Monterey Bay Aquarium Seafood Watch

Environmental sustainability assessment of wild-caught of striped mullet from Florida caught using beach seines and cast nets

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Species:	Striped mullet (*Mugil cephalus*)
Location:	Florida: Western Central Atlantic
Gear:	Beach seines, Cast nets
Type:	Wild Caught
Author:	Seafood Watch
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Assessed using Seafood Watch Fisheries Standard v3

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

Guiding Principles

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

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

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

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

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

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

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

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

Avoid/Red: Take a pass on these for now; they're caught or farmed in ways that harm other marine life or the environment.

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

Summary

Striped mullet (*Mugil cephalus*) is a catadromous, schooling fish inhabiting the coastal areas around the southern Atlantic Ocean (east coast of Florida) and the Gulf of Mexico (west coast of Florida). This species is targeted from October to February for its valuable eggs (sold as roe in seafood markets), but the meat is also used as bait in commercial and recreational fisheries and is consumed in some regions of the southern U.S.

The largest commercial fisheries for striped mullet operate out of southwest Florida (managed by the Florida Fish and Wildlife Conservation) and east of the Mississippi River, off the coast of Louisiana (not covered in this report). A majority of the roe is exported, primarily to Asia. Florida has not conducted a recent stock assessment for striped mullet, although monitoring data suggest that the stock is still not overfished or undergoing overfishing, as was concluded in the 2014 stock assessment. Cast nets and beach seines are used almost exclusively to catch schools of mullet, and bycatch and habitat impacts with this type of gear are thought to be minimal, although beach seines have a greater potential to impact the substrate.

This small, bottom-feeding species is considered important in the overall Gulf marine ecosystem because it is preyed upon by a range of other fauna. Striped mullet is highly fecund, relatively short-lived, with a low age at maturity, making it resilient to heavy fishing pressure. Because of its importance in the ecosystem as well as the state economies, managers have taken steps to prevent fishing mortality from becoming deleterious to stocks. This combination of factors results in an overall Green rating for striped mullet caught in Florida using cast nets, and a Yellow rating for striped mullet caught in Florida using beach seines.

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Striped mullet | Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines	2.644	2.644	4.000	3.464	**Good Alternative (3.137)**	517 (MT) 2021
Striped mullet | Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets	2.644	2.644	4.000	3.873	**Best Choice (3.226)**	1,515 (MT) 2021

In 2021, Florida fishers brought in about 307 MT of striped mullet on the east coast (South Atlantic) and about 1,725 MT of striped mullet on the west coast (Gulf of Mexico) (NOAA 2023). Florida's east coast has been shown to use cast nets for approximately 100% of the striped mullet that is landed, while the west coast uses cast nets for approximately 70% of landed striped mullet and other seine nets (beach seines) for approximately 30% of landed striped mullet (D. Addis, personal communication, 2023b). Therefore, approximately 1,515 MT of striped mullet were caught using cast nets and approximately 517 MT were caught using seine nets (NOAA 2023).

Summary

Striped mullet in Florida Western Central Atlantic fisheries caught by cast nets receives a Green rating because of low impacts on the stock, moderate impacts on other species, highly effective management, and minimal impacts on the environment. Striped mullet in Florida Western Central Atlantic fisheries caught by beach seine receives a Yellow rating because of low impacts on the stock, moderate impacts on other species, highly effective management, and moderate impacts on the environment.

Scoring Guide

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

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

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

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

Introduction

Scope of the analysis and ensuing recommendation

This report covers ratings for striped mullet (*Mugil cephalus*) caught by beach seine and cast net in the waters of the U.S. South Atlantic and the Gulf of Mexico off the coast of Florida.

Species Overview

Striped mullet is the most abundant species in the family Mugilidae, and it inhabits the coastal areas around the Gulf of Mexico (GOM) and southern Atlantic Ocean (Leard et al. 1995). It is catadromous: it spends its adult life in fresh/brackish estuarine habitats and returns to the coastal ocean to spawn (FMNH 2023)(FWCC 2023a). Striped mullet is a bottom-feeding species (detritivores feeding on the top layer of sediment) and considered important in the overall Gulf marine ecosystem because it is preyed upon by a range of other fauna (Chagaris et al. 2014).

This species is highly fecund, relatively short-lived, and with a young age at maturity, which makes it resilient to heavy fishing pressure (FMNH 2023). Striped mullet is fished recreationally in many states (such as Alabama, Mississippi, and Florida), primarily with cast nets (pers. comm., Dustin Addis, March 2023) because it is not easily caught by hook and line. The largest commercial fisheries for this species operate out of southwest Florida (for human consumption, sold domestically), Alabama, and North Carolina, and the most valuable product—roe (eggs)—is primarily exported. Mullet meat is not the best quality during the spawning season, and roe fishery handling procedures do not produce a high quality fish for eating, which is why mullet carcasses are used for bait in other fisheries or for fish emulsion fertilizer for viticulture (FMNH 2023)(Lallo 2015).

Traditionally, gillnets and purse seines were used to catch striped mullet. But because of concerns about bycatch and sportfish stocks, beginning in 1995, Florida and Louisiana prohibited the use of all "entangling nets" (Mahmoudi 2005){The Florida Senate 2015}. The fishing methods currently allowed in Florida's commercial fishery include cast nets, beach or haul seines, hook and line, and spear, with further restrictions for each. In 2020, striped mullet was the third-largest fishery along the west coast of Florida by volume (7.3 million lb; 3,311 MT) (FWCC 2022).

Although striped mullet may inhabit federal waters (3 to 200 mi from shore), it is most abundant in state waters, so management of the fisheries is the responsibility of each state. The Gulf States Marine Fisheries Commission (GSFMC) oversees management by individual states and coordinates an overall Fishery Management Plan (FMP) for striped mullet. The Florida Fish and Wildlife Conservation Commission (FWCC) is responsible for managing the striped mullet fishery in state waters, inshore out to 3 nm on the South Atlantic side, and 9 nm in the Gulf of Mexico.

Production Statistics

The Gulf has supplied the majority of striped mullet in the United States since at least the 1960s (Figure 1). In 2021, Florida fishers brought in nearly 4.5 million lb, or about 2,000 MT, of striped mullet (Figure 2). Dockside revenue in 2020 totaled nearly $3.7 million (NOAA 2023).

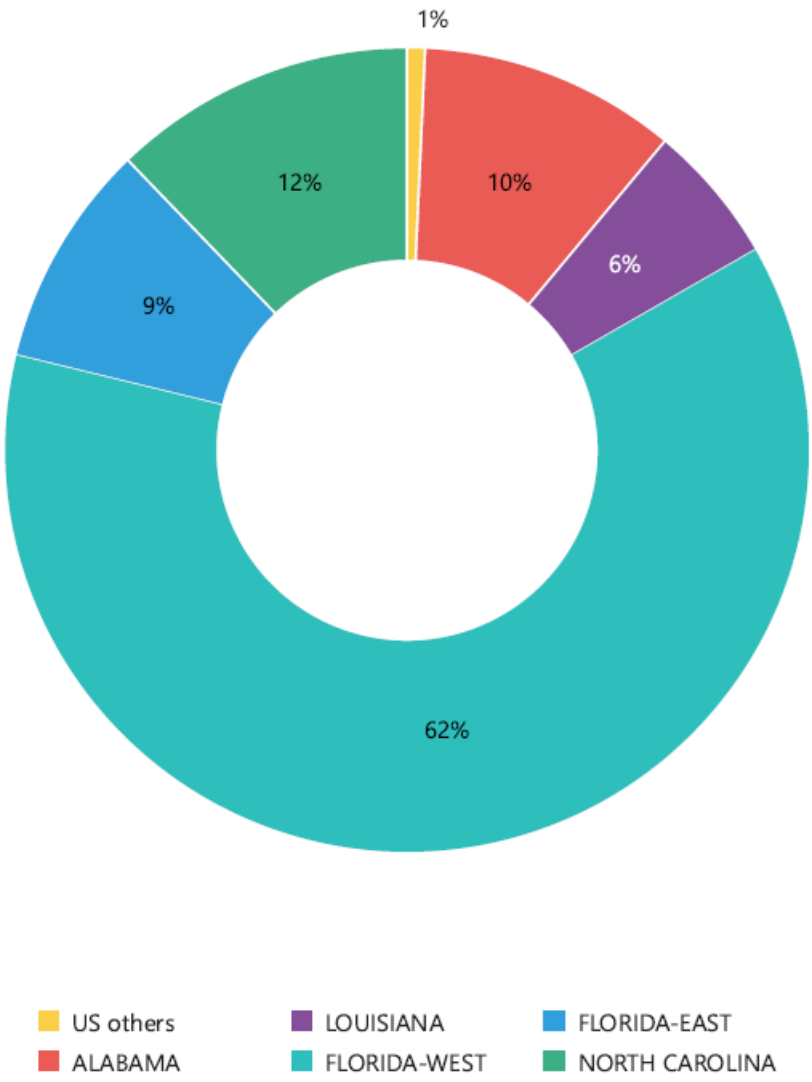

Figure 1: Percentage of total U.S. striped mullet landings for Alabama, Florida-East, Florida-West, Louisiana, North Carolina, and other states. Data are from 2010–21 (NOAA 2023b).

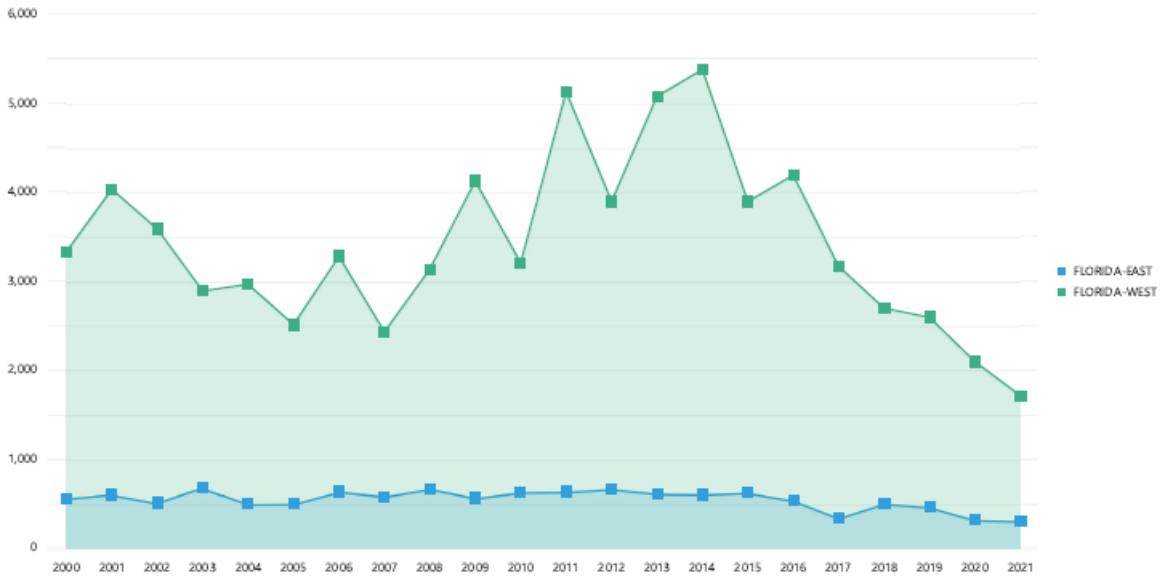

Figure 2: Annual landings of striped mullet (MT) in Eastern and Western Florida from 2000 to 2021 (NOAA 2023).

Importance to the US/North American market.

According to U.S. trade data, mullet roe exports and both meat and roe imports have remained fairly steady over the past decade, while meat exports substantially increased around 2015 and have been decreasing since (Figure 3) (NOAA 2023c). Though the weight of exported mullet meat far exceeds the weight of exported roe, the value of mullet meat is much lower.

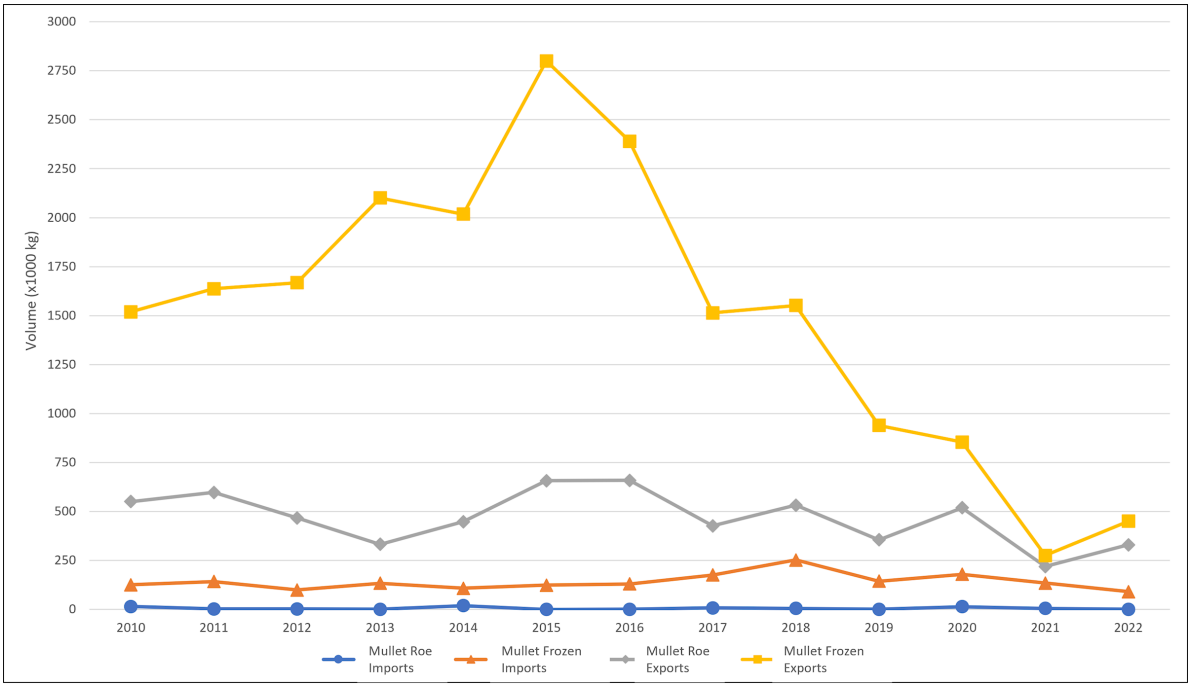

Figure 3: U.S. trade (imports and exports) of frozen mullet and mullet roe from 2010 to 2022. Data from (NOAA 2023c).

In 2020, frozen mullet imports primarily came from Vietnam (68%), Taiwan (16%), and Thailand (10%) (Figure 4). Mullet roe primarily came from Brazil (94%) (Figure 5).

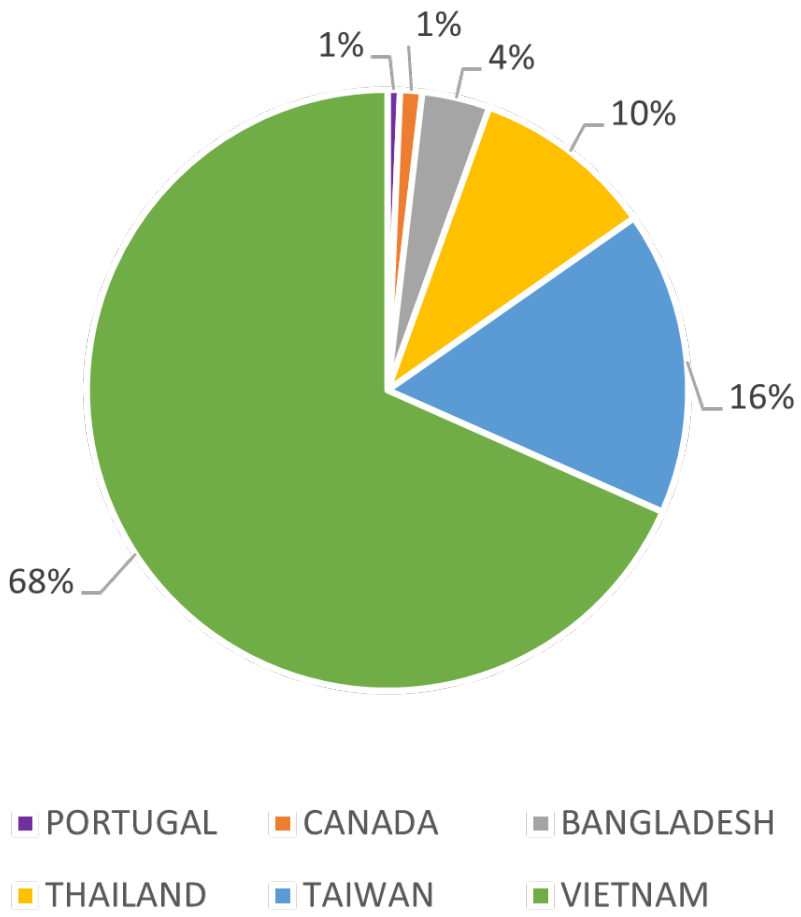

Figure 4: 2020 U.S. imports of frozen mullet by country. Data from (NOAA 2023c).

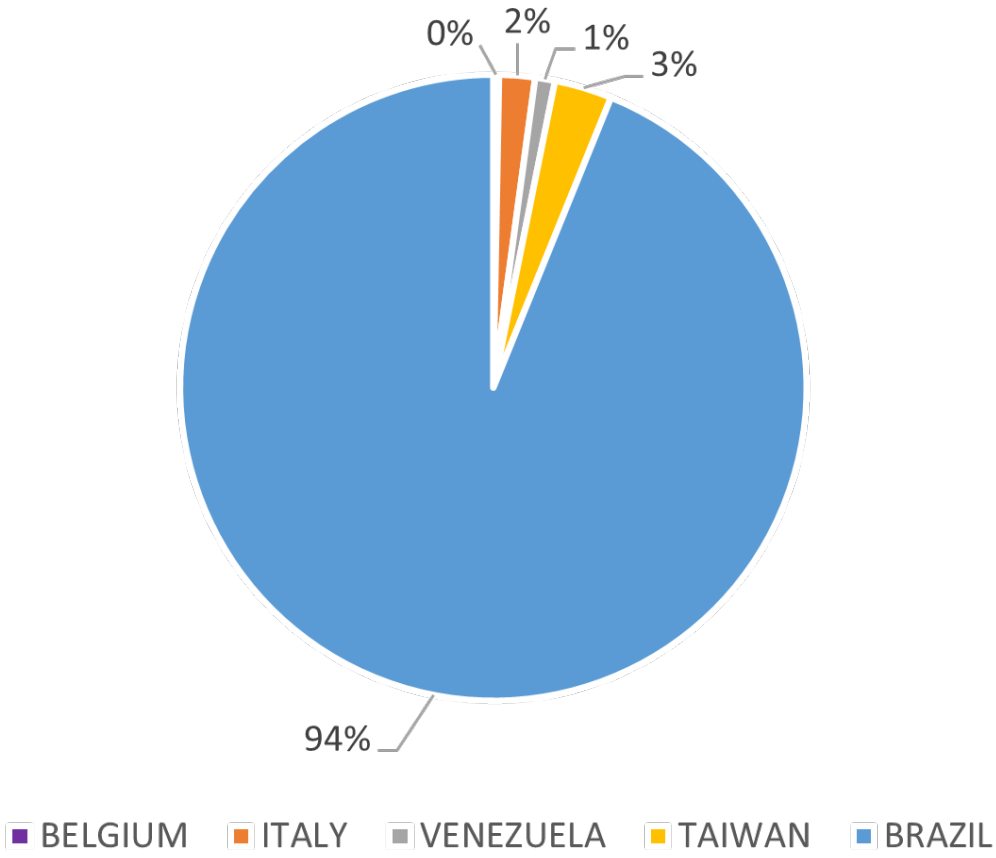

Figure 5: 2020 U.S. imports of mullet roe by country. Data from (NOAA 2023c).

In 2020, frozen mullet was primarily exported to Colombia (46%), Dominican Republic (23%), and Haiti (22%) (Figure 6). Mullet roe was primarily exported to Egypt (24%), Taiwan (23%), and Japan (23%) (Figure 7).

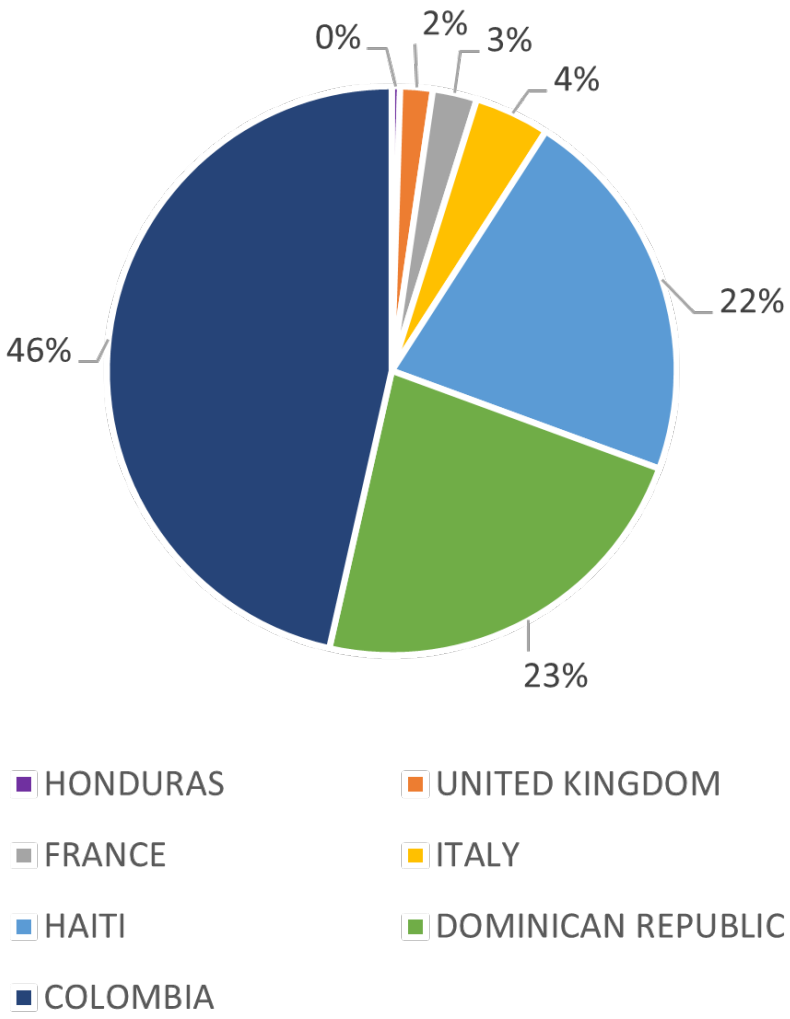

Figure 6: 2020 U.S. exports of frozen mullet by country. Data from (NOAA 2023c).

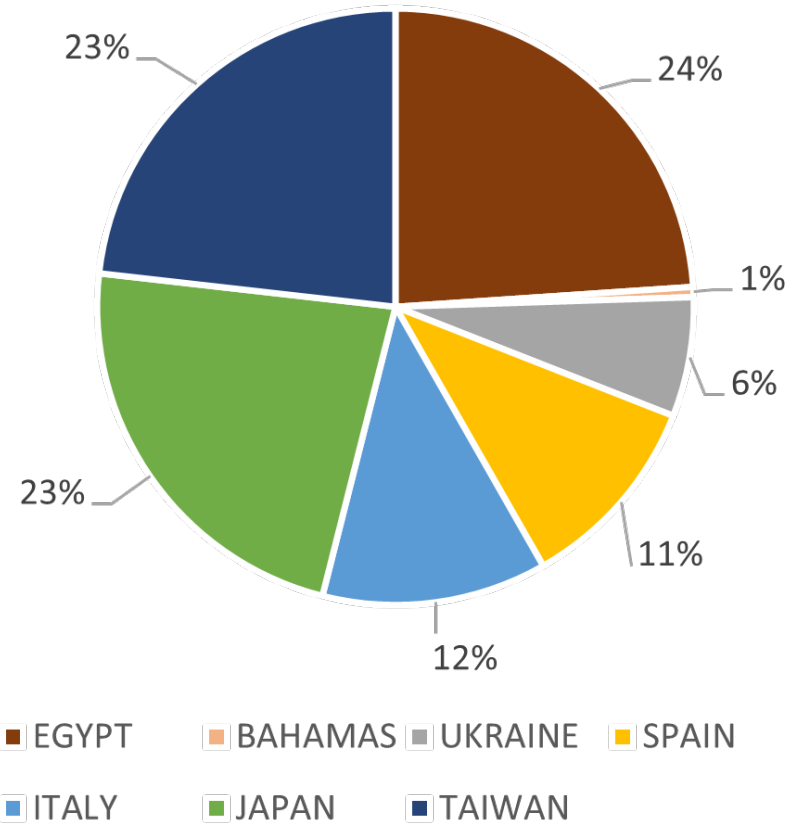

Figure 7: 2020 U.S. exports of mullet roe by country. Data from (NOAA 2023c).

Common and market names.

Striped mullet may be commonly referred to as mullet, jumping mullet, flathead mullet, popeye mullet, river/sea mullet, whirligig mullet, black/black back/grey mullet, jumping jack, lisa/liza, roundhead, springer, and molly/mullé (LSU 2023)(FMNH 2023).

Primary product forms

Mullet is sold whole, collared or gutted, and filleted, either fresh or frozen, smoked or salted (Leard et al. 1995). "Yellow-red roe" are female eggs, while "white roe" are testes. Roe is generally not seen in the U.S. market, except relatively recently in the Gulf (Lallo 2015), but is exported to European and Asian countries, where it is considered a delicacy.

Assessment

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

Criterion 1: Impacts on the species under assessment

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

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

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

Guiding principles

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

Criterion 1 Summary

STRIPED MULLET			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance
Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of*

the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.

- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

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

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

Striped mullet

Factor 1.1 - Abundance

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Moderate Concern

There has not been a quantitative stock assessment for Florida-caught striped mullet in the past 10 years, and there are no planned assessments through 2026 at the minimum (D. Addis, personal communication, 2023a). Although it is not a stock assessment, the most recent annual report on status and trends of commercially and recreationally important species in Florida waters, published by the Florida Fish and Wildlife Conservation Commission (FWCC), suggests that the striped mullet stock is not overfished or undergoing overfishing at this time, just as the last stock assessment in 2014 concluded (FWCC 2022). The most recent annual report from the Fisheries Independent Monitoring Program also developed indices of relative abundance (IOAs) for young-of-the-year striped mullet for the past two decades and found strong year classes in 2015 and 2020 in bay habitats, thus supporting the conclusion that stocks are still not undergoing overfishing or being overfished (FWCC 2022b). There is uncertainty that comes with the lack of a recent stock assessment, there are regularly collected data indicating that the status is not of concern by the management body, and there is a score of Least Concern by the International Union for the Conservation of Nature (IUCN) (Camara et al. 2019); therefore, abundance warrants a score of moderate concern.

Factor 1.2 - Fishing Mortality

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Moderate Concern

There has not been a quantitative stock assessment for Florida-caught striped mullet in the past 10 years, and there are no planned assessments through 2026 at the minimum (D. Addis, personal communication, 2023a). The management entity, the Florida Fish and Wildlife Conservation Commission (FWCC), has suggested that striped mullet is currently not overfished or undergoing overfishing, based on annual trend data and indices of relative abundance rather than a stock assessment (FWCC 2022)(FWCC 2022b). The fishing mortality for this species is still generally unknown, warranting 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.

STRIPED MULLET			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines	2.644	1.000: < 100%	Yellow (2.644)
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets	2.644	1.000: < 100%	Yellow (2.644)

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, WESTERN CENTRAL ATLANTIC | UNITED STATES | FLORIDA | BEACH SEINES			
SUB SCORE: 2.644	DISCARD RATE: 1.000	**SCORE: 2.644**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Finfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Striped mullet	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

GULF OF MEXICO, WESTERN CENTRAL ATLANTIC | UNITED STATES | FLORIDA | CAST NETS			
SUB SCORE: 2.644	DISCARD RATE: 1.000	**SCORE: 2.644**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Finfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Striped mullet	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

The incidental take of nontarget species in the striped mullet fishery is somewhat dependent upon whether fishing occurs during spawning (roe) season. Because striped mullet forms dense schools during spawning and fishers often do sight casting, efficiency is high and incidental take is very low during these times (D. Addis, personal communication, 2023a)(Leard et al. 1995). It is because of these dense schools, and because of the high value of roe, that in Florida waters more than 80% of annual landings are made during the spawning season (October–January).

Potential bycatch species include white mullet, southern flounder, snook, red drum, gulf kingfish, gray snapper, and gulf flounder, although bycatch is considered to be generally quite minimal and the catch composition of these bycatch species is generally unknown (D. Addis, personal communication, 2023a). A significant portion of catch also occurs over seagrass habitats, which results in bycatch of pinfish, redfish, snook, spotted seatrout, sheepshead, and crevalle jack, although the composition and impacts here are also unknown (Marin 2018).

Bycatch is scored according to the Seafood Watch Unknown Bycatch Matrix (UBM), based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The UBM ranks the bycatch susceptibility of different taxonomic groups in various gear types. More information is available in Appendix 2 of the Seafood Watch criteria. The taxa that are most likely to interact with the striped mullet fishery, for both beach seines and cast nets, include finfish.

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

Finfish

Factor 2.1 - Abundance

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Moderate Concern
Most stocks of teleost fish or invertebrates that are not from highly vulnerable taxa are moderately vulnerable to interactions with fishing gear.

Factor 2.2 - Fishing Mortality

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines

Moderate Concern
Unknown finfish caught as bycatch in a bottom seine (beach seine) receive a fishing mortality score of high concern in the Unknown Bycatch Matrix. Given that the majority of the catch is made on schools of mullet and that bycatch is not likely to be of high concern for this fishery, a score of moderate concern is appropriate.

Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Moderate Concern
Cast nets are not listed in the UBM, but are assumed to have similar impacts as beach seines for the purposes of this assessment. Unknown finfish caught as bycatch in a bottom seine (beach seine) receive a fishing mortality of high concern in the UBM. Given that the majority of the catch is made on schools of mullet and that bycatch is not likely to be of high concern for this fishery, a score of moderate concern is appropriate.

Factor 2.3 - Discard Rate/Landings

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines

< 100%

Beach seines have average discard rates that range from negligible in developing countries (because all fish caught are usually used in some way) to 32% in more-developed countries (Kelleher 2005). Therefore, these discard rates warrant a score of 1.

Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

< 100%

There are no discard rate estimates calculated for cast nets, so it is assumed that discards are minimal, because cast netting is usually targeting a school of spawning mullet and therefore is highly efficient (D. Addis, personal communication, 2023a). Thus, the likely low levels of discards and bait use in relation to total landings warrant a score of 1.

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	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines	Highly effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Green (4.000)**
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets	Highly effective	Highly 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.

Factor 3.1 - Management Strategy And Implementation

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Highly effective
The most recent stock assessment from 2014 suggested that the Florida striped mullet population was healthy and that harvest levels were generally stable, although there has not been a stock assessment conducted for Florida-caught striped mullet in 10 years, and there are no planned assessments through 2026 at the minimum (D. Addis, personal communication, 2023a). Management measures include size limits to protect juveniles, seasonal/area closures to protect spawning adults, bag and trip limits, gear restrictions, and licensing requirements in order to catch commercial quantities of mullet (FWCC 2023b)(FWCC 2023c). FWCC also monitors the commercial striped mullet fishery through its Marine Fisheries Trip Ticket Program, which requires that all sales of seafood products from the waters of Florida be reported on a trip ticket at the time of sale (FWCC 2023d). Therefore, the management strategy for this fishery warrants a score of highly effective.

Justification:
In the early 1990s, when the stock was deemed overfished with overfishing occurring, scientific advice was given to managers to decrease fishing mortality and increase spawner escapement in order to reach the reference points (Leard et al. 1995). A public referendum was passed in 1995 that prohibited the use of entangling nets (gillnets) in Florida waters {Florida Senate 2015} and, although not explicitly for striped mullet, it was an important management decision that allowed the striped mullet stock to rebuild.

Overfished and overfishing definitions have been established, but FWCC has not identified separate target and threshold (limit) reference points for the stock nor explicit harvest control rules to guide management decisions; however, quantitative biological reference point targets that appear suitable and conservative relative to the population life history for this stock have been in place since 1993 (Leard et al. 1995)(Mahmoudi 2005)(Chagaris et al. 2014).

Factor 3.2 - Bycatch Strategy

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Highly effective
Bycatch is quite minimal for this fishery with low mortality of nontarget species, because of the ban on entangling nets in Florida waters (since 1995) and the high selectivity and efficiency of beach seines and cast nets that are used on this schooling species (D. Addis, personal communication, 2023a). Therefore, the bycatch strategy warrants a score of highly effective.

Factor 3.3 - Scientific Research And Monitoring

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Moderately Effective

The Florida Fish and Wildlife Commission conducts annual reports on the status and trends of commercially and recreationally important species, including but not limited to information about recent life history, landings and commercial catch, recreational catch rates, and management history. These annual updates are not stock assessments; and, although stock assessments are conducted periodically for a variety of species, there has not been an assessment conducted for striped mullet since the last published one from 2014, and there are no plans to do so for at least the next 5 years (D. Addis, personal communication, 2023a). The most recent annual report from the Fisheries Independent Monitoring Program also develops indices of relative abundance (IOAs) for young-of-the-year striped mullet to provide information on recruitment, through monthly sampling with a 21.3-m seine in major estuaries along Florida's coasts (FWCC 2022b). Despite gaining some insight into the stock's trends from the annual reports, the lack of a recent stock assessment creates uncertainty regarding the effectiveness of the management strategy, thus warranting a score of moderately effective for scientific research and monitoring.

Factor 3.4 - Enforcement Of Management Regulations

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Highly effective

Florida regulations, including gear restrictions, spatial closures, and catch restrictions, are the strictest of all Gulf states and are enforced by both the U.S. Coast Guard and the Florida Fish and Wildlife Conservation Commission's Division of Law Enforcement. Violations of the entangling net ban are considered serious and carry the possibility for license suspension and civil/criminal penalties (FWCC 2023c). Therefore, enforcement of management measures warrants a score of highly effective.

Justification:

Florida regulations prohibit the use of any gear other than cast nets (no more than 14 ft. long, and no more than two per vessel), beach or haul seines (no larger than 500 ft^2, and no more than two may be fished per vessel), hook-and-line, and spearing. Harvest is prohibited seaward of the 3-mile line (Gulf and Atlantic Ocean) and seaward of the Everglades National Park line in Florida Bay. There are county-specific catch requirements between November 1 and January 31, as well as nightly closures between November 1 and the end of February (FWCC 2023b)(FWCC 2023c).

Factor 3.5 - Stakeholder Inclusion

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Highly effective

The management process appears to be transparent and includes stakeholder input (e.g., heeding scientific advice given to managers when the stock was overfished and undergoing overfishing to reduce fishing mortality and increase spawner escapement, holding meetings with commercial fishers regarding targeted discards). The Florida Fish and Wildlife Commission holds five meetings across the state annually to offer stakeholders opportunities to address issues, and it gathers further input through surveys, public comment periods, and online submissions. Therefore, this factor warrants a score of highly effective.

Criterion 4: Impacts on the Habitat and Ecosystem

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

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

Guiding principles

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

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines	Score: 3	+1	Moderate Concern	**Green (3.464)**
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom*

longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.

- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl) Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.*

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

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

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

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

species' ecological roles and ecosystem functioning.

- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

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

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines

Score: 3

Beach seines are primarily deployed in the water column on schools of mullet over sandy or muddy bottoms and dense vegetation, with occasional contact on the bottom habitat. Therefore, beach seines warrant a score of 3.

Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Score: 5

Cast nets are primarily deployed in the water column on schools of mullet over sandy or muddy bottoms, with no contact with the bottom habitat. Therefore, cast nets warrant a score of 5.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines

+1

Beach and haul seines must be smaller than 500 ft^2, and no more than two may be fished per vessel {FWCC 2015}. Although not specific to seining, there are year-round closures that include a prohibition of harvest from federal waters (outside 3 nautical miles [nm] from shore on the South Atlantic side, and 9 nm in the Gulf of Mexico) or outside the Everglades National Park in the Collier-Monroe county region. Seasonal closures also occur in certain areas during the fall and winter {FWCC 2015}. For these reasons, the fishery is deemed to have strong mitigation measures in place.

Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Score: 0

Cast nets are considered to have a negligible impact on seabed habitats; therefore, no mitigation measures are needed.

Factor 4.3 - Ecosystem-based Fisheries Management

Gulf of Mexico, Western Central Atlantic | United States | Florida | Beach seines
Gulf of Mexico, Western Central Atlantic | United States | Florida | Cast nets

Moderate Concern

Striped mullet is both an economically and ecologically important species. It is a bottom feeder, foraging for decaying plant material and microorganisms found on aquatic plants, and also serves as prey for apex predators such as birds, fish, sharks, and marine mammals (FMNH 2023)(LSU 2023)(Marin 2018).

Food web impacts are possible with the removal of this species, although there is a lack of studies regarding these potential impacts and predator-prey interactions, and more research is needed into how the fishery may be managed using more of an ecosystem-based approach (Chagaris et al. 2014)(Marin 2018). Because of the lack of data, there is some uncertainty regarding the effectiveness of current spatial and temporal management measures in place (e.g., regional and nightly closures) in supporting ecosystem functioning. Therefore, a score of moderate concern is warranted.

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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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Appendix A: 2019 Update to Striped Mullet Report

This report was reviewed for any significant stock status and management updates to the fishery on November 20, 2019. None were found that would indicate that the final rating is no longer accurate.

Appendix B: 2023 Update to Striped Mullet Report

This report was reviewed for any significant stock status and management updates in 2023. As a result, some changes occurred, and striped mullet caught using beach seines is now rated Yellow. Striped mullet caught using cast nets is still rated Green.

Criterion 1

For striped mullet caught by both beach seine and cast net, the ratings for abundance and fishing mortality have been changed from very low concern and low concern, respectively, to moderate concern for both because of the lack of a recent stock assessment and uncertainty surrounding this stock's status, despite some data being collected by the management agency. Information regarding abundance and fishing mortality of striped mullet was updated where possible (D. Addis, personal communication, 2023a)(FWCC 2022)(FWCC 2022b)(Camara et al. 2019).

Criterion 2

No score changes. Further information on discard rate and landings was updated (D. Addis, personal communication, 2023a).

Criterion 3

No score changes. Further information on management effectiveness, particularly the lack of a recent stock assessment and updated enforcement measures, was updated as necessary (D. Addis, personal communication, 2023a)(FWCC 2023c)(FWCC 2023b).

Criterion 4

For striped mullet caught by cast net, the mitigation score was changed to 0 because no mitigation measures are needed, although this has not resulted in an overall score change. For striped mullet caught by beach seine, there were no score changes. Information regarding the ecological role of striped mullet and related studies was updated as necessary (FMNH 2023)(LSU 2023).