting and handling techniques of lionfish, how to prepare them to eat, and how to easily obtain collection permits. The FWC encourages divers, anglers and commercial harvesters to remove lionfish in Florida waters to limit negative impacts to native marine life and ecosystems. There are no Florida state or federal regulations (in Gulf state or Atlantic waters) on minimum size limit or daily bag limit. It is illegal to transport and release live lionfish.

Factor 3.1.3 - Recovery of Stock Concerns

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

N/A
Since there are currently no overfished, depleted, endangered or threatened species targeted or retained in the lionfish spear fishery, we have rated this factor not applicable.

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

N/A
Since there are currently no overfished, depleted, endangered or threatened species targeted or retained in the spiny lobster trap fishery, where lionfish are incidental bycatch, we have rated this factor not applicable.

Factor 3.1.4 - Scientific Research / Monitoring

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

Highly effective
There is no formal stock assessment for the lionfish fishery, however NOAA's National Center for Coastal Ocean Science (NCCOS) is spearheading the lionfish invasion study through strong collaborations with the REEF and USGS. Research and monitoring of invasive lionfish is continual. Currently, there are only two estimates of lionfish densities, a multi-year assessment off North Carolina (Morris and Whitfield 2009) and a single-year observation in the Bahamas (Green and Cote 2009). Annual assessments of lionfish densities off North Carolina show that the lionfish population is continuing to increase, but annual assessments of lionfish densities elsewhere are needed to determine the relative abundance of lionfish, when lionfish densities reach their maximum, and when lionfish populations reach equilibrium in their invaded range (NCCOS 2014). Lionfish sightings and captures are kept track of and USGS provides an up-to-date, realtime distribution map which documents their spread.

The Gulf and Caribbean Fisheries Institute (GCFI), the National Park Service (NPS), Bahamian Department of Marine Resources (BDMR), in addition to several universities, marine sanctuaries, public aquariums, and the professional and recreational dive community, are also aiding in research and monitoring efforts (REEF 2012)(NCCOS 2014)(Schofield et al. 2015)(GCFI 2015). As a result, we have rated this factor highly effective.
Justification:

- NOAA's NCCOS is focusing their research efforts on lionfish biology and ecology, their ecological impacts, control and management, population monitoring, and on outreach and education (NCCOS 2014).
- REEF maintains an online educational section on invasive species, as well as an online exotic species reporting page. Since 2006, REEF has been working with government agencies and partners throughout the region to help develop lionfish response plans, train resource managers and dive operators in effective collecting and handling techniques and conduct cutting edge research to help address the invasion (REEF 2012).
- USGS maintains a Non-indigenous Aquatic Species (NAQ) webpage on lionfish which provides access to scientific reports, online/realtime queries, spatial data sets, regional contact lists, and general information (Schofield et al. 2015).
- GCFI maintains an Invasive Lionfish Webportal which focuses on outreach and education, research and monitoring, control, and management specifically in the Gulf of Mexico and the Caribbean Sea. GCFI also holds an annual meeting devoted to technical presentations and workshops on lionfish management in this region (GCFI 2015).
- NPS has a Lionfish Response Plan to guide Parks in addressing threats to fragile coral reef ecosystems and visitor safety, and has additional resources to find out what they are doing in efforts to track and remove lionfish and inform the public about lionfish (NPS 2015).
- BDMR, in collaboration with the College of The Bahamas Marine and Environmental Studies Institute (COB-MESI) and others, launched a multi-year project to develop a National Lionfish Response Plan (NLRP) that entails a partnership between both local and regional government and non-governmental agencies and focuses on ecological research, invasion management and policy development, and educational initiatives to understand the implications of the establishment of the Indo-Pacific lionfish on fisheries resources and the ecology of coastal systems in The Bahamas (BDMP 2009). Along with the Nature Conservancy, the Ministry of Tourism, and other government and private sector agencies and local NGOs, they are on The Bahamas' National Coastal Awareness Committee to heighten awareness of the threat of lionfish and to assist with appropriate strategies to reduce the threat (TNC 2008).
- Mark Hixon's lab at Oregon State University has been studying possible sources of native biotic resistance to the invasion and the ecological effects of the invasion since lionfish first arrived in the central Bahamas in 2005. Their publications and other relevant downloads and information are available on a dedicated web page: http://hixon.science.oregonstate.edu/content/highlight-lionfish-invasion (Hixon 2015).

Factor 3.1.5 - Scientific Advice

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

Highly effective
There is currently no formal assessment of the lionfish fishery, however, for the lionfish fishery management plans that are in progress, scientific advice and research forms their very foundation. Since lionfish are invasive in the western Atantic Ocean, Caribbean Sea, and Gulf of Mexico, there is a fundamental lack of information on the species, how they interact with native organisms, which temperature regimes they can tolerate, etc. Studies are underway in order to ascertain lionfish biology and ecology, ecological impacts, control and management, and population monitoring (NCCOS 2014). As a result, we have rated this factor highly effective.

Factor 3.1.6 - Enforce

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

Highly effective
Since lionfish are invasive in the western Atlantic Ocean, Caribbean Sea, and Gulf of Mexico, and management is focusing on ways to decrease their abundance, there are no TACs set, nor is there a need for enforcement. Multiple management plans for lionfish are in the process of being developed (Morris 2012)(NOAA 2014). As a result, we have rated this factor highly effective.

Factor 3.1.7 - Track Record

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

Moderately Effective
Lionfish populations are thriving, as they have expanded their range since they were introduced into Florida waters in 1985, and abundance has been increasing (Whitfield et al. 2007)(Gonzalez et al. 2009)(Morris and Akins 2009)(Schofield 2009)(Aguilar-Perera and Tuz-Sulub 2010){Lasso-Alcalá and Posada 2010}(Schofield et al. 2010)(Frazer et al. 2012)(Santander-Monsalvo et al. 2012)(Schofield et al. 2015){Callicó Fortunato and Avigliano 2014}. Since management is only recently focusing on ways to reduce the abundance of lionfish, prevent their expansion into areas, and limit negative ecological impacts, we have rated this factor moderately effective.

Factor 3.1.8 - Stakeholder Inclusion

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

Highly effective

Stakeholders are an important part of the lionfish fishery's development. Two region-wide management plans for lionfish are currently being developed (Morris 2012)(NOAA 2014), and will incorporate, and solicit input from, resource users (divers, fishers), relevant government and non-governmental agencies, academic instutitions, neighboring countries, and public and private sector stakeholders in affected areas. As a result, we have rated this factor highly effective.

Factor 3.2.1 - All Species Retained?

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

Yes

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States

No

Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

No

Factor 3.2.2 - Critical?

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States

No

Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

No

Factor 3.2.3 - Mgmt Strategy / Implement

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Moderately Effective

Traps are very selective and non-target species make up a relatively small proportion of catches; comprising no more than 5% of the catch, they include include various finfish and invertebrates, such as grunts, grouper, hogfish, snapper, hermit crabs, arrow crabs, and spider crabs (GMFMC 2017a). The spiny lobster fishery is not a leading cause of a high level of mortality for any species of concern: the 2009 Biological Opinion declared that the species most at risk to the fishery were Acropora corals, smalltooth sawfish, and Atlantic turtles. The impact from the lobster fishery does not reduce the likelihood of survival and recovery of their populations (NMFS 2009) (GMFMC 2017a). The spiny lobster fishery is a Category III fishery under the MMPA, since there is a remote likelihood of mortalities or serious injuries to marine mammals. The Category III listing includes several stocks of the common bottlenose dolphin; however, due to their low likelihood of capture and low level of fishing mortality relative to the PBR, they have received a "low" concern for fishing mortality in Criteria 2.

A suite of measures has been implemented in the FMP to reduce the risk of the spiny lobster fishery on bycatch and ETP species. These generally include gear restrictions, gear identification requirements, a permit program, trap limits, area closures, and prohibitions on capturing or harming species listed on the ESA (see justification for further details). Observer programs are not in place due to the fishery's Category III designation. Instead, the National Oceanographic Atmospheric Administration (NOAA) conducts a mandatory Trip Interview Program (TIP) in Florida for all commercial fishermen (pers. comm., T. Matthews 2017).

There are significant issues with ghost traps in the Florida spiny lobster fishery, causing an estimated mortality of 637,622 lobsters annually (Butler and Matthews 2015), equating to approximately 11% of the total lobster catch. Abandoned traps or buoys are the responsibility of the owner (GMFMC 2017a). Traps must have certificates (availability of which is reduced periodically by the FFWCC through the trap reduction program) (FFWCC 2018a). To mitigate the impact of ghost fishing, plastic lobster traps are required to have a degradable escape panel (on plastic traps) (FFWCC 2017b), and there are requirements for trap materials and sizes. However, derelict traps can continue to fish for over one year (Butler and Matthews 2015). The State of Florida runs two programs dedicated to removing lost and abandoned traps from state waters and has the authority to expand those programs into federal waters (FishWatch 2017). Nonetheless, the efficacy is limited as only 10% of traps are removed annually (Buesa 2018).

Lobster traps are a very selective fishing gear. Management is effective at reducing the impact on bycatch and endangered, threatened and protected (ETP) species. Although programs have been initiated to reduce the risk of ghost fishing, they are relatively new, and more time is required for them to be effective. Therefore, Seafood Watch deems Bycatch Strategy as a "moderately effective."

Factor 3.2.3 - Scientific Research / Monitoring

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Moderately Effective

The SEDAR process includes many different species and distributes information broadly and the FFWCC observer program is intended to aid in the evaluation of bycatch (SEDAR 2005). Otherwise, there is little data aside from logbook data related to other retained species. FFWCC monitors ghost fishing, its effects and trap recovery rates through the two programs (the Spiny Lobster, Stone Crab, and Blue Crab Trap Retrieval Program and the Derelict Trap and Trap Debris Removal Program) (FFWCC 2016d).

Factor 3.2.5 - Scientific Advice

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Highly effective
Little research has been performed about the impacts of the fishery on other species, but the history of the FFWCC and Fishery Management Councils to respond to the information that is available indicates they would react to scientific advice and this factor has therefore been scored highly effective.

Factor 3.2.6 - Enforce

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Highly effective
The FFWCC law enforcement division and the NOAA Office for Law Enforcement, along with the U.S. Coast Guard, are charged with patrolling and enforcing current regulations, which would include illegal possession of various species. Beyond this, there is no additional enforcement related specifically to bycatch species. As such, we have rated this factor highly effective.

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

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States	Very Low Concern	Not Applicable	Low Concern	**Green (4.000)**
Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States	Moderate Concern	Moderate Mitigation	Low Concern	**Yellow (3.162)**
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States	Very Low Concern	Not Applicable	Low Concern	**Green (4.000)**
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States	Moderate Concern	Moderate Mitigation	Low Concern	**Yellow (3.162)**

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 - Impact of Fishing Gear on the Habitat/Substrate

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

Very Low Concern
Spearing gear may come into contact with the substrate (Gittings 2015). Because any contact is localized, and contact does not always occur, damage to substrate is likely negligible and we have rated this factor very low concern.

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Moderate Concern
Lionfish are caught primarily as incidental bycatch in Caribbean spiny lobster traps in the Florida Keys (John Hunt, Bill Kelly, pers. comm.).
Spiny lobsters are generally found on rocky substrates and reefs, or wherever protection and shelter can be found (Holthuis 1991). As such, traps are deployed in a variety of habitats including on rocky reefs and coral, as well as in sand and seagrass areas. The impact of the traps on benthic habitat is variable across the fishery. The spiny lobster fishery in Florida has recently implemented 60 closed areas in federal waters to protect *Acropora* coral species from traps {GMFMC & SAFMC 2012}. Gear impact on substrate will vary because benthic habitat varies, so we have rated this factor moderate concern.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

Not Applicable
We have rated this factor as not applicable because spearing gear does not always contact the substrate, and if it does, it is localized and relatively benign compared to other gear types.

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States

Moderate Mitigation
As a result of the Florida Keys National Marine Sanctuary (FKNMS), there are ecological reserves and sanctuary preservation areas that are closed to all fishing, and consequently prohibit spiny lobster fishing, where lionfish are incidental bycatch (NMFS 2009). Additionally, there are 60 other areas recently closed in order to protect coral (*Acropora* species). Because of this, we have rated this factor moderate mitigation.
Justification:
There are currently several sanctuary preservation areas and ecological reserves within the Florida Keys National Marine Sanctuary (FKNMS) intended to preserve "discrete, biologically important areas that help sustain critical marine species and habitats"

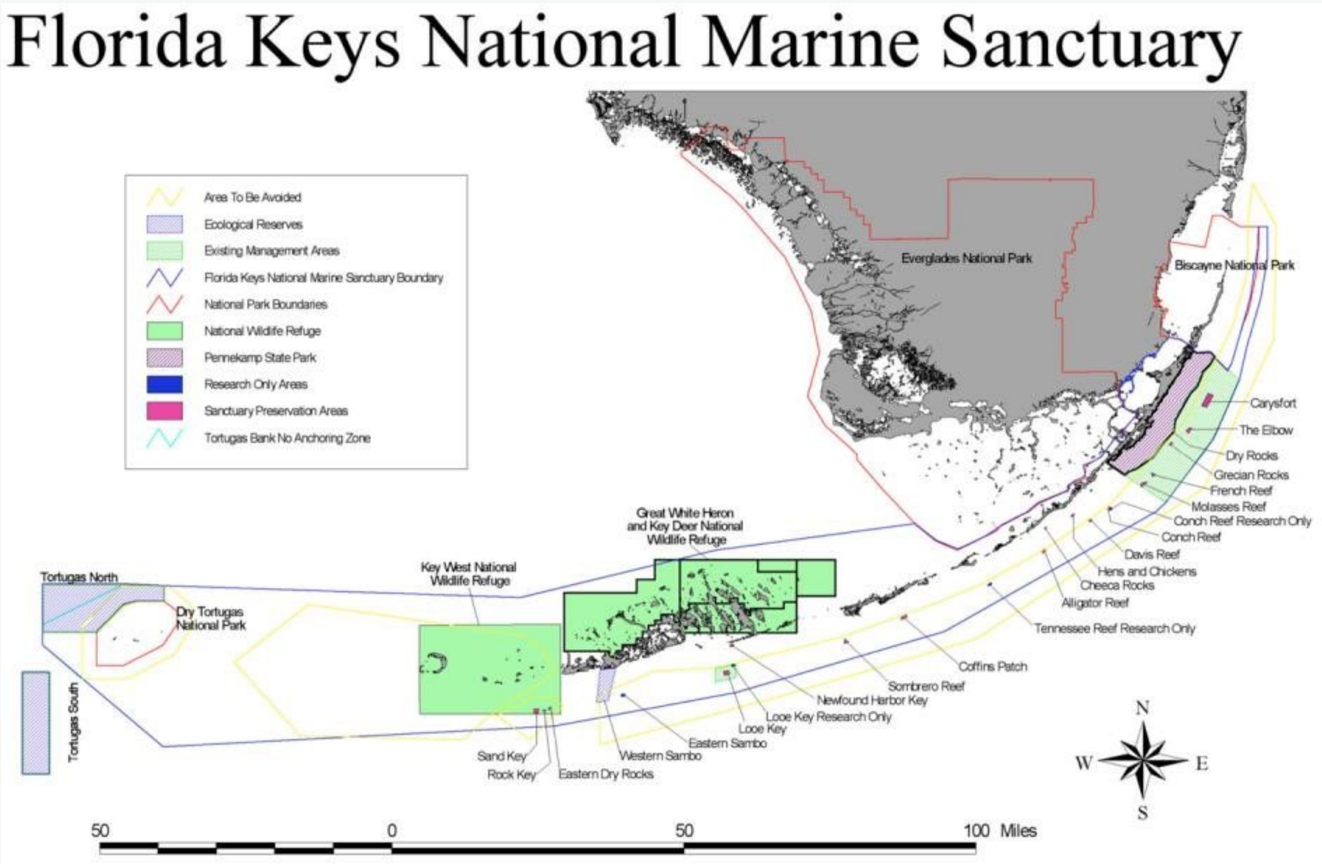

Figure 6: Map of Florida Keys National Marine Sanctuary protected areas. From FKNMS 2012.

(FKNMS 2011). Further, FKNMS regulations prohibit the operation of a vessel in such a manner that will injure coral, as well as anchoring on live coral in water depths less than 40 ft when the bottom can be seen [15CFR 922.163(i) and (ii)](NMFS 2009). Additionally, Final Amendment 11 to the Gulf of Mexico and South Atlantic FMP closed 60 areas to specifically protect *Acropora spp.* {GMFMC & SAFMC 2012}.

Factor 4.3 - Ecosystem-based Fisheries Management

Atlantic and adjacent areas | Atlantic, Northwest | Traps (unspecified) | United States
Gulf of Mexico | Atlantic, Western Central | Traps (unspecified) | United States
Atlantic and adjacent areas | Atlantic, Northwest | Hand implements | United States
Gulf of Mexico | Atlantic, Western Central | Hand implements | United States

Low Concern

Because of the high abundance of lionfish and their negative impact on native fauna (Albins and Hixon 2013)(Barbour et al. 2011)(REEF 2012)(FFWCC 2015)(NOAA 2015)(Schofield et al. 2015), managers are researching the best methods to reduce lionfish densities and limit their distribution. Therefore, since the direct targeting of lionfish would benefit the native species, we have rated this factor low concern.

Justification:

Since their invasion, lionfish have been considered one of the top predators in many coral reef environments of the Atlantic, Caribbean and Gulf of Mexico.

They are resilient to disease and parasites, and have no known predators due to their venomous spines (Morris and Whitfield 2009)(Albins and Hixon 2013)(Sikkel et al. 2014). In combination with their resilience, lionfish are so ecologically devastating because of both their direct and indirect predation effects when found in high densitites.

Lionfish are generalist carnivores that can consume over 70 species of fish, up to half of their body size, including many commercially, receationally and ecologically important native species such as gobies, blennies, damselfish, wrasses, surgeonfish, parrotfish, cardinalfish, goatfish, juvenile snapper, grouper, hogfish, grunts, cleaner shrimp and others (Albins and Hixon 2008)(Morris and Akins 2009)(Morris and Whitfield 2009){Muñoz et al. 2011}(Green et al. 2012)(NOAA 2014)(NOAA 2015). Lionfish are also capable of inhabiting and feeding in different habitats such as mangroves and seagrass beds (Barbour et al. 2010)(Chevalier 2008)(Biggs and Olden 2011)(Claydon 2012), which are nurseries for juvenile reef fish (Beck et al. 2001).

Lionfish have even been found up a river estuary in Florida (Jud et al. 2011)(Jud and Layman 2012). As well as preying upon these species, possibly hampering stock rebuilding efforts, removing herbivious fish that keep the algae growth on reefs in check, and altering food webs, lionfish compete for space and food with some commercially and recreationally important reef-fish species, such as snapper, grouper, and hogfish (Albins and Hixon 2013)(NOAA 2015). When native species compete with lionfish, it may affect their behavior, distrbution, growth, survival and population sizes (Albins and Hixon 2013)(Green et al. 2012)(Albins and Lyons 2012).

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.

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Appendix B: Review Schedule

The Florida Fish and Wildlife Commission, Fish and Wildlife Research Institute is in the process of publishing estimates for mortality of lobsters in lost traps (i.e. ghost fishing). New studies should be available in another year or so (pers. comm. (Matthews 2013).

Appendix

Updates to Lionfish Report : **Updates to the January 11, 2016 U.S. Lionfish report were made on September 30, 2020**

Overall Recommendations for lionfish caught by traps and hand implements remain unchanged, but individual criterion updates are outlined below.

- C2.1 Florida stone crab downgraded from "Low" Concern to "Moderate" Concern because the stock status is considered unknown, but the the stock inherent vulnerability is low as scored in Factor 1.1. Scoring and Summary changed.
- C2 Common bottlenose dolphin was added to the report for the trap fisheries because this fishery has been selected as a category III species for injuring or killing five bottlenose dolphin stocks. Scoring and Summary changed.
- C3.1.1 (Trap fisheries) Downgraded from "Highly" Effective to "Moderately" Effective because there is uncertainty in the effectiveness of management measures for Caribbean spiny lobster. Scoring and Summary changed.