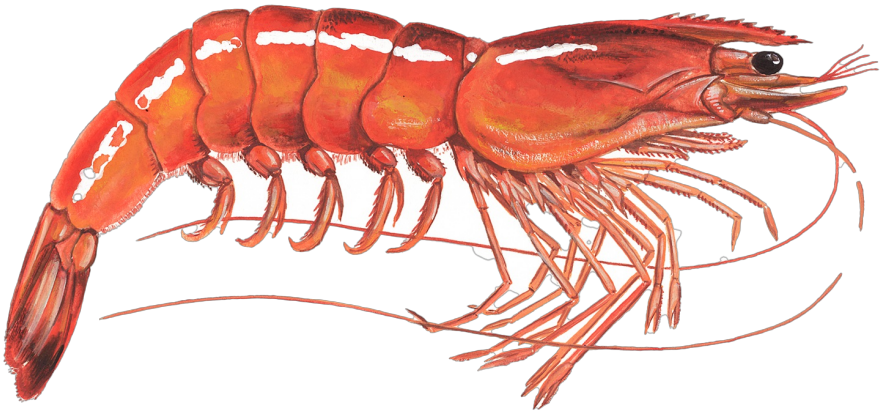
Monterey Bay Aquarium
Seafood Watch

Environmental sustainability assessment of wild-caught Shrimp from the United States (Gulf of Mexico & South Atlantic) caught using bottom trawls and skimmer trawls



Species:	Brown shrimp *(Penaeus aztecus)*, Pink shrimp *(Penaeus duorarum)*, Brown rock shrimp *(Sicyonia brevirostris)*, Royal red shrimp *(Pleoticus robustus)*, White shrimp *(Penaeus setiferus)*
Location:	United States: Gulf of Mexico & South Atlantic
Gear:	Bottom trawl, Skimmer trawl
Type:	Wild Caught
Author:	Seafood Watch
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Assessed using Seafood Watch Fisheries Standard v3

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About the Monterey Bay Aquarium Seafood Watch Program

The mission of the Monterey Bay Aquarium is to inspire conservation of the ocean and enable a future where the ocean flourishes and people thrive in a just and equitable world. To do this, the Aquarium is focused on creating extraordinary experiences that inspire awe and wonder, championing science-based solutions, and connecting people across the planet to protect and restore the ocean. We know that healthy ocean ecosystems are critical to enabling life on Earth to exist, and that our very survival depends on them. As such, our conservation objectives are to mobilize climate action, improve the sustainability of global fisheries and aquaculture, reduce sources of plastic pollution, and restore and protect ocean wildlife and ecosystems.

The aquarium is focused on improving the sustainability of fisheries and aquaculture given the role seafood plays in providing essential nutrition for 3 billion people globally, and in supporting hundreds of millions of livelihoods. Approximately 180 million metric tons of wild and farmed seafood is harvested each year (excluding seaweeds). Unfortunately, not all current harvest practices are sustainable and poorly managed fisheries and aquaculture pose the greatest immediate threat to the health of the ocean and the economic survival and food security of billions of people.

The Seafood Watch program was started 25 years ago as a small exhibit in the Monterey Bay Aquarium highlighting better fishing practices and grew into one of the leading sources of information on seafood sustainability, harnessing the power of consumer choice to mobilize change. The program's comprehensive open-source information and public outreach raises awareness about global sustainability issues, identifies areas for improvement, recognizes and rewards best practices and empowers individuals and businesses to make informed decisions when purchasing seafood.

We define sustainable seafood as seafood from sources, whether fished or farmed, that can maintain or increase production without jeopardizing the structure and function of affected ecosystems, minimize harmful environmental impacts, assure good and fair working conditions, and support livelihoods and economic benefits throughout the entire supply chain. As one aspect of this vision, Seafood Watch has developed trusted, rigorous standards for assessing the environmental impacts of fishing and aquaculture practices worldwide. Built on a solid foundation of science and collaboration, our standards reflect our guiding principles for defining environmental sustainability in seafood.

Seafood Watch Ratings

The Seafood Watch Standard for Fisheries is used to produce assessments for wild-capture fisheries resulting in a Seafood Watch rating of green, yellow, or red. Seafood Watch uses the assessment criteria to determine a final numerical score as well as numerical subscores and colors for each criterion. These scores are translated to a final Seafood Watch color rating according to the methodology described in the table below. The table also describes how Seafood Watch defines each of these categories. The narrative descriptions of each Seafood Watch rating, and the guiding principles listed below, compose the framework on which the criteria are based.

Green	Final Score >3.2, and either criterion 1 or criterion 3 (or both) is green, and no red criteria, and no critical scores	Wild-caught and farm-raised seafood rated green are environmentally sustainable, well managed and caught or farmed in ways that cause little or no harm to habitats or other wildlife. These operations align with all of our guiding principles.
Yellow	Final score >2.2, and no more than one red criterion, and no critical scores, and does not meet the criteria for green (above)	Wild-caught and farm-raised seafood rated yellow cannot be considered fully environmentally sustainable at this time. They align with most of our guiding principles, but there is either one conservation concern needing substantial improvement, or there is significant uncertainty associated with the impacts of the fishery or aquaculture operations.
Red	Final Score ≤2.2, or two or more red criteria, or one or more critical scores.	Wild-caught and farm-raised seafood rated red are caught or farmed in ways that have a high risk of causing significant harm to the environment. They do not align with our guiding principles and are considered environmentally unsustainable due to either a critical conservation concern, or multiple areas where improvement is needed.

Recommended Citation: Seafood Watch (2025) Environmental sustainability assessment of wild-caught Shrimp from the United States (Gulf of Mexico & South Atlantic) caught using bottom trawls and pushed skimmer nets Monterey Bay Aquarium

Guiding Principles

Monterey Bay Aquarium defines sustainable seafood as seafood from sources, whether fished or farmed, that can maintain or increase production without jeopardizing the structure and function of affected ecosystems, minimize harmful environmental impacts, assure good and fair working conditions, and support livelihoods and economic benefits throughout the entire supply chain.

As one aspect of this vision, Seafood Watch has developed trusted, rigorous standards for assessing the environmental impacts of fishing and aquaculture practices worldwide. Environmentally sustainable wild capture fisheries:

1. **Follow the principles of ecosystem-based fisheries management**

   The fishery is managed to ensure the integrity of the entire ecosystem, rather than solely focusing on maintenance of single species stock productivity. To the extent allowed by the current state of the science, ecological interactions affected by the fishery are understood and protected, and the structure and function of the ecosystem is maintained.

2. **Ensure all affected stocks[1] are healthy and abundant**

   Abundance, size, sex, age and genetic structure of the main species affected by the fishery (not limited to target species) is maintained at levels that do not impair recruitment or long-term productivity of the stocks or fulfillment of their role in the ecosystem and food web.

   Abundance of the main species affected by the fishery should be at, above, or fluctuating around levels that allow for the long-term production of maximum sustainable yield. Higher abundances are necessary in the case of forage species, in order to allow the species to fulfill its ecological role.

3. **Fish all affected stocks at sustainable levels**

   Fishing mortality for the main species affected by the fishery should be appropriate given current abundance and inherent resilience to fishing while accounting for scientific uncertainty, management uncertainty, and non-fishery impacts such as habitat degradation.

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[1]"Affected" stocks include all stocks affected by the fishery, no matter whether target or bycatch, or whether they are ultimately retained or discarded.

The cumulative fishing mortality experienced by affected species must be at or below the level that produces maximum sustainable yield for single-species fisheries on typical species that are at target levels.

Fishing mortality may need to be lower than the level that produces maximum sustainable yield in certain cases such as forage species, multispecies fisheries, highly vulnerable species, or fisheries with high uncertainty.

For species that are depleted below target levels, fishing mortality must be at or below a level that allows the species to recover to its target abundance.

4. **Minimize bycatch**

   Seafood Watch defines bycatch as all fisheries-related mortality or injury other than the retained catch. Examples include discards, endangered or threatened species catch, pre-catch mortality and ghost fishing. All discards, including those released alive, are considered bycatch unless there is valid scientific evidence of high post-release survival and there is no documented evidence of negative impacts at the population level.

   The fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss and by efficiently using marine and freshwater resources as bait.

5. **Have no more than a negligible impact on any threatened, endangered or protected species**

   The fishery avoids catch of any threatened, endangered or protected (ETP) species. If any ETP species are inadvertently caught, the fishery ensures and can demonstrate that it has no more than a negligible impact on these populations.

6. **Are managed to sustain the long-term productivity of all affected species**

   Management should be appropriate for the inherent resilience of affected marine and freshwater life and should incorporate data sufficient to assess the affected species and manage fishing mortality to ensure little risk of depletion. Measures should be implemented and enforced to ensure that fishery mortality does not threaten the long term productivity or ecological role of any species in the future.

   The management strategy has a high chance of preventing declines in stock productivity by taking into account the level of uncertainty, other impacts on the stock, and the potential for increased pressure in the future.

   The management strategy effectively prevents negative population impacts on bycatch species, particularly species of concern.

7. **Avoid negative impacts on the structure, function or associated biota of aquatic habitats where fishing occurs**

The fishery does not adversely affect the physical structure of the seafloor or associated biological communities.

If high-impact gears (e.g. trawls, dredges) are used, vulnerable seafloor habitats (e.g. corals, seamounts) are not fished, and potential damage to the seafloor is mitigated through substantial spatial protection, gear modifications and/or other highly effective methods.

8. **Maintain the trophic role of all aquatic life**

   All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web, as informed by the best available science.

9. **Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts**

   Fishing activities must not result in harmful changes such as depletion of dependent predators, trophic cascades, or phase shifts.

   This may require fishing certain species (e.g., forage species) well below maximum sustainable yield and maintaining populations of these species well above the biomass that produces maximum sustainable yield.

10. **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**

    Any enhancement activities are conducted at levels that do not negatively affect wild stocks by reducing diversity, abundance or genetic integrity.

    Management of fisheries targeting enhanced stocks ensures that there are no negative impacts on the wild stocks, in line with the guiding principles described above, as a result of the fisheries.

    Enhancement activities do not negatively affect the ecosystem through density dependent competition or any other means, as informed by the best available science.

Final Ratings

Ratings Details	C 1 Target Species	C 2 Other Species	C 3 Management	C 4 Habitat	Rating
Brown rock shrimp United States - Gulf of Mexico - Bottom trawls	2.644	0.750	4.000	3.162	Yellow (2.238)
Brown rock shrimp United States - Western Central Atlantic Ocean - Bottom trawls	2.644	0.750	4.000	3.162	Yellow (2.238)
Brown shrimp United States - Gulf of Mexico - Bottom trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central	5.000	0.750	4.000	3.162	Yellow (2.624)
Brown shrimp United States - Western Central Atlantic Ocean - Bottom trawls	2.644	0.750	4.000	3.162	Yellow (2.238)
Brown shrimp United States - Florida - Gulf of Mexico - Skimmer trawls	5.000	0.750	4.000	3.162	Yellow (2.624)
Brown shrimp United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels greater than 40 feet are required to use Turtle Excluder Devices	5.000	0.750	4.000	3.162	Yellow (2.624)
Brown shrimp United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels less than 40 feet are not required to use Turtle Excluder Devices	5.000	0.750	1.000	3.162	Red (1.856)
Pink shrimp United States - Gulf of Mexico - Bottom trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central	5.000	0.750	4.000	3.162	Yellow (2.624)
Pink shrimp United States - Western Central Atlantic Ocean - Bottom trawls	2.644	0.750	4.000	3.162	Yellow (2.238)

Ratings Details	C 1 Target Species	C 2 Other Species	C 3 Management	C 4 Habitat	Rating
Pink shrimp United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels greater than 40 feet are required to use Turtle Excluder Devices	5.000	0.750	4.000	3.162	Yellow (2.624)
Pink shrimp United States - Florida - Gulf of Mexico - Skimmer trawls	5.000	0.750	4.000	3.162	Yellow (2.624)
Pink shrimp United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels less than 40 feet are not required to use Turtle Excluder Devices	5.000	0.750	1.000	3.162	Red (1.856)
Royal red shrimp United States - Gulf of Mexico - Bottom trawls	3.413	0.750	4.000	3.162	Yellow (2.385)
Royal red shrimp United States - Western Central Atlantic Ocean - Bottom trawls	2.644	0.750	4.000	3.162	Yellow (2.238)
White shrimp United States - Gulf of Mexico - Bottom trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central	5.000	0.750	4.000	3.162	Yellow (2.624)
White shrimp United States - Western Central Atlantic Ocean - Bottom trawls	2.644	0.750	4.000	3.162	Yellow (2.238)
White shrimp United States - Florida - Gulf of Mexico - Skimmer trawls	5.000	0.750	4.000	3.162	Yellow (2.624)
White shrimp United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels greater than 40 feet are required to use Turtle Excluder Devices	5.000	0.750	4.000	3.162	Yellow (2.624)

Ratings Details	C 1 Target Species	C 2 Other Species	C 3 Management	C 4 Habitat	Rating
White shrimp United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels less than 40 feet are not required to use Turtle Excluder Devices	5.000	0.750	1.000	3.162	Red (1.856)

Summary

This Seafood Watch® report covers wild-caught, warmwater shrimp species from the Gulf of Mexico and the South Atlantic regions of the United States. Wild-caught warmwater shrimp from outside the U.S. are covered in separate reports. Shrimp is overwhelmingly caught by bottom (modified otter) trawl, although other gears such as skimmer trawls (aka pushed skimmer nets) are also used in certain regions. The main U.S. wild-caught shrimp species are: brown (*Farfantapenaeus aztecus*), Atlantic white (*Litopenaeus setiferus*), pink (*Farfantepenaeus duorarum*), royal red (*Pleoticus robustus*), and rock (*Sicyonia brevirostris*) shrimp. Note that previous versions of this report included seabob shrimp (*Xiphopenaeus kroyeri*), which is caught incidentally in the Gulf but on average makes up less than 1% of the total catch, so it is omitted here.

Although royal red shrimp can live for several years, peneaid shrimps are generally short-lived (18–24 months), highly prolific broadcast spawners that mature early (usually within 6–12 months). Brown, pink, and white shrimp populations are considered healthy in both the Gulf and South Atlantic regions. The stock statuses for royal red and rock shrimp are less certain, but there are no significant concerns about southeastern U.S. shrimp abundance.

By-catch is a significant concern in the southeastern U.S. shrimp fisheries. A variety of species are caught incidentally, and the take of endangered or threatened sea turtles continues to be the primary by-catch issue throughout shrimp fisheries. In the United States, the use of turtle excluder devices (TEDs) has been instrumental in reducing sea turtle by-catch and allowing most sea turtle populations to begin to recover. Despite the reduction in sea turtle mortalities from the use of TEDs, these shrimp fisheries are still estimated to be the leading cause of sea turtle by-catch mortality in the southeastern U.S., with hundreds of sea turtle mortalities each year, and all sea turtle populations in the region are still listed as endangered or threatened. For all shrimp trawl fisheries assessed, green turtle, Kemp's ridley turtle, and loggerhead turtle are of particular concern due to their endangered status, combined with the likely high cumulative impact and high estimated interactions with the shrimp trawl fishery leading to mortalities. Aside from sea turtles, spotted seatrout is also a species of concern in the otter trawl shrimp fishery in the Gulf of Mexico.

Management of shrimp populations is generally effective, but the primary challenge to shrimp fishery sustainability is mitigating by-catch. Over the long term, management agencies have generally addressed by-catch reduction in a progressive manner. Despite these efforts, shrimp fishery by-catch greatly outweighs actual shrimp landings, and includes threatened and endangered sea turtles and other species of concern. The effectiveness of regulations to reduce by-catch (e.g., TED and by-catch reduction device [BRD] regulations) depends largely on regulatory scope and compliance with regulations, along with enforcement capacity and the ongoing efforts between fishery managers and fishers to ensure compliance. Otter trawls in all regions are required to use TEDs, and enforcement of and compliance with these regulations is fairly effective, which reduces the concern with by-catch management in the otter trawl fishery.

Skimmer trawls also interact with sea turtles, but are only required to use TEDs in vessels longer than 40 ft, except in Florida where TEDs are mandatory to all skimmer vessels. Currently, the only mitigation strategy to reduce sea turtle by-catch in skimmer trawls shorter than 40 ft is through limits on tow time, but compliance with the tow-time regulations is reported as low. Because the landings volumes between skimmer trawlers shorter than 40 ft and longer than 40 ft are similar (about 28 million pounds or 46% on vessels longer than 40 ft, and about 29 million pounds or 48% on vessels shorter than 40 ft) (NOAA 2019d), we scored these two groups of skimmer trawlers differently to highlight the concerns that skimmer trawlers may not be compliant with tow times, and that this measure alone is not as effective as TEDs (turtle mortality can still happen after release).

U.S. shrimping takes place largely over sandy, silt, or mud bottom habitat. Otter trawls generate the vast majority of shrimp landings, especially in federal waters, and have the most bottom contact. Skimmer trawls are also commonly used in the Gulf, especially in inshore waters. Overall, damage to habitat caused by the fishery is a moderate concern.

Introduction

Scope of the analysis and ensuing rating

This Seafood Watch® report update covers wild-caught, warmwater shrimp species from the Gulf of Mexico and the South Atlantic regions of the United States. Shrimp is overwhelmingly caught by bottom (modified otter) trawl, although other gears such as skimmer trawls (aka pushed skimmer nets) are fished in some regions. The main U.S. wild-caught shrimp species are: brown (*Farfantapenaeus aztecus*), Atlantic white (*Litopenaeus setiferus*), pink (*Farfantepenaeus duorarum*), royal red (*Pleoticus robustus*), and rock (*Sicyonia brevirostris*) shrimp. Note that previous versions of this report included seabob shrimp (*Xiphopenaeus kroyeri*), which is caught incidentally in the Gulf but on average makes up less than 1% of the total catch. Wild-caught warmwater shrimp from outside the U.S. are covered in separate reports.

Species Overview

All U.S. Gulf Coast and South Atlantic states have warmwater shrimp fisheries, with brown, white, and pink shrimp composing most of the landed volume and value in both regions. Gulf shrimp fisheries, as well as those in the Carolinas and Georgia, are centered on brown and white shrimp (NMFS 2012a). Rock shrimp is incidental catch in most of the Gulf but a significant portion of the catch on both coasts of Florida, as is pink shrimp. Royal red shrimp is the target of small deepwater trawl fisheries in the Gulf and South Atlantic (GMFMC 1997; Oceana 2007; SAFMC 2009).

Brown shrimp has a reddish-brown shell with dark green and red tail-fan appendages (SCDNR 2007), grows to about 9 inches in length (NCDMF 2001), and favors muddy or peaty bottoms, often with clay, sand, or broken shells (FAO 2003). It concentrates in depths around 30–50 meters, although it has been found as deep as 160 m (FAO 2003). White shrimp is a white to greenish-gray color and distinguished by long antennae that typically exceed body length (FAO 2003; SCDNR 2001). White shrimp can reach a length of 10 in and is most abundant in areas with extensive estuarine marshes, such as the Mississippi River Delta of Louisiana and along the South Carolina coast (SCDNR 2001). Compared to brown and pink shrimps, the white shrimp is often found higher in the water column (Barnette 2003). The pink shrimp has a pink to lemon-yellow shell with a prominent spot on each side and a bluish tail fan (SCDNR 2001). Pink shrimp is most abundant at depths of 11–26 m in estuaries and shallow marine waters (SAFMC 2009a); it is relatively uncommon in the Gulf of Mexico and found in the greatest densities in the Tortugas and Sanibel areas off Florida (GMFMC 2002).

Rock shrimp is a mid-shelf shrimp species that is distinguished by its thick, stony exoskeleton (SAFMC 2002). It is active at night and favors shell or sandy bottom habitat between 256 and 547 m (SAFMC 1993). Royal red shrimp is a deepwater shrimp species that, unlike the other shrimp covered in this report, lives for several years (Oceana 2007).

Shrimp fisheries are managed federally under Shrimp Fishery Management Plans by the Gulf of Mexico Fishery Management Council (GMFMC) and the South Atlantic Fishery Management Council (SAFMC). The GMFMC regulates shrimp fishing in federal waters off the coasts of Texas, Louisiana, Mississippi, Alabama, and the west (Gulf) coast of Florida. The SAFMC regulates shrimp fishing in federal waters off the coasts of North Carolina, South Carolina, Georgia, and the east (Atlantic) coast of Florida. Each state regulates the fishery in state waters, and corresponding management regulations vary among the states in the region.

Both by-catch and habitat effects were exacerbated by historical overcapitalization of the fishery, but overall fishing effort has dropped considerably in recent years. A variety of factors—overcapitalization itself, hurricane damage to fishing infrastructure (especially in 2005 from Hurricanes Katrina and Rita), rising fuel costs, declining prices due to the influx of cheap imported farmed shrimp, and the 2010 Deepwater Horizon oil spill—have made it difficult to profit economically from shrimping. These factors, as well as a moratorium on new federal permits in the Gulf region, have resulted in a continual decline in overall fishing effort (Andrews 2008; Griffin et al. 2008; GMFMC 2016). Consequently, CPUE has improved and reduced effort has resulted in increased shrimp size in landings, because shrimp have more time to grow before harvest (GMFMC 2009). In Louisiana, it was estimated that the impacts from the 2020–21 hurricane season, which led to declines in fisheries infrastructure, revenues, and biological resources, will continue into 2022 (Pratt 2022).

Production Statistics

The majority of shrimp consumed in the United States is imported: in 2019, shrimp imports totaled over 1,977,926 thousand pounds, with the top five countries of origin being India, Indonesia, Ecuador, Vietnam, and Thailand, respectively. The total volume accounts for 25% of all imported seafood/edible products (NMFS 2021c). U.S. commercial landings of shrimp in 2019 totaled over 248,055 thousand pounds of shrimp, with the Gulf of Mexico and South Atlantic regions accounting for roughly 83% of all U.S. production (NMFS 2021c). Total weight of all shrimp imports has been oscillating around 2,000,000 thousand pounds since 2017 (NMFS 2021c). Most shrimp imported to the U.S.—80% according to the Fisheries and Agriculture Organization of the United Nations—is farmed (Gillett 2008). Farmed shrimp are covered in separate Seafood Watch reports.

Gulf region landings were the nation's largest, with 177,800 thousand pounds and 72 percent of the national total, whereas the South Atlantic region was the third one in production, totaling 27.3 million pounds in 2019 (NMFS 2021c). In both the Gulf and the South Atlantic, shrimp fisheries are considered the region's most valuable commercial fisheries, with the greatest number of licensed participants (GMFMC 2002; SAFMC 1999). As Table 1 summarizes, white and brown shrimp are still the major species in volume and value in both regions. Gulf shrimp fisheries account for over 80% of southeastern shrimp landings for many decades (NMFS 2022).

Table 1

	2020 landings (pounds)	2010-2020 Average landings (pounds)	2010-2020 Average landed value ($)
Gulf of Mexico	211,561,509	123,397,229	**$ 392,047,542.7**
Brown shrimp	111,309,186	18,228,337.98	$ 173,915,239.3
Pink shrimp	11,875,256	10,307,502.18	$ 24,330,531.64
Rock shrimp	n/a	369,209.5	$ 749,315
Royal red shrimp	190,767	242,587.13	$ 831,604
White shrimp	88,186,300	94,249,592.18	$ 192,220,852.8
South Atlantic	23,898,607	21,785,956.44	**$ 52,488,716.69**
Brown shrimp	2,246,310	5,475,402.82	$ 10,800,879.09
Pink shrimp	155,535	539,101.36	$ 776,578.45
Rock shrimp	n/a	994,562.89	$ 1,706,885.33
Royal red shrimp	n/a	339,215.1	$ 930,728.9

White shrimp	21,496,762	14,437,674.27	$ 38,273,644.91
Southeast All	235,460,116	145,183,185.4	**$ 444,536,259.4**

Table: Regional shrimp landings by all gears from 2010–2020. n/a: species was not registered for that year. Does not include confidential data. Data from NMFS 2022.

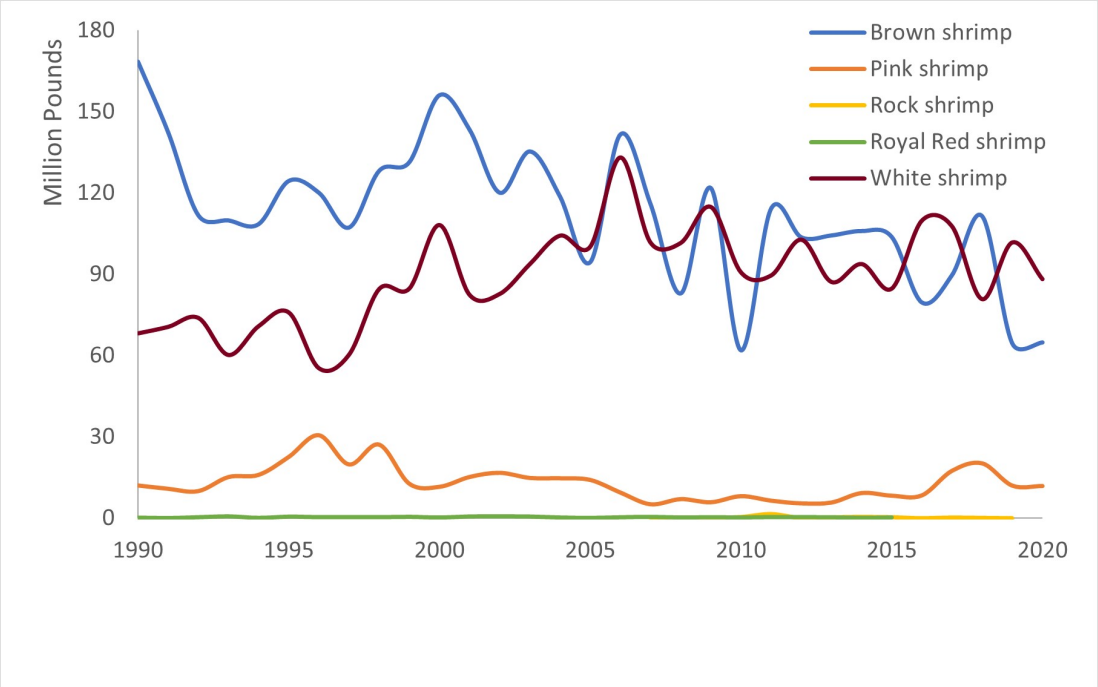

Figure 1: Shrimp landings (pounds) in the Gulf of Mexico 1990–2020, by all gears (NMFS 2022). Does not include confidential data.

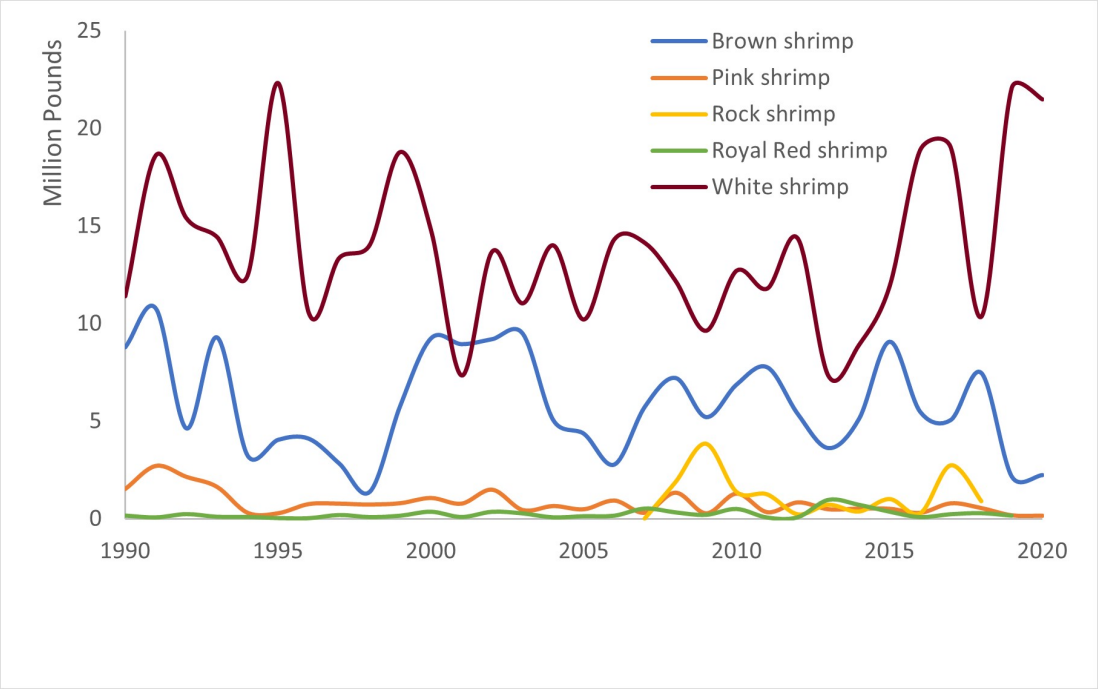

Figure 2: Shrimp landings (pounds) in the South Atlantic 1990–2020, by all gears (NMFS 2022). Does not include confidential data.

The majority of U.S. commercial shrimp catch is taken by otter trawls, particularly in offshore waters (NOAA 2019d). In addition to otter trawls, a variety of gears can be used in shrimp fisheries, including but not limited to cast nets, dip nets, haul seines, stationary butterfly nets, wing nets (butterfly trawls), skimmer trawls, traps, and beam trawls (NOAA 2019d). Skimmer trawls are important gears in the Gulf of Mexico, particularly in Louisiana state waters—Louisiana accounts for a significant amount of shrimp landings, averaging approximately 41% of total landings from 2000–2013 (LDWF 2016b; NOAA 2019d). Also, "skimmer trawls ranging from 30–49 ft in length accounted for the highest proportion of shrimp landings among all vessel size classes (77.1% of total shrimp within the category and 28.4% of total shrimp amongst all vessel categories)" (NOAA 2019d). State licensed vessels in the Southeastern U.S. shrimp trawl fisheries account for over 10,800 vessels, with otter trawl being the most abundant (almost 5,000 vessels), followed by skimmer trawls (over 3,800 vessels). The state of Louisiana has the largest amount of registered vessels (over 7,100 vessels) (NOAA 2019d).

Importance to the US/North American market

Shrimp imports to the United States in 2019 were valued at $6 billion, and accounted for 27.1% of the total value of edible seafood imports. Shrimp exports from the U.S. in 2019 were valued at over $117 million dollars. U.S. domestic landings of all shrimp in 2019 totaled just over 153,000 thousand pounds, valued at over $467 million dollars, the fifth most valuable species group behind salmon, lobster, crabs, and scallops (NMFS 2021c). Shrimp is now the most

consumed seafood group in the U.S., with annual per capita consumption doubling from 2 to 4 pounds within two decades.

Common and market names

The various shrimp can have a range of names on the market. White shrimp is also called common, southern, grey, lake, green, green- or blue-tailed, rainbow, or Daytona shrimp (SAFMC 2009a). Brown shrimp may go by brownie; “summer shrimp” in North Carolina; or red, redtail, green lake, golden, or native shrimp (SAFMC 2009a). Pink shrimp is also referred to as hopper, skipper, or pink spotted, brown spotted, grooved, green, red, pink night, spotted, or pushed shrimp (SAFMC 2009a). Rock shrimp is commonly called brown rock shrimp. When used for sushi or sashimi, warmwater shrimp is commonly sold as ebi.

Primary product forms

Shrimp product forms include fresh, frozen, head-on, shell-on, peeled, cooked, or breaded {UrnerBarry 2012}.

Summary

Warmwater shrimp (brown, pink, white, royal red, and rock) collected by otter trawl fisheries in the Gulf of Mexico and Southeast Atlantic and by skimmer trawls in the Gulf of Mexico (only by vessels 40 ft and longer) as well as in Florida are rated a Good Alternative, due to uncertainties on the stock statuses and overall effective management but with concerns regarding impacts on other species.

Warmwater shrimp collected by skimmer trawls shorter than 40 ft in the Gulf of Mexico are rated an Avoid, due to a lack for this group of vessels of by-catch strategies known to effectively prevent sea turtle mortality.

Assessments

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

Brown rock shrimp			
Region / Method	**Abundance**	**Fishing Mortality**	**Score**
United States - Gulf of Mexico - Bottom trawls	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**
United States - Western Central Atlantic Ocean - Bottom trawls	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**

Brown shrimp			
Region / Method	**Abundance**	**Fishing Mortality**	**Score**
United States - Gulf of Mexico - Bottom trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**
United States - Western Central Atlantic Ocean - Bottom trawls	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**
United States - Florida - Gulf of Mexico - Skimmer trawls	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels greater than 40 feet are required to use Turtle Excluder Devices	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels less than 40 feet are not required to use Turtle Excluder Devices	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**

Pink shrimp			
Region / Method	**Abundance**	**Fishing Mortality**	**Score**
United States - Gulf of Mexico - Bottom trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**
United States - Western Central Atlantic Ocean - Bottom trawls	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels greater than 40 feet are required to use Turtle Excluder Devices	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**
United States - Florida - Gulf of Mexico - Skimmer trawls	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels less than 40 feet are not required to use Turtle Excluder Devices	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**

Royal red shrimp			
Region / Method	**Abundance**	**Fishing Mortality**	**Score**
United States - Gulf of Mexico - Bottom trawls	2.330 Moderate Concern	5.000 Low Concern	**Green (3.413)**
United States - Western Central Atlantic Ocean - Bottom trawls	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**

White shrimp			
Region / Method	**Abundance**	**Fishing Mortality**	**Score**
United States - Gulf of Mexico - Bottom trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**
United States - Western Central Atlantic Ocean - Bottom trawls	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**
United States - Florida - Gulf of Mexico - Skimmer trawls	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels greater than 40 feet are required to use Turtle Excluder Devices	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels less than 40 feet are not required to use Turtle Excluder Devices	5.000 Very Low Concern	5.000 Low Concern	**Green (5.000)**

Criterion 1 Assessment

Scoring Guidelines

Factor 1.1 - Abundance

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

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

Factor 1.2 - Fishing Mortality

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

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

Brown rock shrimp *(Sicyonia brevirostris)*

1.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

All shrimp species are inherently resilient according to the PSA analysis (see details in Justification (GMFMC 1995; GMFMC 2015)). Brown rock shrimp has not been formally assessed and, because stock status is unknown without other data-limited indicators to evaluate (NMFS 2021), brown rock shrimp abundance is rated a moderate concern.

Supplementary Information

Productivity Attribute	**Relevant Information** Same for all OR royal red / all others (brown, pink, rock)	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity (years)	3/ <1 year	1
Average maximum age (years)	5/1	1
Fecundity	500,000	1
Reproductive strategy	Broadcast spawner	1
Trophic level	2	2

Refs: GMFMC 1995, GMFMC 2015

The average Productivity score is 1.20

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Vertical overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Selectivity of fishery (Specific to fishery under assessment)	Default score (Species is targeted and there are no special circumstances increasing its susceptibility)	2
Post-capture mortality (Specific to fishery under assessment)	Default score (species is retained)	3

The multiplicative Susceptibility score is 2.62

Figure 3: Productivity-Susceptibility Analysis for Southeastern U.S. shrimp

1.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Despite existing estimates from FSSI for brown rock, brown, pink, and white shrimp in the South Atlantic, and for royal red shrimp in the Gulf of Mexico (NMFS 2021), a formal stock assessment is not available for any of these species. Because current fishing mortality is unknown, this factor receives a score of moderate concern.

Brown shrimp *(Penaeus aztecus)*

1.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Very Low Concern

Amendment 15 to the Gulf of Mexico Shrimp Fishery Amendment Plan updated shrimp stock status determination criteria, according to the National Standard, and incorporated an updated stock assessment model approach (GMFMC 2015). The statuses of Gulf pink, white, and brown penaeid shrimp stocks were last assessed in 2018 (Hart 2018)(Hart 2018b)(Hart 2018c); all three species are considered healthy, as shown in the Justification section. Due to the recent stock assessments estimating biomass at above a target reference point for each species, abundance is rated as a very low concern.

Supplementary Information

According to the latest FSSI stock update, the B/B_{MSY} or proxy estimates for pink, white, and brown shrimp stocks in the Gulf are greater than 1 (B/B_{MSY} = 2.65 for pink, 1.76 for white, and 4.39 for brown shrimp) (NMFS 2021). Spawning biomass estimates are shown in the images below.

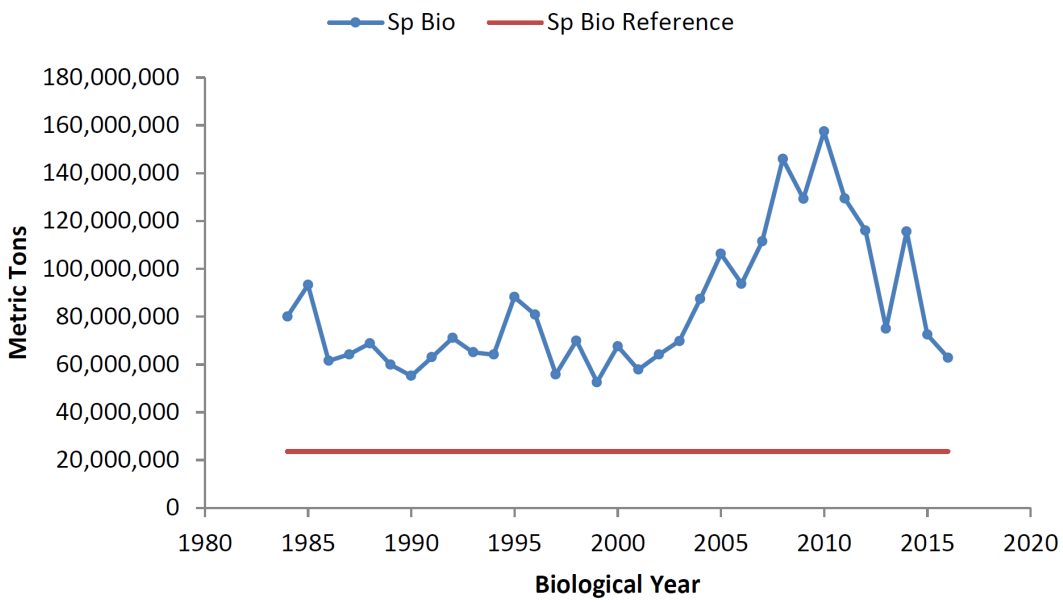

Figure 4: Biological year pink shrimp spawning biomass estimates, 1984–2017 (Hart 2018).

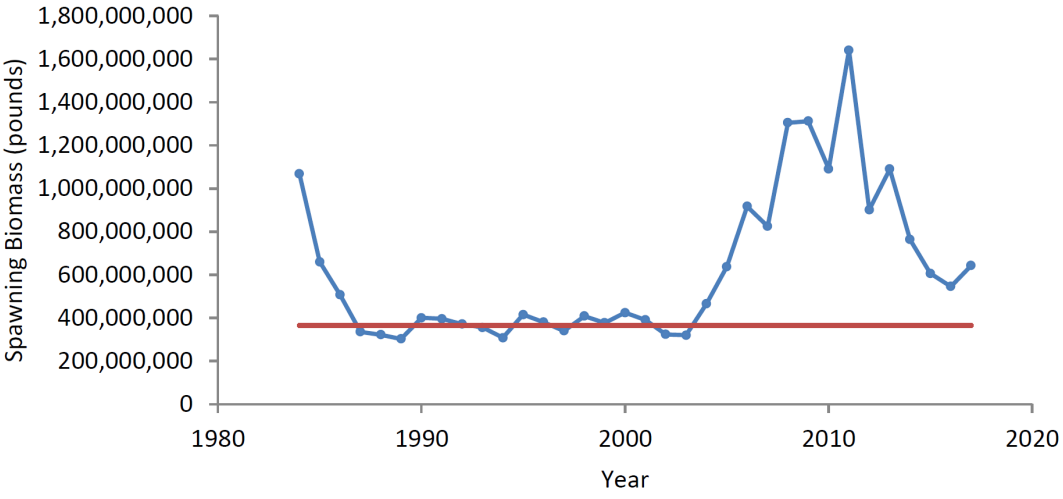

Figure 5: White shrimp spawning biomass estimates, 1984–2017 (Hart 2018b).

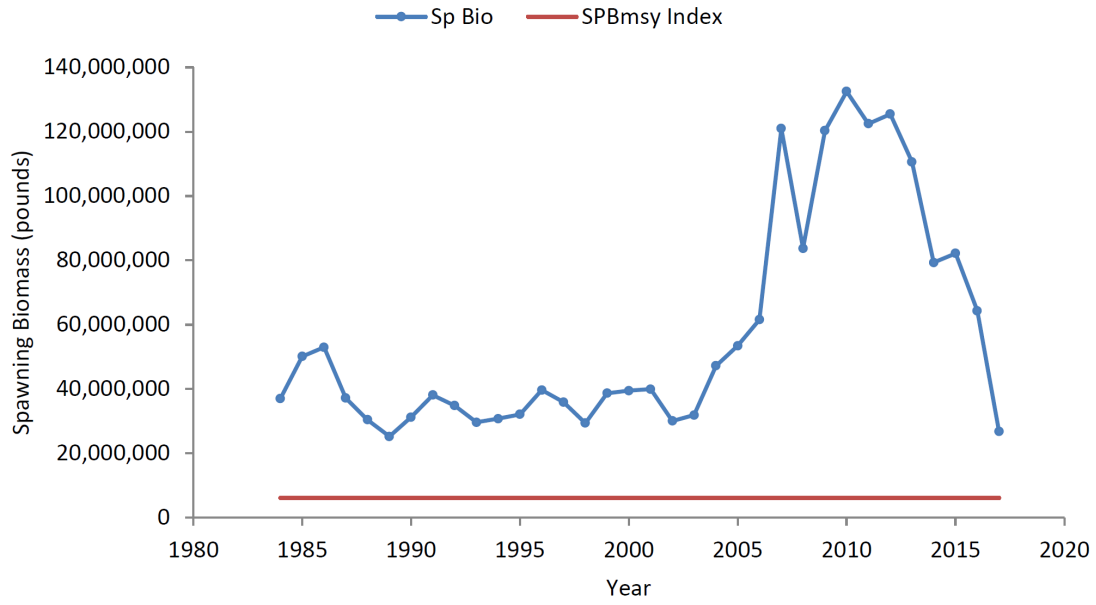

Figure 6: Brown shrimp spawning biomass estimates, 1984–2017 (Hart 2018c).

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Although there are annual FSSI estimates for pink, white, and brown shrimp in the South Atlantic (NMFS 2021), a formal stock assessment is not available for any of the species. Indices for the South Atlantic have not been updated for a long period and, because a recent formal stock assessment is not available, a PSA was used for all the species. All shrimp species are inherently resilient according to the PSA and have a low vulnerability rate (see table in Justification (GMFMC 1995; GMFMC 2015)). Because of the low vulnerability according to the PSA and a lack of other evidence to suggest that the stock is either above or below reference points, abundances for all these shrimp species are scored as moderate concern.

Supplementary Information

Table 2

Productivity Attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity (y)	3 (royal red), <1 (brown, pink, rock, white)	1
Average maximum age (y)	5 (royal red), 1 (brown, pink, rock, white)	1
Fecundity	500,000	1
Reproductive strategy	Broadcast spawner	1
Trophic level	2	1

Density dependence	Compensatory dynamics at low population size demonstrated or likely	1
Quality of habitat	Moderately altered	2
	Productivity sub score	**1.14**

Table 3

Susceptibility Attribute	**Relevant information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	There is high overlap among the fishery and species	3
Vertical overlap (Considers all fisheries)	There is high overlap among the fishery and species	3
Selectivity of fishery (Specific to fishery under assessment)	Species are targeted and there are no special circumstances increasing its susceptibility	2
Post-capture mortality (Specific to fishery under assessment)	Default score (species are retained)	3
	Susceptibility sub score	**2.32**

Table 4

Productivity-Susceptibility score	2.59
Vulnerability rating	Low

1.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Low Concern

The most recent FSSI (NMFS 2021) indicates that there is no overfishing occurring for pink, white, or brown shrimp in the Gulf or in the South Atlantic (Hart 2018)(Hart 2018b) (Hart 2018c). Furthermore, for all stocks, effort has continually and substantially declined in recent years and is not expected to increase. Because of these factors, fishing mortality is rated a low concern.

Supplementary Information

Where F_{MSY} has been defined for Gulf penaeid species, F is below F_{MSY} for Gulf pink, white, and brown shrimp (Hart 2018; Hart 2018b; Hart 2018c) (see figures). In the South Atlantic, average annual catches of pink, white, and brown shrimp are all less than the defined MSY proxies.

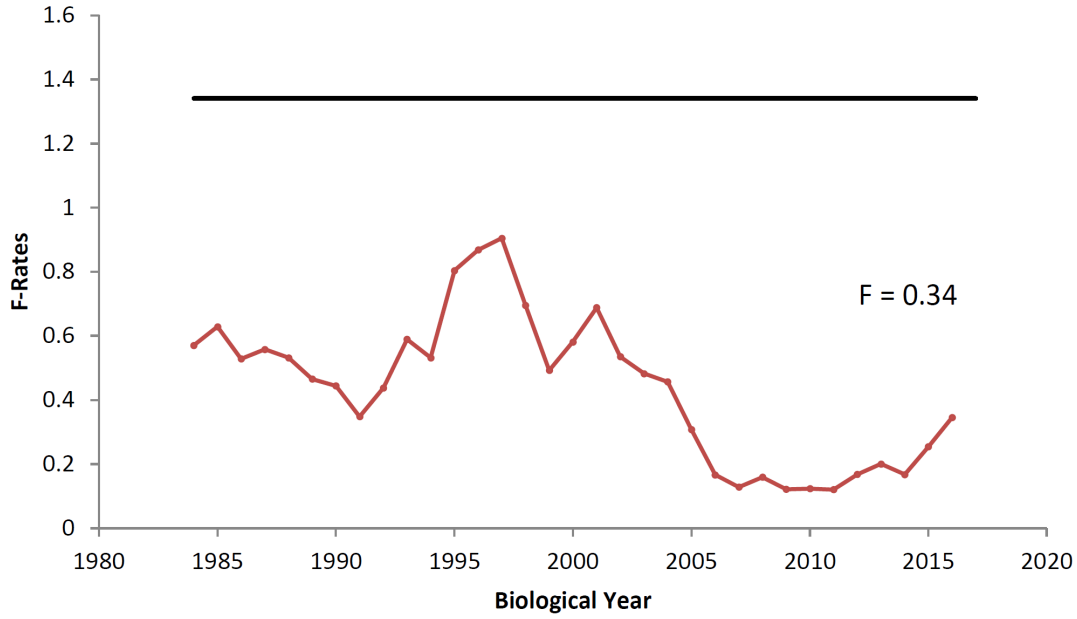

Figure 7: Pink shrimp weighted annual F values across ages for biological years 1984–2017 (Hart 2018).

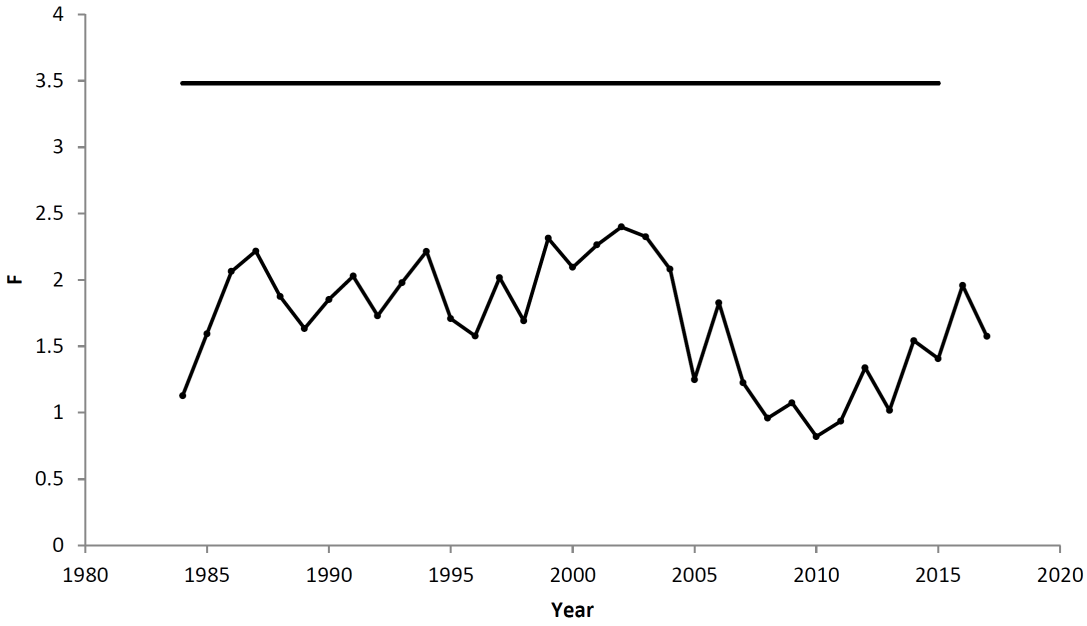

Figure 8: White shrimp weighted annual F values across ages for biological years 1984–2017 (Hart 2018b).

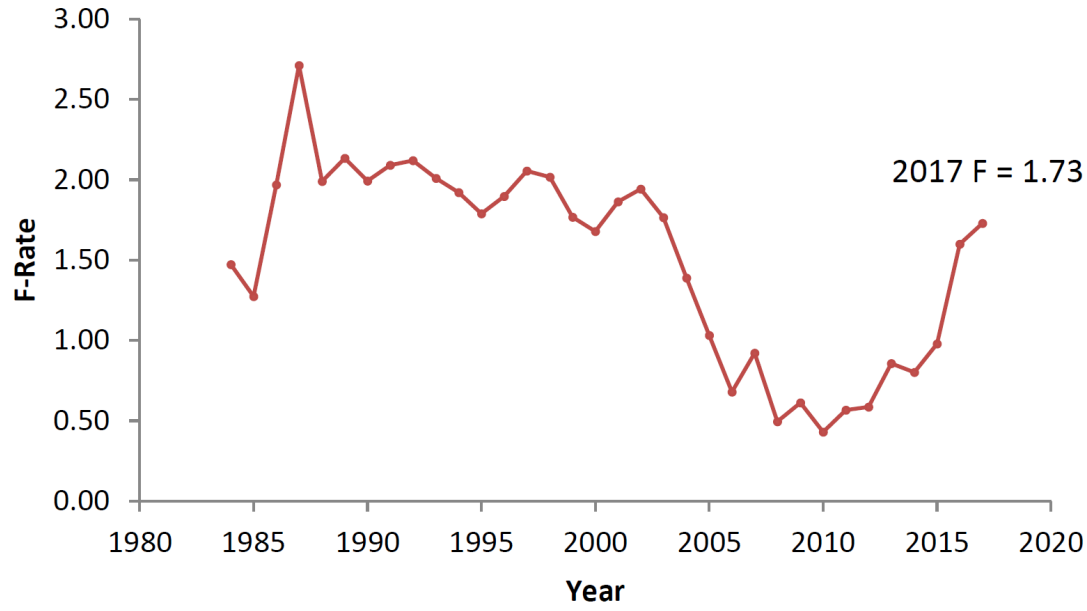

Figure 9: Brown shrimp annual F value across ages for biological years 1984–2017 (Hart 2018c).

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Pink shrimp *(Penaeus duorarum)*

1.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Very Low Concern

Amendment 15 to the Gulf of Mexico Shrimp Fishery Amendment Plan updated shrimp stock status determination criteria, according to the National Standard, and incorporated an updated stock assessment model approach (GMFMC 2015). The statuses of Gulf pink, white, and brown penaeid shrimp stocks were last assessed in 2018 (Hart 2018)(Hart 2018b)(Hart 2018c); all three species are considered healthy, as shown in the Justification section. Due to the recent stock assessments estimating biomass at above a target reference point for each species, abundance is rated as a very low concern.

Supplementary Information

According to the latest FSSI stock update, the B/B_{MSY} or proxy estimates for pink, white, and brown shrimp stocks in the Gulf are greater than 1 (B/B_{MSY} = 2.65 for pink, 1.76 for white, and 4.39 for brown shrimp) (NMFS 2021). Spawning biomass estimates are shown in the images below.

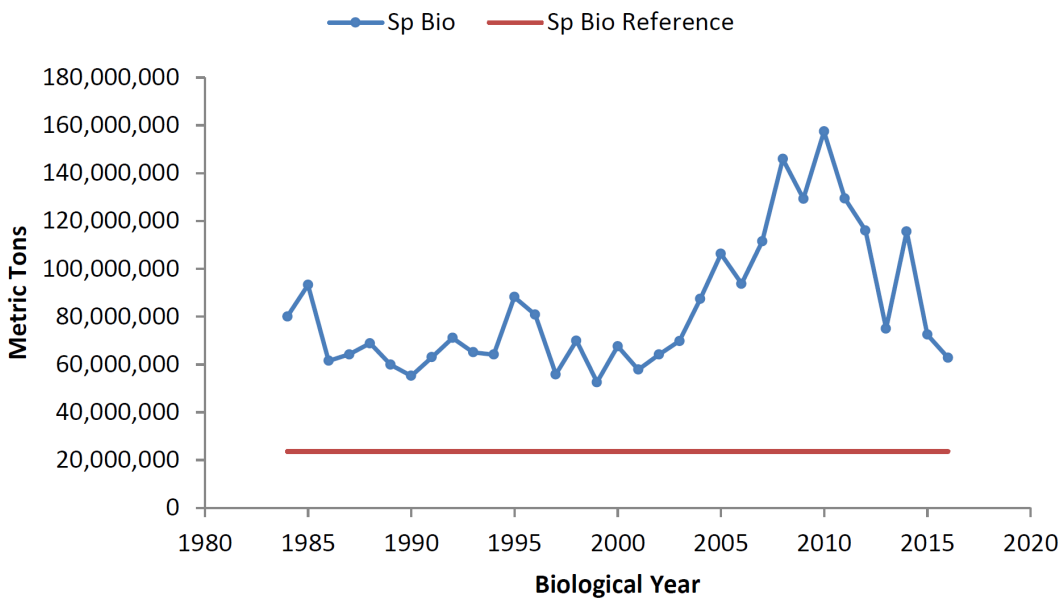

Figure 4: Biological year pink shrimp spawning biomass estimates, 1984–2017 (Hart 2018).

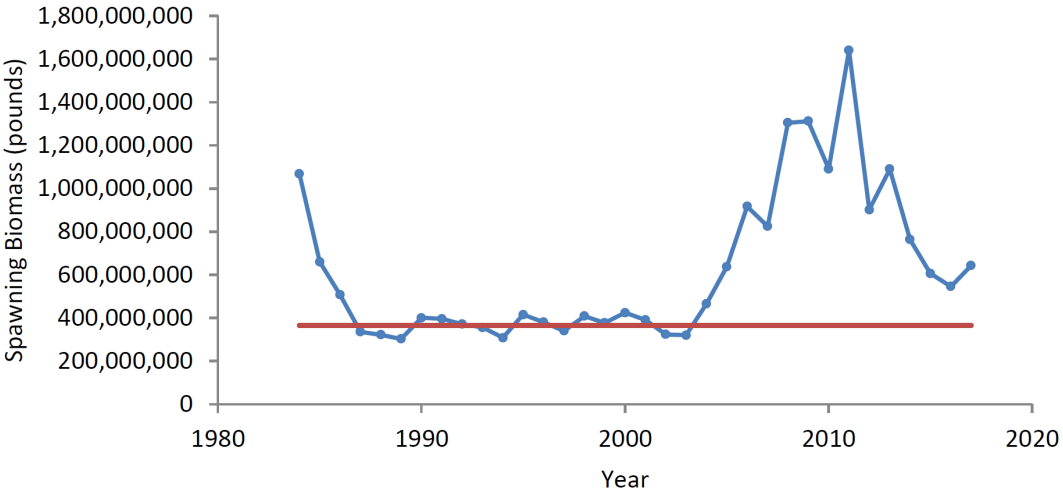

Figure 5: White shrimp spawning biomass estimates, 1984–2017 (Hart 2018b).

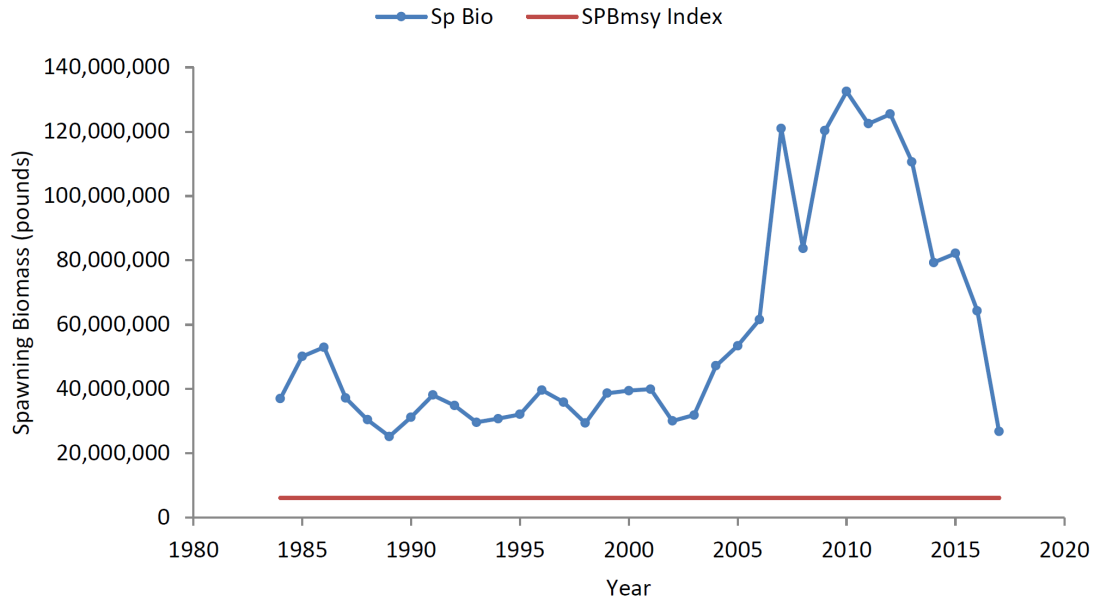

Figure 6: Brown shrimp spawning biomass estimates, 1984–2017 (Hart 2018c).

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Although there are annual FSSI estimates for pink, white, and brown shrimp in the South Atlantic (NMFS 2021), a formal stock assessment is not available for any of the species. Indices for the South Atlantic have not been updated for a long period and, because a recent formal stock assessment is not available, a PSA was used for all the species. All shrimp species are inherently resilient according to the PSA and have a low vulnerability rate (see table in Justification (GMFMC 1995; GMFMC 2015)). Because of the low vulnerability according to the PSA and a lack of other evidence to suggest that the stock is either above or below reference points, abundances for all these shrimp species are scored as moderate concern.

Supplementary Information

Table 2

Productivity Attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity (y)	3 (royal red), <1 (brown, pink, rock, white)	1
Average maximum age (y)	5 (royal red), 1 (brown, pink, rock, white)	1
Fecundity	500,000	1
Reproductive strategy	Broadcast spawner	1
Trophic level	2	1

Density dependence	Compensatory dynamics at low population size demonstrated or likely	1
Quality of habitat	Moderately altered	2
	Productivity sub score	**1.14**

Table 3

Susceptibility Attribute	**Relevant information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	There is high overlap among the fishery and species	3
Vertical overlap (Considers all fisheries)	There is high overlap among the fishery and species	3
Selectivity of fishery (Specific to fishery under assessment)	Species are targeted and there are no special circumstances increasing its susceptibility	2
Post-capture mortality (Specific to fishery under assessment)	Default score (species are retained)	3
	Susceptibility sub score	**2.32**

Table 4

Productivity-Susceptibility score	2.59
Vulnerability rating	Low

1.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Low Concern

The most recent FSSI (NMFS 2021) indicates that there is no overfishing occurring for pink, white, or brown shrimp in the Gulf or in the South Atlantic (Hart 2018)(Hart 2018b) (Hart 2018c). Furthermore, for all stocks, effort has continually and substantially declined in recent years and is not expected to increase. Because of these factors, fishing mortality is rated a low concern.

Supplementary Information

Where F_{MSY} has been defined for Gulf penaeid species, F is below F_{MSY} for Gulf pink, white, and brown shrimp (Hart 2018; Hart 2018b; Hart 2018c) (see figures). In the South Atlantic, average annual catches of pink, white, and brown shrimp are all less than the defined MSY proxies.

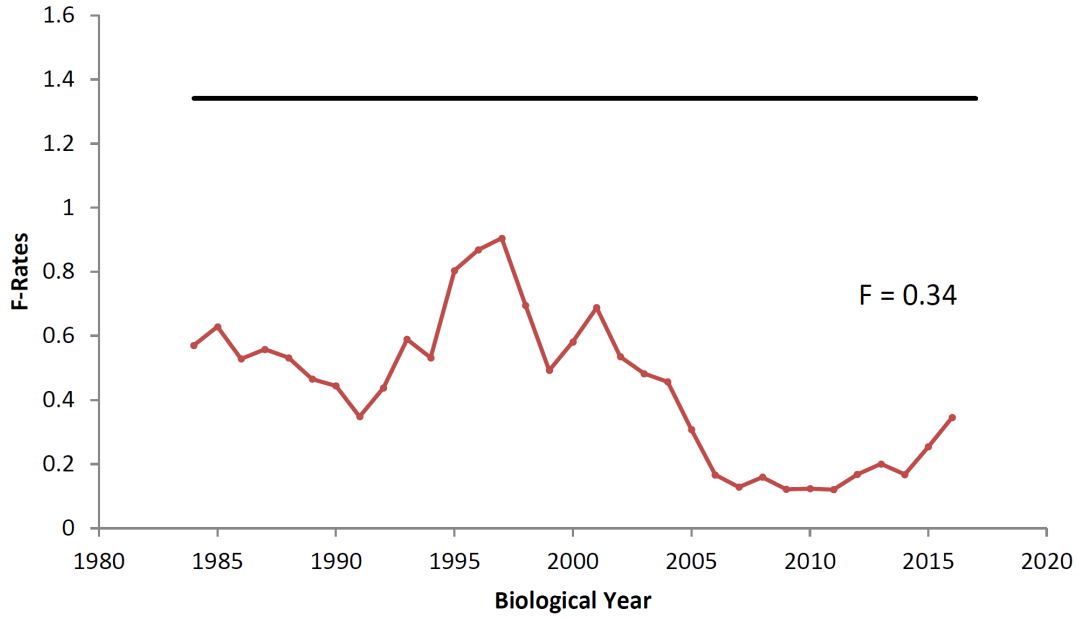

Figure 7: Pink shrimp weighted annual F values across ages for biological years 1984–2017 (Hart 2018).

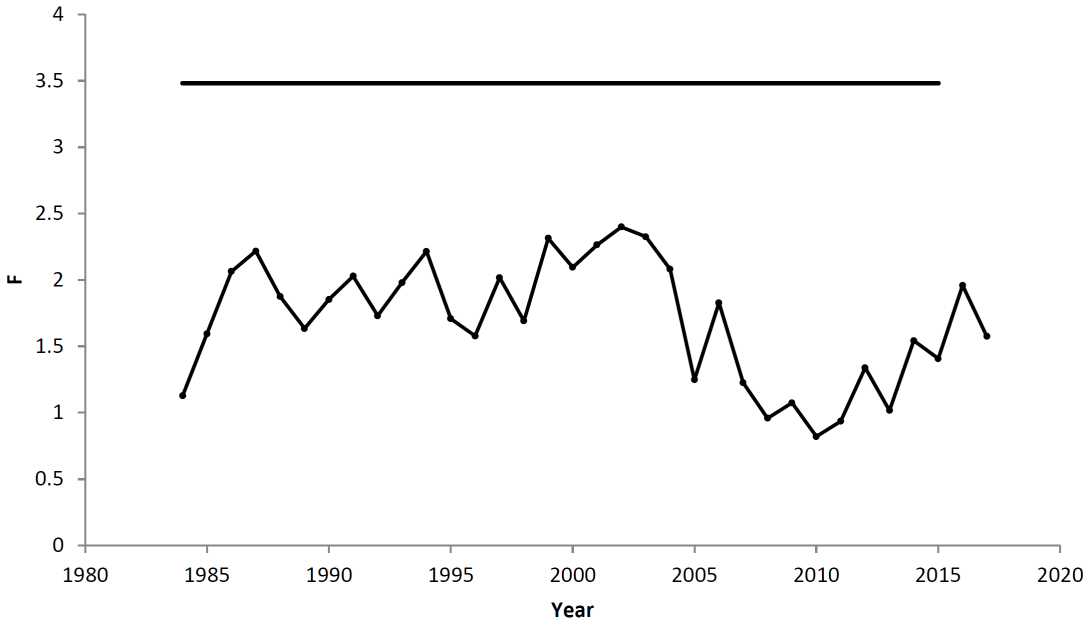

Figure 8: White shrimp weighted annual F values across ages for biological years 1984–2017 (Hart 2018b).

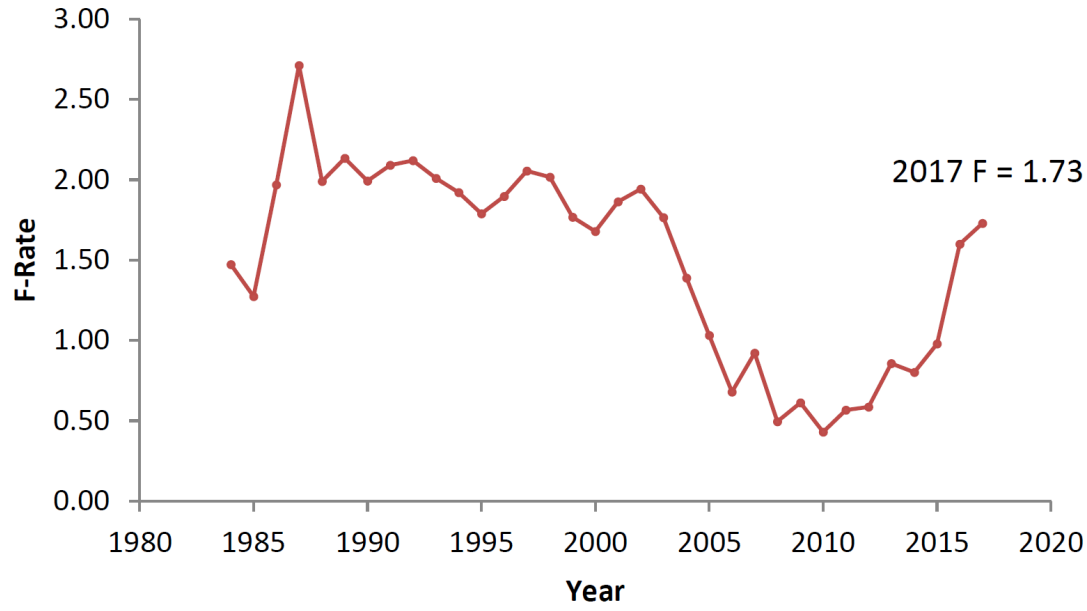

Figure 9: Brown shrimp annual F value across ages for biological years 1984–2017 (Hart 2018c).

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Despite existing estimates from FSSI for brown rock, brown, pink, and white shrimp in the South Atlantic, and for royal red shrimp in the Gulf of Mexico (NMFS 2021), a formal stock assessment is not available for any of these species. Because current fishing mortality is unknown, this factor receives a score of moderate concern.

Royal red shrimp *(Pleoticus robustus)*

1.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

All shrimp species are inherently resilient according to the PSA analysis (see details in Justification (GMFMC 1995; GMFMC 2015)). Current abundance/overfished status is unknown (NMFS 2021). Royal red shrimp abundance is rated a moderate concern, because it is not highly vulnerable and the overfished status is unknown.

Supplementary Information

Productivity Attribute	**Relevant Information** Same for all OR royal red / all others (brown, pink, rock)	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity (years)	3/ <1 year	1
Average maximum age (years)	5/1	1
Fecundity	500,000	1
Reproductive strategy	Broadcast spawner	1
Trophic level	2	2

Refs: GMFMC 1995, GMFMC 2015

The average Productivity score is 1.20

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Vertical overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Selectivity of fishery (Specific to fishery under assessment)	Default score (Species is targeted and there are no special circumstances increasing its susceptibility)	2
Post-capture mortality (Specific to fishery under assessment)	Default score (species is retained)	3

The multiplicative Susceptibility score is 2.62

Figure 3: Productivity-Susceptibility Analysis for Southeastern U.S. shrimp

1.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Low Concern

The most recent FSSI update indicates that royal red shrimp is not experiencing overfishing (NMFS 2021). The 2019 fishing mortality was estimated at 118,191 lbs of tails (F_{MSY} = 337,000 lbs of tails) (NMFS 2021b). Fishing mortality receives a score of low concern, because there is a recent assessment and overfishing is not occurring.

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Despite existing estimates from FSSI for brown rock, brown, pink, and white shrimp in the South Atlantic, and for royal red shrimp in the Gulf of Mexico (NMFS 2021), a formal stock assessment is not available for any of these species. Because current fishing mortality is unknown, this factor receives a score of moderate concern.

White shrimp *(Penaeus setiferus)*

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Very Low Concern

Amendment 15 to the Gulf of Mexico Shrimp Fishery Amendment Plan updated shrimp stock status determination criteria, according to the National Standard, and incorporated an updated stock assessment model approach (GMFMC 2015). The statuses of Gulf pink, white, and brown penaeid shrimp stocks were last assessed in 2018 (Hart 2018)(Hart 2018b)(Hart 2018c); all three species are considered healthy, as shown in the Justification section. Due to the recent stock assessments estimating biomass at above a target reference point for each species, abundance is rated as a very low concern.

Supplementary Information

According to the latest FSSI stock update, the B/B_{MSY} or proxy estimates for pink, white, and brown shrimp stocks in the Gulf are greater than 1 (B/B_{MSY} = 2.65 for pink, 1.76 for white, and 4.39 for brown shrimp) (NMFS 2021). Spawning biomass estimates are shown in the images below.

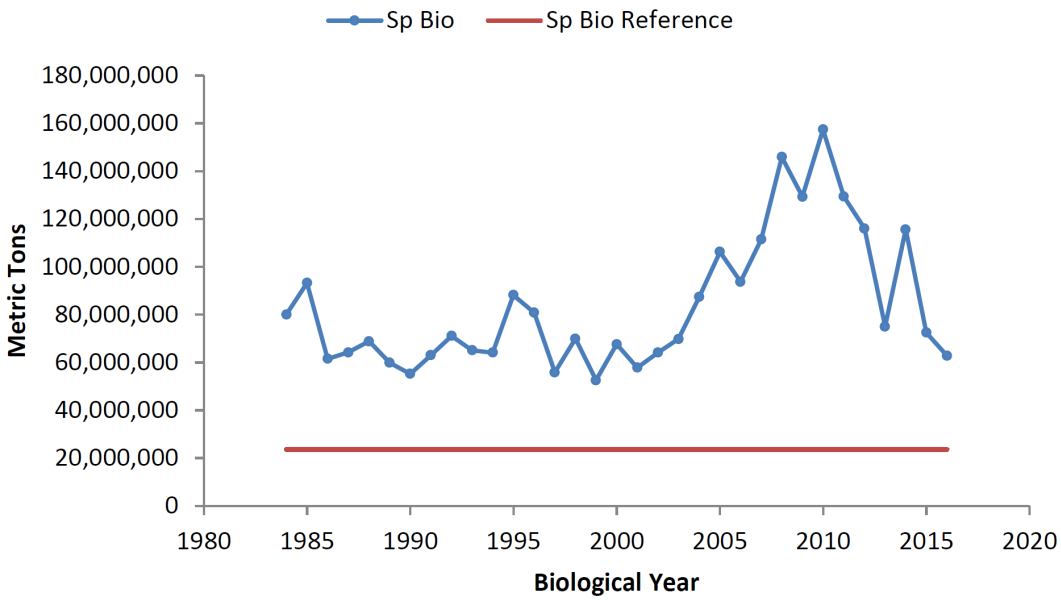

Figure 4: Biological year pink shrimp spawning biomass estimates, 1984–2017 (Hart 2018).

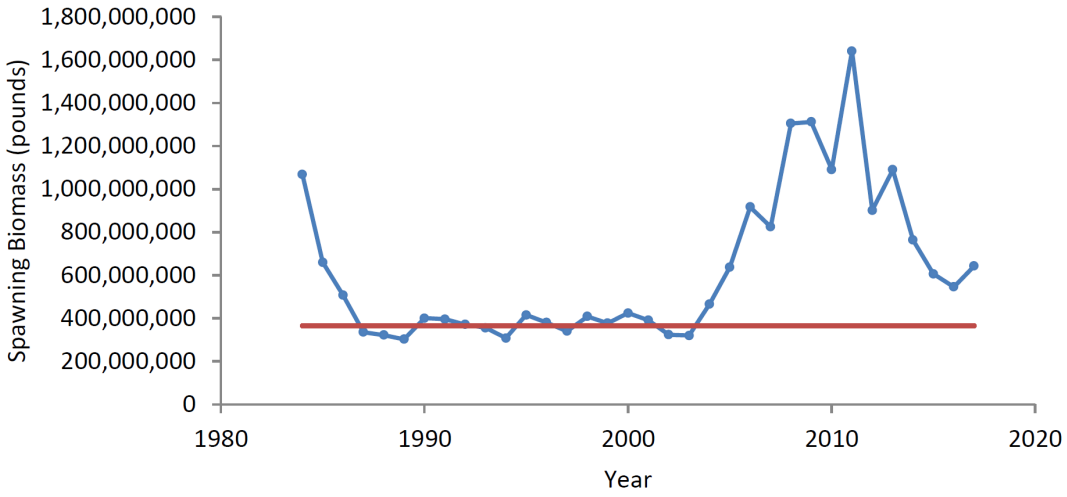

Figure 5: White shrimp spawning biomass estimates, 1984–2017 (Hart 2018b).

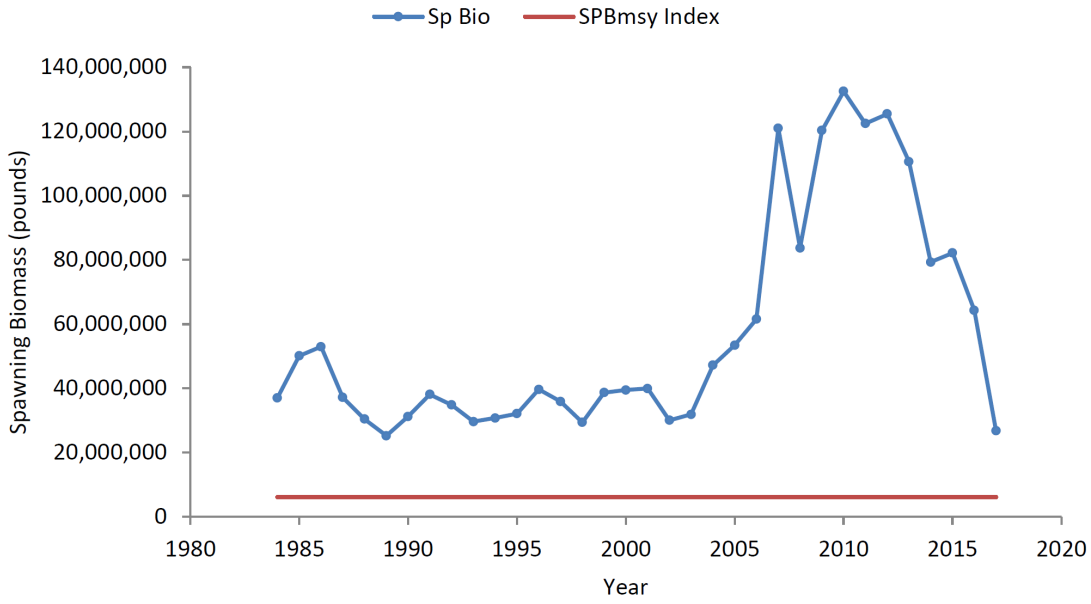

Figure 6: Brown shrimp spawning biomass estimates, 1984–2017 (Hart 2018c).

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Although there are annual FSSI estimates for pink, white, and brown shrimp in the South Atlantic (NMFS 2021), a formal stock assessment is not available for any of the species. Indices for the South Atlantic have not been updated for a long period and, because a recent formal stock assessment is not available, a PSA was used for all the species. All shrimp species are inherently resilient according to the PSA and have a low vulnerability rate (see table in Justification (GMFMC 1995; GMFMC 2015)). Because of the low vulnerability according to the PSA and a lack of other evidence to suggest that the stock is either above or below reference points, abundances for all these shrimp species are

scored as moderate concern.

Supplementary Information

Table 2

Productivity Attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity (y)	3 (royal red), <1 (brown, pink, rock, white)	1
Average maximum age (y)	5 (royal red), 1 (brown, pink, rock, white)	1
Fecundity	500,000	1
Reproductive strategy	Broadcast spawner	1
Trophic level	2	1
Density dependence	Compensatory dynamics at low population size demonstrated or likely	1
Quality of habitat	Moderately altered	2
	Productivity sub score	**1.14**

Table 3

Susceptibility Attribute	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	There is high overlap among the fishery and species	3
Vertical overlap (Considers all fisheries)	There is high overlap among the fishery and species	3
Selectivity of fishery (Specific to fishery under assessment)	Species are targeted and there are no special circumstances increasing its susceptibility	2
Post-capture mortality (Specific to fishery under assessment)	Default score (species are retained)	3
	Susceptibility sub score	**2.32**

Table 4

Productivity-Susceptibility score	2.59
Vulnerability rating	Low

1.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Low Concern

The most recent FSSI (NMFS 2021) indicates that there is no overfishing occurring for pink, white, or brown shrimp in the Gulf or in the South Atlantic (Hart 2018)(Hart 2018b) (Hart 2018c). Furthermore, for all stocks, effort has continually and substantially declined in recent years and is not expected to increase. Because of these factors, fishing mortality is rated a low concern.

Supplementary Information

Where F_{MSY} has been defined for Gulf penaeid species, F is below F_{MSY} for Gulf pink, white, and brown shrimp (Hart 2018; Hart 2018b; Hart 2018c) (see figures). In the South Atlantic, average annual catches of pink, white, and brown shrimp are all less than the defined MSY proxies.

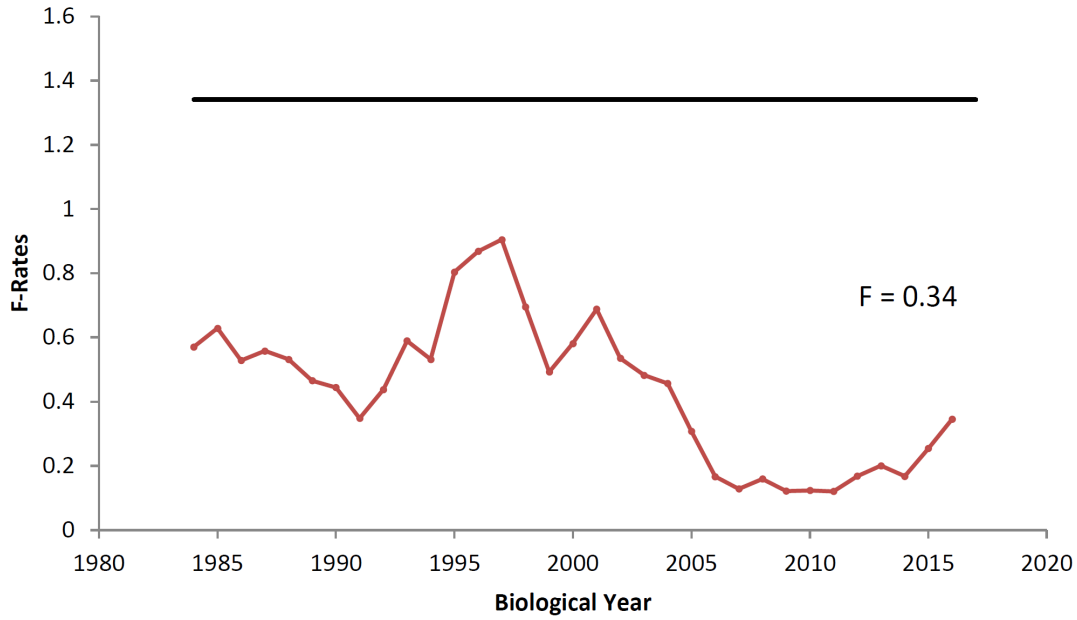

Figure 7: Pink shrimp weighted annual F values across ages for biological years 1984–2017 (Hart 2018).

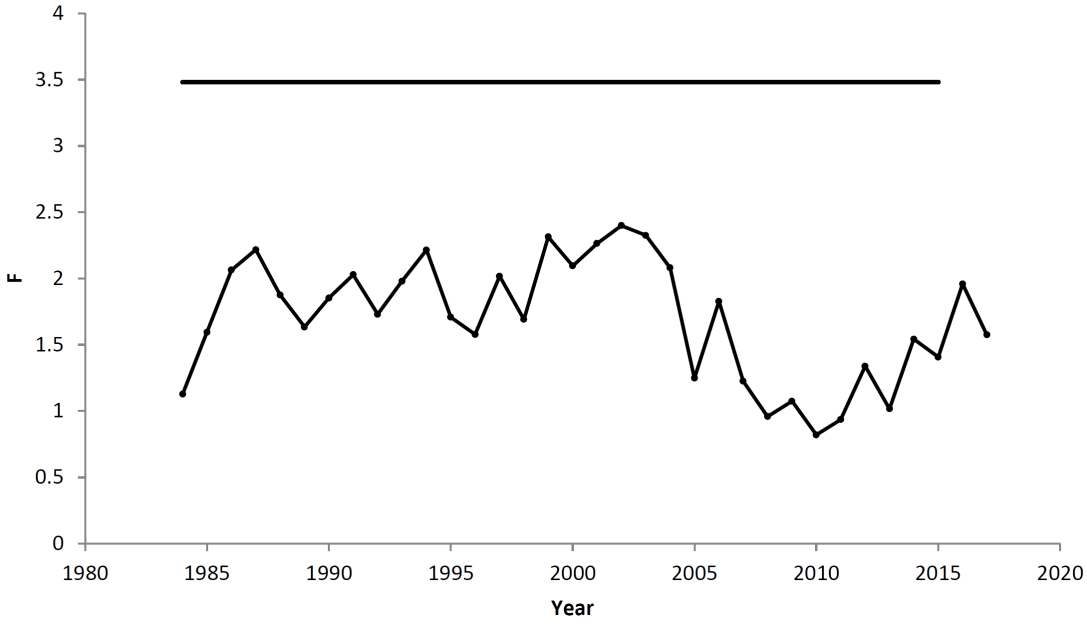

Figure 8: White shrimp weighted annual F values across ages for biological years 1984–2017 (Hart 2018b).

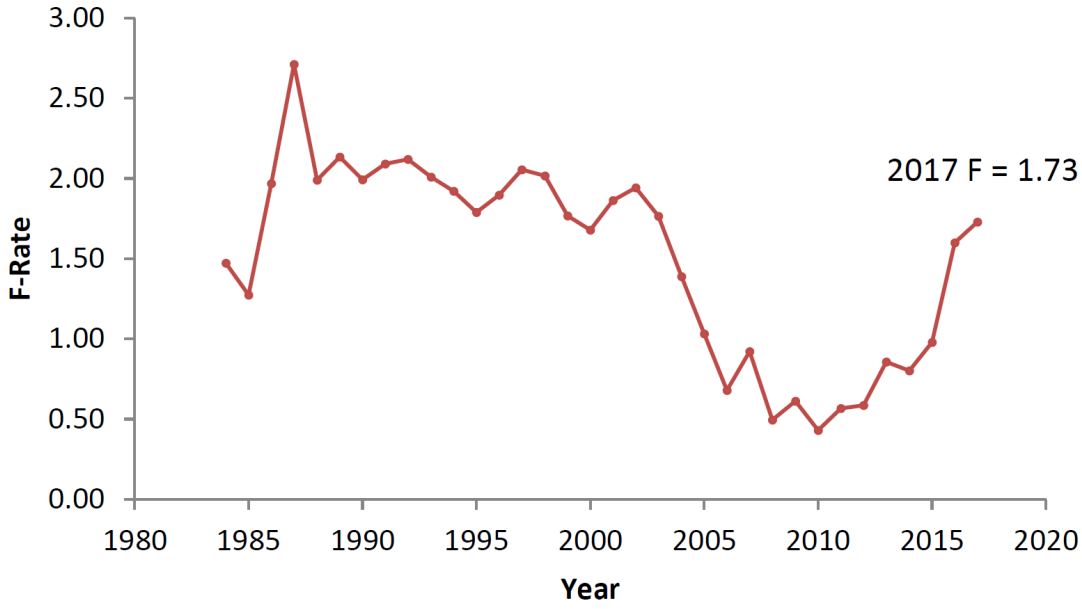

Figure 9: Brown shrimp annual F value across ages for biological years 1984–2017 (Hart 2018c).

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Despite existing estimates from FSSI for brown rock, brown, pink, and white shrimp in the South Atlantic, and for royal red shrimp in the Gulf of Mexico (NMFS 2021), a formal stock assessment is not available for any of these species. Because current fishing mortality is unknown, this factor receives a score of moderate 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.

Brown rock shrimp			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
United States - Gulf of Mexico - Bottom trawls	1.000	0.750: >= 100%	Red (0.750)
United States - Western Central Atlantic Ocean - Bottom trawls	1.000	0.750: >= 100%	Red (0.750)

Brown shrimp			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
United States - Gulf of Mexico - Bottom trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central	1.000	0.750: >= 100%	Red (0.750)
United States - Western Central Atlantic Ocean - Bottom trawls	1.000	0.750: >= 100%	Red (0.750)
United States - Florida - Gulf of Mexico - Skimmer trawls	1.000	0.750: >= 100%	Red (0.750)
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels greater than 40 feet are required to use Turtle Excluder Devices	1.000	0.750: >= 100%	Red (0.750)
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels less than 40 feet are not required to use Turtle Excluder Devices	1.000	0.750: >= 100%	Red (0.750)

Pink shrimp			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
United States - Gulf of Mexico - Bottom trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central	1.000	0.750: >= 100%	Red (0.750)
United States - Western Central Atlantic Ocean - Bottom trawls	1.000	0.750: >= 100%	Red (0.750)
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels greater than 40 feet are required to use Turtle Excluder Devices	1.000	0.750: >= 100%	Red (0.750)
United States - Florida - Gulf of Mexico - Skimmer trawls	1.000	0.750: >= 100%	Red (0.750)
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels less than 40 feet are not required to use Turtle Excluder Devices	1.000	0.750: >= 100%	Red (0.750)

Royal red shrimp			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
United States - Gulf of Mexico - Bottom trawls	1.000	0.750: >= 100%	Red (0.750)
United States - Western Central Atlantic Ocean - Bottom trawls	1.000	0.750: >= 100%	Red (0.750)

White shrimp			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
United States - Gulf of Mexico - Bottom trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central	1.000	0.750: >= 100%	Red (0.750)
United States - Western Central Atlantic Ocean - Bottom trawls	1.000	0.750: >= 100%	Red (0.750)
United States - Florida - Gulf of Mexico - Skimmer trawls	1.000	0.750: >= 100%	Red (0.750)
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels greater than 40 feet are required to use Turtle Excluder Devices	1.000	0.750: >= 100%	Red (0.750)
United States - Gulf of Mexico - Skimmer trawls - Flag Country: United States - FAO Major Area: Atlantic, Western Central - Specific Fishery: Vessels less than 40 feet are not required to use Turtle Excluder Devices	1.000	0.750: >= 100%	Red (0.750)

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.

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls			
Sub Score: 1.000	**Discard Rate: 0.750**		**Score: 0.750**
Species	**Abundance**	**Fishing Mortality**	**Score**
Kemp's ridley turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Seatrout	1.000: High Concern	1.000: High Concern	Red (1.000)
Green turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Benthic inverts	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Bottlenose dolphin	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Smalltooth sawfish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Sharks	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Gulf Sturgeon	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Hawksbill turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Leatherback turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic croaker	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Brown rock shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Royal red shrimp	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Brown shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Pink shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
White shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls			
Sub Score: 1.000	**Discard Rate: 0.750**		**Score: 0.750**
Species	**Abundance**	**Fishing Mortality**	**Score**
Green turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Kemp's ridley turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Benthic inverts	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Bottlenose dolphin	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Hawksbill turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Leatherback turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Sharks	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic croaker	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Brown shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Pink shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
White shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices			
Sub Score: 1.000	**Discard Rate: 0.750**		**Score: 0.750**
Species	**Abundance**	**Fishing Mortality**	**Score**
Green turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Kemp's ridley turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Benthic inverts	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Bottlenose dolphin	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Hawksbill turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Leatherback turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Sharks	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic croaker	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blue crab	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Gulf menhaden	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Brown shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Pink shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
White shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices			
Sub Score: 1.000	**Discard Rate: 0.750**		**Score: 0.750**
Species	**Abundance**	**Fishing Mortality**	**Score**
Green turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Kemp's ridley turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Benthic inverts	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Bottlenose dolphin	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Hawksbill turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Leatherback turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Sharks	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic croaker	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blue crab	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Gulf menhaden	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Brown shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Pink shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
White shrimp	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

Western Central Atlantic - United States - Bottom trawls			
Sub Score: 1.000	**Discard Rate: 0.750**		**Score: 0.750**
Species	**Abundance**	**Fishing Mortality**	**Score**
Green turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Kemp's ridley turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Benthic inverts	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Longspine swimming crab	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Atlantic sturgeon	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Smalltooth sawfish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Bottlenose dolphin	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Sharks	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Hawksbill turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Leatherback turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic croaker	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Spot	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Royal red shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Pink shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Inshore lizardfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Dusky flounder	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Cannonball jellyfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Brown shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Brown rock shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Star drum	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
White shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Overall, the mandate for turtle exclusion devices (TED) and by-catch reduction devices (BRD) over the past decades has primarily reduced large by-catch (e.g., sharks and many other, but not all, fish and sea turtles) (Scott-Denton et al. 2020). Data used to select incidental and by-catch include the International Union for the Conservation of Nature (IUCN) Red List, the Endangered Species Act (ESA) species, observer coverage (Scott-Denton et al. 2020; Cagle and West 2020), and the South Atlantic Coastal Trawl Surveys (SEAMAP 2019; SEAMAP 2019b). Aside from species of concern, other species were included if they were at least 5% of the total catch in any assessed shrimp trawl fishery.

Sea turtles are species of high concern as by-catch in shrimp trawl fisheries in both the Gulf and South Atlantic, and they are the main limiting factor for this Criterion due to their threatened or endangered status and frequent interactions with the fisheries (Babcock et al. 2018; Finkbeiner et al. 2011; NOAA 2021b; Scott-Denton et al. 2020; Cagle and West 2020). Green, Kemp's ridley, and loggerhead sea turtles, which are migratory species known to swim through shrimp trawling grounds, have been extensively documented as by-catch in shrimp fisheries. Leatherback and hawksbill turtles, although still captured in shrimp trawlers, are encountered much less frequently than the other species.

Gulf and South Atlantic shrimp fisheries also interact with sharks and rays, although with much less regularity (Scott-Denton et al. 2020). From 2010 to 2015, it is estimated that shark by-catch was over 16 million pounds in the Southeastern shrimp trawl fisheries (including the Gulf of Mexico) {Savoca et al. 2020}. According to the last available observer coverage (2011–2016), the main elasmobranch species include Atlantic sharpnose shark, bonnethead shark, blacktip shark, smooth dogfish shark, cownose ray, scalloped hammerhead shark, Atlantic stingray, spinner shark, and blacknose shark (Scott-Denton et al. 2020). Both scalloped hammerhead and blacknose shark are also listed as overfished in the U.S. (NMFS 2021) and, except for Atlantic sharpnose shark and Atlantic stingray (both IUCN rated as "Least Concern"), all elasmobranch species have an IUCN status ranging from "Near Threatened" to "Critically Endangered" (Carlson et al. 2020; Carlson et al. 2021; Carlson et al. 2021b; Carlson et al. 2021c; Pollom et al. 2021; Rigby et al. 2020; Rigby et al. 2019). Even though all elasmobranch species currently make up much less than 5% of the catch (Scott-Denton et al. 2020), they were included in the assessment for being species of concern.

Other species of concern included in the assessment were bottlenose dolphin, Atlantic sturgeon, Gulf sturgeon, and smalltooth sawfish.

In observer coverage in the Gulf of Mexico otter trawl shrimp fishery, Atlantic croaker, seatrout (genus), and invertebrates each made up >5% of the catch composition, whereas in the South Atlantic penaeid fishery, Atlantic croaker, spot, and cannonball jellyfish each made up >5% of the total catch (Scott-Denton et al. 2020). For the rock shrimp trawl fishery, invertebrates, inshore lizardfish, longspine swimming crab, and dusky flounder each made up >5% of the total catch, while in the skimmer trawl fishery, Atlantic croaker was the only species with over 5% of total catch (Scott-Denton et al. 2020). A finfish group is also listed as a substantial contributor to by-catch in otter trawl fisheries (both in the Gulf and the South Atlantic) as well as skimmer trawls (ranging from 12% to almost 33% on each fishery). But, because specific information on species was not available and other finfish species of concern were already included in our assessment, a finfish group was not included in this report.

In Louisiana, where skimmer trawl corresponds to 51% of annual commercial shrimp gear licenses, gulf menhaden, Atlantic croaker, and blue crab are the most frequent by-catch according to observer coverage (Cagle and West 2020). Lastly, red snapper was not included in this current assessment species list; although it is a species of concern and historically the shrimp fishery in the Gulf has been considered a limiting factor in its recovery, recent observer

coverage showed that the species now accounts for only up to 0.3% of total by-catch in the Gulf shrimp trawl fishery (Scott-Denton et al. 2020).

For all shrimp trawl fisheries assessed, green turtle, Kemp's ridley turtle, and loggerhead turtle limit the score for Criterion 2, due to their endangered status and the likelihood of high cumulative impact and high estimated interactions with the shrimp trawl fishery leading to mortalities. Seatrouts (Cynoscion spp.) also limit the score for otter trawl in the Gulf of Mexico because one species (spotted seatrout) is overfished and undergoing overfishing.

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

Atlantic croaker *(Micropogonias undulatus)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Moderate Concern

There is no stock assessment for Atlantic croaker in the Gulf of Mexico. The IUCN Red List classifies Atlantic croaker as “Least Concern” (IUCN 2017). Due to the lack of a quantitative stock assessment but with the IUCN indicating that status is not of concern, abundance is rated a moderate concern.

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

The most recent benchmark stock assessment for Atlantic croaker was completed in 2017. Nevertheless, as a result of conflicting indicators on the metrics for harvest (survey gear selectivity) and abundance (population trends), the current stock could not be determined or approved by the panel (Able et al. 2017; Schmidtke et al. 2018.}. Although reference points could not be estimated, the 2017 assessment includes indices of abundance that appear to be increasing throughout most of Atlantic croaker's range, thus not indicating an immediate cause for concern (Able et al. 2017). The previous stock assessment is from 2010, which is still used for management actions, and indicates that Atlantic croaker was not overfished and that biomass was increasing (ASMFC 2010). In 2020, a stock status overview was published by the Atlantic States Marine Fisheries Commission, indicating that the Atlantic croaker overfished status is unknown (ASMFC 2020). Because of conflicting information, a productivity-susceptibility analysis was performed for the species. The PSA for Atlantic croaker indicates a moderate vulnerability (PSA score = 2.65; detailed information in Justification). Abundance for Atlantic croaker is scored a moderate concern, because precise values for stock biomass are not available, the valid stock assessment is 10 years old, and the PSA indicates that the species has moderate vulnerability.

Supplementary Information

Table 5

Productivity Attributes	Value	Score (1 = low risk; 2 = medium risk; 3 = high risk)	Reference
Average age at maturity (years)	2	1	(Barbieri et al. 1994)
Average maximum age (years)	12	2	(ASMFC 2010)
Fecundity (eggs/yr)	176,137 (an older study reports a wider range, from 100,800 to 1.7 million) Recruitment of Atlantic croaker has been linked to environmental factors, such as winter temperature in nursery areas and larval output after spawning, as well as prevailing winds, currents, and hurricanes	1	(ASMFC 2007; Morse 1980; Hare and Able 2007)
Average maximum size (cm) (not to be used when scoring invertebrate species)	45.6	1	(Lee 2005) (pers. comm., Rickabaugh H. 2020)
Average size at maturity (cm) (not to be used when scoring invertebrate species)	18.2 for males, 17.3 for females	1	(ASMFC 2010; Barbieri et al. 1994)
Reproductive strategy	Broadcast spawner	1	(ASMFC 2010)

Trophic level	n/a	-	-
Quality of Habitat	moderately altered	2	(Odell et al. 2017)
Productivity Subscore		1.3	

Table 6

Susceptibility Attribute	Information	Score (1 = low risk; 2 = medium risk; 3 = high risk)	Reference
Areal overlap	Unknown, default value is used	3	
Vertical overlap	Species is targeted, default value is used	3	
Selectivity of fishery	It is known that adults form spawning aggregations during the winter season. Although it is not clear where exactly such spawning aggregations occur, it is expected that they occur in deeper offshore waters. It is also known that offshore trawl and gillnet fisheries occur during spawning season; however, the nature and diffuseness of the aggregations suggest a medium risk because they are not being targeted directly.	2	(Odell et al. 2017)
Post-capture mortality	Species is retained, default value is used.	3	
Susceptibility Subscore		2.3	

Productivity-Susceptibility Score	2.65		
Vulnerability Rating (high, medium or low)	Moderate		

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Moderate Concern

In the Gulf of Mexico otter trawl shrimp fishery, Atlantic croaker makes up 16% of the total catch based on observer coverage from 2011–2016 (Scott-Denton et al. 2020). For the skimmer trawl fishery, Atlantic croaker makes up 11% of the total catch based on the same period and assessment (Scott-Denton et al. 2020). There is no stock assessment for Atlantic croaker in the Gulf of Mexico, so fishing mortality has not been calculated in the region (GSMFC 2017). Based on observer coverage, high-density CPUE for the species occurs only in small concentrated areas for both the Gulf of Mexico and South Atlantic regions (see Justification section) (Scott-Denton et al. 2020). Observer coverage in Louisiana had Atlantic croaker making up 5.4% of total catches in shrimp trawlers (Cagle and West 2020). Due to the lack of limit reference points, fishing mortality is rated a moderate concern.

Supplementary Information

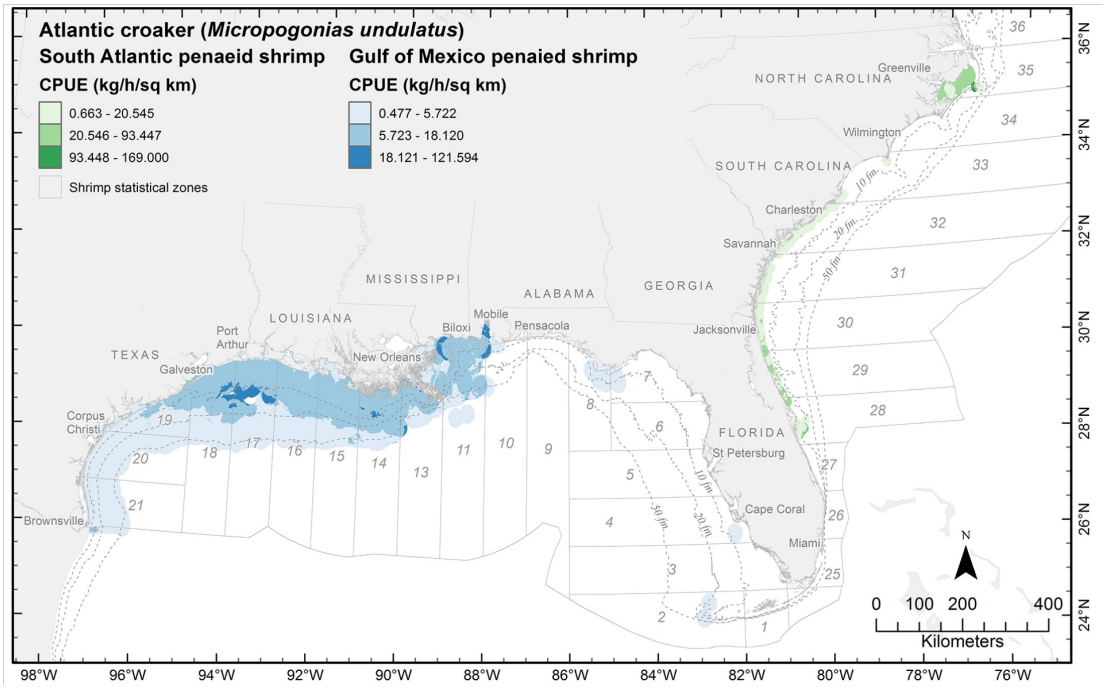

Figure 10: CPUE density surface for Atlantic croaker by area and target, from 2011–2016. Data from mandatory observer coverage (Scott-Denton et al. 2020).

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

The 2017 stock assessment for Atlantic croaker estimated values for fishing mortality; however, because the assessment was not recommended for management use, those values are not used (Able et al. 2017; Schmidtke et al. 2018.}. Nonetheless, the trends observed in the time series parameters indicate a decrease in F values (Able et al. 2017). In addition, catch appears to be stable or declining over time (Able et al. 2017). Although the estimates were not precise, there was an agreement among the panel that recent removals of the stock were sustainable (Able et al. 2017). The previous assessment from 2010 indicates that overfishing was not occurring and that total F values had decreased over the years (ASMFC 2010). The current ASMFC stock status overview indicates an unknown fishing mortality and low harvest in 2018 (ASMFC 2020). In the Southeast Area Monitoring and Assessment Program (SEAMAP) 2018 South Atlantic Coastal Trawl Survey, Atlantic croaker was the most abundant species in both spring (45.4%) and summer cruises (32%) (SEAMAP 2019b). From observer data during 2011–2016 for the South Atlantic otter trawl shrimp fishery, the species makes up almost 25% of catches (Scott-Denton et al. 2020). Fishing mortality is deemed a moderate concern, because of uncertainties about current F estimates and the substantial contribution of the fishery to species mortality.

Atlantic sturgeon *(Acipenser oxyrinchus)*

2.1 Abundance

Western Central Atlantic - United States - Bottom trawls

High Concern

The latest stock assessment lists all distinct population segments of this species as depleted. In addition, the species is listed under the Endangered Species Act (ASMFC 2017b). Due to the species' endangered status and depleted stock, this factor is rated a high concern.

2.2 Fishing Mortality

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

The species has been on a moratorium since 1998, based on a continuous decline in landings due to overfishing, habitat loss, and degradation. Because of the moratorium, landings data were unavailable for assessments, which rely on data from NMFS observer data and/or fishery-independent sources (ASMFC 2017b; NOAA 2021b). Atlantic sturgeon has been documented as occasional by-catch in the South Atlantic shrimp trawl fishery, but since observer coverage became mandatory, data provided by the program has become more random, unbiased, and better suited for statistics (NOAA 2021b). The most recent biological opinion estimates that 268 Atlantic sturgeon were captured in otter trawl gear annually during the 2014–2018 period (NOAA 2021b). The estimated number of total interactions with Atlantic sturgeon in the South Atlantic federal shrimp fishery is 300, resulting annually in 39 by-catches and 9 mortalities (NOAA 2021b). Because documented by-catch is occasional but with uncertainty regarding overall fishing mortality, it is rated a moderate concern.

Supplementary Information

YEAR	LOCATION	DEPTH (FT)	NET	STATUS
2008	SC STATE WATERS	18.2	STANDARD NET	ALIVE
2008	SC STATE WATERS	20.7	STANDARD NET	ALIVE
2008	SC STATE WATERS	18	TRY NET	ALIVE
2008	SC STATE WATERS	25.3	STANDARD NET	ALIVE
2008	SC STATE WATERS	25.3	STANDARD NET	DEAD
2008	SC STATE WATERS	25.3	STANDARD NET	ALIVE
2008	SC STATE WATERS	29.3	STANDARD NET	ALIVE
2011	SC STATE WATERS	35	STANDARD NET	ALIVE
2011	GA STATE WATERS	17	STANDARD NET	ALIVE
2011	GA STATE WATERS	14	STANDARD NET	ALIVE
2016	NC STATE WATERS	38	STANDARD NET	DEAD
2016	NC STATE WATERS	27	STANDARD NET	DEAD
2020	SC STATE WATERS	N/A	TRY NET	ALIVE

Figure 11: Documented by-catch of Atlantic sturgeon in the South Atlantic shrimp fisheries, based on NMFS observer program data (NOAA 2021b).

Although these reported catches occurred in state waters, it is expected that the federal shrimp fishery catches them too.

DPS (MSA %)	Total Interactions	Try Net Bycatch/Mortalities	Standard Net Bycatch/Mortalities	Total Bycatch/Mortalities
Gulf of Maine DPS (1.0%)	3 (300 x 0.01)	0/0 (6 x 0.01)	0/0 (33/9 x 0.01)	0/0 (39/9 x 0.01)
New York Bight DPS (3.6%)	11 (300 x 0.036)	0/0 (6 x 0.036)	1/0 (33/9 x 0.036)	1/0 (39/9 x 0.036)
Chesapeake Bay DPS (9.6%)	29 (300 x 0.096)	1/0 (6 x 0.096)	3/1 (33/9 x 0.096)	4/1 (39/9 x 0.096)
Carolina DPS (33.8%)	101 (300 x 0.338)	2/0 (6 x 0.338)	11/3 (33/9 x 0.338)	13/3 (39/9 x 0.338)
SA DPS (52.9%)	159 (300 x 0.529)	3/0 (6 x 0.529)	17/5 (33/9 x 0.529)	21/5 (39/9 x 0.529)
Atlantic Sturgeon Total[1]	300	6/0	33/9	39/9

[1] Note that the total bycatch and mortality of each category by DPS may be different than bycatch and mortality of Atlantic sturgeon as a whole due to rounding issues.

Figure 12: Total annual estimated interactions, by-catch, and mortalities for Atlantic sturgeon in the South Atlantic federal shrimp fishery (NOAA 2021b).

Benthic inverts *(Unknown benthic invertebrate spp.)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Moderate Concern

According to mandatory observer coverage from 2011–2016, invertebrates make up to 5% of catch on average for all shrimp trawl fisheries in the Gulf and South Atlantic (see table in Justification (Scott-Denton et al. 2020)). Abundance of unidentified benthic invertebrates is scored a moderate concern, following scoring guidelines for the warmwater shrimp trawl fisheries provided by the Seafood Watch Unknown By-catch Matrix.

Supplementary Information

Invertebrates documented from by-catch characterization samples, based on mandatory observer coverage of the U.S. southeastern shrimp fishery from 2011–2016 (adapted from (Scott-Denton et al. 2020)).

Table 7

Common name	Gulf mandatory penaeid (kg)	Gulf mandatory penaeid (%)	South Atlantic mandatory penaeid (kg)	South Atlantic mandatory penaeid (%)	Mandatory rock (kg)	Mandatory rock (%)	Gulf mandatory skimmer (kg)	Gulf mandatory skimmer (%)	Total (kg)	Percent total
Invertebrate	210,182.3	5.2	6,347.3	2.2	5,062.4	7.6	137.7	0.6	221,729.6	5.0

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

High Concern

According to observer coverage from 2011–2016, invertebrate by-catch makes up to 5% of catch on average in the shrimp trawl fishery in both the South Atlantic and the Gulf (see table in Justification (Scott-Denton et al. 2020)). Fishing mortality of unidentified benthic invertebrates is scored a high concern, following scoring guidelines for the warmwater shrimp trawl fisheries provided by the Seafood Watch Unknown By-catch Matrix.

Supplementary Information

Invertebrates documented from by-catch characterization samples, based on mandatory observer coverage of the U.S. southeastern shrimp fishery from 2011–2016 (adapted from (Scott-Denton et al. 2020)).

Table 8

Common name	Gulf mandatory penaeid (kg)	Gulf mandatory penaeid (%)	South Atlantic mandatory penaeid (kg)	South Atlantic mandatory penaeid (%)	Mandatory rock (kg)	Mandatory rock (%)	Gulf mandatory skimmer (kg)	Gulf mandatory skimmer (%)	Total (kg)	Percent total
Invertebrate	210,182.3	5.2	6,347.3	2.2	5,062.4	7.6	137.7	0.6	221,729.6	5.0

Blue crab *(Callinectes sapidus)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Moderate Concern

Blue crab is not considered overfished; however, abundance for the Western and Eastern Gulf of Mexico (GOM) stocks is close to the estimated abundance for maximum sustainable yield (MSY) {Perry & VanderKooy 2015}. The Western GOM is above 75% of MSY, which is often considered the target biomass level. Biomass in the Eastern GOM is below 75% of MSY (17.25 million individuals), but well above 50% of MSY (11.5 million individuals), which is often considered the threshold biomass level before a stock is considered overfished; therefore, neither stock is considered overfished. The Western stock has been in a depressed state and is trending toward the overfished limit (GSMFC 2013).

Louisiana conducts its own annual stock assessments and has also classified the Louisiana blue crab stock as not overfished (LDWF 2019). In Louisiana, the biomass target reference point SSB_{TARGET} equals the $SSB_{LIMIT} \times 1.5$, or 29.1 million pounds. The SSB/SSB_{LIMIT} estimate for 2018 was 2.05, which suggests that the stock is not overfished. But, because blue crab fishing mortality is highly variable from year to year and dependent on

environmental conditions, the indication that neither blue crab stock is overfished should be taken with caution, due to the Western stock declining trend. For this reason, abundance is ranked a moderate concern.

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Low Concern

Overfishing is not occurring for blue crab in the Gulf of Mexico, and in Louisiana, the 2017 ratio of F/FLIMIT is 0.60, which also suggests that the stock is not experiencing overfishing (F/FLIMIT > 1) (GSMFC 2013; LDFW 2019}. Louisiana has a control rule in place, and management actions to prevent overfishing are being proposed (Louisiana Register 2016). Because blue crab fishing mortality is variable from year to year and dependent on environmental conditions, and management actions are being implemented, it is likely that overfishing will be prevented and harvest will be controlled. Based on limited observer coverage in the past, blue crab made up 7% of the catch composition in the Gulf of Mexico shrimp skimmer trawl fishery in 2004–2005 (Scott-Denton et al. 2006) and < 2% of the catch composition in 2014 (Scott-Denton et al. 2014). The latest set of observer coverage, from 2011–2016, shows blue crab as less than 0.5% of catch composition in the Gulf and only 1% in the South Atlantic (Scott-Denton et al. 2020). The 2020 observer coverage in Louisiana had blue crab making up 4.9% of the total catch in the trawl fishery (Cagle and West 2020). Because the contribution to fishing mortality is expected to be low enough to not adversely affect the overall population, and the stocks are not experiencing overfishing, fishing mortality is rated a low concern.

Bottlenose dolphin *(Tursiops truncatus)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

High Concern

The Gulf of Mexico shrimp trawl fishery may interact with a number of populations of bottlenose dolphin, including the Gulf of Mexico bay, sound, and estuary (BSE) stocks, the Eastern Coastal Stock (ECS), and the Western Coastal Stock (WCS). As a marine mammal, bottlenose dolphin has a high inherent vulnerability. The best population abundance estimate for Gulf of Mexico bottlenose dolphin from the WCS is 20,161 individuals, based on surveys from 2011 and 2012 (NOAA 2021). The best population abundance estimate for Gulf of Mexico bottlenose dolphin from the ECS is 12,388 (CV = 0.13) individuals (NOAA

2021). Population estimates for most of the 31 Gulf of Mexico bay, sound, and estuary stocks of bottlenose dolphin are outdated or unknown (NOAA 2021).

Because of limited data availability for the BSE stocks and because marine mammals have a high inherent vulnerability, abundance is rated a high concern.

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

High Concern

The Florida skimmer trawl fishery may interact with bottlenose dolphin from a number of populations, including the Gulf of Mexico bay, sound, and estuary stocks (BSE) and the Eastern Coastal Stock (ECS). As a marine mammal, bottlenose dolphin has a high inherent vulnerability. Population estimates for most of the 31 Gulf of Mexico bay, sound, and estuary stocks of bottlenose dolphin are outdated or unknown (NOAA 2021). The best population abundance estimate for Gulf of Mexico bottlenose dolphin from the ECS is 12,388 (CV = 0.13) individuals (NOAA 2021), and it is not considered a strategic stock.

Because of limited data availability for the Gulf of Mexico bay, sound, and estuary stocks and because marine mammals have a high inherent vulnerability, abundance is rated a high concern.

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

High Concern

The Gulf of Mexico skimmer trawl fishery may interact with several stocks of bottlenose dolphin, including the Gulf of Mexico bay, sound, and estuary stocks (BSE) and the Western Coastal Stock (WCS). As a marine mammal, bottlenose dolphin has a high inherent vulnerability. The best population abundance estimate for Gulf of Mexico bottlenose dolphin from the WCS is 20,161 individuals based on surveys from 2011 and 2012 (NOAA 2021). Population estimates for most of the 31 Gulf of Mexico bay, sound, and estuary stocks of bottlenose dolphin are outdated or unknown (NOAA 2021).

Because of limited data availability for the BSE stocks and because marine mammals have a high inherent vulnerability, abundance is rated a high concern.

Western Central Atlantic - United States - Bottom trawls

High Concern

As a marine mammal, bottlenose dolphin has a high inherent vulnerability. The best population abundance estimate for the Western North Atlantic South Carolina/Georgia

Coastal Stock is 6,027 (CV = 0.34) individuals, and the stock is considered strategic under the Endangered Species Act (ESA) (NOAA 2021). Because the species is highly vulnerable and the stock is listed as strategic, abundance is rated a high concern.

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Moderate Concern

The shrimp trawl fishery is a Category II fishery. NMFS considers the Gulf of Mexico bay, sound, and estuary (BSE) bottlenose dolphin stocks to be strategic, because stock sizes are likely small enough that a few mortalities would exceed PBR (NOAA 2021). Total fishery-related mortality is unknown but likely exceeds 10% from all sources. Little is known about BSE dolphin mortality attributed to the shrimp trawl fisheries, because there is no observer coverage in the BSE region for the otter trawl fishery and limited coverage in the skimmer trawl fishery. When extrapolating shrimp trawl by-catch data from Gulf bottlenose dolphin mortalities to estimate inshore mortality attributed to the shrimp trawl fisheries, the mean annual mortality estimate was 132.4, omitting skimmer trawl effort (NOAA 2017a).

Mean annual mortality on the Eastern Coastal Stock is estimated to be 1.6 dolphins (NOAA 2021), which is <10% of PBR (PBR = 111) (NOAA 2021). Mean annual mortality on the Western Coastal Stock is estimated to be 0.6 dolphin (NOAA 2021). This mortality is <10% of PBR (PBR = 175) (NOAA 2021) and cumulative fisheries mortality is unknown.

Because the BSE stocks are strategic and PBR is unknown, fishing mortality on bottlenose dolphin is rated a moderate concern.

Supplementary Information

The mean annual mortality estimates for the BSE stocks were calculated by state as follows (NOAA 2019):

Table 9

State	Mean Annual Mortality
Texas	0
Louisiana	61
Mississippi/Alabama	27
Florida	2.4

These estimates omit skimmer trawl effort due to limited observer coverage. In Louisiana, Alabama, and Mississippi, the skimmer trawl fishery may represent up to 50% fishing effort inshore (NOAA 2019). During NMFS fisheries research in skimmer trawls in 2013 and 2014, there were two incidental bottlenose dolphin takes documented that were assigned to the Mississippi Sound, Lake Borgne, Bay Boudreau stock (pers. comm., Dr. Keith Mullin, NOAA 2017). In 2013, the dolphin was a live take and serious injury could not be determined; in 2014, the dolphin was a mortality.

In the observer coverage from 2011–2016, four bottlenose dolphins were reported in the Gulf of Mexico shrimp otter trawl fishery, being entangled in the fishing gear and freshly dead upon release (Scott-Denton et al. 2020).

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Moderate Concern

The shrimp trawl fishery is a Category II fishery. NMFS considers the Gulf of Mexico bay, sound, and estuary (BSE) bottlenose dolphin stocks to be strategic, because stock sizes are likely small enough that a few mortalities would exceed PBR (NOAA 2021). Total fishery-related mortality is unknown but likely exceeds 10% from all sources. Little is known about BSE dolphin mortality attributed to the shrimp trawl fisheries, because there is no observer coverage in the BSE region for the otter trawl fishery and limited coverage in the skimmer trawl fishery. When extrapolating shrimp trawl by-catch data from Gulf bottlenose dolphin mortalities to estimate inshore mortality attributed to the shrimp trawl fisheries, the mean annual mortality estimate was 132.4, omitting skimmer trawl effort (NOAA 2017a).

Mean annual mortality is estimated to be 1.6 Eastern Coastal Stock dolphin (NOAA 2021). This mortality attributed to the shrimp trawl fishery is <10% of PBR (PBR = 111) (NOAA 2021).

Because the BSE stocks is strategic and PBR is unknown, fishing mortality on bottlenose dolphin is rated a moderate concern.

Supplementary Information

The mean annual mortality estimates for the BSE stocks were calculated by state as follows (NOAA 2019):

Table 10

State	Mean Annual Mortality
Texas	0
Louisiana	61
Mississippi/Alabama	27
Florida	2.4

These estimates omit skimmer trawl effort due to limited observer coverage. In Louisiana, Alabama, and Mississippi, the skimmer trawl fishery may represent up to 50% fishing effort inshore (NOAA 2019). During NMFS fisheries research in skimmer trawls in 2013 and 2014, there were two incidental bottlenose dolphin takes documented that were assigned to the Mississippi Sound, Lake Borgne, Bay Boudreau stock (pers. comm., Dr. Keith Mullin, NOAA 2017). In 2013, the dolphin was a live take and serious injury could not be determined; in 2014, the dolphin was a mortality.

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Moderate Concern

The shrimp trawl fishery is a Category II fishery. NMFS considers the Gulf of Mexico bay, sound, and estuary (BSE) bottlenose dolphin stocks to be strategic, because stock sizes are likely small enough that a few mortalities would exceed the potential biological removal (PBR) (NOAA 2021). Total fishery-related mortality is unknown but likely exceeds 10% of PBR from all sources. Little is known about BSE dolphin mortality attributed to the shrimp trawl fisheries, because there is no observer coverage in the BSE region for the otter trawl fishery and limited coverage in the skimmer trawl fishery. When extrapolating shrimp trawl by-catch data from Gulf bottlenose dolphin mortalities to estimate inshore mortality attributed to the shrimp trawl fisheries, the mean annual mortality estimate was 132.4, omitting skimmer trawl effort (NOAA 2017a). Mean annual

mortality on the WCS is estimated to be 0.6 dolphin (NOAA 2021). This mortality is <10% of PBR (PBR = 175) (NOAA 2021) and cumulative fisheries mortality is unknown; this is not a strategic stock.

Because the BSE stock is strategic and PBR is unknown, fishing mortality is rated a moderate concern.

Western Central Atlantic - United States - Bottom trawls

Low Concern

The shrimp trawl fishery is a Category II fishery and mean annual mortality is 1.0–1.2 Western North Atlantic South Carolina/Georgia stock dolphin (NOAA 2021). Total mean annual mortality from all sources is 1.4–1.6; however, this estimate is uncertain due to minimal observer coverage (NOAA 2021). Mortality attributed to the shrimp trawl fishery is <10% of PBR (PBR = 46) (NOAA 2021), resulting in a rating of low fishing mortality concern.

Cannonball jellyfish *(Stomolophus meleagris)*

2.1 Abundance

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

There is no stock assessment and there are no data-limited assessments for cannonball jellyfish. A productivity-susceptibility analysis (see table in Justification) yields a score of low vulnerability (PSA = 2.62 (Álvarez-Tello et al. 2016; Palomares & Pauly 2017)). Because of limited data availability and a lack of reference points but with low vulnerability, abundance is rated a moderate concern.

Supplementary Information

Productivity Susceptibility Analysis – Cannonball jellyfish

Productivity Attribute	**Relevant Information**	**Score (1 = low, 2 = med, 3 = high risk)**
Average age at maturity	< 5 yrs	1
Average maximum age	< 10 yrs	1
Fecundity	>20,000 eggs per year	1
Average maximum size	N/A	N/A
Average size at maturity	N/A	N/A
Reproductive strategy	Broadcast spawner	1
Trophic level	3	2

Refs: Palomares & Pauly 2017, Alvarez-Tello et al. 2015

The average Productivity score is 1.2

Susceptibility Attribute	**Relevant Information**	**Score (1 = low, 2 = med, 3 = high risk)**
Areal overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Vertical overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Selectivity of fishery (Specific to fishery under assessment)	Default score (Species is targeted and there are no special circumstances increasing its susceptibility)	2
Post-capture mortality (Specific to fishery under assessment)	Default score (species is retained)	3

The multiplicative Susceptibility score is 2.33

Overall PSA Score: 2.62 Low

Figure 13:

2.2 Fishing Mortality

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

In observer coverage in the South Atlantic shrimp trawl fishery from 2011–2016, cannonball jellyfish made up 5% of catch composition by weight (Scott-Denton et al. 2020). Because there is uncertainty regarding overall fishing mortality, it is rated a moderate concern.

Dusky flounder *(Syacium papillosum)*

2.1 Abundance

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

There is no stock assessment and there are no data-limited assessments for dusky flounder. A productivity-susceptibility analysis (see table in Justification) yields a score of medium vulnerability (PSA = 2.71 (Martin & Drewry 1978; Froese & Pauly 2017). Because of limited data availability and a lack of reference points but with medium vulnerability, abundance is rated a moderate concern.

Supplementary Information

Productivity Susceptibility Analysis – Dusky flounder

Productivity Attribute	**Relevant Information**	**Score (1 = low, 2 = med, 3 = high risk)**
Average age at maturity	Unknown	N/A
Average maximum age	Unknown	N/A
Fecundity	>20,000 eggs per year	1
Average maximum size	25 cm	1
Average size at maturity	16 cm	1
Reproductive strategy	Broadcast spawner	1
Trophic level	3.6	3

Refs: Froese & Pauly 2017, Martin & Drewry 1978

The average Productivity score is 1.4

Susceptibility Attribute	**Relevant Information**	**Score (1 = low, 2 = med, 3 = high risk)**
Areal overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Vertical overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Selectivity of fishery (Specific to fishery under assessment)	Default score (Species is targeted and there are no special circumstances increasing its susceptibility)	2
Post-capture mortality (Specific to fishery under assessment)	Default score (species is retained)	3

The multiplicative Susceptibility score is 2.33

Overall PSA Score: 2.71 Medium

Figure 14:

2.2 Fishing Mortality

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

In observer coverage of the South Atlantic rock shrimp trawl fishery from 2007-2010, dusky flounder made up 10.6% of catch composition by weight (Scott-Denton et al. 2012). From 2011–2016, catches decreased to 5.7% of by-catch weight composition (Scott-Denton et al. 2020). Because there is uncertainty regarding overall fishing mortality, it is rated a moderate concern.

Green turtle *(Chelonia mydas)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

High Concern

The North Atlantic DPS of the green sea turtle has an estimated nester abundance of over 167,000 adult females (NOAA 2021b) and is listed as “Threatened” under the Endangered Species Act {81 FR 20057}. Therefore, abundance is rated a high concern.

Supplementary Information

A nesting-trend monitoring program has been in place in Florida since 1989 with consistent data collection (including location, fixed dates, and annual training of surveyors) (FFWCC 2022). Such data include both the Atlantic and Gulf coasts of Florida. For green sea turtle, the nest counts have increased from less than 300 in 1989 to almost 41,000 in 2019 (FFWCC 2022).

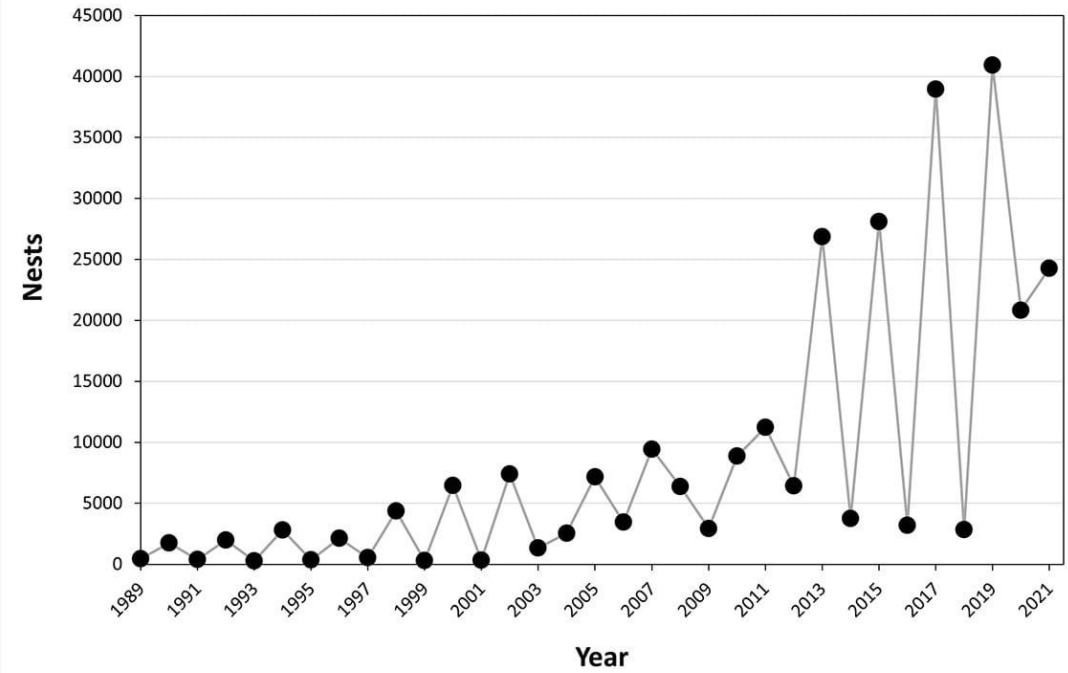

Figure 15: Number of green turtle nests counted on core index beaches in Florida, from 1989 to 2021 (FFWCC 2022).

Another region with a consistently high nesting population is the Caribbean coast of Costa Rica (Tortuguero) where, on average, 30,000 females nest every season (NOAA 2022), and it is the most important nesting concentration for green sea turtle for the North Atlantic DPS (NOAA 2021b).

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

High Concern

Observer coverage for shrimp trawl fisheries in both the South Atlantic and Gulf of Mexico is quite low (about 2% of days) (Babcock et al. 2018). In the Gulf of Mexico, estimated total by-catch in try nets was about 4,000 to 8,000 sea turtles, and in standard nets was about 5,000 to 10,000 sea turtles of all species from 2007–2015 (Babcock et al. 2018). In the South Atlantic, the estimated numbers were 7,000 to 13,000 in try nets and 4,000 to 11,000 in standard nets during 2007–2016 (Babcock et al. 2018).

The sea turtle species most caught in try nets was loggerhead in the Gulf of Mexico, but the species was rarely found in standard nets. The estimated by-catch of the species from 2007–2015 has decreased, from a 95% credible interval of 17–127 to 5–36 (Babcock et al. 2018). The estimate for Kemp's ridley turtle in 2015 was 19–130; for loggerhead turtle, 5–36; for green sea turtle, 22–81; and for unknown/other species of sea turtle, 24–99 (leatherback sea turtle had only 3 individuals observed, whereas hawksbill turtle had only 1 individual in standard nets) (Babcock et al. 2018). A substantial increase in observer coverage would help estimate species-specific by-catch mortalities (Babcock et al. 2018).

Similarly to the Gulf, most sea turtle by-catch in the South Atlantic was in try nets, with a high survival rate. For standard nets, the total by-catch in 2016 was estimated at around 5–111 for Kemp's ridley turtle; 9–139 for loggerhead turtle; 2–86 for green sea turtle; and 13–168 for unknown/other sea turtles (95% credible interval). For the South Atlantic, not only is an increase in observer coverage needed, but also more even distribution across strata (area, depth, and season) (Babcock et al. 2018).

Because it is uncertain (but likely) that cumulative fishing mortality is above a sustainable level and the shrimp trawl fisheries are significant contributors to mortality, fishing mortality for green sea, loggerhead, and Kemp's ridley turtles is rated a high concern.

Supplementary Information

	TRY NET		STANDARD NET	
	BYCATCH	MORTALITIES	BYCATCH	MORTALITIES
KEMP'S RIDLEY	4,212	77	5,801	440
LOGGERHEAD	10,603	202	3,305	120
GREEN	1,095	36	2,433	208
LEATHERBACK	5	0	21	1
HAWKSBILL	6	0	28	1
TOTAL	**15,921**	**315**	**11,588**	**770**

Figure 16: Total adjusted annual estimated by-catch and mortality for sea turtle species in the southeastern U.S. otter trawl fisheries during 2007–2015. For more details on methods and protocols used, see (NOAA 2021b).

Species	Try Nets		Standard Nets		Total Mortalities
	Captures	Mortalities	Captures	Mortalities	
Kemp's Ridley Sea Turtle	42,120	770	58,010	4,400	5,170
Loggerhead Sea Turtle	106,030	2,020	33,050	1,200	3,220
Green Sea Turtle	11,782	388	26,179	2,238	2,626
NA DPS (96%)	11,310	372	25,132	2,148	2,520
SA DPS (4%)	472	16	1,048	90	106

Figure 17: Estimates of southeast U.S. shrimp fisheries otter trawl by-catch and mortality within the next 10 years. For green sea turtle, values presented have adjusted capture and mortality estimates because anticipated population growth was included in the analysis (NOAA 2021b).

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

High Concern

During the 2011–2016 observer coverage, a total of 45 turtles were caught in skimmer trawls (36 Kemp's ridley, 4 green sea, 4 loggerhead, and 1 unidentified hardshell) (Scott-Denton et al. 2020). Estimates of annual by-catch and mortality for Kemp's ridley, loggerhead, and green sea turtles indicate substantial interaction of these species with this fishery (see Justification (NOAA 2021b)). Because this fishery is a substantial contributor to mortality of these species, this factor receives a score of high concern.

Supplementary Information

Species	Skimmer Trawl Bycatch	Skimmer Trawl Mortalities
Kemp's Ridley Sea Turtle	6,886	1,184
Loggerhead Sea Turtle	626	108
Green Sea Turtle	415	72
TOTAL	**7,928**	**1,364**

Figure 18: Estimates of recent annual skimmer trawl by-catch and mortality of sea turtle species in the southeastern U.S. shrimp fisheries (NOAA 2021b).

Species	Skimmer Trawl Captures	Skimmer Trawl Mortalities
Kemp's Ridley Sea Turtle	68,860	11,840
Loggerhead Sea Turtle	6,260	1,080
Green Sea Turtle	4,466	774
NA DPS (96%)	4,288	744
SA DPS (4%)	178	30

Figure 19: Estimates of southeast U.S. shrimp fisheries skimmer trawl by-catch and mortality within the next 10 years. For green sea turtle, the values presented have adjusted capture and mortality estimates because anticipated population growth was included in the analysis (NOAA 2021b).

Gulf menhaden *(Brevoortia patronus)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Low Concern

The Gulf menhaden Fishery Management Plan had established SSB or fecundity-based benchmarks at $SSB_{30\%}$ (limit) and $SSB_{35\%}$ (target) (SEDAR 2018b). Under these reference points, Gulf menhaden stock is not overfished ($SSB_{2015–2017}$ at 3,522,173 t; $SSB_{30\%}$ < 2,074,992 t and $SSB_{35\%}$ < 2,074,992 t) (SEDAR 2018b). A recent stock assessment update was released ($SSB/SSB_{25\% \text{ at } F=0}$ = 2.33, $SSB_{25\% \text{ at } F=0}$ = 1,274,663, $SSB_{50\% \text{ of } F=0}$ = 2,549,325, and SSB_{2020} = 2,967,933) and suggests that the stock is still not overfished (GSMFC 2021). Because biomass has been constantly updated, is above target reference points, and is appropriate to a forage species (see Justification), abundance is rated a low concern.

Supplementary Information

In the 2018 Stock Assessment Report for Gulf menhaden, an SSB-based benchmark was recommended by the assessment panel, using percentages based on equilibrium values when F = 0: “The panel then recommended that the target be the SSB value at 50% of the SSB when F = 0. Theoretically, this would be the level at MSY given that when looking at the surplus production curve, MSY occurs at half the SSB or B on the curve (optimum harvest levels are at that point on the curve). Thus, the assessment panel recommended this level as the target because the fishery would be harvested optimally and would be at a place where replacement by recruitment would be optimal to sustain the population. In addition, the assessment panel recommended using 25% of the SSB when F = 0 as the threshold for the population. This threshold is used for groundfish stocks on the West Coast (PFMC 2016) and provides the level below which SSB should not drop in order to maintain a sustainable population. The limit reference point of SSB value at 25% of the SSB when F = 0 is generally consistent with the equilibrium limit reference point of 0.3 B_0 selected by Fisheries and Oceans Canada for Pacific herring (*Clupea pallasii*); (Sainsbury 2008, DFO 2017).” (SEDAR 2018b).

The most recent stock assessment update calls to attention the need to develop ecosystem-based assessments to address food web impacts, particularly with forage species, although the importance of single-species assessment should be maintained. In the future, comparisons of the two assessment types are expected (GSMFC 2021) .

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Low Concern

The most recent stock assessment indicates that Gulf menhaden is not experiencing overfishing. The latest estimates are $F_{2015–2017} = 0.78$; $F_{30\%} > 10.0$; $F_{35\%} > 10.0$ (SEDAR 2018b) and $F/F_{F=M} = 0.42$, $F_{2020} = 0.56$, and $F_{2018–2020} = 0.67$ (GSMFC 2021). Limited observer coverage in the shrimp skimmer trawl fishery noted that Gulf menhaden made up 8% of the catch composition from 2004–2005 (Scott-Denton et al. 2006). From 2011–2016, Gulf menhaden by-catch decreased to 0.1% of total catch composition (Scott-Denton et al. 2020). The 2020 observer coverage in Louisiana had Gulf menhanden among the most abundant species (14.1%) in skimmer trawlers (Cagle and West 2020). Because it is probable that fishing mortality from all sources is below a sustainable level that is appropriate (given the species' ecological role), fishing mortality is rated a low concern.

Supplementary Information

The biological reference points for Gulf menhaden set in the latest stock assessment update are described: "As in SEDAR 63, the F-based biological reference points are based on F = M for the threshold and F = 0.75M as the target. The natural mortality associated with the F-based reference points was the geometric mean natural mortality for ages 0 to 2, which is the bulk of the incoming fishery in future years. All equilibrium benchmark calculations were based upon current fishery selectivity, M-at-age (which was constant over time), weight-at-age, and fecundity-at-age from the model inputs. Population fecundity (FEC, number of maturing or ripe eggs) was used as the measure of reproductive capacity. The SSB- or FEC-based metrics were the SSB value at 25% and 50% of the equilibrium value when F = 0." (GSMFC 2021).

The Lenfest Forage Fish Task Force recommends that, for forage species, the fishing mortality rate, *F*, should not exceed the natural mortality rate, M (i.e., F/M ≤ 1) (Pikitch et al. 2012). Following this guideline, $F_{2018–2020} < 1$ for all age groups.

Life history characteristics at age of Gulf menhaden: maturity, natural mortality (M), fecundity, and weight (g) at spawning (GSMFC 2021).

Table 11

Age	Maturity	M	Fecundity	Weight at spawning
0	0.0	1.67	0	0.0
1	0.8	1.26	164,106	53.4
2	1.0	1.10	404,404	97.5
3	1.0	1.02	744,264	146.7
4+	1.0	0.98	1,149,697	196.4

Estimated status indicators, benchmarks, and related quantities from the Beaufort catch-age model conditional on estimated current selectivity. Rate estimates (F) are in units of y^{-1}, and status indicators are dimensionless (GSMFC 2021).

Table 12

Quantities	Units	Estimates
$F_{F = M}$	y^{-1}	1.32
$F_{F = 0.75 M}$	y^{-1}	0.99

$F_{2018–2020}$	y^{-1}	0.67
$F_{2018–2020}/F_{F = M}$	—	0.51
$F_{2018–2020}/F_{F = 0.75 M}$	—	0.68

Gulf Sturgeon *(Acipenser)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

High Concern

Gulf sturgeon is a subspecies of Atlantic sturgeon, a long-lived, late-maturing, highly vulnerable species. Gulf sturgeon has been listed as “Threatened” under the Endangered Species Act (ESA) since 1991. Estimates of population abundance vary but appear stable in the eastern part of its range, while population trends in the western range are less clear {NOAA 2012b}. Because it is a threatened species, abundance is rated a high concern.

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Low Concern

Gulf sturgeon’s susceptibility to interaction with shrimp trawls only occurs between November and February, due to its feeding habits (NOAA 2021b). There are only two reported cacthes of Gulf sturgeon with a shrimp trawl in the Gulf: one in state waters and the other in federal waters (NOAA 2021b), and it is likely that sturgeon benefits from required by-catch reduction devices (NMFS 2014; NOAA 2021b). Other information available by state agencies shows different interactions and incidental catch in Louisiana, Alabama, and Mississippi (NOAA 2021b). But, observer coverage is limited (<2%) and it has been previously suggested that Gulf sturgeon is commonly encountered by the shrimp trawl fishery in some regions during nocturnal fishing (NMFS 2009b). In addition, it is assumed that for every Gulf sturgeon caught in a trawl, an additional eight may escape undetected via turtle exclusion devices (TED) (NOAA 2021b). By utilizing a conservative mortality rate, it is estimated that one out of four interactions will result in mortality (or one mortality in federal waters every 4 years) (NOAA 2021b). Because this fishery is not a substantial contributor to Gulf sturgeon mortality, this factor is rated a low concern.

Hawksbill turtle *(Eretmochelys imbricata)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

High Concern

The hawksbill turtle is listed as “Endangered” throughout its range under the Endangered Species Act {35 FR 8491}, so abundance is rated a high concern.

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Low Concern

For otter trawls, interactions with leatherback and hawksbill turtles are not common. From 2011–2016, a total of three individuals of leatherback were captured (two released, one death) in the U.S. Gulf of Mexico and South Atlantic shrimp fisheries (Scott-Denton et al. 2020). Only one hawksbill was captured during the 2007–2017 period (Babcock et al. 2018). Due to very low observer coverage, by-catch mortality could not be modeled for either species (Babcock et al. 2018) and is estimated at one death per year (NOAA 2021b). Both hawksbill and leatherback turtles are expected to be infrequently encountered by nearshore skimmer trawl fisheries, because the turtles’ preferred habitats do not overlap with areas of high trawl effort (NMFS 2014; NOAA 2021b) and recent observer data showed no interaction (Scott-Denton et al. 2020). The estimates of total (otter and skimmer trawl gear, all nets combined) by-catch and mortality in the southeast U.S. shrimp fisheries over the next 10 years are 260 leatherback catches (10 mortalities) and 340 hawksbill catches (10 mortalities) (NOAA 2021b). Because skimmer and otter trawl fisheries are not expected to be substantial contributors to either leatherback or hawksbill mortality, and there are few encounters with the species in otter trawls (NOAA 2021b), fishing mortality is rated a low concern.

Inshore lizardfish *(Synodus foetens)*

2.1 Abundance

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

There is no stock assessment and there are no data-limited assessments for the overall range of inshore lizardfish. A productivity-susceptibility analysis (see table in Justification) yields a score of medium vulnerability (PSA = 2.91 (Jeffers et al. 2008; Froese & Pauly 2017)). Because of limited data availability and a lack of reference points but with medium vulnerability, abundance is rated a moderate concern.

Supplementary Information

Productivity Susceptibility Analysis – Inshore lizardfish

Productivity Attribute	Relevant Information	Score (1 = low, 2 = med, 3 = high risk)
Average age at maturity	Unknown	N/A
Average maximum age	9	1
Fecundity	Unknown	N/A
Average maximum size	35 cm	1
Average size at maturity	Unknown	N/A
Reproductive strategy	Demersal egg layer	2
Trophic level	4.5	3

Refs: Froese & Pauly 2017, Jeffers et al. 2008

Refs: Froese & Pauly 2017, Jeffers et al. 2008

The average Productivity score is 1.75

Susceptibility Attribute	Relevant Information	Score (1 = low, 2 = med, 3 = high risk)
Areal overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Vertical overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Selectivity of fishery (Specific to fishery under assessment)	Default score (Species is targeted and there are no special circumstances increasing its susceptibility)	2
Post-capture mortality (Specific to fishery under assessment)	Default score (species is retained)	3

The multiplicative Susceptibility score is 2.33

Overall PSA Score: 2.91 Medium

Figure 20:

2.2 Fishing Mortality

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Fishing mortality of lizardfish attributed to the shrimp trawl fishery is unknown due to limited observer coverage. Research suggests that fishing mortality from the shrimp trawl fishery fully exploits the lizardfish populations in the Gulf of Mexico despite not having a directed fishery, and exploitation ratios indicate that fishing pressure could lead to overexploitation in some years (Jeffers et al. 2008). In the Atlantic fishery, limited observer coverage noted that inshore lizardfish made up 9% of catch composition from 2007–2010 (Scott-Denton et al. 2012). A different assessment using SEAMAP CPUE data for penaeid shrimp trawling presented a wider percentage range for inshore lizardfish (6% during 1992–2005 and less than 5% from 2007–2010); however, there are uncertainties in these results (Raborn et al. 2014). Observer coverage from 2011–2016 shows that inshore lizardfish was 7.2% of catch composition in the rock shrimp fishery, and only 0.1% in the

Gulf otter trawl fishery. Because the shrimp trawl fishery is the main contributor to mortality but with uncertainty regarding magnitude, fishing mortality is rated a moderate concern.

Kemp's ridley turtle *(Lepidochelys kempii)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

High Concern

The Kemp's ridley turtle is listed as "Endangered" throughout its range under the Endangered Species Act {35 FR 18319}, so abundance is rated a high concern.

Supplementary Information

The Kemp's ridley turtle population has been recovering since the 1985 season, with more stable numbers since 2009 (Bevan et al. 2016). But, the number of annual nests is still much lower than historical abundance (Bevan et al. 2016), which results in the species being listed as "Critically Endangered" by the International Union for the Conservation of Nature (IUCN) (Wibbels and Bevan 2019). In addition, a higher by-catch may be expected due to increasing abundance of the species (Putman et al. 2020). Lastly, researchers have suggested that a recent nesting setback of Kemp's ridley turtle could have been caused by the declining carrying capacity of a greatly altered Gulf of Mexico, compared to historical conditions that could support much higher abundance (Caillouet et al. 2018).

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

High Concern

Observer coverage for shrimp trawl fisheries in both the South Atlantic and Gulf of Mexico is quite low (about 2% of days) (Babcock et al. 2018). In the Gulf of Mexico, estimated total by-catch in try nets was about 4,000 to 8,000 sea turtles, and in standard nets was about 5,000 to 10,000 sea turtles of all species from 2007–2015 (Babcock et al.

2018). In the South Atlantic, the estimated numbers were 7,000 to 13,000 in try nets and 4,000 to 11,000 in standard nets during 2007–2016 (Babcock et al. 2018).

The sea turtle species most caught in try nets was loggerhead in the Gulf of Mexico, but the species was rarely found in standard nets. The estimated by-catch of the species from 2007–2015 has decreased, from a 95% credible interval of 17–127 to 5–36 (Babcock et al. 2018). The estimate for Kemp's ridley turtle in 2015 was 19–130; for loggerhead turtle, 5–36; for green sea turtle, 22–81; and for unknown/other species of sea turtle, 24–99 (leatherback sea turtle had only 3 individuals observed, whereas hawksbill turtle had only 1 individual in standard nets) (Babcock et al. 2018). A substantial increase in observer coverage would help estimate species-specific by-catch mortalities (Babcock et al. 2018).

Similarly to the Gulf, most sea turtle by-catch in the South Atlantic was in try nets, with a high survival rate. For standard nets, the total by-catch in 2016 was estimated at around 5–111 for Kemp's ridley turtle; 9–139 for loggerhead turtle; 2–86 for green sea turtle; and 13–168 for unknown/other sea turtles (95% credible interval). For the South Atlantic, not only is an increase in observer coverage needed, but also more even distribution across strata (area, depth, and season) (Babcock et al. 2018).

Because it is uncertain (but likely) that cumulative fishing mortality is above a sustainable level and the shrimp trawl fisheries are significant contributors to mortality, fishing mortality for green sea, loggerhead, and Kemp's ridley turtles is rated a high concern.

Supplementary Information

	TRY NET		STANDARD NET	
	BYCATCH	MORTALITIES	BYCATCH	MORTALITIES
KEMP'S RIDLEY	4,212	77	5,801	440
LOGGERHEAD	10,603	202	3,305	120
GREEN	1,095	36	2,433	208
LEATHERBACK	5	0	21	1
HAWKSBILL	6	0	28	1
TOTAL	**15,921**	**315**	**11,588**	**770**

Figure 16: Total adjusted annual estimated by-catch and mortality for sea turtle species in the southeastern U.S. otter trawl fisheries during 2007–2015. For more details on methods and protocols used, see (NOAA 2021b).

Species	Try Nets		Standard Nets		Total Mortalities
	Captures	Mortalities	Captures	Mortalities	
Kemp's Ridley Sea Turtle	42,120	770	58,010	4,400	5,170
Loggerhead Sea Turtle	106,030	2,020	33,050	1,200	3,220
Green Sea Turtle	11,782	388	26,179	2,238	2,626
NA DPS (96%)	11,310	372	25,132	2,148	2,520
SA DPS (4%)	472	16	1,048	90	106

Figure 17: Estimates of southeast U.S. shrimp fisheries otter trawl by-catch and mortality within the next 10 years. For green sea turtle, values presented have adjusted capture and mortality estimates because anticipated population growth was included in the analysis (NOAA 2021b).

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Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

High Concern

During the 2011–2016 observer coverage, a total of 45 turtles were caught in skimmer trawls (36 Kemp's ridley, 4 green sea, 4 loggerhead, and 1 unidentified hardshell) (Scott-Denton et al. 2020). Estimates of annual by-catch and mortality for Kemp's ridley, loggerhead, and green sea turtles indicate substantial interaction of these species with this fishery (see Justification (NOAA 2021b)). Because this fishery is a substantial contributor to mortality of these species, this factor receives a score of high concern.

Supplementary Information

Species	Skimmer Trawl Bycatch	Skimmer Trawl Mortalities
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Figure 19: Estimates of southeast U.S. shrimp fisheries skimmer trawl by-catch and mortality within the next 10 years. For green sea turtle, the values presented have adjusted capture and mortality estimates because anticipated population growth was included in the analysis (NOAA 2021b).

Leatherback turtle *(Dermochelys coriacea)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

High Concern

The leatherback turtle is listed as "Endangered" throughout its range under the Endangered Species Act {35 FR 8491}, so abundance is rated a high concern.

Supplementary Information

Stock-level (annual geometric mean change in nest counts) trends for Northwest Atlantic leatherback turtle have varied by relative abundance and data availability, and have a negative trend (Northwest Atlantic Leatherback Working Group 2018). Potential drivers for such declines in nesting abundance include habitat loss, anthropogenic impacts, and life history/demographic factors (Northwest Atlantic Leatherback Working Group 2018).

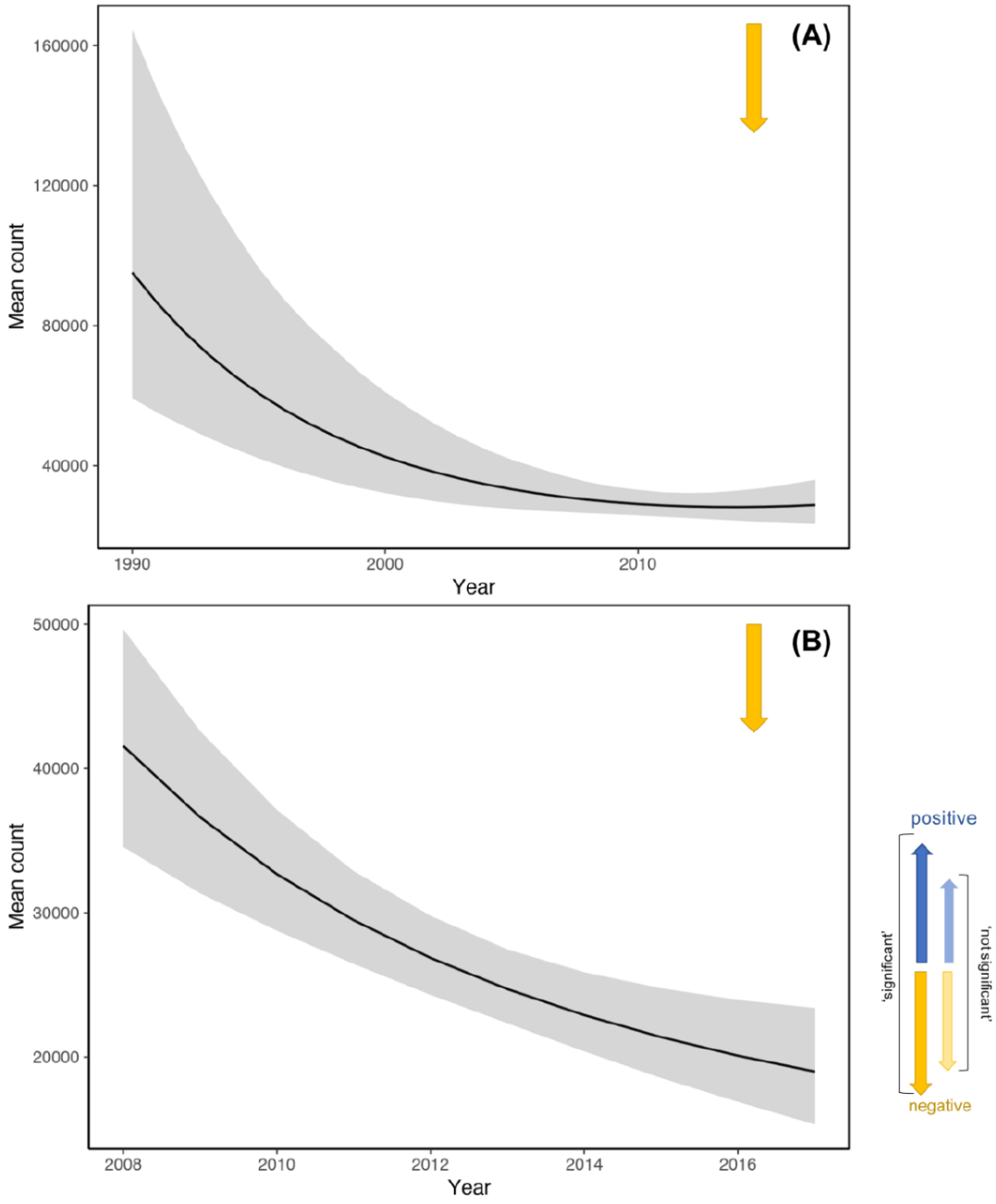

Figure 21: Regional-level trends for (A) 1990–2017 and (B) 2008–2017. Line means geometric annual mean trend and shaded area is 95% credible intervals. More details in: Northwest Atlantic Leatherback Working Group 2018.

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Low Concern

For otter trawls, interactions with leatherback and hawksbill turtles are not common. From 2011–2016, a total of three individuals of leatherback were captured (two released, one death) in the U.S. Gulf of Mexico and South Atlantic shrimp fisheries (Scott-Denton et al. 2020). Only one hawksbill was captured during the 2007–2017 period (Babcock et al. 2018). Due to very low observer coverage, by-catch mortality could not be modeled for either species (Babcock et al. 2018) and is estimated at one death per year (NOAA 2021b). Both hawksbill and leatherback turtles are expected to be infrequently encountered by nearshore skimmer trawl fisheries, because the turtles' preferred habitats do not overlap with areas of high trawl effort (NMFS 2014; NOAA 2021b) and recent observer data showed no interaction (Scott-Denton et al. 2020). The estimates of total (otter and skimmer trawl gear, all nets combined) by-catch and mortality in the southeast U.S. shrimp fisheries over the next 10 years are 260 leatherback catches (10 mortalities) and 340 hawksbill catches (10 mortalities) (NOAA 2021b). Because skimmer and otter trawl fisheries are not expected to be substantial contributors to either leatherback or hawksbill mortality, and there are few encounters with the species in otter trawls (NOAA 2021b), fishing mortality is rated a low concern.

Loggerhead turtle *(Caretta caretta)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

High Concern

The Northwest Atlantic Ocean DPS of the loggerhead turtle is listed as “Threatened” under the Endangered Species Act {76 Federal Register 184}, so abundance is rated a high concern.

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

High Concern

Observer coverage for shrimp trawl fisheries in both the South Atlantic and Gulf of Mexico is quite low (about 2% of days) (Babcock et al. 2018). In the Gulf of Mexico, estimated total by-catch in try nets was about 4,000 to 8,000 sea turtles, and in standard nets was about 5,000 to 10,000 sea turtles of all species from 2007–2015 (Babcock et al. 2018). In the South Atlantic, the estimated numbers were 7,000 to 13,000 in try nets and 4,000 to 11,000 in standard nets during 2007–2016 (Babcock et al. 2018).

The sea turtle species most caught in try nets was loggerhead in the Gulf of Mexico, but the species was rarely found in standard nets. The estimated by-catch of the species from 2007–2015 has decreased, from a 95% credible interval of 17–127 to 5–36 (Babcock et al. 2018). The estimate for Kemp’s ridley turtle in 2015 was 19–130; for loggerhead turtle, 5–36; for green sea turtle, 22–81; and for unknown/other species of sea turtle, 24–99 (leatherback sea turtle had only 3 individuals observed, whereas hawksbill turtle had only 1 individual in standard nets) (Babcock et al. 2018). A substantial increase in observer coverage would help estimate species-specific by-catch mortalities (Babcock et al. 2018).

Similarly to the Gulf, most sea turtle by-catch in the South Atlantic was in try nets, with a high survival rate. For standard nets, the total by-catch in 2016 was estimated at around 5–111 for Kemp’s ridley turtle; 9–139 for loggerhead turtle; 2–86 for green sea turtle; and 13–168 for unknown/other sea turtles (95% credible interval). For the South Atlantic, not only is an increase in observer coverage needed, but also more even distribution across strata (area, depth, and season) (Babcock et al. 2018).

Because it is uncertain (but likely) that cumulative fishing mortality is above a sustainable level and the shrimp trawl fisheries are significant contributors to mortality, fishing mortality for green sea, loggerhead, and Kemp’s ridley turtles is rated a high concern.

Supplementary Information

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	BYCATCH	MORTALITIES	BYCATCH	MORTALITIES
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Green Sea Turtle	11,782	388	26,179	2,238	2,626
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Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

High Concern

During the 2011–2016 observer coverage, a total of 45 turtles were caught in skimmer trawls (36 Kemp's ridley, 4 green sea, 4 loggerhead, and 1 unidentified hardshell) (Scott-Denton et al. 2020). Estimates of annual by-catch and mortality for Kemp's ridley, loggerhead, and green sea turtles indicate substantial interaction of these species with this fishery (see Justification (NOAA 2021b)). Because this fishery is a substantial contributor to mortality of these species, this factor receives a score of high concern.

Supplementary Information

Species	Skimmer Trawl Bycatch	Skimmer Trawl Mortalities
Kemp's Ridley Sea Turtle	6,886	1,184
Loggerhead Sea Turtle	626	108
Green Sea Turtle	415	72
TOTAL	**7,928**	**1,364**

Figure 18: Estimates of recent annual skimmer trawl by-catch and mortality of sea turtle species in the southeastern U.S. shrimp fisheries (NOAA 2021b).

Species	Skimmer Trawl Captures	Skimmer Trawl Mortalities
Kemp's Ridley Sea Turtle	68,860	11,840
Loggerhead Sea Turtle	6,260	1,080
Green Sea Turtle	4,466	774
NA DPS (96%)	4,288	744
SA DPS (4%)	178	30

Figure 19: Estimates of southeast U.S. shrimp fisheries skimmer trawl by-catch and mortality within the next 10 years. For green sea turtle, the values presented have adjusted capture and mortality estimates because anticipated population growth was included in the analysis (NOAA 2021b).

Longspine swimming crab *(Portunus spinicarpus)*

2.1 Abundance

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

There is neither a stock assessment for longspine swimming crab nor data-limited assessments. A productivity-sensitivity analysis (PSA) was used to inform the species vulnerability to fisheries. Little information was available for the species, so default values were used where appropriate. The PSA (see table in Justification) yields a score of medium vulnerability (PSA = 2.71). Because of limited data availability and a lack of reference points but with medium vulnerability, abundance is rated a moderate concern.

Supplementary Information

Table 13

Productivity Attributes	Value	Score (1 = low risk; 2 = medium risk; 3 = high risk)	Reference		Susceptibility Attribute	Information	Score (1 = low risk; 2 = medium risk; 3 = high risk)	Reference
Average age at maturity (years)	<1	1			**Areal overlap**	Default value was used	3	
Average maximum age (years)	<10 years	1			**Vertical overlap**	Default value was used	3	
Fecundity (eggs/yr)	53,984	1	(Pardal-Souza and Pinheiro 2014)		**Selectivity of fishery**	Default value was used	2	
Average maximum size (cm) (not to be used when scoring invertebrate species)	NA				**Post-capture mortality**	Default value was used	3	

Average size at maturity (cm) (not to be used when scoring invertebrate species)	NA				**Susceptibility Subscore**		2.325	
Reproductive strategy	Demersal egg layer or brooder	2	(Palomares and Pauly 2021)					
Trophic level	NA				**Productivity-Susceptibility Score**	2.71		
Density dependence (invertebrates only)	NA				**Vulnerability Rating (high, medium or low)**	Medium		
Quality of Habitat	Moderately altered	2						
Productivity Subscore		**1.4**						

2.2 Fishing Mortality

Western Central Atlantic - United States - Bottom trawls

High Concern

Observer coverage from 2011–2016 showed that longspine swimming crab made up 5.9% of catch in the rock shrimp fishery (Scott-Denton et al. 2020). A 2017 shrimp/groundfish trawl survey throughout 342 trawl stations across the Gulf of Mexico had longspine swimming crab making up 27.5% of occurrence in the summer survey and 32.4% in the winter survey (GSMFC 2019). Because a stock assessment is not available for the species and the trawl fishery is likely a substantial contributor to fishing mortality due to overlap

of habitat with target shrimp species, this factor receives a score of high concern.

Seatrout *(Cynoscion spp.)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

High Concern

The most frequently reported *Cynoscion* species interacting with the shrimp trawl fisheries are silver seatrout, spotted seatrout, and sand seatrout (Odom 2015; Stallings et al. 2014; Monk et al. 2015). Recent biomass/abundance information for these species is not available for the Gulf of Mexico (GSMFC 2011)(GSMFC 2001), but there are recent stock assessments provided by state level agencies. For spotted seatrout, the current estimate of SSB/SSB_{LIMIT} is <1.0, suggesting that the stock is currently in an overfished state. The current assessment model also indicates that the stock has been overfished since 2016. The current SPR estimate is 6.3% (SPR_{LIMIT} = 9.8%) (LDWF 2021). Because at least one of the seatrout species is currently overfished, this factor receives a score of high concern.

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

High Concern

Because recent stock assessments are not available for the Gulf of Mexico, only state-level assessments were consulted. For spotted seatrout, the current estimate of F/F_{LIMIT} is >1.0, suggesting that the stock is currently undergoing overfishing. This assessment model also indicates that the stock has been undergoing overfishing for almost a decade, and it experienced overfishing in a few years earlier in the time series (LDWF 2021). In observer coverage, seatrout makes up 5.4% of total catch in shrimp otter trawls in the Gulf of Mexico (Scott-Denton et al. 2020). Because specific information on catch composition of seatrout species is not available, overfishing is currently occurring for at least one species, and it is not clear whether this fishery is a substantial contributor to species mortality, this factor receives a score of high concern.

Sharks *(Selachimorpha)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

High Concern

Elasmobranch species caught in shrimp trawl fisheries (both otter and skimmer trawlers) include several shark and ray species, such as Atlantic sharpnose shark, bonnethead shark, blacktip shark, smooth dogfish shark, cownose ray, scalloped hammerhead shark, Atlantic stingray, spinner shark, and blacknose shark (Scott-Denton et al. 2020). Except for Atlantic sharpnose shark and Atlantic stingray (both IUCN listed as "Least Concern") and for smooth dogfish (IUCN "Near Threatened"), the majority of these species are on the IUCN Red List (blacktip shark, spinner shark, and cownose ray as "Vulnerable"; bonnethead shark and blacknose shark as "Endangered"; and scalloped hammerhead shark as "Critically Endangered") (Carlson et al. 2020; Carlson et al. 2021; Carlson et al. 2021b; Carlson et al. 2021c; Pollom et al. 2021; Rigby et al. 2020; Rigby et al. 2019). Scalloped hammerhead shark and blacknose shark are also listed as overfished in the U.S. (B/B_{MSY} = 0.45 and 0.43–0.64, respectively) (NMFS 2021).

Because most elasmobranch species caught in these fisheries are species of concern, this factor receives a score of high concern.

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Low Concern

The most frequently caught elasmobranch species in both the otter and skimmer shrimp trawl fisheries (Atlantic sharpnose shark, bonnethead shark, blacktip shark, smooth dogfish shark, cownose ray, scalloped hammerhead shark, Atlantic stingray, spinner shark, and blacknose shark) do not make a significant portion of the fisheries' total by-catch, according to the latest available set of observer data (Scott-Denton et al. 2020). Although overfishing has been currently occurring for blacknose shark and scalloped hammerhead shark (NMFS 2021), most of these species account for less than 0.5% of by-catch (see table in Justification). Shark by-catch from the shrimp fishery was the major contributor to overall mortality until 1994, but gillnet and bottom longline fisheries have

been the main contributors to shark by-catch in the past decades {SEDAR 2011a}. Because of the low contribution of this fishery to these elasmobranch species' mortalities, this factor scores a low concern.

Supplementary Information

Most frequent elasmobranch species documented from by-catch characterization samples, based on mandatory observer coverage of the U.S. southeastern shrimp fishery from 2011–2016. Adapted from (Scott-Denton et al. 2020).

Table 14

Common name	Gulf mandatory penaeid (kg)	Gulf mandatory penaeid (%)	South Atlantic mandatory penaeid (kg)	South Atlantic mandatory penaeid (%)	Mandatory rock (kg)	Mandatory rock (%)	Gulf mandatory skimmer (kg)	Gulf mandatory skimmer (%)	Total (kg)	Percent total
Atlantic sharpnose shark	15,354.5	0.4	1,770.8	0.6	80.7	0.1	26.2	0.1	17,232.3	0.4
Bonnethead shark	2,950.7	0.1	834.3	0.3	-	-	1.6	0.0	3,786.6	0.1
Blacktip shark	2,399.3	0.1	67.9	0.0	-	-	48.1	0.2	2,515.3	0.1
Smooth dogfish	2,108.6	0.1	21.8	0.0	-	-	-	-	2,130.4	0.0
Cownose ray	860.7	0.0	-	-	-	-	412.2	1.8	1,272.9	0.0
Scalloped hammerhead	413.1	0.0	146.4	0.1	-	-	-	-	559.5	0.0

Atlantic stingray	510.1	0.0	-	-	-	-	-	-	510.1	0.0
Spinner shark	486.5	0.0	-	-	-	-	-	-	486.5	0.0
Blacknose shark	300.2	0.0	7.5	0.0	-	-	-	-	307.7	0.0

Smalltooth sawfish *(Pristis pectinata)*

2.1 Abundance

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

High Concern

The U.S. DPS of smalltooth sawfish was listed as "Endangered" in 2003 (NMFS 2012b). The species' life history is not well known but, based on the closely related largetooth sawfish, smalltooth sawfish is likely long-lived and slow-growing (NMFS 2014). Researchers have estimated that population abundance is approximately 5% of historic levels, but data on encounters with juveniles indicate that the species is reproducing and still viable (NMFS 2014). Because of its "Endangered" status, abundance is rated a high concern.

2.2 Fishing Mortality

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Fishing mortality for smalltooth sawfish is unknown but considered to be the factor most responsible for its overall population decline (NMFS 2014). It is required for the species to be released; however, fishery interactions may still lead to injury and/or mortality (Brame et al. 2019). From 2009–2018, 13 individuals were reported by the U.S. federal shrimp trawl survey, but limited observer coverage may display only a small fraction of actual catches (Brame et al. 2019). The most recent biological opinion estimates a conservative 50% mortality rate for captured smalltooth sawfish, implying an annual mortality rate of 172 individuals as a direct result of by-catch in U.S. shrimp trawl fisheries (South Atlantic and Gulf of Mexico) (NOAA 2021b). Because of limited data availability, fishing mortality

for smalltooth sawfish is rated a moderate concern.

Spot *(Leiostomus xanthurus)*

2.1 Abundance

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

The 2020 species stock status for spot is unknown (ASMFC 2020). A productivity-susceptibility analysis yields a score of low vulnerability (PSA = 2.59; see table in Justification (ASMFC 2017; Froese & Pauly 2017)). Because of conflicting information regarding stock status but with low vulnerability, abundance is rated a moderate concern.

Supplementary Information

Productivity Susceptibility Analysis – Spot

Productivity Attribute	**Relevant Information**	**Score (1 = low, 2 = med, 3 = high risk)**
Average age at maturity	2.5	1
Average maximum age	6	1
Fecundity	>20,000	1
Average maximum size	36 cm	1
Average size at maturity	19 cm	1
Reproductive strategy	Broadcast spawner	1
Trophic level	3.2	2

Refs: ASMFC 2017, Froese & Pauly 2017

The average Productivity score is 1.14

Susceptibility Attribute	**Relevant Information**	**Score (1 = low, 2 = med, 3 = high risk)**
Areal overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Vertical overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Selectivity of fishery (Specific to fishery under assessment)	Default score (Species is targeted and there are no special circumstances increasing its susceptibility)	2
Post-capture mortality (Specific to fishery under assessment)	Default score (species is retained)	3

The multiplicative Susceptibility score is 2.33

Overall PSA Score: 2.59 Low

Figure 22:

2.2 Fishing Mortality

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Because of conflicting models and data uncertainty, fishing mortality for spot from all sources is unknown (ASMFC 2017). In observer coverage from 2007–2010 in the shrimp trawl fishery, spot was 7.3% of the catch composition in the South Atlantic (Scott-Denton et al. 2012). From 2011–2016, the species' contribution to catch composition increased to 10.3% in the same fishery (Scott-Denton et al. 2020). In 2016, the fall cruise for the South Atlantic Coastal Trawl Survey identified several taxa, and spot was the fifth most abundant species (7.4%) (SEAMAP 2019). In 2018, spot was the second most abundant species in both the spring (13.8%) and summer cruises (20.8%) (SEAMAP 2019b). The overfishing status for spot is unknown; however, traffic light analysis indicates a low harvest in recent years (ASMFC 2020). Because of interaction with the fishery but with limited data availability, fishing mortality is rated a moderate concern.

Star drum *(Stellifer lanceolatus)*

2.1 Abundance

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

There is no stock assessment for star drum. A productivity-susceptibility analysis yields a medium score for vulnerability (PSA = 2.68; see table in Justification (Waggy et al. 2006; Froese & Pauly 2017)). Because of limited data availability and a medium vulnerability, abundance is rated a moderate concern.

Supplementary Information

Productivity Susceptibility Analysis – Star drum

Productivity Attribute	Relevant Information	Score (1 = low, 2 = med, 3 = high risk)
Average age at maturity	1.5	1
Average maximum age	5	1
Fecundity	Unknown	N/A
Average maximum size	20 cm	1
Average size at maturity	10 cm	1
Reproductive strategy	Broadcast spawner	1
Trophic level	3.5	3

Refs: Waggy et al. 2006, Froese & Pauly 2017

The average Productivity score is 1.33

Susceptibility Attribute	Relevant Information	Score (1 = low, 2 = med, 3 = high risk)
Areal overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Vertical overlap (Considers all fisheries)	Default score (there is high overlap between the fishery and this species; it is the target species)	3
Selectivity of fishery (Specific to fishery under assessment)	Default score (Species is targeted and there are no special circumstances increasing its susceptibility)	2
Post-capture mortality (Specific to fishery under assessment)	Default score (species is retained)	3

The multiplicative Susceptibility score is 2.33

Overall PSA Score: 2.68 Medium

Figure 23:

2.2 Fishing Mortality

Western Central Atlantic - United States - Bottom trawls

Moderate Concern

Fishing mortality is unknown for star drum. In observer coverage from 2007–2010 in the shrimp trawl fishery, star drum was 5.8% of the catch composition (Scott-Denton et al. 2012), and this value decreased to 3.7% during the 2011–2016 observer coverage (Scott-Denton et al. 2020). The fall cruise for the South Atlantic Coastal Trawl Survey identified several taxa, and star drum was the fourth most abundant species in 2016–2017 (9%) and 2017–2018 (11.8%) (SEAMAP 2019; SEAMAP 2019b). Because of interaction with the fishery with limited data availability, fishing mortality is rated a moderate concern.

2.3 Discard Rate/Landings

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

>= 100%

According to the National Bycatch Report Update 2 (2019), which has data up to 2015, by-catch still exceeds landings in the shrimp fishery (Benaka et al. 2019). For the Gulf of Mexico shrimp trawl, the by-catch ratio in 2015 was 0.67 (over 253 million pounds of by-catch for 126 million pounds of shrimp landed) (Benaka et al. 2019). For the Southeastern Atlantic shrimp trawl, the by-catch ratio was 0.73 (64 million pounds of by-catch for 23 million pounds of shrimp landed) (Benaka et al. 2019). Data for the skimmer trawl fishery was not available. Observer data from 2011–2016 reported a by-catch ratio of 2.54 for the Gulf of Mexico and 3.5 for the South Atlantic (also without a ratio for the skimmer trawl fishery) (Scott-Denton et al. 2020).

The skimmer trawl fishery by-catch rate has varied, based on extrapolations of catch composition data from a few years of observer coverage. Skimmer trawl by-catch to landings ratios were 1.24 and 0.92 in 2012 and 2013, respectively (Pulver et al. 2012; Pulver et al. 2014). According to the observer data, penaeid shrimp catch was estimated to account for 35% of the total weight of the skimmer trawl catch, with a by-catch to landings ratio of 1.94 (Scott-Denton et al. 2014).

It is worth mentioning that there has been a declining trend in by-catch in these fisheries, particularly after the implementation of turtle excluder devices (TED) and by-catch reduction devices (BRD), which reduced large by-catch (sharks, fish, and sea turtles), thus changing the finfish to shrimp ratios in recent years (Scott-Denton et al. 2020).

Criterion 3: Management Effectiveness

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

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

The Criterion 3 rating is determined as follows:

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

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

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

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

Criterion 3 Summary

Fishery	Management Strategy And Implementation	Bycatch Strategy	Scientific Research And Monitoring	Enforcement Of Management Regulations	Stakeholder Inclusion	Score
Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls	Highly effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	Green (4.000)
Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls	Highly effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	Green (4.000)
Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices	Highly effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	Green (4.000)
Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices	Highly effective	Ineffective	Moderately Effective	Ineffective	Highly effective	Red (1.000)
Western Central Atlantic - United States - Bottom trawls	Highly effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	Green (4.000)

Criterion 3 Assessment

Scoring Guidelines

Factor 3.1 - Management Strategy and Implementation

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

Factor 3.2 - Bycatch Strategy

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

effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring

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

Factor 3.4 - Enforcement of Management Regulations

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

Factor 3.5 - Stakeholder Inclusion

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

3.1 Management Strategy And Implementation

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Highly effective

Active federal management measures have been in place for targeted species in U.S. southeastern shrimp fisheries for just over 30 years in the Gulf of Mexico, and almost 20 years in the South Atlantic. Amendments to shrimp fishery management plans (FMP) have focused on juvenile shrimp habitat, gear conflicts, limit reference points, and other thresholds for shrimp populations. The condition of stocks is monitored annually, and the Gulf Shrimp FMP has been continually modified to refine shrimp overfishing indices and definitions (GMFMC 1991; GMFMC 2005). A precautionary policy is implemented such that measures are in place for active management if overfishing occurs (GMFMC 1991). If parent stock levels are below specified indices, the National Marine Fisheries Service (NMFS) is prepared to reduce fishing effort by implementing seasonal closures, trip limits, or quotas. Shrimp catches have been effectively maintained relatively steadily over the long term, although this trend is likely also due to shrimp life history as much as management. In all sectors of the Southeastern shrimp fishery, the overall management strategy is considered highly effective due to incorporation of limit reference points, inclusion of scientific advice, and a track record of population stability for target species.

Supplementary Information

The Gulf of Mexico Fishery Management Council (GMFMC) has actively updated and amended its Shrimp FMP since its first iteration in 1981, to protect shrimp stocks from overfishing, reduce turtle mortality, reduce finfish by-catch, and protect essential fish habitat. The original South Atlantic Shrimp Fishery Management Plan set a basic form of maximum sustainable yield (MSY) and outlined ways the SAFMC would reduce shrimping effort in years following severe winter freezes (which kill adult shrimp and result in low stocks the following year) (SAFMC 1993). Atlantic states may request penaeid shrimp fishery closures if severe winters cause shrimp abundance to drop by 80% or if temperatures drop below 9 ºC. In the ensuing years, South Atlantic shrimp management has evolved to include ecosystem and habitat measures, additional species (rock shrimp), and by-catch mitigation measures. Shrimp fishing also occurs in state waters. Though this report focuses on management in place at the federal level, most of the states with shrimp fisheries have closed seasons to protect spawning and/or juvenile shrimp, and also employ minimum mesh size requirements (NMFS 2012b).

3.2 Bycatch Strategy

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Moderately Effective

By-catch, particularly of sea turtles, remains the greatest conservation concern associated with the South Atlantic and Gulf of Mexico shrimp trawl fisheries. In both regions, multiple Shrimp FMP amendments (Gulf amendments 9, 10, 13 and 14; and South Atlantic amendments 2, 4 and 6) focus on by-catch reduction and/or quantification and reporting. For the most part, state management efforts on shrimp by-catch duplicate or exceed federal management. Numerous regulations mandate turtle excluder devices (TED) (for otter trawls in all regions, for skimmer trawls in Florida, and for vessels 40 ft and longer elsewhere) and fleetwide use of by-catch reduction devices (BRD) (NMFS 2012a; NMFS 2012b; 84 FR 70048, 2019). In recent years, increased effort has been made in improving compliance with by-catch management measures across both otter trawl and skimmer trawl gears. NOAA has conducted extensive testing and evaluation of TED effectiveness, estimating that a properly installed and maintained TED has a 95–98% turtle exclusion efficiency rate (NOAA 2016b), but overall fishery by-catch remains high and still regularly includes threatened and endangered sea turtles. Low observer coverage (consistently around 2% in federal waters) throughout the fishery results in uncertainty of the effectiveness of by-catch regulations. Overlapping human activities (including shrimping and commercial line fishing) in foraging areas for sea turtles may also impose severe threats for these species (Hart et al. 2018). In 2020, shrimp effort was authorized to be increased by up to 21%, and this increment would not have a significant impact on by-catch fish species (Gallaway et al. 2020). Another concern raised is that, with the increase of sea turtle populations, an increase in sea turtle interaction with this fishery is expected, potentially increasing mortality if TEDs are not broadly used (84 FR 70048, 2019).

Since the Deepwater Horizon oil spill in 2010, NOAA has established several restoration areas in the Gulf of Mexico and, more recently, some projects are being developed that focus on TED prototypes to reduce by-catch of small juvenile sea turtles and on improved BRDs to reduce finfish by-catch in the Gulf commercial shrimp trawl fishery (NOAA 2019b; NOAA 2019c). Enhanced devices are expected to decrease sea turtle mortality by particularly increasing the escapement of small, juvenile individuals, as well as reducing the unintentional catch of species such as juvenile red snapper, croaker, and Gulf menhaden (NOAA 2019b; NOAA 2019c). The Gulf of Mexico shrimp trawl fishery was proposed for inclusion in the 2020 Annual Determination (AD), which works within the current observer programs and allows NMFS the flexibility to further consider sea turtle

data collection needs when allocating observer resources (85 FR 3880, 2020). Since August 1, 2021, the NMFS requires all skimmer trawl vessels 40 ft and longer to use TEDs designed to exclude small sea turtles in their nets ((84 FR 70048, 2019), updated by (85 FR 59198 2020)).

Because some of these initiatives are recent, their effectiveness cannot be assessed. Also, increased observer coverage would foster a greater understanding of the effectiveness of management measures.

Because management measures are in place but with uncertain effectiveness due to low observer coverage, by-catch strategy is ranked moderately effective.

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Ineffective

In 2021, a turtle excluder device (TED) rule was implemented in the Gulf of Mexico and South Atlantic (this rule was implemented in Louisiana only in 2022, after a Motion for Preliminary Injunction enjoined from imposing the regulation until February 1, 2022), where NMFS requires all skimmer trawl vessels 40 feet and longer to use TEDs designed to exclude small sea turtles in their nets (84 FR 70048, 2019). On the other hand, smaller skimmer trawl vessels (<40 ft) only have to follow tow time requirements: 55 minutes from April 1 through October 31, and 75 minutes from November 1 through March 31 {64 FR 14068, 1999}. The use of tow times as the only by-catch strategy on vessels <40 ft raises concerns, because there is evidence from observer data of sea turtle mortality from incidental catch in skimmer trawls in vessels that are both compliant and noncompliant with tow times. According to the final environmental impact statement (FEIS), “best available information and expert opinion indicate that persistent or delayed effects can lead to mortality (post-interaction mortality), including deaths of some turtles that appear to be in good health at the time of release. Analysis of the behavioral condition of the turtles caught by skimmer trawls, using current criteria for estimating post-interaction mortality for trawl fisheries (as described in NMFS Procedural Directive 02-110-21), indicated that mortality could be more than triple the number estimated based on dead and comatose turtles alone” (84 FR 70048, 2019). Another concern raised is that, with the increase in sea turtle populations, an increase in sea turtle interaction with this fishery is also expected, potentially increasing mortality if TEDs are not broadly used (84 FR 70048, 2019).

In addition, different tests on TEDs resulted in new TED designs known to be effective on skimmer trawl vessels shorter than 40 ft; therefore, NMFS is considering additional ESA rulemaking to protect and conserve threatened and endangered sea turtles in the southeast U.S. shrimp fisheries (NOAA 2021c). Technological advancements have resulted in a TED that can be used in smaller vessels and regulations have been proposed for their introduction to vessels <40 ft, further demonstrating that the use of TEDs is the best

approach for reducing the impact on turtles.

At this point, because existing rules that are widely accepted as effective are not being used by this portion of the skimmer trawl fleet (i.e., vessels shorter than 40 ft), we deem this factor ineffective. With the potential for the new TED requirements for skimmer trawl vessels shorter than 40 ft to move forward and be implemented, it is expected that the score would change to moderately effective.

Supplementary Information

One of the main strategies to prevent sea turtle mortalities in the shrimp skimmer trawl fisheries (except for those in Florida) is utilizing tow time limits (Sasso & Epperly 2006; NMFS 2012a). An observer program's study of tow timings suggests that they are not effective and often exceeded (Sasso & Epperly 2006); however, their study methods did not meet the legal definition of tow time (researchers recorded the time when the cod end was onboard rather than when it was removed from the water), leading to overestimation of noncompliance and overall uncertainty. Skimmer trawls are used in Louisiana, Alabama, Mississippi, North Carolina, and Florida, but Florida is the only state to require TEDs in all skimmer trawls {NOAA 2012a}. Skimmer trawls have been exempted from turtle excluder device (TED) requirements if they operate with alternative tow-time restrictions, with trawling time not to exceed 55 or 75 minutes during specific times of the year (NMFS 2012a). In the winter, towing must not exceed 55 minutes, but this limit is not conservative enough because sea turtle mortalities can occur after just 10 minutes (Sasso & Epperly 2006). In the past, public comment and law enforcement data suggested that tow-time requirements were exceeded and that some fishers were not even aware of these restrictions (NMFS 2012a). There have been recent efforts to increase awareness, most notably a "Tow the Time" campaign by the Louisiana Sea Grant/Audubon Nature Institute.

Since the Deepwater Horizon oil spill in 2010, NOAA has established several restoration areas in the Gulf of Mexico and, more recently, some projects are being developed that focus on TED prototypes to reduce by-catch of small juvenile sea turtles and on improved by-catch reduction devices (BRD) to reduce finfish by-catch in the Gulf commercial shrimp trawl fishery (NOAA 2019b; NOAA 2019c). Enhanced devices are expected to decrease sea turtle mortality by particularly increasing the escapement of small, juvenile individuals, as well as reducing the unintentional catch of species such as juvenile red snapper, croaker, and Gulf menhaden (NOAA 2019b; NOAA 2019c).

3.3 Scientific Research And Monitoring

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Moderately Effective

NOAA's Southeast Fisheries Science Center labs in Galveston, TX and Miami, FL collect fishery-dependent and fishery-independent data to assess and monitor shrimp stocks and shrimp fishery effects on other species. Extensive by-catch reduction research and outreach is conducted by the SEFSC Pascagoula, MS lab. Fishery-independent data are available through the SEAMAP survey in the Gulf, as well as maintained by state agencies. Shrimp stock assessments are conducted periodically in the South Atlantic and annually in the Gulf. Observer coverage of the shrimp fishery is low, remaining around 2% overall. Because of regular data collection and analyses to monitor stock abundance, but with limited observer coverage and by-catch monitoring that are less than that needed to determine impacts on species of concern such as sea turtles, scientific research and monitoring is rated a moderate concern.

3.4 Enforcement Of Management Regulations

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Highly effective

The success of regulations—particularly by-catch mitigation measures, in the case of shrimp fisheries—depends largely on compliance. Previously documented TED compliance issues (various types of violations, and including net retailers), primarily in the Gulf region (NMFS 2012a; NMFS 2012b), have resulted in significant attention by managers and fishers. An overall TED effectiveness rate at or above 88% has been required since April 2014 (SERO 2016). If compliance falls below this threshold, management will respond with increased enforcement pulses and outreach. If compliance falls below 84% for two consecutive seasons, management will close the fishery in the corresponding region for 30 days. The TED effectiveness rate has remained at compliance levels since April of 2015, when the rate fell to 85%. Electronic logbooks are required in the Gulf of Mexico fisheries and in the South Atlantic rock shrimp fishery, identifying when fishing is taking place and ensuring compliance with spatial restrictions. Vessels with limited-access rock shrimp permits are also required to carry onboard an operating vessel monitoring system (VMS) approved by the NMFS for use in the South Atlantic rock shrimp fishery when on a trip in the South Atlantic (78 FR 22952, 2013). Because of regular enforcement and monitoring

within the otter trawl sectors, enforcement of management regulations is considered highly effective.

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Ineffective

The new turtle excluder device (TED) regulation for skimmer trawl that applies only to vessels 40 ft and longer has been causing conflicts among stakeholders such as conservationists and fish workers, particularly due to concerns about compliance with tow times and their consequences on sea turtle survival, as well as concerns over elevated TED costs on smaller vessels (CBD v. NMFS, 2021). Law enforcement data present evidence that stranded turtles may have died from drowning associated with fishery interactions in the past, and that state-level enforcement agencies (such as in Mississippi) have identified skimmer trawl vessels exceeding tow-time requirements in previous years (77 FR 91 2012; 81 Federal Register 242, 2016}. Longer, unsupervised tow times have impacts (e.g., setting the proper time required to monitor a given vessel actively towing, the inability to monitor covertly, and limited visibility at night, when most vessels fish) that are likely fatal to sea turtles, and vessels exempted from TED requirements may end up killing more sea turtles than previously expected by NMFS (Gahm 2019; CBD v. NMFS, 2021).

Because of uncertainties related to the compliance with tow times and their consequences on sea turtle survival, this factor is scored ineffective.

3.5 Stakeholder Inclusion

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Highly effective

The U.S. federal fishery management process is public and transparent in both regions, encourages stakeholder participation, and addresses user conflicts; therefore, it is considered highly effective with respect to stakeholder inclusion.

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	Impact of Fishing Gear on the Habitat/Substrate	Modifying Factor: Mitigation of Gear Impacts	Ecosystem-based Fisheries Management	Score
Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls	Score: 2	+.5	Low Concern	Yellow (3.162)
Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls	Score: 2	+.5	Low Concern	Yellow (3.162)
Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices	Score: 2	+.5	Low Concern	Yellow (3.162)
Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices	Score: 2	+.5	Low Concern	Yellow (3.162)
Western Central Atlantic - United States - Bottom trawls	Score: 2	+.5	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.*

4.1 Impact of Fishing Gear on the Habitat/Substrate

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Score: 2

Penaeid shrimp in the Gulf and South Atlantic are fished by bottom trawls on silt, mud, shell, or sand benthos (SAFMC 2009a; NMFS 2012a). According to the Seafood Watch Criteria for bottom trawl fisheries, the physical impact of the fishing gear on habitat is scored a 2.

4.2 Modifying Factor: Mitigation of Gear Impacts

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

+.5

Moderate mitigations of impacts to habitat from shrimp fisheries are in place. In the Gulf, the Essential Fish Habitat (EFH) Generic Amendment 3 prohibited trawling (as well as other gear types) on all coral areas throughout the Gulf exclusive economic zone (EEZ) and required weak links in tickler chains of bottom trawls in all habitats {GMFMC 2005b}. The South Atlantic Fishery Management Council has implemented several Coral Habitat Areas of Particular Concern (HAPCs) to protect deepwater coral (SAFMC 2009a).

Although indirect, the substantial decline in fishing effort has effectively reduced the habitat impact of shrimp fisheries. Fishing effort in the Gulf during 2008–2009 was an estimated 61% less than in 2001, and overall effort reduction in the South Atlantic between 2002 and 2009 was estimated at 38% (NMFS 2012b). A 10-year moratorium on issuing new federal commercial shrimp vessel permits was established in 2006 and extended another 10 years in 2016 (GMFMC 2016).

4.3 Ecosystem-based Fisheries Management

Gulf of Mexico - Atlantic, Western Central - United States - Bottom trawls

Western Central Atlantic - United States - Bottom trawls

Gulf of Mexico - Atlantic, Western Central - United States - Florida - Skimmer trawls

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels greater than 40 feet are required to use Turtle Excluder Devices

Gulf of Mexico - Atlantic, Western Central - United States - Skimmer trawls - Vessels less than 40 feet are not required to use Turtle Excluder Devices

Low Concern

Both management councils have amended management in response to ecosystem concerns by implementing spatial and temporal closures. The SAFMC prohibits trawling in regions of Florida to protect *Oculina* coral, while the GMFMC developed a Tortugas Shrimp Sanctuary in Florida and a temporal 45-day closure in Texas to protect juvenile shrimp. SAFMC has developed a Fishery Ecosystem Plan; an Integrated Ecosystem Assessment of the Gulf of Mexico (GMX) has been completed; and the NMFS Southeast Fisheries Science Center has been working with counterparts in Mexico through the Gulf of Mexico Large Marine Ecosystem (LME) program {Karnauskas et al. 2013}. In an effort to further ecosystem-based management, an optimal yield (OY) was implemented in 2018 that takes into consideration sea turtle by-catch and juvenile red snapper by-catch thresholds in addition to shrimp landings and CPUE (GMFMC 2017). There is not a high likelihood of trophic cascades attributed to the shrimp trawl fisheries; the mean trophic level (MTL) of species in the ecosystem in the GMX was relatively stable over a 30-year survey period (NOAA 2017c). But, it has been demonstrated that shrimp trawling can alter the community structure of fishes and invertebrates and result in reduced length frequencies of fishes (Wells et al. 2008).

Because policies are in place to protect ecosystem functioning and account for capture species' ecological roles (using spatial management with unlikely detrimental food web effects), ecosystem-based fishery management is rated a low concern.

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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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References

77 FR 91 2012. Sea Turtle Conservation; Shrimp Trawling Requirements.

78 FR 22952, 2013. 50 CFR 622.205(a) Vessel monitoring systems (VMSs).

84 FR 70048. 2019. Sea Turtle Conservation; Shrimp Trawling Requirements. A Rule by the National Oceanic and Atmospheric Administration on 12/20/2019. P. 70048-70064

85 FR 3880. 2020 Annual Determination To Implement the Sea Turtle Observer Requirement: A Proposed Rule by the National Oceanic and Atmospheric Administration on 01/23/2020.

85 FR 59198. Sea Turtle Conservation; Shrimp Trawling Requirements: A Proposed Rule by the National Oceanic and Atmospheric Administration on 09/21/2020.

Able K, Cass-Calay S, Wilber M. 2017. 2017 Atlantic Croaker Stock Assessment Peer Review. Atlantic States Marine Fisheries Commission, 14pp.

Álvarez-Tello, F., J. López-Martínez, & D. Lluch-Cota. 2016. Trophic spectrum and feeding pattern of cannonball jellyfish Stomolophus meleagris (Agassiz, 1862) from central Gulf of California. J. Mar. Biol. Assoc. U. K. 96(6), 1217-1227.

Andrews, K.I. 2008. Estimation of Spanish mackerel and vermilion snapper bycatch in the shrimp trawl fishery in the South Atlantic (SA). SEDAR 17-DW12. NOAA Fisheries, Panama City, FL.

ASMFC. 2007. ASMFC Fisheries Focus. Vol 16, issue 3.

ASMFC. 2010. Atlantic croaker benchmark stock assessment. Atlantic States Marine Fisheries Commission, Arlington, Virginia.

ASMFC. 2017. 2017 Spot Stock Assessment Peer Review. Available at: http://www.asmfc.org/uploads/file/59c2b9edSpotAssessmentPeerReviewReport_May2017.pdf

ASMFC. 2017b. 2017 Atlantic Sturgeon Benchmark Stock Assessment and Peer Review Report. Available at: http://www.asmfc.org/uploads/file//59f8d5ebAtlSturgeonBenchmarkStockAssmt_PeerReviewReport_2017.pdf

ASMFC. 2020. ASMFC Stock Status Overview. 45pp.

Babcock EA, Barnette M, Bohnsack J, Isely JJ, Porch C, Richards PM, Sasso C, Zhang X. 2018. Integrated Bayesian models to estimate bycatch of sea turtles in the Gulf of Mexico and southeastern U.S. Atlantic coast shrimp otter trawl fishery. NOAA Technical Memorandum NMFS-SEFSC-271. 54p.

Barbieri LR, Chittenden Jr. ME, Lowerre-Barbieri SK. 1994. Maturity, spawning, and ovarian cycle of Atlantic croaker Micropogonias undulatus, in the Chesapeake Bay and adjacent coastal waters. Fishery Bulletin 92(4):671-685

Barnette, Michael C. 2003. NMFS Southeast. Personal communication with Alice Cascorbi, by phone, 12/23/2003.

Benaka LR, Bullock D, Hoover AL, Olsen NA. 2019. U.S. National Bycatch Report First Edition Update 3: Table 4.4.2a SOUTHEAST REGION FISH BYCATCH BY FISHERY (2015). NOAA Technical Memorandum NMFS-F/SPO-190

Bevan E, Wibbels T, Najera BMZ, Sarti L, Martinez FI, Cuevas JM, Gallaway BJ, Pena LJ, Burchfield PM. 2016. Estimating the historic size and current status of the Kemp's ridley sea turtle (Lepidochelys kempii) population. Ecosphere 7(3):e01244. 10.1002/ecs2.1244

Brame AB, Wiley TR, Carlson JK, Fordham SV, Grubbs RD, Osborne J, Scharer RM, Bethea DM, Poulakis GR. 2019. Biology, ecology, and status of the smalltooth sawfish Pristis pectinata in the USA. Endang Species Res 39: 9-23.

Cagle P and West J. 2020. Evaluation of commercial shrimp fishery bycatch in Louisiana Waters. Louisiana Department of Wildlife and Fisheries, 14p.

Caillouet CW, Raborn SW, Shaver DJ, Putman NF, Gallaway BJ, Mansfield KL. 2018. Did Declining Carrying Capacity for the Kemp's Ridley Sea Turtle Population Within the Gulf of Mexico Contribute to the Nesting Setback in 2010–2017? Chelonian Conservation and Biology, 17(1):123-133 (2018). https://doi.org/10.2744/CCB-1283.1

Carlson J, Charvet P, Avalos C, Blanco-Parra MP, Briones Bell-Iloch A, Cardenosa D, Espinoza E, Morales-Saldaña, JM, Naranjo-Elizondo, B, Pérez Jiménez JC, Schneider EVC, Simpson NJ, Talwar BS, Crysler Z, Derrick D, Kyne PM and Pacoureau N. 2021. *Carcharhinus acronotus*. *The IUCN Red List of Threatened Species* 2021: e.T161378A887542. Accessed on 23 February 2022.

Carlson, J., Charvet, P., Avalos, C., Blanco-Parra, MP, Briones Bell-Iloch, A., Cardenosa, D., Crysler, Z., Derrick, D., Espinoza, E., Morales-Saldaña, J.M., Naranjo-Elizondo, B., Pacoureau, N., Pérez Jiménez, J.C., Schneider, E.V.C., Simpson, N.J. & Dulvy, N.K. 2020. *Rhinoptera bonasus*. *The IUCN Red List of Threatened Species* 2020: e.T60128A3088381. Accessed on 23 February 2022.

Carlson, J., Charvet, P., Blanco-Parra, MP, Briones Bell-Iloch, A., Cardenosa, D., Derrick, D., Espinoza, E., Morales-Saldaña, J.M., Naranjo-Elizondo, B., Pacoureau, N., Pérez Jiménez, J.C., Schneider, E.V.C., Simpson, N.J. & Talwar, B.S. 2021. *Rhizoprionodon terraenovae*. *The IUCN Red List of Threatened Species* 2021: e.T39382A124408927. Accessed on 23 February 2022.

Carlson, J., Charvet, P., Blanco-Parra, MP, Briones Bell-Iloch, A., Cardenosa, D., Derrick, D.,

Espinoza, E., Morales-Saldaña, J.M., Naranjo-Elizondo, B., Pacoureau, N., Pérez Jiménez, J.C., Schneider, E.V.C., Simpson, N.J., Talwar, B.S. & Pollom, R. 2021. *Mustelus canis*. *The IUCN Red List of Threatened Species* 2021: e.T39359A2908200. Accessed on 23 February 2022.

Center for Biological Diversity, Defenders of Wildlife, Turtle Island Restoration Network v. National Marine Fisheries Service, Gina Raimondo, Case 1:21-cv-00930 (2021). Complaint for Declaratory and Injunctive Relief.

FAO 2003. FIGIS: Fisheries Global Information System, database of species and life-history information for fish and shellfish. United Nations Food and Agriculture Organization (FAO). Available online at http://www.fao.org/fishery/figis/en

FFWCC 2022. Index Nesting Beach Survey Totals (1989-2021). Accessed in Feb 15, 2022.

Finkbeiner, E.M., B.P. Wallace, J.E. Moore, R.L. Lewison, L.B. Crowder, and A.J. Read. 2011. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biological Conservation 144: 2719-2727.

Fisheries One Stop Shop (FOSS) Landings System. Specific Query for this present work (spreadsheet)

Froese, R. and D. Pauly, Editors. 2017. FishBase. World Wide Web electronic publication. www.fishbase.org

Gahm MP. 2019. The development and evaluation of small specialized turtle excluder devices to reduce sea turtle bycatch in various small shrimp gears. University of New Orleans Theses and Dissertations. 2665.

Gallaway BJ, Raborn SW, Picariello L, Putman NF. 2020. Changes in Shrimping Effort in the Gulf of Mexico and the Impacts to Red Snapper. iScience 23, 101111. doi: https://doi.org/10.1016/j.isci.2020.101111

Gillett, R. 2008. Global Study of Shrimp Fisheries. FAO Technical Paper 475. Fisheries and Agriculture Organization of the United Nations, Rome.

GMFMC 2002. Amendment 10 to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters, with environmental assessment, regulatory impact review, initial regulatory flexibility analysis, and social impact statement. July 2002. Gulf of Mexico Fishery Management Council, Tampa, Florida.

GMFMC 2005. Amendment 13 to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters. Gulf of Mexico Fisheries Management Council, Tampa, FL.

GMFMC 2009. Shrimp Management Committee Meeting. October 19, 2009, Corpus Christi, TX.

GMFMC 2016. Shrimp Permit Moratorium. Final Amendment 17A to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters. Gulf of Mexico Fisheries Management Council, Tampa, FL

GMFMC. 1991. Amendment Number 5 to The Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico United States Waters Includes Environmental Assessment. January 1991.

GMFMC. 1995. Amendment 8 to the Fishery Management Plan for the shrimp fishery of the Gulf of Mexico United States waters. Gulf of Mexico Fishery Management Council, Tampa, Florida.

GMFMC. 1997. Amendment 9 to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters. Gulf of Mexico Fisheries Management Council, Tampa, FL. Available at: http://archive.gulfcouncil.org/Beta//GMFMCWeb/downloads/SHRIMP%20Amend-09%20Final%201997-02.pdf

GMFMC. 2015. Amendment 15 to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters. Gulf of Mexico Fisheries Management Council, Tampa, FL.

Griffin, E., K.L. Miller, S. Harris, and D. Allison. 2008. Trouble for Turtles: Trawl Fishing in the Atlantic Ocean and Gulf of Mexico. Oceana, Washington, D.C. 16 pages.

GSMFC 2001. The spotted seatrout fishery of the Gulf of Mexico, United States: a regional management plan. Gulf States Marine Fisheries Commission, 204p.

GSMFC 2011. The sand and silver seatrout fishery of the Gulf of Mexico, United States: A Fisheries Profile. e Gulf States Marine Fisheries Commission, 194p.

GSMFC 2019. SEAMAP environmental and biological atlas of the Gulf of Mexico, 2019. Gulf States Marine Fisheries Commission number 284, 70p.

GSMFC 2021. GDAR 03 Gulf Menhaden Stock Assessment 2021 Update. Gulf States Marine Fisheries Commission, 73p.

GSMFC. 2013. GDAR 01 Stock Assessment Report Gulf of Mexico Blue Crab. GSMFC No. 215

GSMFC. 2017. Biological Profile for the Atlantic Croaker Fishery in the Gulf of Mexico. GSMFC Pub Number 266.

Gulf of Mexico Fishery Management Council (GMFMC). 2017. Yield, Threshold Number of Permits, and Transit Provisions. Final Amendment 17B to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters Including Environmental Assessment, Fishery Impact Statement, Regulatory Impact Review, and Regulatory Flexibility Act Analysis. Available at: http://gulfcouncil.org/wp-content/uploads/Final-Shrimp-Amendment-17B.pdf

Hare JA and Able KW. 2007. Mechanistic links between climate and fisheries along the east coast of the United States: explaining population outbursts of Atlantic croaker (Micropogonias undulatus). Fish. Oceanogr. 16:1, 31–45.

Hart KM, Iverson AR, Fujisaki I, Lamont MM, Bucklin D and Shaver DJ. 2018. Marine Threats Overlap Key Foraging Habitat for Two Imperiled Sea Turtle Species in the Gulf of Mexico. Front. Mar. Sci. 5:336. doi: 10.3389/fmars.2018.00336

Hart RA. 2018. Stock assessment for pink shrim (Farfantepenaeus duorarum) in the U.S. Gulf of Mexico for the 2017 fishing year. NOAA Fisheries, Southeast Fisheries Science Center. Gavelston, Texas.

Hart RA. 2018b. Stock assessment update for white shrimp (Litopenaeus setiferus) in the U.S. Gulf of Mexico for the 2017 fishing year. NOAA Fisheries, Southeast Fisheries Science Center. Gavelson, Texas.

Hart RA. 2018c. Stock assessment update for brown shrimp (Farfantepenaeus aztecus) in the U.S. Gulf of Mexico for the 2017 fishing year. NOAA Fisheries, Southeast Fisheries Science Center. Gavelson, Texas.

IUCN. 2017. IUCN Red List of Threatened Species. Version 2017-2. Available at : http://www.iucnredlist.org/

Jeffers, S.A. W.F Patterson III and J.H. Cowan Jr. 2008. Habitat and bycatch effects on population parameters of inshore lizardfish (Synodus foetens) in the north central Gulf of Mexico. Fish Bull, 106(4), pp. 417-426.

LDWF 2016b. Louisiana Shrimp Fishery Management Plan. 158p.

LDWF 2021. Update Assessment of Spotted Seatrout (Cynoscion nebulosus) in Louisiana Waters 2021 Report. Office of Fisheries, Louisiana Department of Wildlife and Fisheries. 121p

LDWF. 2016. Update Assessment of Blue Crab in Louisiana Waters 2016 Report.

LDWF. 2019. Update Assessment of Blue Crab in Louisiana Waters 2019 Report.

Lee LM. 2005. Population dynamics of Atlantic croaker occurring along the US east coast, 1981-2002. MS thesis, North Carolina State Universisty. 98pp.

Louisiana Register 2016. Notice of Intent: Department of Wildlife and Fisheries, Wildlife and Fisheries Commission: Blue Crab Harvest. Louisiana Department of Wildlife and Fisheries: Vol. 42 No. 7

Martin, F.D. and G.B. Drewry. 1978. Development of fishes of the mid-Atlantic bight. An atlas of egg, larval and juvenile stages. Volume VI, Stromateidae through Ogcocephalidae. Biological

Services Program, Fish and Wildlife Service, U.S. Department Interior. FWS/OBS-78-12.

Monk MH, Powers JE, Brooks EN. 2015. Spatial patterns in species assemblages associated with the northwestern Gulf of Mexico shrimp trawl fishery. Mar Ecol Prog Ser 519: 1–12.

Morse WW. 1980. Maturity, spawning, and fecundity of Atlantic croaker, Micropogonias undulatus, occurring north of Cape Hatteras, North Carolina. Fishery Bulletin 78(1):190–195.

Morse WW. 1980. Maturity, spawning, and fecundity of Atlantic croaker, Micropogonias undulatus, occurring north of Cape Hatteras, North Carolina. Fishery Bulletin 78(1):190–195.

NCDMF. 2001. North Carolina Division of Marine Fisheries. DMF Index: Brown, Pink and White Shrimp.

NMFS 2021b. Stock SMART - Status, Management, Assessments & Resource Trends.

NMFS 2021c. Fisheries of the United States, 2019. U.S. Department of Commerce, NOAA Current Fishery Statistics No. 2019.

NMFS. 2009. Fisheries of the United States, 2008. National Marine Fisheries Service, Office of Science and Technology, Silver Spring, MD.

NMFS. 2009b. Gulf sturgeon (Acipenser oxyrinchus desotoi) 5-Year Review:Summary and Evaluation.

NMFS. 2012a. Draft Environmental Impact Statement to reduce incidental bycatch and mortality of sea turtles in the Southeastern U.S. Shrimp fisheries. Available at: http://www.nmfs.noaa.gov/pr/pdfs/species/deis_seaturtle_shrimp_fisheries_interactions.pdf

NMFS. 2012b. Reinitiation of Endangered Species Act (ESA) Section 7 Consultation on the Continued Implementation of the Sea Turtle Conservation Regulations, as Proposed to Be Amended, and the Continued Authorization of the Southeast U.S. Shrimp Fisheries in Federal Waters under the Magnuson-Stevens Act. Available at: http://sero.nmfs.noaa.gov/protected_resources/section_7/freq_biop/documents/fisheries_bo/southeastshrimpbiop_final.pdf

NMFS. 2014. ESA Section 7 Consultation Reinitiation of Endangered Species Act (ESA) Section 7 Consultation on the Continued Implementation of the Sea Turtle Regulations Under the ESA and the Continued Authorization of the Southeast U.S. Shrimp Fisheries in Federal Waters under the Magnuson-Stevens Fishery Management and Conservation Act (MSFMCA). Biological Opinion. Consultation No. SER-201 3-12255. NOAA, NMFS, SERO, Protected Resources Division (F/SER3) and Sustainable Fisheries Division (F/SER2).

NMFS. 2021. Status of U.S. Fisheries; Fish Stock Sustainability Index (FSSI) for 2021, Third Quarter. NOAA Fisheries Office of Sustainable Fisheries.

NOAA 2019d. Final Environmental Impact Statement to reduce the incidental bycatch and mortality of sea turtles in the Southeastern U.S. shrimp fisheries. November 9, 2019.

NOAA 2021b. Endangered Species Act (ESA) - Section 7 Consultation Biological Opinion. National Marine Fisheries Service (NMFS), Southeast Regional Office (SERO), St. Petersburg, Florida. 297p.

NOAA 2021c. Potential New Turtle Exclusion Device Requirements for Skimmer Trawl Vessels Less Than 40 Feet (12.2 meters) in Length. NOAA-NMFS-2021-0075-0001

NOAA 2022. Species directory: Green Turtle. Accessed in Feb 15, 2022.

NOAA. 2016. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessment – 2015. NOAA Technical Memorandum NMFS-NE-238.

NOAA. 2016b. Draft Environmental Impact Statement to Reduce the Incidental Bycatch and Mortality of Sea Turtles in the Southeastern U.S. Shrimp Fisheries. NOAA National Marine Fisheries Service, Southeast Regional Office. St. Petersburg, FL.

NOAA. 2017a. US Atlantic and Gulf of Mexico marine mammal stock assessments - 2016. NOAA Tech Memo NMFS-NE-241.

NOAA. 2017c. 2017 Ecosystem Status Report Update for the Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC-706

NOAA. 2019. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2018. NOAA Technical Memorandum NMFS-NE-258. 306p.

NOAA. 2019b. Deepwater Horizon Natural Resource Damage Assessment and Restoration? Better Bycatch Reduction Devices for the Gulf of Mexico Commercial Shrimp Trawl Fishery - Fish Restoration Type. 2pp.

NOAA. 2019c. Deepwater Horizon Natural Resource Damage Assessment and Restoration: Reducing Juvenile Sea Turtle Bycatch through Development of Reduced Bar Spacing in Turtle Excluder Devices - Sea Turtles Restoration Type. 2pp.

NOAA. 2021. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments 2020. NOAA Tech Memo NMFS-NE-271.

Northwest Atlantic Leatherback Working Group 2018. Northwest Atlantic Leatherback Turtle (Dermochelys coriacea) Status Assessment (Bryan Wallace and Karen Eckert, Compilers and Editors). Conservation Science Partners and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). WIDECAST Technical Report No. 16. Godfrey, Illinois. 36 pp.

Oceana. 2007. Deep-sea trawl fisheries of the Southeast U.S. and Gulf of Mexico – Rock

shrimp, Royal red shrimp, Calico scallops.

Odell J, DH Adams, B Boutin, W Collier II, A Deary, LN Havel, JA Johnson Jr., SR Midway, J Murray, K Smith, KM Wilke, MW Yuen. 2017. Atlantic Sciaenid Habitats: A Review of Utilization, Threats, and Recommendations for Conservation, Management, and Research. Atlantic States Marine Fisheries Commission Habitat Management Series No. 14, Arlington, VA.

Odom AR 2015. Analyses of Indices of Abundance for Important Groundfish Species in the Northern Gulf of Mexico from 1987-2009, Relative to Shrimp Bycatch with Age and Growth of Three Sciaenid Species . The University of Southern Mississippi The Aquila Digital Community Master's Theses , 225p.

Palomares, M.L.D. and D. Pauly. Editors. 2017. SeaLifeBase. World Wide Web electronic publication. www.sealifebase.org, version (08/2017).

Palomares, M.L.D. and D. Pauly. Editors. 2021. SeaLifeBase - Portunus spinicarpus. World Wide Web electronic publication. www.sealifebase.org, version (04/2021).

Pardal-Souza AL and Pinheiro MAA. 2014. Relative growth and reproduction in Achelous spinicarpus (Crustacea: Portunidae) on the south-eastern continental shelf of Brazil. Journal of the Marine Biological Association of the United Kingdom, 93(3), 667–674.

Pikitch E, Boersma PD, Boyd IL, Conover DO, Cury P, Essington T, Heppell SS, Houde ED, Mangel M, Pauly D, Plagányi É, Sainsbury K, and Steneck RS. 2012. Little Fish, Big Impact: Managing a Crucial Link in Ocean Food Webs. Lenfest Ocean Program. Washington, DC. 108 pp.

Pollom, R., Carlson, J., Charvet, P., Avalos, C., Bizzarro, J., Blanco-Parra, MP, Briones Bell-Iloch, A., Burgos-Vázquez, M.I., Cardenosa, D., Cevallos, A., Derrick, D., Espinoza, E., Espinoza, M., Mejía-Falla, P.A., Morales-Saldaña, J.M., Navia, A.F., Pacoureau, N., Pérez Jiménez, J.C. & Sosa-Nishizaki, O. 2021. *Sphyrna tiburo* (amended version of 2020 assessment). *The IUCN Red List of Threatened Species* 2021: e.T39387A205765567. Accessed on 23 February 2022.

Pratt E. 2022. Study: 2020-21 hurricanes caused $579 million of damage to LA fishing industry. Louisiana Wildlife and Fisheries.

Pulver, J.R., E. Scott-Denton, and J.A. Williams. 2012. Characterization of U.S. Gulf of Mexico skimmer trawl fishery based on observer coverage. NOAA Technical Memorandum NMFS-SEFSC-636, 27p.

Pulver, J.R., E. Scott-Denton, and J.A. Williams. 2014. Observer coverage of the 2013 Gulf of Mexico skimmer trawl fishery. NOAA Technical Memorandum NMFS-SEFSC-654, 25p.

Putman NF, HAwkins J, Gallaway BJ 2020. Managing fisheries in a world with more sea turtles. Proc. R. Soc. B 287: 20200220.

Raborn S, Gallaway B and J Cole. 2014. Sustainable Fisheries Partnership and the Florida pink and Texas shrimp Fishery Improvement Projects.

Rigby, C.L., Carlson, J., Smart, J.J., Pacoureau, N., Herman, K., Derrick, D. & Brown, E. 2020. *Carcharhinus brevipinna*. *The IUCN Red List of Threatened Species* 2020: e.T39368A2908817. Accessed on 23 February 2022.

Rigby, C.L., Dulvy, N.K., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M.P., Herman, K., Jabado, R.W., Liu, K.M., Marshall, A., Pacoureau, N., Romanov, E., Sherley, R.B. & Winker, H. 2019. *Sphyrna lewini*. *The IUCN Red List of Threatened Species* 2019: e.T39385A2918526. Accessed on 23 February 2022.

SAFMC. 1993. Fishery Management Plan for the Shrimp Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, Charleston, South Carolina.

SAFMC. 1999. Stock Assessment and Fishery Evaluation Report for the Shrimp Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, Charleston, South Carolina.

SAFMC. 2002. Final Amendment 5 to the Fishery Management Plan of the South Atlantic Region (Rock Shrimp), including a final supplemental EIS, initial regulatory flexibility analysis, regulatory impact review, and social impact assessment/fishery impact statement. South Atlantic Fishery Management Council, Charleston, South Carolina.

SAFMC. 2009. Comprehensive Ecosystem-Based Amendment 1 for the South Atlantic Region. [Amendment 8 for the Shrimp Fishery] South Atlantic Fisheries Management Council, North Charleston, SC.

SAFMC. 2009a. Fishery Ecosystem Plan of the South Atlantic Region, Volumes 1 – VI. South Atlantic Fisheries Management Council, North Charleston, SC.

Sasso, C.R. and S. P. Epperly. 2006. Seasonal sea turtle mortality risk from forced submergence in bottom trawls. Fish Res 81: 86-88.

SCDNR. 2001. White Shrimp—Description, Habitat and Biology. South Carolina Department of Natural Resources ACE Basin Species Gallery Fact Sheets. Available at: www.csc.noaa.gov/acebasin/specgal/whshrimp.htm

SCDNR. 2007. Shrimp in South Carolina. Sea Science: an information/education series from the Marine Resources Division. South Carolina Department of Natural Resources, Columbia, SC. Available at: http://www.dnr.sc.gov/marine/pub/seascience/shrimp.html

Schmidtke M, Kenyon A, Laney W, McDonough C, Zapf D. 2018. 2018 Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Atlantic croaker - 2017 Fishing year. Atlantic States Marine Fisheries Commission. 22pp.

Scott-Denton E, Cryer PF, Duffin BV, Duffy MR, Gocke JP, Harrelson MR. 2020. Characterization of the U.S. Gulf of Mexico and South Atlantic Penaeidae and Rock Shrimp (Sicyoniidae) Fisheries through Mandatory Observer Coverage, from 2011 to 2016. *Marine Fisheries Review*, vol. 82, no. 1-2, wntr-spring 2020, pp. 17+

Scott-Denton E., P.F. Cryer, M.R. Duffy, J.P. Gocke, M.R. Harrelson, D.L. Kinsella, J.M. Nance, J.R. Pulver, R.C. Smith, and J.A. Williams. 2012. Characterization of the U.S. Gulf of Mexico and South Atlantic penaeid and rock shrimp fisheries based on observer data. Mar Fish Rev 74(4): 1-26

Scott-Denton, E., J.A. Williams and Pulver, J.R. 2014. Observer coverage of the 2014 Gulf of Mexico skimmer trawl fishery. NOAA Technical Memorandum NMFS-SEFSC666, 27 p.

Scott-Denton, E., P. Cryer, J. Gocket, M. Harrelson, K. Jones, J. Nance, J. Pulver, R. Smith, and J.A. Williams. 2006. Skimmer Trawl Fishery Catch Evaluations in Coastal Louisiana, 2004 and 2005. Mar Fish Rev 68(1-4): 30 - 35.

Sea Turtle Conservation; Shrimp Trawling Requirements; Notice of proposed rulemaking. 81 Federal Register 242 (16 Dec 2016), pp. 91097-91104.

SEAMAP. 2019. Joint annual report of the Southeast Area Monitoring and Assessment Program Oct 1, 2016 - Sep 30, 2017. 23pp.

SEAMAP. 2019b. Joint annual report of the Southeast Area Monitoring and Assessment Program Oct 1, 2017 - Sep 30, 2018. 22pp.

SEDAR. 2011. SEDAR 21: HMS Atlantic blacknose shark. Southeast Data, Assessment, and Review, North Charleston, SC

SEDAR. 2018. SEDAR 52 Stock Assessment Report - Gulf of Mexico Red Snapper. 413pp.

SEDAR. 2018b. SEDAR 63 – Gulf Menhaden Stock Assessment Report. SEDAR, North Charleston SC. 352 pp. available online at: http://sedarweb.org/sedar-63

SERO. 2016. Turtle Excluder Device (TED) compliance policy. NOAA Southeast Regional Office. Available at: http://sero.nmfs.noaa.gov/protected_resources/sea_turtle_protection_and_shrimp_fisheries/documents/final_ted_compliance_policy.pdf

Stallings CD, Brower JP, Heinlein Loch JM, Mickle A 2014. Commercial trawling in seagrass beds: bycatch and long-term trends in effort of a major shrimp fishery. Mar Ecol Prog Ser 513: 143–153.

Waggy, G. L., N. J. Brown-Peterson, and M.S. Peterson. 2006. Evaluation of the reproductive life history of the Sciaenidae in the Gulf of Mexico and Caribbean Sea: “Greater” versus “lesser” strategies? Proc. Gulf Caribb. Fish. Inst. 57:263–282.

Wells D., J.H. Cowan Jr., W.F. Patterson III. 2008. Habitat use and the effect of shrimp trawling on fish and invertebrate communities over the northern Gulf of Mexico continental shelf. ICES J Mar Sci. 65(9):1610–1619

Wibbels T and Bevan E 2019. *Lepidochelys kempii* (errata version published in 2019). *The IUCN Red List of Threatened Species* 2019: e.T11533A155057916.