Open Ocean Fish and Water Column Invertebrates Strategic Plan

Deepwater Horizon Open Ocean Trustee Implementation Group

MARCH 2022

Executive Summary

The *Deepwater Horizon* Open Ocean Trustee Implementation Group (OO TIG) and the Core Fish Team, a planning team composed of representatives from federal trustee agencies, developed a strategic plan to inform future Fish and Water Column Invertebrates (FWCI) restoration under the Natural Resource Damage Assessment (NRDA). The purpose of this strategic plan is to guide restoration planning for FWCI by establishing a process that prioritizes species for restoration, identifies threats to, and associated restoration opportunities for injured species, and establishes and prioritizes restoration objectives. Additionally, this document identifies strategic considerations for project implementation and data gaps that are identified during the strategic planning process. This plan incorporates prior restoration planning and projects. It also builds on the injury assessment and restoration goals identified in the Deepwater Horizon (DWH) Programmatic Damage Assessment and Restoration Plan (DWH NRDA Trustees, 2016) for restoring FWCI resources.

An overview of the planning process is presented in **Section 1.** Based on input from stakeholder engagement (described in **Section 2**), the Team grouped FWCI resources to represent ecosystem and/or taxonomic species groups and selected a suite of priority species on which to focus restoration efforts (Table E.1). Priority species were selected for 12 of the species groups. For the remaining groups, limitations to data availability, injury information, or lack of identifiable restoration opportunity in the open ocean precluded the selection of a priority species. Details of priority species selections are provided in **Section 3**. Following prioritization, groups were then categorized into high and low priorities to guide FWCI restoration efforts.

Table E.1 FWCI Species Groups and associated priority species selected for potential near term restoration planning for FWCI resources.

FWCI Species Group	Priority Species
Billfish*	Blue marlin (*Makaira nigricans*)
Drums and seatrout*	Spotted seatrout (*Cynoscion nebulosus*)
Flatfishes	Southern flounder (*Paralichthys lethostigma*)
Jacks*	Greater amberjack (*Seriola dumerili*)
Forage fish*	Mullets (*Mugil cephalus* and *curema*) Gulf menhaden (*Brevoortia patronus*)
Sea basses/Groupers*	Red grouper (*Epinephelus morio*)
Snappers*	Red snapper (*Lutjanus campechanus*) Vermilion snapper (*Rhomboplites aurorubens*)
Tunas/mackerels*	Yellowfin tuna (*Thunnus albacares*) King mackerel (*Scomberomorus cavalla*)
Other demersal	American eel (*Anguilla rostrata*)
Other reef-associated	Golden tilefish (*Lopholatilus chamaeleonticeps*)
Crabs and Lobsters	Blue crab (*Callinectes sapidus*)
Shrimp	Royal red shrimp (*Pleoticus robustus*)

* Indicates high priority groups. All others are lower priority groups.

Section 4 identifies broad threats to the FWCI resources and correlates specific threats to priority species as a basis for identifying restoration opportunities. The following threats were identified:

- Fishing impacts.
- Marine debris, including derelict fishing gear.
- Invasive species.
- Climate change.
- Water quality, including harmful algal blooms (HABs).
- Other direct threats related to anthropogenic activities including energy production and marine pollution.

The resulting information was used to identify restoration objectives to guide near- (less than 5 years) and medium-term (between 5 and 10 years) restoration planning, which are presented in **Section 5**. Restoration objectives listed in order of priority and are broken into two priority levels as follows:

Priority Level: High

- Reduce bycatch of FWCI resources.
- Reduce illegal, unregulated, and unreported (IUU) fishing of FWCI resources.
- Develop and implement tools and techniques to reduce uncertainty in restoration and provide best practices to stakeholders and fishing communities.
- Reduce the threat of marine debris to FWCI resources.
- Reduce post-release mortality of FWCI resources.
- Reduce risks from invasive species to FWCI resources.

Priority Level: Low

- Reduce risks to FWCI from energy production activities.
- Reduce mortality of FWCI resources due to HABs.
- Enhance *Sargassum* and other pelagic communities.

Strategic considerations for restoration planning and implementation are presented in **Section 6**, including:

- Coordinate with ongoing efforts for other DWH Restoration Types to maximize benefits to FWCI resources and seek synergies across Types.
- Coordinate with research, management, fisheries, and non-profit programs and entities to support technique development and implementation that benefits both groups.
- Complete a communications plan that supports both planning and implementation efforts and describes options for participatory restoration planning.
- Focus on large scale (regional) restoration projects where possible to create restoration at the scale of the injury, to focus on a restoration scale not covered by other programs, and to maximize stakeholder involvement.
- Support technique development through pilot scale projects, when necessary, but use approaches for techniques that have been proven in principle at smaller scale.
- Continue to track restoration progress as well as emerging threats and stressors throughout the restoration process to identify additional restoration opportunities.
- Review and synthesize information on DWH injury to FWCI to facilitate incorporation of new information into future restoration planning approximately every five years.

Table of Contents

List of Figures

Figure 3.1 Steps in species prioritization process 9
Figure 3.2 MARPP results for billfish. 14
Figure 3.3 MARPP results for drums and seatrout. 15
Figure 3.4 MARPP results for flatfishes. 16
Figure 3.5 MARPP results for forage fish. 17
Figure 3.6 MARPP results for jacks. 18
Figure 3.7 MARPP results for sea basses and groupers. 19
Figure 3.8 MARPP results for snappers. 20
Figure 3.9 MARPP results for tunas and mackerels. 21
Figure 3.10 MARPP results for other demersal fish. 22
Figure 3. 11 MARPP results for other reef associated fish. 23

List of Tables

Acronym List

Acronym	Definition
CITES	Convention on International Trade in Endangered Species
DO	Dissolved oxygen
DWH	Deepwater Horizon
EEZ	Exclusive Economic Zone
ESA	Endangered Species Act
FWCI	Fish and Water Column Invertebrates
GOM	Gulf of Mexico
HAB	Harmful Algal Bloom
IUCN	International Union for the Conservation of Nature
IUU	Illegal, Unregulated, and Unreported
MARPP	Multi-Attribute Restoration Prioritization Process
MDBC	Mesophotic and Deep Benthic Communities
MRIP	Marine Recreational Information Program
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NGO	Non-Governmental Organization
NOAA	National Oceanographic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
OO	Open Ocean
OPA	Oil Pollution Act
PDARP/PEIS	Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement
RESTORE	Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies
SAV	Submerged Aquatic Vegetation
SMART	Specific, Measurable, Achievable, Relevant and Time-Bound
TIG	Trustee Implementation Group

Section 1: Introduction and overview of strategic planning process

Federal and state natural resource trustee agencies (Trustees) conducted a natural resource damage assessment (NRDA), as required under the Oil Pollution Act of 1990 (OPA), to restore injuries to natural resources as a result of the *Deepwater Horizon* (DWH) oil spill incident. As part of the NRDA process, the Trustees selected a comprehensive, integrated ecosystem approach to restoration in the Gulf of Mexico (GOM), which is detailed in the DWH Oil Spill Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement (PDARP/PEIS). The PDARP/PEIS describes a programmatic restoration plan composed of restoration types (Figure 1.1). To manage and implement restoration projects, seven geographic restoration areas were established: one for each of the five GOM States; the Open Ocean, which includes open waters of the GOM; and a region-wide restoration area, to coordinate projects for species that move between areas. Restoration occurring in each of these areas is overseen by a Trustee Implementation Group (TIG), which develops project-specific restoration plans consistent with the PDARP/PEIS.

In 2016, the Trustees reached a settlement resulting from the Natural Resource Damage Assessment process to resolve BP's liability for natural resource injuries from the DWH oil spill. Under this settlement, BP will pay up to $8.8 billion (including funds already allocated for early restoration) to the Trustees over 15 years to restore natural resources and the services they provide that were injured by the spill. A total of $400 million was allocated to restoring injured fish and water column resources. Of these funds, approximately $320 million remains available for future planning activities and restoration projects to address outstanding injury to FWCI resources. The FWCI Restoration Type includes FWCI that use the open ocean areas and *Sargassum* communities. Restoration for these species is coordinated by the Open Ocean (OO) TIG, which is responsible for wide-ranging and migratory species, including FWCI and also birds, Gulf sturgeon, sea turtles, marine mammals, and deep-sea coral communities.

The PDARP/PEIS presents broad programmatic goals across restoration types as well as restoration approaches for each restoration type. FWCI resources are included under the PDARP/PEIS goal "to replenish and protect living coastal and marine resources." The FWCI goals are:

- Restore injured fish and invertebrate species across the range of coastal and oceanic zones by reducing direct sources of mortality.
- Increase the health of fisheries by providing fishing communities with methodologies and incentives to reduce impacts to fishery resources.

The OO TIG previously selected restoration projects to address a subset of FWCI resources as part of early restoration[1] and Open Ocean Restoration Plan 2,[2] listed below.

- Oceanic Fish Restoration Project.
- Reduction of post-release mortality from barotrauma in GOM reef fish recreational fisheries.

[1] https://www.gulfspillrestoration.noaa.gov/restoration/early-restoration
[2] https://www.gulfspillrestoration.noaa.gov/sites/default/files/DWH-ARZ003947.pdf

- Better bycatch reduction devices for the GOM commercial shrimp trawl fishery.
- Communication networks and mapping tools to reduce bycatch – Phase 1.
- Restoring for bluefin tuna via fishing depth optimization.

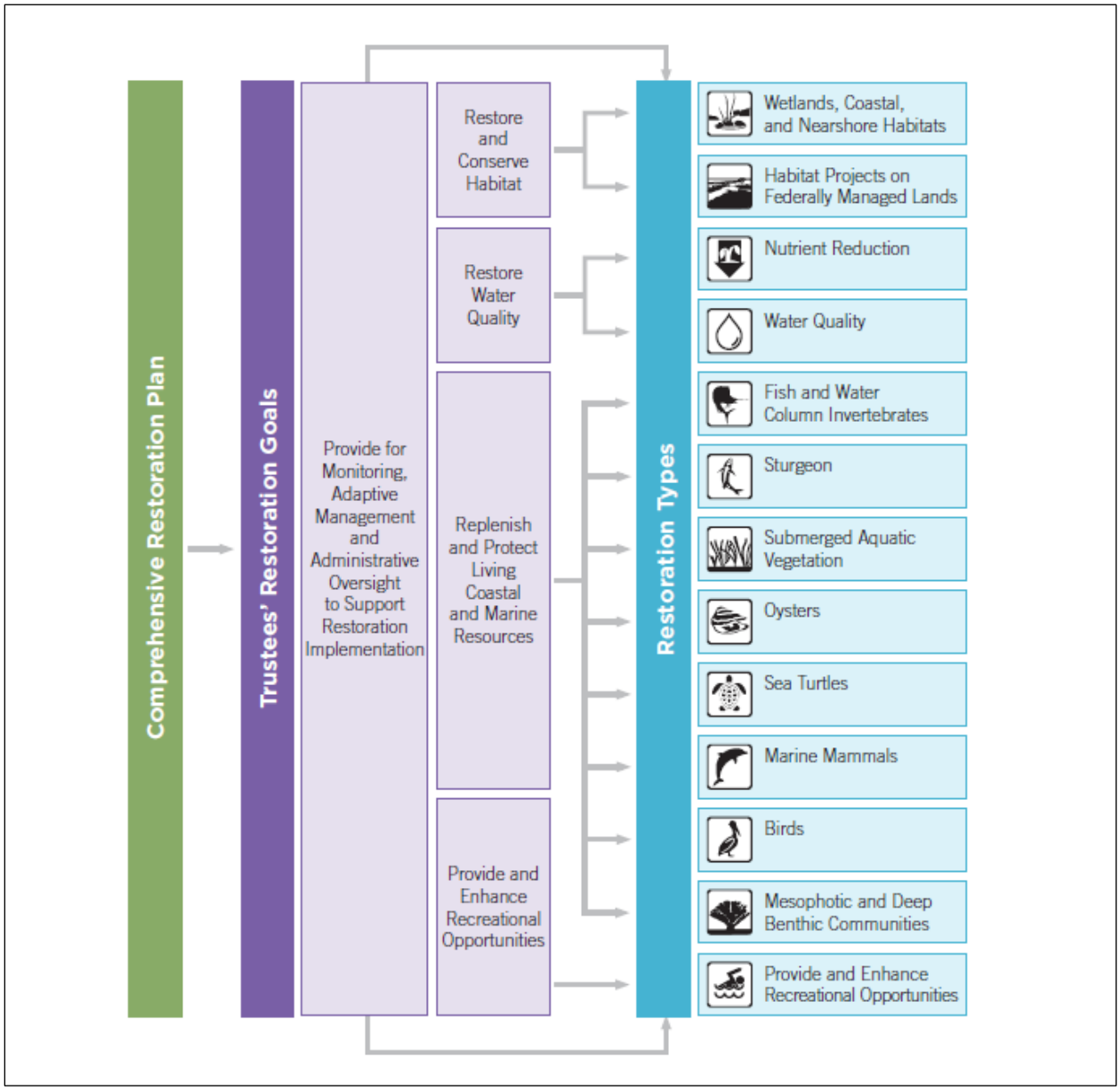

Figure 1.1 The Trustees' comprehensive restoration plan showing the goals and their related restoration type(s). Source: https://www.gulfspillrestoration.noaa.gov/sites/default/files/wp-content/uploads/Finalized-PDARP-Factsheet-Feb-2016-8.5-by-11-Final.pdf

Purpose of this plan

The purpose of the strategic plan is to guide restoration planning for FWCI by establishing a prioritization process, which includes prioritizing species for restoration, identifying threats to injured species and associated restoration opportunities, and setting restoration objectives for those species and/or species groups. Additionally, this document identifies strategic considerations for project implementation and data gaps useful for restoration planning and evaluation. Data gaps identified during the process are presented in Appendix A.

Scope of this planning effort

To consider the full scope of injury to FWCI resources, the Team developed and used a systematic approach to prioritize species for restoration planning, identify restoration opportunities for these priorities, and set objectives for restoration.

This planning effort is specific to the Open Ocean FWCI Restoration Type, which includes fish and water column invertebrates and *Sargassum.* The PDARP/PEIS identified other, habitat-focused restoration types, whose restoration goals will also contribute to the restoration of FWCI resources, including Wetlands, Coastal and Nearshore habitats; Oysters; Mesophotic and Deep Benthic Communities (MDBC); Water Quality; Nutrient Reduction; and Submerged Aquatic Vegetation. Some FWCI resources may be better restored through these restoration types. The shared opportunity to restore multiple resources highlights the importance of coordination among restoration type teams.

The results of this effort may be revisited as appropriate and/or the process may be repeated to update the restoration strategy. For example, new information can be used to update prioritization criteria, such as catch statistics, threats, and vulnerabilities. New threats, new information about impacted FWCI, or newly developed restoration approaches and/or techniques, may make it appropriate for the Trustees to update restoration priorities and objectives.

Strategic planning process

The remainder of this document is organized into the following sections outlined below, each of which represents a part of the planning process (Figure 1.2).

- **Stakeholder engagement:** This section provides a summary of the stakeholder engagement process and the results of engagement.
- **Species prioritization process:** This section provides a summary of the process and methods used to prioritize species and the list of priority species identified for restoration.
- **Threats identification:** This section identifies threats to and stressors of FWCI resources to develop and identify opportunities for restoration.
- **Objective setting:** This section identifies restoration objectives to address specific threats to priority species.
- **Strategic considerations for restoration:** This section provides information on restoration identified during engagement sessions as important to stakeholders for implementation during restoration planning efforts.

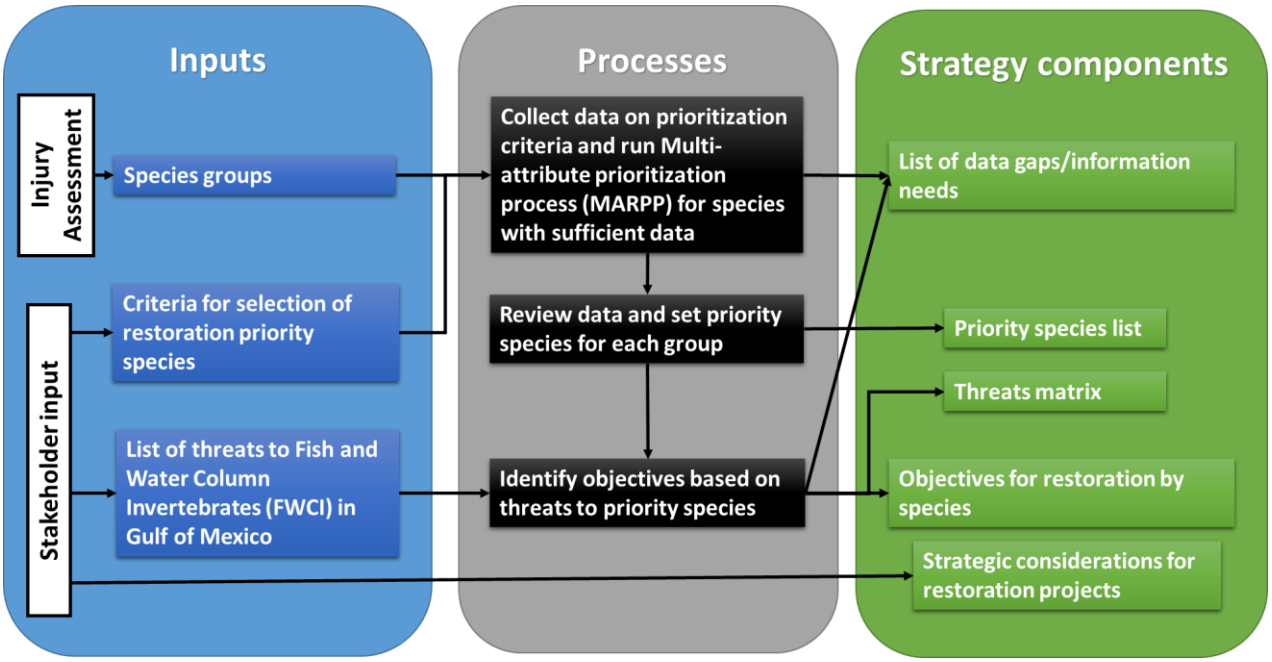

Figure 1.2 Diagram of the FWCI strategic planning process and strategy components

Section 2: Stakeholder engagement

The purpose of this section is to describe and summarize stakeholder engagement efforts, including the development of a stakeholder engagement plan, discussions with external (non-federal organizations and general public) and internal stakeholders, and the incorporation of the results of these discussions into the strategic planning process.

Successful restoration incorporates continued engagement with stakeholders to ensure that they are well informed, and their priorities are effectively considered during the restoration process. To accomplish this, the Team solicited input from external and internal stakeholders. External stakeholders were non-federal organizations who have an interest in or rely on healthy fish and water column invertebrate stocks in the GOM and Atlantic, such as fishing advocacy groups, fishery management organizations, non-governmental organizations (NGOs), and academic institutions. Internal stakeholders were representatives from the National Oceanic and Atmospheric Administration (NOAA) and other federal agencies

In fall 2020, the Team conducted pilot interviews with stakeholders, during which stakeholder understanding of NRDA and the planning process, priorities and goals for restoration planning, and general opinions regarding restoration progress were assessed and best practices for stakeholder communication were developed. These interviews were used to create a stakeholder engagement plan, which served as a guide for stakeholder engagement for this strategic planning effort.

External stakeholder engagement

NOAA facilitated four subsequent virtual meetings with external stakeholder groups in spring 2021. Each meeting began with a short presentation summarizing the meeting purpose, followed by guided discussion. Topics were posed to participants both before and during the meeting to solicit stakeholder input regarding the strategic planning process, aspects of restoration project development, and restoration priorities.

The first stakeholder engagement meeting was held during a public session of the Gulf States Marine Fisheries Commission meeting. Two roundtable discussions were held with small groups, one representing NGOs and another with academic representatives. For these roundtable discussions, participants with expertise relevant to FWCI resources and restoration efforts ongoing in the GOM were identified and invited to participate. Ultimately, the groups represented expertise covering a breadth of FWCI resources, including fish and invertebrates, ranging from coastal areas to offshore, and occurring throughout the water column. Efforts were made to include participants that had not been previously interviewed during the stakeholder engagement process. The final stakeholder engagement meeting was open to the general public and announced on the Gulf Spill Restoration website and social media and in collaboration with the Gulf of Mexico Fishery Management Council. A summary of meetings and key messages from each engagement meeting are summarized below. More detailed summaries related to the development of the strategic plan are included in the remaining sections of the document.

March 17, 2021 – Gulf States Marine Fisheries Commission

A discussion was held during a regular council meeting of the Gulf States Marine Fisheries Commission. General themes from the discussion are listed below.

- Species priorities should be focused on species vulnerable to fishing impacts, data poor species, injured species, and species that are critical to ecosystem function (i.e., forage species).
- Time scale for restoration activities should be based on the species life history parameters.
- Long-term monitoring of restoration outcomes is essential.
- Participants provided a list of threats to species in the GOM.

April 20, 2021 – Nongovernmental Organization (NGO) Representatives

NGO participants included Pew Charitable Trust, Ocean Conservancy, Environmental Defense Fund, National Fish and Wildlife Foundation, and The Nature Conservancy. General themes that emerged from the meeting are listed below.

- An ecosystem-based approach to restoration is preferred over single-species approaches.
- Restoration goals and approaches need to reflect changes in the ecosystem that have happened since the spill and be revisited periodically to account for future changes.
- Long-term monitoring of the ecosystem and fish populations is essential and can provide benefits by informing stock assessments and other management goals.
- More information gathering efforts on the ecosystem should be funded to plan for restoration of some species.
- Stakeholder engagement is critical and should be encouraged to appropriately engage stakeholders (e.g., through citizen science initiatives); however, care should be taken to engage stakeholders at appropriate times to avoid stakeholder fatigue and loss of interest.

May 12, 2021 – Academic Representatives

Stakeholder participants included five representatives: three from the University of Southern Mississippi, and one each from Texas A&M University and Nova Southeastern University. Discussion during this session was heavily focused on identification of data gaps regarding ecological knowledge of the GOM and synthesis that are necessary to inform ecosystem-based restoration planning. Data gaps identified during the process are summarized as part of Appendix A. General themes that emerged from the meeting are listed below.

- Data synthesis is needed to compile existing information, identify data gaps and trends based on available data, and to identify restoration opportunities.
- Consideration of trophic linkages and connectivity is necessary when determining restoration priorities and projects.
- In some cases, the negative effects of the spill extended beyond decreased abundance (e.g., reduced reproductive capabilities or negative effects on fisheries resources) and need to be considered in strategic planning and prioritization.
- It is important to consider the economic aspect of fisheries in the restoration planning process.

May 13, 2021 – Fisheries-focused Public Meeting

A total of 119 participants registered for the webinar, including meeting facilitators. Participants represented a variety of stakeholder interests, including the fishing community, academic institutions, state and local agencies, NGO representatives, and interested members of the general public. Themes prevalent during the meeting are summarized below.

- Participants rated the following as high priorities for restoration planning:
    - Linking restoration projects to species injured by the spill.
    - Focusing on more vulnerable/less resilient species.
    - Ensuring that projects have measurable, quantifiable results.
    - Ensuring that projects do not negatively affect recreational and commercial fishers.
- Projects should be centered on areas affected by the oil spill (northern GOM) but could be done in other areas to address threats that are outside of the GOM.
- The scale of restoration projects should vary based on the restoration objective and target species.
- There are many threats (e.g., climate change, fisheries mortality, marine debris, hypoxia, marine pollution) to GOM ecosystems that provide restoration opportunities.
- Participants were eager to remain involved in the planning process. Some thought that the current means and frequency of communication are effective. Some participants would like more opportunities to provide input during the restoration planning process.
- Participants favored collaborative efforts between NOAA and other stakeholders, including fishermen and existing management organizations, to design and implement restoration projects.
- Participants stressed the importance of transparency in all steps of the planning and implementation process.

Internal stakeholder engagement

Internal stakeholder meetings included a series of meetings held with NOAA and other federal agency stakeholders to gather information on FWCI restoration priorities and objectives. Offices and programs included in these efforts are the RESTORE (Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies) Act science program, Sea Grant, Office of Science and Technology, Southeast Regional Office, Southeast Fisheries Science Center, and the Office of Sustainable Fisheries. Themes prevalent during the meeting are summarized below.

- Participants suggested several approaches to selecting priority species, including selecting focal species, identifying ecosystem drivers, using the species groups used for assessment, and identifying umbrella species. Participants were supportive of using one or a combination of these.
- Participants identified the following criteria as important to consider while selecting priority species: vulnerability to threats, ecological importance, stocks with overfished/overfishing status, DWH-injured species, endangered species, data poor species, stocks important to vulnerable communities, species/stocks with high commercial and recreational value, culturally important species, and species with fishery interaction.
- Participants identified the following threats and stressors as important to injured fish species: HABs, habitat loss, hypoxia, plastics/microplastic pollution, marine debris, invasive species, illegal fishing, and data limitations for management/conservation/restoration initiatives.
- Participants identified strategic considerations for restoration, which included: working cooperatively with management councils; diversifying restoration projects according to risk, time

frame, and resources targeted; reviewing priorities from allied organizations to identify opportunities; continuing stakeholder engagement outreach and efforts; applying an ecosystem approach to identify restoration that benefits multiple restoration types; and investigating international opportunities in Mexico and Cuba.

Incorporation of stakeholder input

Stakeholder engagement sessions were successful in gathering information to help guide the restoration planning process. Information compiled and synthesized from stakeholder engagement sessions was incorporated into the process of developing restoration priorities and objectives, which are presented in sections 3-6 of this document. As such, more detailed results from stakeholder engagement efforts are summarized in subsequent sections.

Section 3: Species prioritization

This section describes the process for species prioritization on which FWCI restoration will be focused. Many fish and invertebrate species in the GOM were injured by the DWH oil spill. It is impractical to plan and account for restoration to every species injured due to the spill. For this reason, it is necessary to prioritize injured species for restoration planning and project development. Prioritization allows restoration planners and stakeholders to focus efforts and make the best use of available funds.

> *Restoration priority species* are species selected to be the focus of restoration efforts, due to their level of injury, ecosystem and fisheries importance, and vulnerability. A suite of priority species has been selected to represent taxonomic classes representative of the breadth of ecological roles and habitats within the marine environment. It is expected that restoration benefits to these species will also benefit co-occurring species. With many hundreds of species of FWCI resources to restore, the identification of these species makes restoration planning tractable.

Stakeholders favored an ecosystem-based approach to restoration, to account for the linkages between injured species and contribute to restoring the whole ecosystem. To achieve this, stakeholders were supportive of selecting a suite of priority species that represented a broad range of ecological roles. In many cases, priority species function as umbrella species, which are species whose conservation confers protection to numerous naturally co-occurring species (Roberge & Angelstam, 2004). The identification of a suite of priority species across FWCI taxa and habitats will ensure that restoration benefits address many components of the ecosystem.

Priority species will be the focus of future restoration efforts and may also serve as indicators of restoration for species groups, that is, adequate restoration for a priority species will indicate that restoration for the species group has been fulfilled. An indicator in ecology and environmental planning is a component or a measure of environmentally relevant phenomena used to depict or evaluate environmental conditions or changes or to set environmental goals (Heink and Kowarik, 2010). Indicator species, therefore, can become the focus for monitoring and data collection efforts. Figure 3.1 lists the steps taken to identify priority species. The process by which these species were selected is described in the rest of this section, with supporting information in Appendix B.

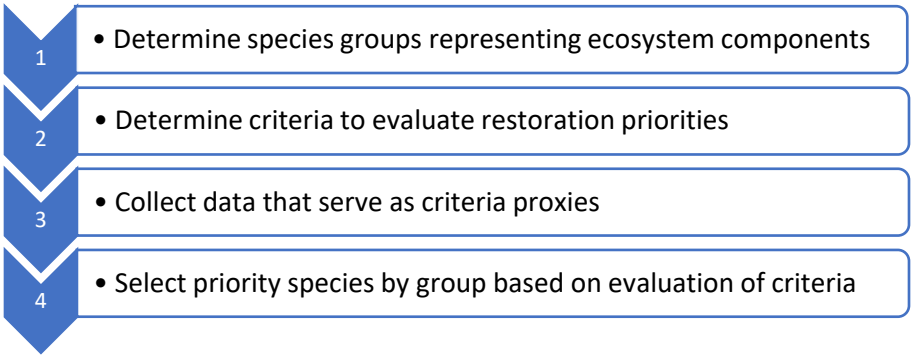

Figure 3.1 Steps in species prioritization process

Species groups

FWCI resources were divided into 19 species groups from which priority species were selected (Table 3.1). Species groups were originally derived from work completed as part of the injury assessment, which identified FWCI species occurring in open ocean and coastal waters of the GOM and categorized them into groups based on taxonomy, ecosystem function/role, and expert consultation. These groups do not necessarily correspond to fisheries management groups as described in fishery management plans. For example, the billfish group includes blue and white marlin, sailfish, and swordfish; however, under the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan and its amendments, swordfish are managed separately from billfish (i.e., five species of marlin, sailfish, and spearfish). The full list of species considered for prioritization, along with group affiliation can be found in Appendix B.

Table 3.1 Species groups used for selection of priority species for restoration planning.

Fish	Invertebrates
Billfish[a]	Cephalopods
Drums and seatrout	Crabs and lobsters
Elasmobranchs	Gastropods
Flatfish	Jellies and other cnidaria[c]
Forage fish	Shrimp
Fundulus family[b]	Other crustaceans*
Jacks	
Sea basses and groupers	
Snappers	
Tunas and mackerels	
Other deepwater fish*	
Other demersal fish*	
Other reef-associated fish*	

[a] includes billfish (blue and white marlin, sailfish) and swordfish; [b] includes other small estuarine resident species; [c] includes other gelatinous zooplankton; *these groups include many taxonomic groups that share similar habitats

Restoration prioritization

Restoration priority criteria were developed through stakeholder engagement and team discussion. The following themes emerged as criteria for designation of priority species:

- DWH injury – Species and populations that have documented effects from the DWH oil spill. Effects can either be lethal (e.g., mortality due to exposure to toxic concentrations of oil) or sublethal (e.g., changes in body condition or reproduction due to exposure to oil).
- Vulnerability – Species that are vulnerable to anthropogenic or environmental disturbances and/or change. This can be due to many reasons, including life-history characteristics (e.g., long

generational times), behavior, distributional patterns, and/or habitat associations that make a species or population susceptible to impacts and/or slow to recover from impacts.

- Conservation concern – Species whose regional populations have been identified as declining or reduced to the point that conservation and/or management action is needed to restore their populations. These species typically have assigned statuses under state, federal, or international regulations, treaties, or conservation initiatives, including but not limited to the Endangered Species Act (ESA), Magnuson-Stevens Fishery Conservation and Management Act (MSA), International Union for Conservation of Nature (IUCN), or the Convention on International Trade for Endangered Species (CITES).
- Ecological importance – Ecosystem integrity is dependent on species that serve as links between trophic levels, geographic areas, or provide habitat for other species. Examples include forage fish, which provide nutrition for a wide variety of species and undergo ontogenetic shifts which transport nutrients from inshore to offshore habitats.
- Fisheries importance – Species that are targeted by commercial or recreational fisheries.
- Restoration opportunity – Species populations for which there are opportunities for successful restoration and whose injury are less likely to be addressed by habitat-based restoration.

Prioritization approach

Species prioritization was conducted for each species group based on the restoration prioritization criteria identified above. The master species list was cross-referenced with the list of injured species identified from the injury assessment conducted by the Trustees[3] to generate the initial species list. The result was a refined list of species and corresponding injury from the DWH oil spill that was subsequently used as the basis for priority species designations. Data in support of prioritization criteria were collected and incorporated as described in Table 3.2 and Appendix B. Species groups with sufficient data availability were prioritized using the Multi-Attribute Restoration Prioritization Process (MARPP), a decision analysis tool customized for this purpose. The MARPP incorporates all metrics into one score by first normalizing values to range between 0 and 1, and then calculating a weighted score based on the importance of each metric (see Appendix B for full methods and results). The MARPP provides transparency to the decision process, provides a clear and consistent rationale for outcomes, has reasonable data requirements, and can be updated for future use to incorporate additional data as it becomes available. Analyses were done using functions from the MODA package in R (R Core team, 2021). The Team used the outputs of the MARPP in conjunction with additional qualitative information, such as information on life history, population health, and management status (e.g. overfished/overfishing designations[4], restoration opportunity provided by other restoration types, ability to address threats, geographic range) to select priority species representing each group.

[3] https://www.fws.gov/doiddata/dwh-ar-documents/830/DWH-AR0195958.pdf

[4] Throughout the document, the terms "overfished", "overfishing", and "rebuilding" are used to refer to stocks that have been specifically designated as such by a management agency. All designations in this document are current as of December 1, 2021.

Table 3.2 Table of metrics and sources representing prioritization criteria used to determine priority species. For more details on methods, see Appendix B

Prioritization Criteria	Prioritization Metric	Description and Source
Injury	Biomass injury (kg)	Estimated fish injury biomass sustained during the DWH oil spill, obtained from the injury assessment conducted by the Trustees (DWH NRDA Trustees, 2016).
	Production Foregone (kg)	Estimated production foregone sustained during the DWH oil spill, obtained from the injury assessment conducted by the Trustees (DWH NRDA Trustees, 2016).
Vulnerability	Vulnerability	Score ranging from 0-100, assigned based on life-history traits, e.g. large, slow-growing, long-lived, late-reproducing species are most vulnerable (Cheung et al., 2005), available at fishbase.org.
Conservation status	IUCN Red List of Threatened Species™ Conservation Status	Unless otherwise specified, categorical risk of species' extinction based on assessment of available literature regarding trends in population size and geographic range (IUCN 2012). Conservation status (e.g., Endangered, Vulnerable, Near threatened, Least concern, Data deficient, and Not evaluated) is available at https://www.iucnredlist.org/ (IUCN 2021).
Commercial Importance	Catch information from the *Sea Around Us* (kg)	Catch information was provided from the Sea Around Us Project (www.seaaroundus.org). Reconstructed catches from the GOM Large Marine Ecosystem, which includes the Exclusive Economic Zone (EEZ) for USA (GOM), Cuba, and Mexico (Atlantic) and summed over 4 years (2013-16). This source includes industrial, artisanal, and subsistence fisheries. For methods see McCrea-Strub, 2015 and Dunstan et al., 2020.
Recreational Importance	MRIP Total Catch (individuals)	Annual average total catch reported to the marine recreational information program (MRIP) was calculated for injured species from 2013 – 2017 for all modes and geographic areas in the GOM. Data were obtained by personal communication from National Marine Fisheries Service, Fisheries Statistics Division. [12/11/2019].
Restoration Opportunity	Estuarine Dependence	Higher levels of estuarine dependence indicate species that will benefit from other restoration activities (i.e. to oysters, salt marshes, water quality, submerged aquatic vegetations (SAV)). Categorical factor that describes the degree of dependence on estuarine habitat for a fish species based on the injury assessment efforts. Potential values are (in descending order): Estuarine Dependent, Estuarine Obligate, Estuarine Facultative, Not Estuarine, Unknown.

Priority species selections and group prioritization

Priority species selections are shown in Table 3.3. The MARPP process was completed for 11 of the species groups. Tabular results are provided in Appendix B, and graphical results are presented for each group below. In these figures (e.g. Figure 3.2), the bar colors show the relative contribution of each metric to the prioritization score, and the length of the bar shows the overall score.

Data for invertebrates and elasmobranchs as groups were insufficient to calculate scores using the MARPP; however, available data were evaluated individually. Data on prioritization metrics for each group were evaluated by Team members, who made recommendations for priority species via discussion and subsequent ranking based on quantitative data and expert knowledge. For some groups, a priority species was not designated (Table 3.4).

Following species prioritization, the team created a prioritization amongst applicable species groups to help direct the level of near-term effort for restoration planning on a species group basis. Prioritization was done by group discussion and then individual team member ranking and was informed by analysis of priority scores aggregated by species group (Appendix C). The species groups were categorized into two priority levels (Table 3.3).

Prioritization decisions are summarized below for fish and invertebrate groups.

Table 3.3 Priority species selections by FWCI Species Group. Groups without priority species designated are indicated by (--).

Category	FWCI Species Group	Species	Priority Level
Fish	Billfish	Blue marlin	High
	Drums and seatrout	Spotted seatrout	High
	Elasmobranchs	--	--
	Flatfishes	Southern Flounder	Low
	Forage fish	Mullets and Gulf menhaden	High
	Fundulus family	--	--
	Jacks	Greater amberjack	High
	Sea basses/Groupers	Red grouper	High
	Snappers	Red snapper & Vermilion snapper	High
	Tunas/mackerels	Yellowfin tuna & King mackerel	High
	Other deepwater species	--	--
	Other demersal	American eel	Low
	Other reef-associated	Golden tilefish	Low
Invertebrates	Crabs and Lobsters	Blue crab	Low
	Cephalopods	--	--
	Gastropods	--	--
	Jellies/Cnidaria	--	--
	Shrimp	Royal red shrimp	Low
	Other crustacea	--	--
Other	*Sargassum* communities	--	--

Table 3.4 Rationale for not identifying priority species for certain species FWCI Species Group.

Group	Reason for not designating a priority species
Elasmobranchs	Lack of synthesis of available injury information
Fundulus family	Habitat restoration is more appropriate
Other deepwater species	Insufficient information about these species
Cephalopods	Low level of injury and limited restoration opportunities
Gastropods	Low level of injury and limited restoration opportunities
Jellies/Cnidaria	Insufficient information about these species and limited restoration opportunities
Other crustacea	Limited restoration opportunities
Sargassum	Limited restoration opportunities

Billfish

MARPP results, in order of descending priority, ranked the four species in the billfish group as follows: blue marlin, swordfish, white marlin, and sailfish (Figure 3.2). Blue marlin was chosen because it had the highest priority score, it is considered overfished and overfishing is occurring under the MSA as of September 30, 2021,[5] and there is a strong recreational interest in this species.

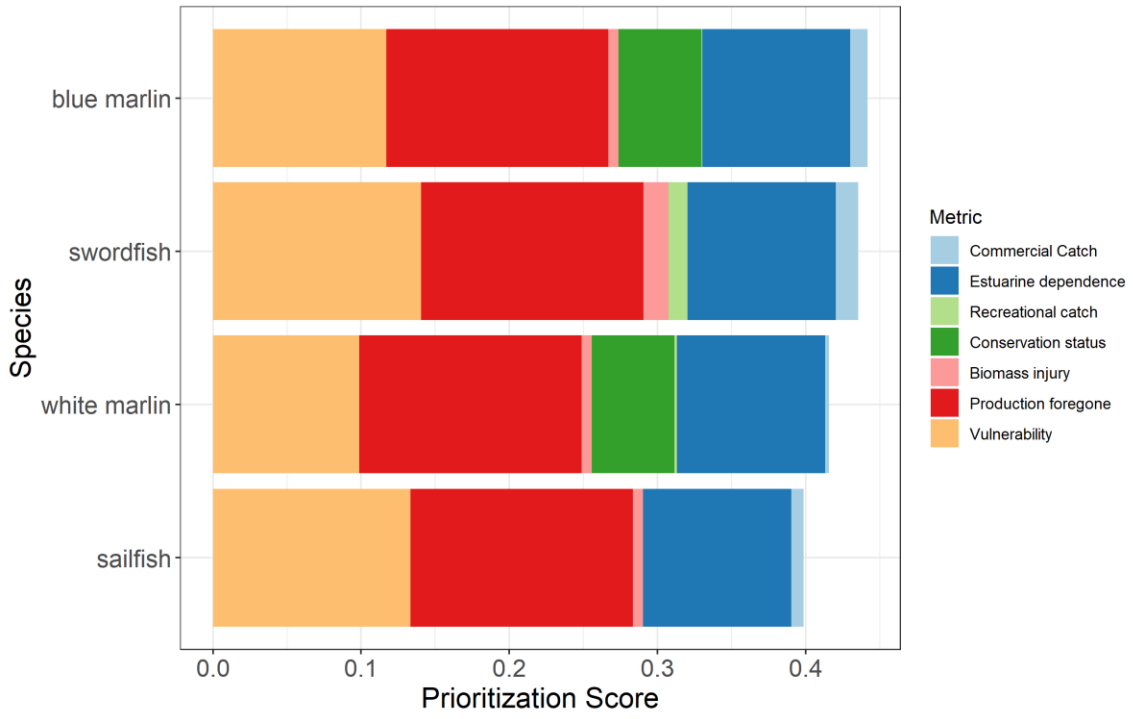

Figure 3.2 MARPP results for billfish.

[5] https://www.fisheries.noaa.gov/national/population-assessments/fishery-stock-status-updates

Drums and seatrout

MARPP results, in order of descending priority, ranked the top four species in the drums and seatrout group as follows: spotted seatrout, red drum, silver seatrout and black drum (Figure 3.3). Spotted seatrout was chosen because it had the highest prioritization score, but also because it has high vulnerability relative to other species in this group and recent population declines have been observed in some areas of the GOM.

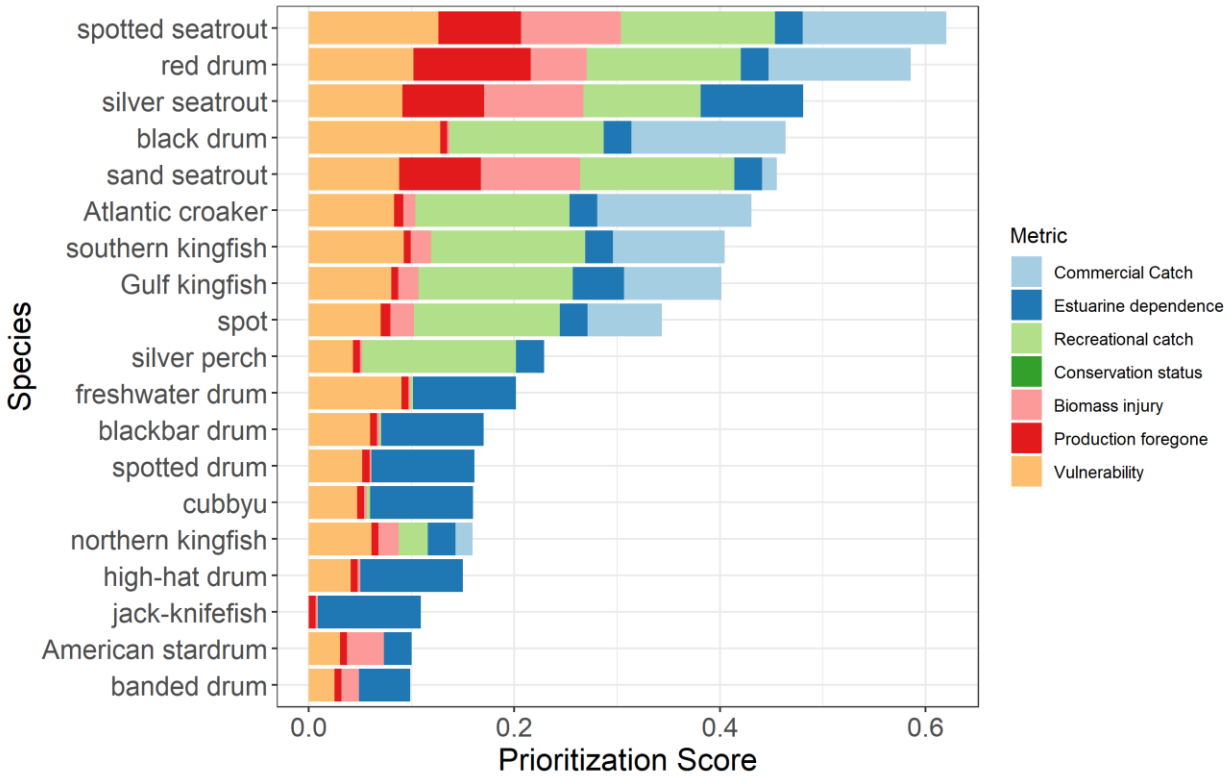

Figure 3.3 MARPP results for drums and seatrout.

Elasmobranchs

This group includes sharks, skates, and rays. Elasmobranchs were not prioritized using MARPP because DWH injury calculations were based on larval distributions of species in the GOM, and these species do not have a pelagic larval stage. However, these species are found in nearshore, open ocean, and deep water environments, where they likely encountered oil, and research that has been completed since the DWH injury assessment has documented impacts from oiling at levels experienced after the DWH oil spill (e.g., Cave & Kajiura, 2018). Additionally, several elasmobranchs are listed as threatened or endangered under the ESA, indicating high vulnerability. Therefore, the Team suggests that elasmobranchs be considered for restoration. However, a priority species was not identified at this time due to uncertainties in injury across this group.

Flatfishes

MARPP results, in order of descending priority, ranked the top four species in the flatfishes group as follows: southern flounder, twospot flounder, eyed flounder, and Gulf flounder (Figure 3.4). Both southern and Gulf flounder support recreational fisheries. Southern flounder was chosen as the priority species because it has the highest prioritization score and ranks higher than Gulf flounder according to vulnerability metrics.

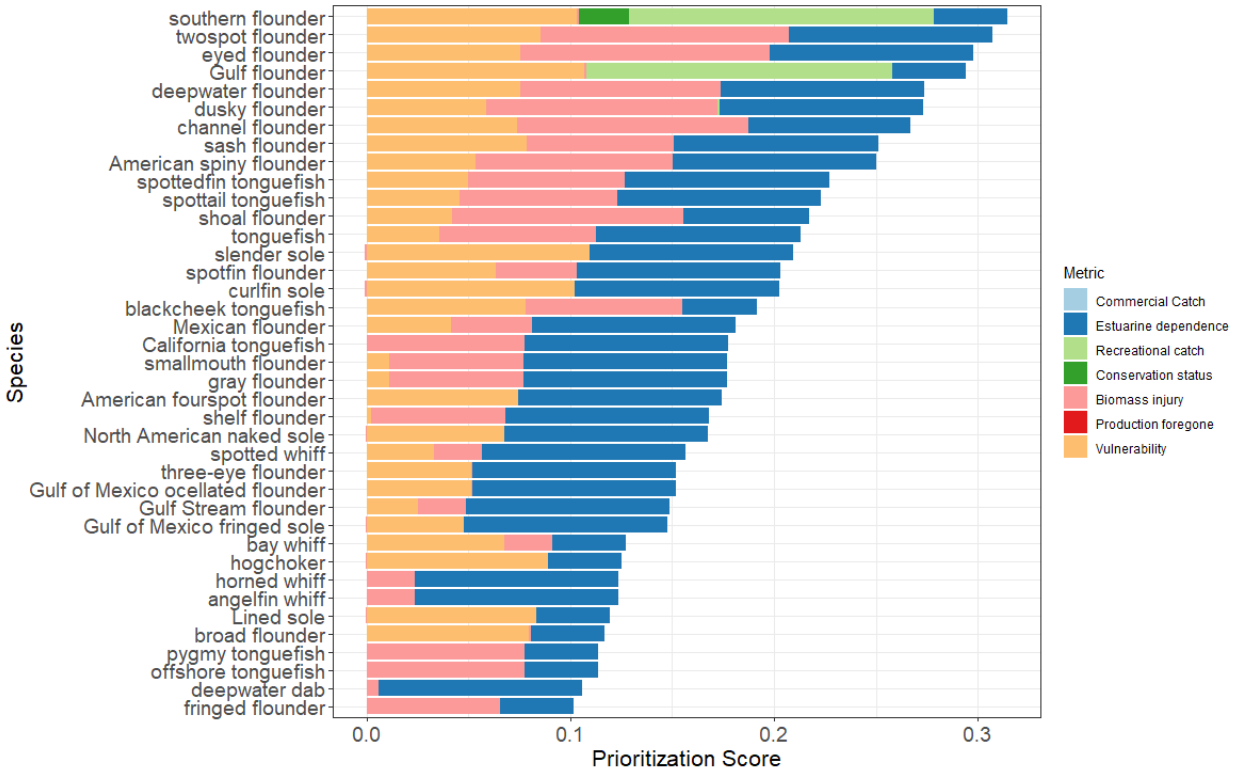

Figure 3.4 MARPP results for flatfishes.

Forage fish

MARPP results, in order of descending priority, ranked the top four species in the forage fish group as follows: Atlantic threadfin herring, white mullet, Gulf menhaden, and striped mullet (Figure 3.5). Gulf menhaden is ecologically important and supports a large commercial fishery (by mass harvested). Mullet species are well known and support recreational fisheries. Atlantic threadfin herring is an important forage fish in offshore food webs, which make them ecologically important to species of interest to this group. The Team selected multiple species as priorities. Both Gulf menhaden and mullets (white and striped) were selected to have broader geographical coverage than selecting Gulf menhaden alone.

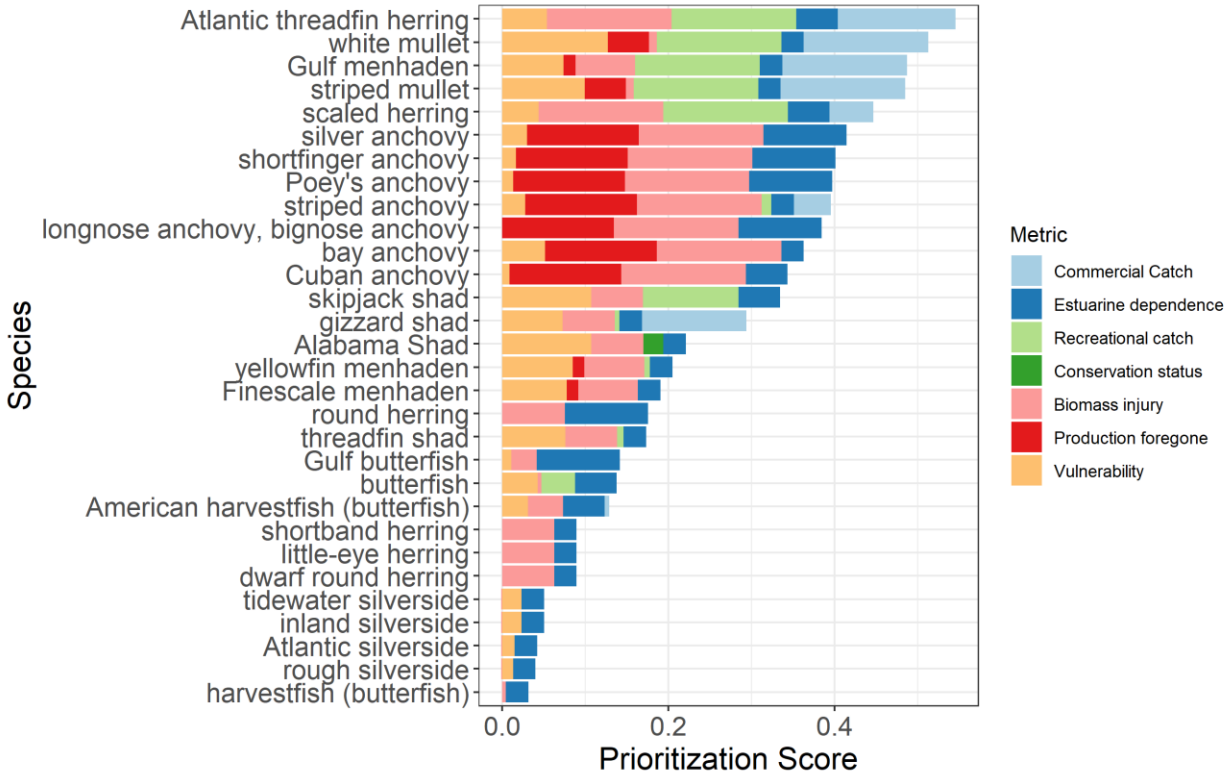

Figure 3.5 MARPP results for forage fish.

Fundulus family

The Fundulus family group consists of fish that are resident to marsh habitats and are not exploited for fisheries purposes. Because of this, restoration for these species is likely to be conducted by other restoration types (e.g., marsh restoration); therefore, a priority species was not chosen. Restoration benefits from other restoration types can be evaluated to assess restoration of these species.

Jacks

MARPP results, in order of descending priority, ranked the top four species in the jacks group as follows: greater amberjack, blue runner, Atlantic bumper, and cobia (Figure 3.6). Greater amberjack was chosen as the priority species because of its vulnerability. As of September 30, 2021, it is designated as overfished and undergoing overfishing under the MSA and is under a rebuilding plan.[6] Team members noted that cobia, which is also in this group may be declining in abundance and may be a species to consider in future planning efforts.

[6] https://www.fisheries.noaa.gov/species/greater-amberjack

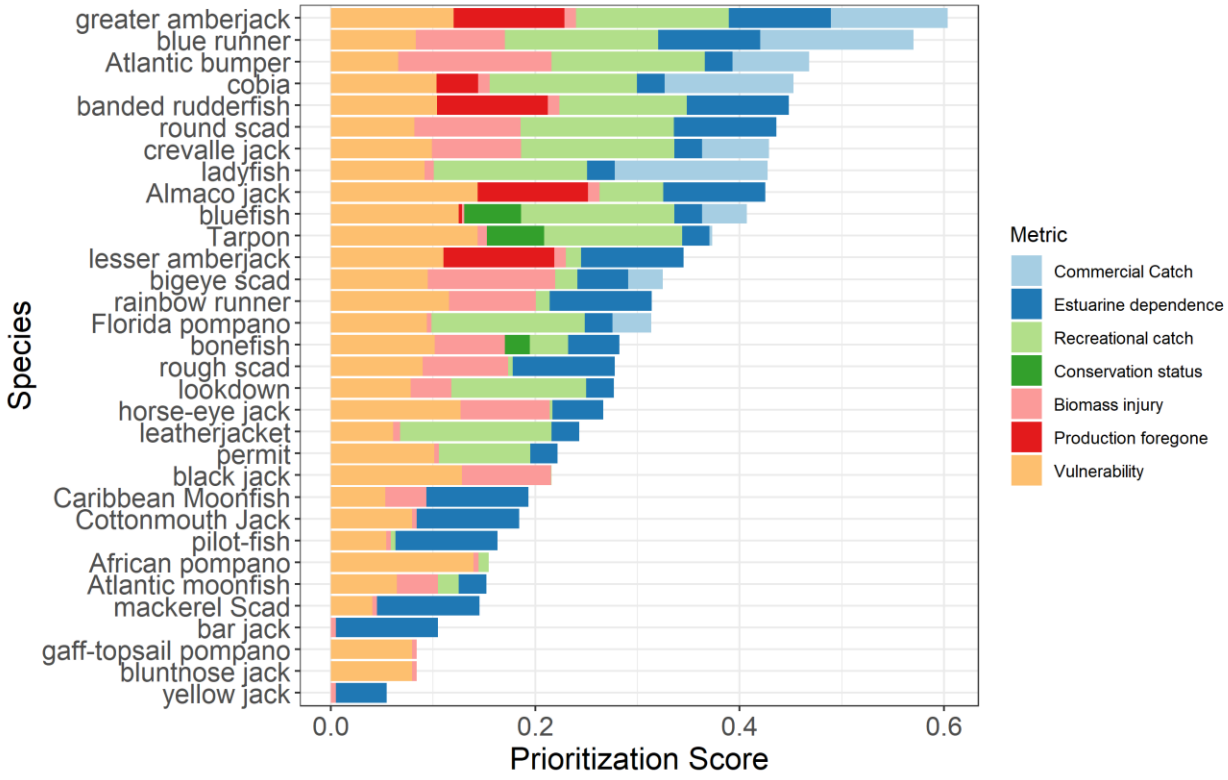

Figure 3.6 MARPP results for jacks.

Sea basses and groupers

MARPP results, in order of descending priority, ranked the top four species in the sea basses and groupers group as follows: red grouper, gag, scamp, and yellowedge grouper (Figure 3.7). Red grouper was chosen because it had the highest prioritization score. It also has a large fishery in terms of number of participants and geography, which provides ample restoration opportunities. Yellowedge grouper was also noted to have likely been affected by DWH because it is a deepwater species. Team members noted the threat of HABs to juvenile gag and red grouper as a threat to address with restoration.

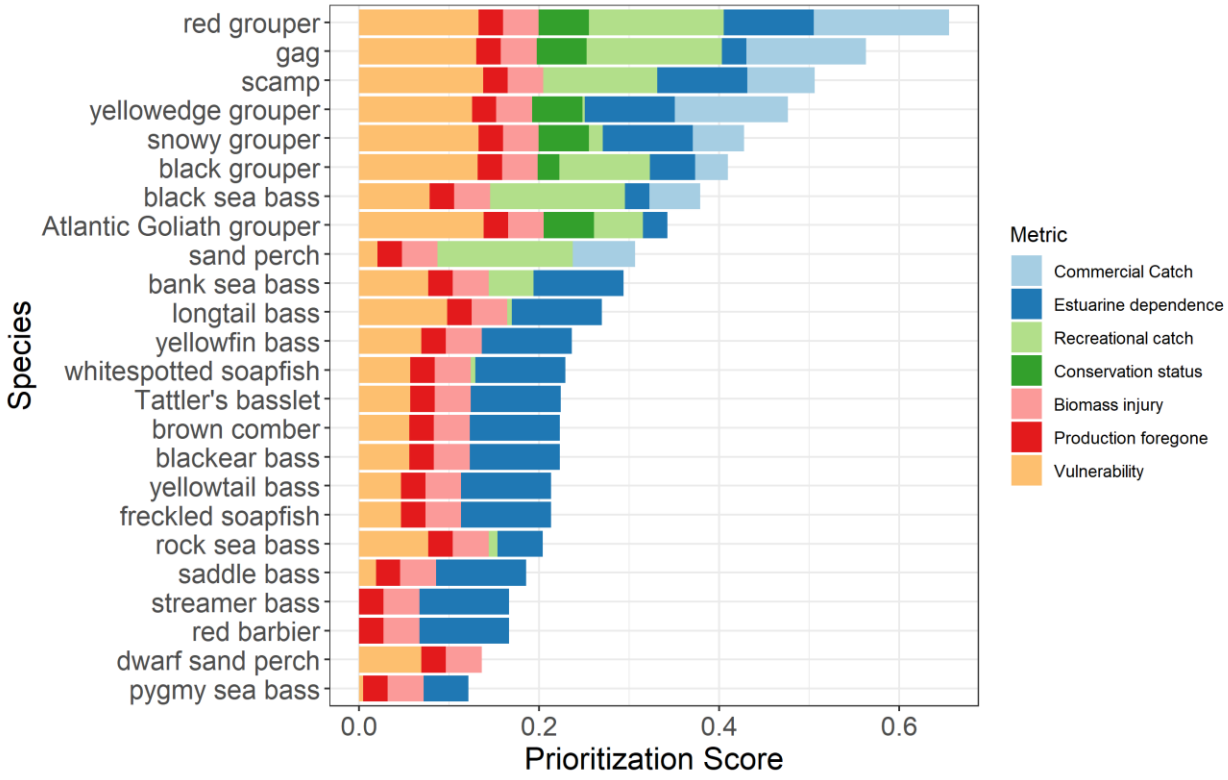

Figure 3.7 MARPP results for sea basses and groupers.

Snappers

MARPP results, in order of descending priority, ranked the top four species in the snappers group as follows: red snapper, vermilion snapper, lane snapper, and grey snapper had the highest prioritization scores (Figure 3.8). Red snapper had high vulnerability and injury scores and is commercially and recreationally important. Efforts to enhance the population of red snapper are ongoing through current DWH restoration projects and other funding efforts; however, it is important ecologically and economically to the GOM, so it was selected as a priority species. Vermilion snapper was chosen as a priority species to broaden restoration efforts to other snappers in the GOM.

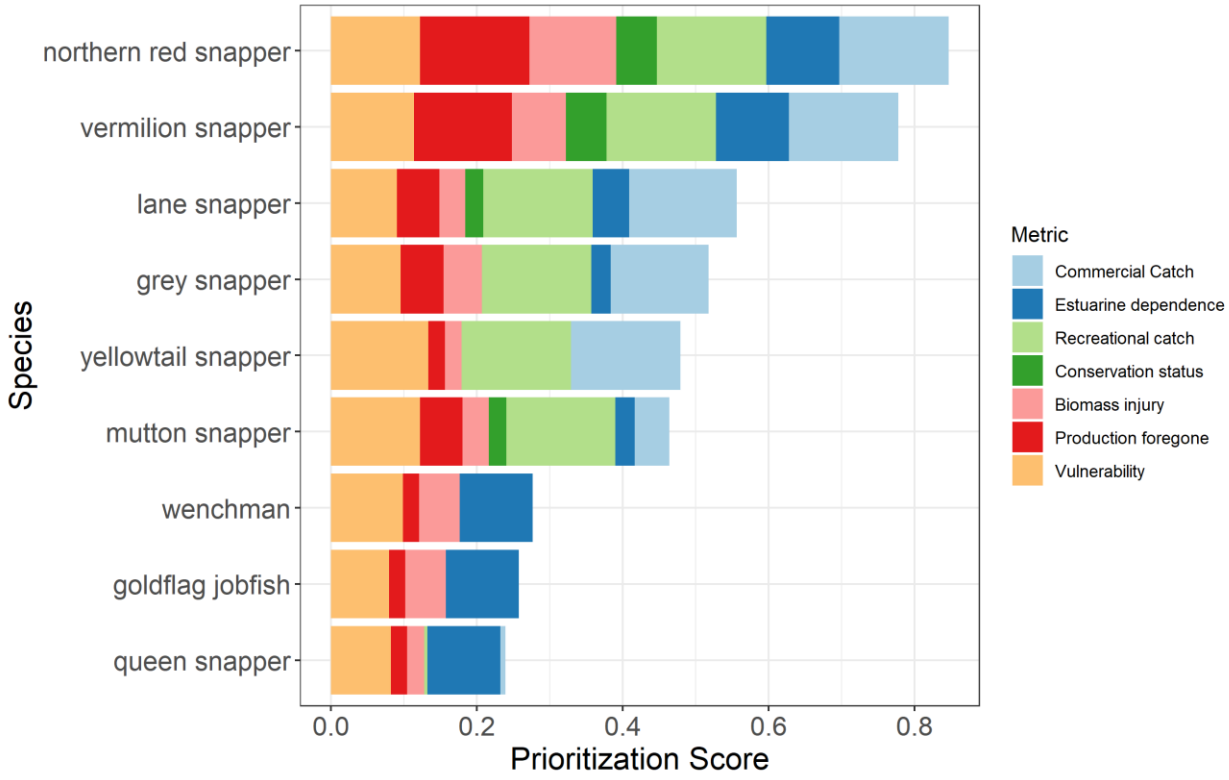

Figure 3.8 MARPP results for snappers.

Tunas and mackerels

MARPP results, in order of descending priority, ranked the top four species in the tunas and mackerels group as follows: king mackerel, yellowfin tuna, Spanish mackerel, and bluefin tuna (Figure 3.9). The decision was made to select two priority species, one for tunas and one for mackerels, since tunas and mackerels occupy different habitats, have different ecological roles, and are managed by different management plans in the United States. King mackerel was chosen as a priority species because it had high injury and vulnerability scores, and is targeted by a wide variety of gears, and therefore, presents multiple restoration opportunities. Yellowfin tuna was chosen for tunas because it had a higher MARPP prioritization score than other tunas.

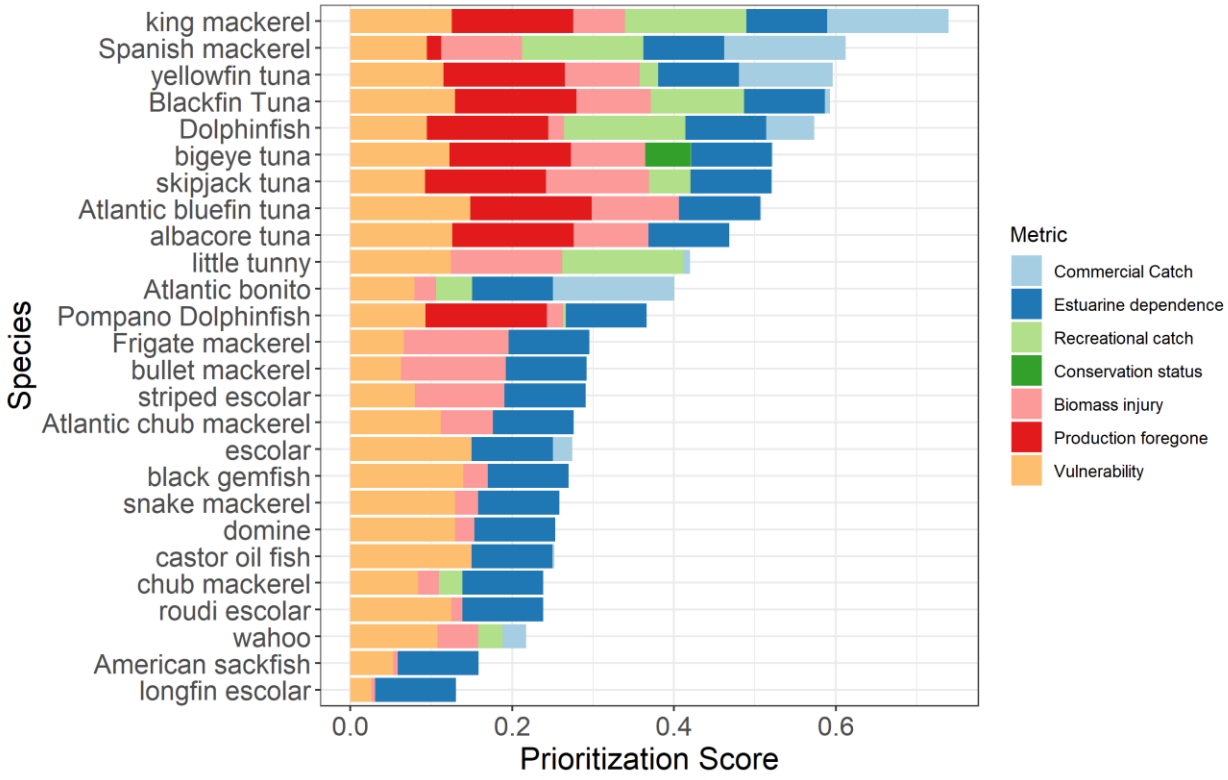

Figure 3.9 MARPP results for tunas and mackerels.

Other deepwater fish

The injury assessment quantified a high loss of biomass to this species group due to oil exposure from the DWH spill. Furthermore, this species group has an important role in the GOM ecosystem (e.g., they are an important food source and due to their daily vertical migrations, they transfer nutrients from high in the water column to deep waters), and populations are declining (Sutton et al., 2020). However, a priority species was not chosen at this time because there is not enough known about their individual roles in the ecosystem at this time. Deepwater fish may also be benefited by the Mesophotic and Deep Benthic Community Restoration Type.

Other demersal fish

MARPP results, in order of descending priority, ranked the top four species in the "other demersal fish" group as follows: pigfish, red porgy, shortnose greeneye, and American eel (Figure 3.10). American eel was chosen by the group because of its high vulnerability. Red porgy were also noted as important by the group because they are the most likely to be affected by fishing and are an important prey item for GOM species.

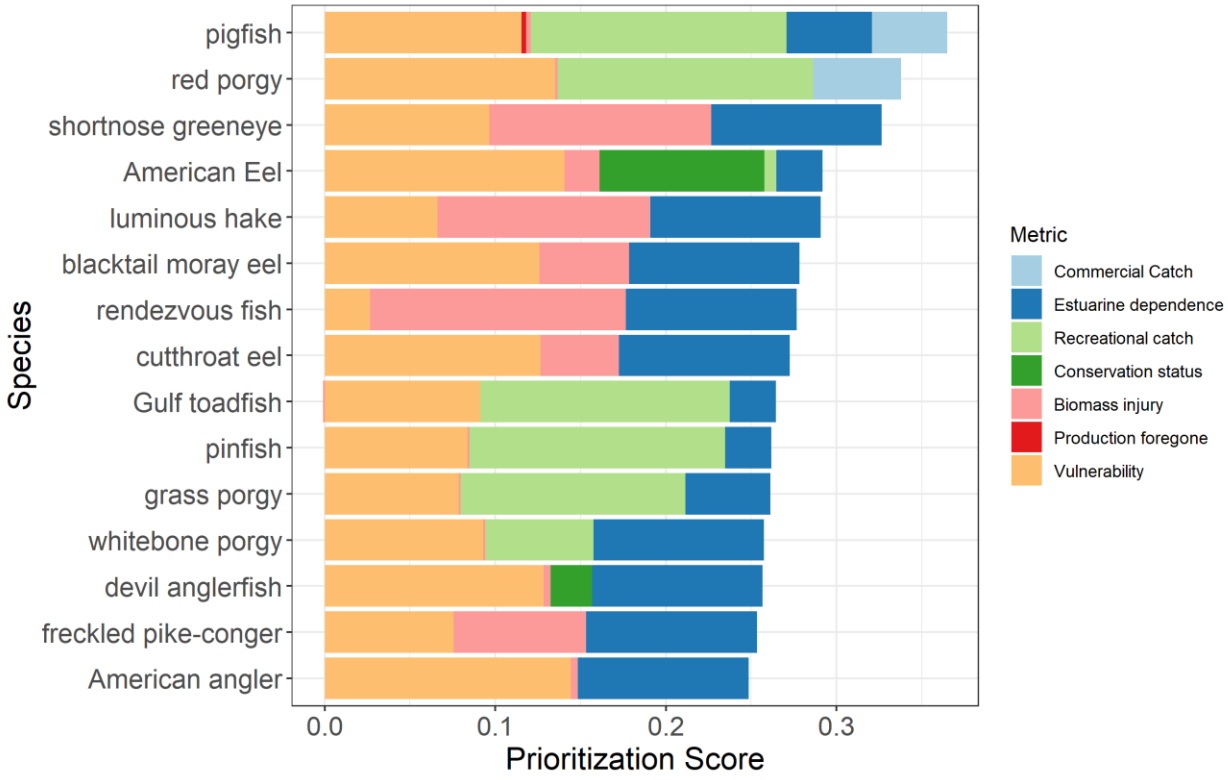

Figure 3.10 MARPP results for other demersal fish.

Other reef-associated fish

MARPP results, in order of descending priority, ranked the top four species in the "other reef-associated fish" group as follows: hogfish, Atlantic cutlassfish, golden tilefish, and ballyhoo (Figure 3.11). Golden tilefish was chosen as the priority species because of their high vulnerability to PAH contamination due to their burrowing behavior (Pulster et al., 2020) and fishery interest. Additionally, they are considered umbrella species because their burrows support a variety of fish and invertebrates.

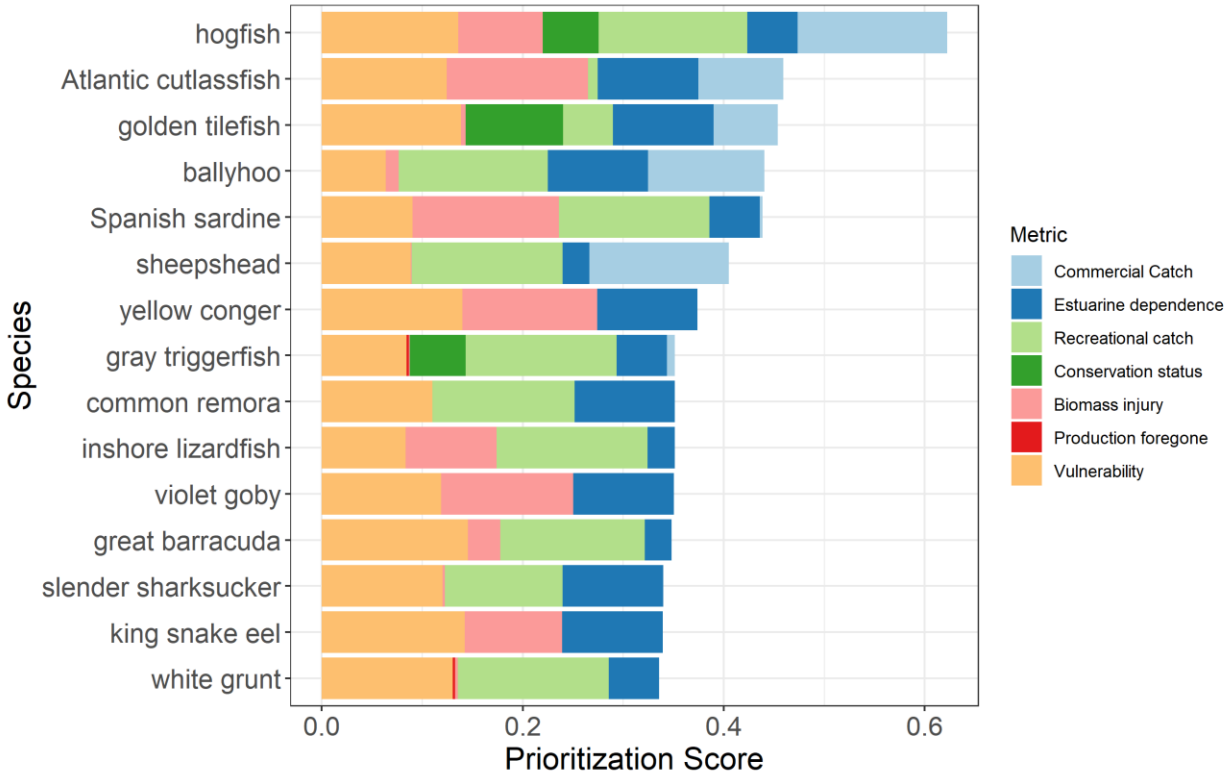

Figure 3. 11 MARPP results for other reef associated fish.

Cephalopods

The DWH injury assessment quantified a moderate-low loss of biomass for this species group and there are limited restoration options. Consequently, a priority species was not selected for this group.

Crabs and lobsters

Data were available for DWH injury and commercial landings for crabs and lobsters; however, few species are evaluated for status by IUCN status or have recreational landings, so MARPP was not conducted for these species. Many species will benefit from other restoration types, including Wetlands, Coastal, and Nearshore Habitats and MDBC. The Team considered the following species based on the quantification of injury, commercial importance, and restoration opportunities: blue crab, spiny lobster, stone crab, and deepsea red crab. Blue crab was chosen because injury was quantified for this species (DWH NRDA Trustees, 2016), they are commercially important, and there are identified restoration opportunities for this species.

Gastropods

The DWH injury assessment quantified a moderate-low loss of biomass to species in the gastropod group and limited restoration opportunities are available. Many gastropods will likely benefit from restoration of other coastal habitat restoration types (e.g., marshes and SAV). Due to these factors, a priority species was not chosen at this time.

Jellies and other cnidaria

This group includes gelatinous nekton and zooplankton from the orders: *Doliolida, Copelata Calycophora, Salpidae, Medusozoa*. The injury assessment quantified a high loss of biomass at the order level. Despite being able to quantify an injury to this species group based on the larval distribution and exposure to oil, very little information is available regarding offshore population dynamics and limited restoration opportunities exist. Consequently, no priority species was identified for this group.

Shrimp

Data were available for DWH injury and commercial landings for species in the shrimp group; however, few species are evaluated for status by IUCN status or have recreational landings. Furthermore, many species, including marsh resident shrimp and commercially important shrimp species, are estuarine dependent or estuarine obligate, and will benefit from restoration activities undertaken by the Wetlands, Coastal, and Nearshore Habitats Restoration Type; therefore, shrimp were not prioritized using MARPP. The Team considered several species of commercially exploited shrimp as priority candidates, focusing on species that are not estuarine obligate species. Ultimately, royal red shrimp was chosen as the priority species because injury was quantified, and they are deep water shrimp that are not estuarine obligates. Objectives targeting restoration of these species will involve collaboration with restoration for MDBC.

Other crustaceans

This group includes zooplankton species, such as calanoids, euphausiids and amphipods. The injury assessment quantified a high loss of biomass to these organisms, based on identified larval distributions of these species and exposure to oil. However, limited options for restoration have been identified, and no priority species was selected for this group.

Sargassum communities

Despite injury occurring to *Sargassum* from the DWH oil spill, at present, *Sargassum* abundance does not appear to be depressed from the spill. More work is needed to understand the ecology of *Sargassum* communities, which will allow the Team to identify restoration approaches that could be used to restore these communities in the offshore environment for priority species.

Section 4: Threats

Threats to FWCI priority species were enumerated to identify restoration opportunities for priority species. This section first describes threats and stressors (hereafter "threats") relevant to injured FWCI resources. Following a description of threats, Table 4.1 identifies which priority species are vulnerable to each threat.

Identified threats include fishing impacts, marine debris, invasive species, climate change, water quality impacts, and other direct impacts. This list was compiled from feedback and a non-exhaustive search. This list was developed to identify initial focus areas for FWCI restoration and may not be comprehensive. Inclusion of threats on this list do not necessarily imply that restoration action can or should be taken to address these threats. In addition to identified threats, the OO TIG should continue to track emerging threats and stressors throughout the restoration process to identify additional restoration opportunities.

Fishing impacts

This section comprises threats related to fishing activities. Fishing impacts can result in injury or mortality to FWCI resources. The identification of fishing impacts as a threat is not intended to imply that all fishing constitutes a threat to FWCI populations, but rather to aid in identifying situations where fishing impacts can be reduced to provide restoration consistent with the FWCI restoration goals set by the PDARP/PEIS (see section 1). Fishing impacts to GOM FWCI resources may occur inside or outside of the U.S. EEZ, as some populations occurring in the GOM migrate between U.S. and international waters during their lifespan or depend on sources of larvae that were spawned in international waters. Threats identified related to fishing practices fall into four broad categories:

- **Overfishing risk**. Overfishing can occur because of complex interactions between the environment, fisheries management, and fishing behavior. This category encompasses threats related to the over exploitation of FWCI resources. When harvest levels are too high, with respect to the current environmental conditions and stressors, a population may not be able to reproduce at levels that can support healthy fisheries. Stressed populations are more susceptible to the risk of further decline due to fishing or from other threats, such as extreme climate events or disease. Threats that cause overfishing risk can emerge due to changes in fishing practices that increase catchability and/or vulnerability of a population to fishing impacts. Understanding these threats can provide opportunities to reduce the risk of overfishing and improve the health of FWCI resources.
- **Bycatch**. Bycatch is catch that is not retained, either because it cannot be sold or is not allowed to be kept due to regulations. These animals may suffer injuries and/or death. Bycatch mortality can occur before a species is brought on board a boat or after release, due to injuries from being caught. Bycatch mortality can be reduced through technological innovations and changes in fishing practices that reduce the amount of bycatch and/or increase the post-release survival of species that are not retained.
- **Illegal, unregulated, and unreported (IUU) fishing**. IUU threats identified by stakeholders are primarily related to illegal fishing. Illegal fishing is the targeting and/or retention of species that

are prohibited from capture and/or retention by law. Illegal fishing can refer to domestic or foreign vessels fishing without permits or against regulations. Examples include foreign vessels fishing in U.S. waters, and domestic vessels fishing in closed areas, retaining catch that is out of season, exceeding catch limits, or retaining fish that do not comply with size limits for a particular species. Developing tools to help limit the impacts of illegal fishing would benefit injured species.

- **Data limitations.** While data limitations are not a direct threat to species populations, restoration is based on the ability to identify and understand trends in species populations over time. Improving data available to understand the ecology of FWCI resources, such as ecological relationships, habitat requirements, or population dynamics, will allow more precise evaluation of threats and restoration of species, help identify opportunities for restoration.

Marine debris

Marine debris is defined by NOAA as "any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes."[7] Marine debris can range in size from microplastics (small pieces of plastics less than 5 mm in size) to abandoned vessels and infrastructure. Marine debris, including plastics, can harm FWCI resources by entangling animals, mimicking prey items, destroying sensitive environments, and transporting pollutants into the marine environment. Threats to FWCI resources from marine debris that were identified included:

- **Ghost fishing due to abandoned and derelict gear**. Ghost fishing refers to fishing by gear that is lost or abandoned and no longer tended but continues to capture organisms. Crab traps and lobster pots are of particular concern in the nearshore GOM and may unintentionally fish for years before degrading to the point that they are no longer fishing, contributing substantial mortality to affected nearshore species (Butler & Matthews, 2015; Arthur et al., 2020). Gill nets and other fishing gear are also present and can cause mortality if lost or abandoned; however, they are typically lost less frequently than trap gears (Richardson et al., 2019).
- **Ingestion of plastic and microplastics.** Plastic debris is common in the GOM. Recent studies have shown that plastics comprised 69-95% of marine debris at 12 barrier island sites across the GOM (Wessel et al., 2019) and microplastics were "abundant" in northern GOM shelf waters (Di Mauro et al., 2017) with an average of seven microplastic particles per Liter (Wessel pers. comm.). Plastics and microplastics can be ingested by animals that mistake them for food and cause physical harm due to the composition of these materials or decreases in the consumption of natural prey due to plastic ingestion (Foley et al., 2018; NOAA MDP 2021). Studies have documented ingestion of microplastics by common fish species in the GOM (e.g., Peters et al., 2017, Phillips & Bonner 2015), but the full breadth of impacts is currently unknown.

Invasive species

An invasive species is an organism that causes ecological or economic harm in an environment where it is not native.[8] Invasive species may affect native species directly, through predation or competition, or

[7] https://marinedebris.noaa.gov/discover-marine-debris/what-marine-debris
[8] https://oceanservice.noaa.gov/facts/invasive.html

indirectly, for example by spreading disease. Indo-Pacific lionfish (*Pterois volitans*) is an invasive species of concern in marine waters of the GOM, causing stress to reef ecosystems by competing with native reef fish species for prey and disrupting ecological relationships.[9] Future invasions may also represent a significant risk to native species and ecosystems.

Climate change

Climate change can threaten species populations through changes to the physical environment that alter habitat suitability for FWCI resources. Key climate-related concerns for the GOM region include increasing ocean temperature, rising sea level, and ocean acidification (Lovett et al., 2016). Dell'Apa et al. (2018) reviewed climate impacts to highly migratory species and determined that increasing water temperatures, changes in ocean circulation, and changes in storm and wind patterns all had a high likelihood of impacting FWCI resources in the next 30-40 years in the GOM. Climate change impacts are being incorporated into management actions via the GOM Regional Action Plan,[10] which identifies key actions needed to better understand, prepare for, and respond to climate-related impacts to marine resources (Lovett et al., 2016). Regional Action Plans are updated every five years. While it is unlikely that the threat of climate change can be directly addressed by DWH restoration planners, the broad impact of the threat makes it important to consider during restoration planning.

Water quality

FWCI resources can be negatively affected by changes to water quality, some of which may result in HABs, eutrophication and hypoxic events. Changes to water quality can occur due to recurring, persistent pollution (e.g., runoff from land-based sources), and/or episodic events (e.g., spills), as well as freshwater input. Impacts can range in severity from minor effects, such as temporal shifts in behavior, to illness and death if species can or do not avoid impaired areas. Many of these impacts originate from land-based sources. Restoration objectives addressing water quality threats to FWCI resources would involve coordination with the Water Quality Restoration Type. Specific water quality threats affecting FWCI resources are discussed below.

- **HABs** are naturally occurring algal blooms that develop regularly throughout the summer in the nearshore GOM. The occurrence and severity of HABs fluctuates annually. HABs develop offshore but their growth can be accelerated when they come into contact with nutrient-rich coastal waters. When the concentration of certain organisms becomes high enough, it can be toxic to FWCI species, resulting in fish kills and shellfish toxicity. HABs impact many nearshore species and have been documented to cause declines in recruitment for red grouper (Chagaris & Sinnickson, 2018), spotted seatrout (Flaherty & Landsberg 2011). Restoration objectives designed to address HABs as a threat may involve coordination with other restoration types, including the water quality team.
- **Nutrient enrichment** can cause sudden population expansions of primary producers, which can deplete dissolved oxygen (DO) concentrations in enriched waters, causing "dead zones." Some animals, including larvae of many species, may be unable to escape dead zones, resulting in mortality. Mobile FWCI species can avoid areas of low DO; however, the size and location of these dead zones can change their habitat use patterns (e.g., Prince et al., 2010), affecting their vulnerability to fishing and other threats.

[9] https://www.fisheries.noaa.gov/southeast/ecosystems/impacts-invasive-lionfish
[10] https://www.fisheries.noaa.gov/content/southeastern-us-continental-shelf-and-gulf-mexico-regional-action-plans

- **Hydrologic changes** in currents or salinity due to changes in freshwater input can affect FWCI resources by shifting habitats. Juveniles of some species (e.g., shrimp) are dependent on specific salinity ranges occurring in nursery habitat for development. Other species are dependent on hydrologic and/or salinity patterns for migration cues. Changes in hydrology due to manipulation of water regimes as well as natural causes can affect these species.
- **Pollution** in the water column can negatively affect health and possibly even cause mortality depending on the substance and concentration.

Other direct threats

Anthropogenic activities can threaten FWCI resources by causing habitat degradation and direct mortality. Activities identified by stakeholders included:

- **Sediment pollution**. Some pollutants can bind or become mixed into sediments, causing long-term negative affects to organisms that burrow or forage in these habitats.
- **Oil and gas extraction.** Seismic exploration, marine noise construction disturbances, explosive removal of platforms, and oil spills all can negatively impact FWCI resources; however, the construction of platforms creates habitat for some species of FWCI.
- **Offshore wind energy**. Wind energy development is ongoing in the Atlantic Ocean and is under consideration in the GOM. Development of wind energy could cause impacts to FWCI resource during planning, construction, and operational phases through physical disturbance to habitats, increased vessel traffic, and emission of noise, vibrations, and electromagnetic fields from functional turbines and transmission cables (BOEM, 2007).
- **Noise**. Sound is an efficient way to communicate in the marine environment, and many FWCI resources produce sounds for communication. Anthropogenic noise (e.g., seismic testing, vessel traffic) can affect FWCI resources by disrupting normal behavior, causing hearing loss, causing stress to organisms, and/or forcing animals to alter their normal behavior.[11]
- **Dams**. Construction of dams fragments upstream habitat and disrupts migration routes. For example, dams can prevent up- and down-stream migration of anadromous and catadromous species, including American eels and other restoration types such as Gulf sturgeon.

Habitat degradation and loss. Anthropogenic activities, such as construction and development, can lead to degradation and loss of habitat critical to spawning/mating, nursery function, and migration in FWCI resources. Stakeholders specifically mentioned loss of seagrass and degradation of coral reef habitats as threats to FWCI resources. Habitat-based restoration initiatives will be addressed through coordination with other restoration types, including Nearshore Habitats, SAV, Oysters, and MDBC.

[11] https://www.fisheries.noaa.gov/national/science-data/ocean-noise

Threats by priority species

Table 4.1 shows threats that are identified to impact each priority species. Threats to priority species identified in this section were identified using a combination of external and internal stakeholder input and discussion, a review of the IUCN database of threats, and a cursory literature search. Most of the priority species were subject to fishing threats, marine debris, and climate change impacts. Exposure to other types of threats vary based on individual species life-history characteristics and habitat requirements.

Table 4.1 Threats to priority species.

Threat		Blue marlin	Yellowfin tuna	Greater amberjack	Red grouper	Red snapper	Vermilion snapper	Mullets and menhaden	Royal red shrimp	Golden tilefish	King mackerel	Spotted seatrout	Blue crab	Southern Flounder	American eel
Fishing impacts															
	Overfishing risk	XX*	XX	XX*	XX	XX*		XX		XX	XX	XX*	X	XX*	
	Bycatch	XX		XX	XX	XX	XX			XX	XX	XX	XX	X	
	IUU fishing		X			XX	X								
	Data limitations	XX		XX					XX	XX	XX	XX		XX	
Marine debris															
	Plastic/Microplastic	X	X	X	X	XX	X	X	X	X	XX	XX	X	XX	X
	Derelict gear	X	X	X	X	X	X				X	XX	XX	X	X
Invasive species						XX	XX								
Climate change		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Water quality															
	HABs				XX			XX				XX			
	Nutrient enrichment/hypoxia	XX			XX										
	Pollution (including PAH contamination)	X	XX	X	XX	X	X	X	X	XX	X	X	X	XX	X

Threat		Blue marlin	Yellowfin tuna	Greater amberjack	Red grouper	Red snapper	Vermilion snapper	Mullets and menhaden	Royal red shrimp	Golden tilefish	King mackerel	Spotted seatrout	Blue crab	Southern Flounder	American eel
	Salinity/hydrologic changes												XX		
Other direct impacts															
	Sediment pollution									XX			X		
	Anthropogenic Noise														
	Wind development														
	Oil & Gas activities			XX	XX	XX	XX			XX					
	Dams														XX
	Habitat loss/degradation							X				X	XX	XX	XX
Sources		***1-4***	***5,6***	***7,8, 9***	***8,10, 11***	***8,11, 12,13***	***8,14***	***12,22, 23,24***		***5, 15***	***8,12, 16***	***12,17***	***18***	***12,19, 20***	***21***

Entries with "XX" indicate threats that have been identified to affect a particular species. Entries with "X" indicate that a threat likely impacts a given species. Entries that contain a "*" indicate that a species is designated as "overfished/overfishing or rebuilding" in the GOM, either by federal or state management agencies. Blank cells have not been identified as a threat to the species at this time. References that support these designations are in the final row of the table. The key to supporting references are as follows: 1 - Prince et al., 2010; 2 - NOAA Fisheries, 2021a; 3 - NOAA Fisheries 2019; 4 - Collette et al., 2011a; 5 – Pulster et al., 2020; 6 – Collette et al., 2021; 7 - SEDAR, 2020; 8 – Benaka et al., 2019.; 9 - Smith-Vaniz et al., 2015; 10 – Colemen & Koenig, 2010; 11 - NOAA Fisheries 2021b; 12 – Phillips & Bonner, 2015; 13 - Anderson et al., 2015; 14 – Lindeman et al., 2016.; 15 – Aiken et al., 2015; 16 - Collette et al., 2011b; 17 – Chao et al., 2020; 18 – Bourgeois et al., 2014; 19 – GSMFC, 2000; 20 - Munroe, 2015; 21 – Jacoby et al., 2017; 22 – Collette et al., 2015; 23 – Camara et al., 2019; 24 – Castro et al., 2019

Section 5: Restoration objectives

FWCI restoration objectives were developed to address primary threats to priority species or species groups that were identified in sections 3 and 4. This section includes high-level restoration objectives for achieving the FWCI restoration goals set out in the DWH PDARP/PEIS, which are as follows:

- Restore injured fish and invertebrate species across the range of coastal and oceanic zones by reducing direct sources of mortality.
- Increase the health of fisheries by providing fishing communities with methodologies and incentives to reduce impacts to fishery resources.

Examples of methods to restore injured fish and invertebrate species include implementing techniques such as gear conversions and/or removal of derelict fishing gear, quota banks, barotrauma mitigation tools, circle hook distributions, shrimp trawl bycatch reduction devices. Objectives may vary in the level of specificity, depending on the amount of available information relating to a threat, and information on the target species. In some cases, enough information is available to identify objectives with respect to the threat, appropriate geography, and target species, and potential restoration actions with a fair degree of specificity and certainty. In other cases, some of this information is not known or available; however, the Team determined that it is likely that restoration opportunities may be present based on the information available regarding the threat.

Restoration Objectives are presented in ranked priority, and divided into high and low priority objectives. Objectives 7, 8 and 9 are considered low priority. Objectives that are ranked higher will be the focus of our near-term effort. Lower-ranking objectives will be considered on a more opportunistic basis, are areas where additional information would be needed to inform potential actions, or will be reconsidered when new information becomes available. Restoration Objectives are presented below, along with corresponding planning needs and potential actions (see also Appendix D).

One or more Potential Actions can support progress towards each Restoration Objective, and Potential Actions can support multiple objectives. Potential Actions are presented below to illustrate actions that could contribute to an objective. Their inclusion below does not imply that they have been chosen to be implemented. When initiating future restoration plans, the OO TIG will request project ideas from the public and evaluate restoration projects under the Oil Pollution Act to determine restoration benefits and to meet Natural Resource Damage Assessment requirements. Decisions on restoration projects are only made after consideration of public comments through the restoration planning process. Depending on results of restoration planning work, including analysis of feasibility and need, not all restoration objectives may be addressed.

Objective 1: Reduce bycatch of FWCI resources

Priority species targeted: spotted seatrout, southern flounder, king mackerel, red grouper, greater amberjack, red snapper, vermilion snapper, golden tilefish, blue marlin, yellowfin tuna, blue crab

Planning needs:

- Identify species, fisheries, and geographically specific bycatch risks to identify current and potential future restoration opportunities.

Potential Actions:

- Reduce regulatory and/or non-regulatory discards from commercial fisheries.
- Reduce incidental or non-target catch in recreational fisheries.
- Develop new bycatch reduction technologies
- Improve efficiency of current bycatch reduction technologies.
- Increase utilization of bycatch reduction technologies in domestic and international fisheries.

Objective 2: Reduce illegal, unregulated, and unreported (IUU) fishing of FWCI resources

Priority species targeted: yellowfin tuna, vermilion snapper, red snapper

Planning needs:

- Identify restoration opportunities by synthesizing information on IUU fishing to FWCI resources.

Potential Actions:

- Reduce illegal fishing in U.S. waters by providing tools or resources to resource managers.
- Educate stakeholders to increase awareness and compliance with existing laws.

Objective 3: Develop tools and techniques to reduce uncertainty in restoration and encourage best practices among stakeholders and fishing communities for reduction of fisheries impacts.

Priority species targeted: blue marlin, southern flounder, king mackerel, yellowfin tuna, golden tilefish, greater amberjack, red snapper, white mullet, striped mullet, Gulf menhaden

Planning needs:

- Identify fisheries, and geographically specific threats to identify current and future restoration opportunities.
- Identify methods to reduce unintended fishing impacts occurring in international waters for injured species, particularly for undersized fish.
- Understand the factors that influence fishery efficiency (including catch and bycatch) to support the identification of restoration opportunities.

- Understand fishing behavior related to fish aggregating devices (FADs) in order to identify restoration opportunities.
- Provide information on species ecology that can be used to plan and implement restoration projects, including larval distribution mechanisms, important habitats, and factors influencing recruitment.
- Understand vulnerability of priority species during spawning events to identify restoration opportunities.
- Analyze data on Mexican fisheries for better identification of eastern and western stock components to guide restoration opportunities.
- Develop models to evaluate population changes and stressors to priority species.

Potential Actions:

- Implement projects to reduce unintentional fishing impacts occurring in international waters to highly migratory species.
- Develop techniques to reduce juvenile mortality of yellowfin tuna in international fisheries targeting other tunas, such as techniques related to the number of sets made on mixed-species schools targeting skipjack tuna.
- Provide fishermen and stakeholders tools, techniques, and information.

Objective 4: Reduce the threat of marine debris to FWCI resources

Priority species targeted: all

Planning needs:

- Identify impacts of plastics, micro-plastics, and other marine debris on priority species and *Sargassum* habitats.
- Identify and develop new opportunities to reduce mortality to fish and water column invertebrates resulting from derelict fishing gear based on gear type or geography.

Potential Actions:

- Remove plastic and/or microplastic from the marine environment.
- Prevent entry of plastics and/or microplastic into the marine environment using current or developing future technologies.
- Locate and remove ghost fishing gear (traps, nets, lines) from the GOM.
- Develop new or encourage the use of existing methods to reduce or remove marine debris accumulation in the GOM.
- Educate the public regarding threats from marine debris.

Objective 5: Reduce post-release mortality of FWCI resources

Priority species targeted: blue marlin, spotted seatrout, southern flounder, greater amberjack, red snapper

Planning needs:

- Characterize impacts of recreational fishing release mortality to priority species to identify additional restoration opportunities.

Potential Actions:

- Increase angler awareness of best practices for catch and release practices to reduce post-release mortality.
- Increase successful use of barotrauma mitigation techniques.
- Reduce Gulf-wide discard mortality via innovations in best practices in the recreational fishery (e.g., comparing the use of artificial versus live baits).

Objective 6: Reduce risks from invasive species to FWCI resources

Priority species targeted: red snapper, vermilion snapper, red grouper

Planning needs:

- Define and characterize extent and severity of impacts of invasive species to identify restoration opportunities.
- Analyze and characterize risks and potential for future invasions.

Potential Actions:

- Implement lionfish removal activities.
- Educate and train marine stakeholders on invasive species risks and prevention measures.

Objective 7: Reduce risks to FWCI from energy development and production activities

Priority species targeted: red snapper, vermilion snapper

Planning needs:

- Define and characterize impacts to priority species.
- Determine impacts of new methods of energy production (e.g., wind) to priority species.

Potential Actions:

- Develop and implement practices to reduce mortality during removal of infrastructure.

Objective 8: Reduce mortality of FWCI resources due to HABs

Priority species targeted: red grouper, spotted seatrout, mullets and menhaden

Planning needs:

- Characterize impacts of HABs on priority species to identify restoration strategies.

- Coordinate with other restoration types to develop projects that address HABs and benefit FWCI resources.

Potential Actions:

- Develop novel methods to reduce impacts of HABs to priority species in coastal waters.

Objective 9: Enhance *Sargassum* and other pelagic habitats

Species groups targeted: *Sargassum* communities, pelagic species

Planning needs:

- Synthesize information on role of pelagic habitats, including *Sargassum* and ephemeral features (eddies, fronts, etc.), to identify restoration opportunities that protect or improve these habitats for FWCI resources and potentially other restoration types (e.g. sea turtles).

Potential Actions:

- No actions have been identified at this time.

Section 6: Strategic considerations

Coordination with DWH restoration goals for other Restoration Types

Actions that are implemented to address the goals for restoration of other (non-FWCI) DWH restoration types may also benefit FWCI resources.

Specific restoration goals that will benefit FWCI resources include:

- Under the goal of Restore and Conserve Habitat, the Trustees identified two restoration types: 1) Wetlands, Coastal, and Nearshore Habitats and 2) Habitat Projects on Federally Managed Lands. These restoration types will benefit injured coastal and nearshore habitats, as well as many injured species of fish and invertebrates in the water column, by providing food, shelter, and breeding and nursery habitat.
- Under the goal of Restore Water Quality, the Trustees identified two restoration types: 1) Nutrient Reduction and 2) Water Quality (a more general restoration type designed to address broader water quality degradation). The Trustees recognized that water quality improvements benefit will contribute to the overall health and resiliency of coastal ecosystems of which fish and water column invertebrates are a major constituent.
- Under the goal of Replenish and Protect Living Coastal and Marine Resources, the Trustees identified two restoration types that will benefit FWCI resources: 1) Oysters and 2) MDBC. These restoration types will benefit injured species of fish and vertebrates by restoring habitat. In particular, the MDBC Restoration Type will restore fish and invertebrate abundance and biomass in priority mesophotic and deep water hard-ground areas.

In addition, restoration projects that benefit other species, such as Gulf sturgeon, sea turtles, or marine mammals, may also benefit FWCI resources.

Restoration planning for FWCI will seek opportunities to coordinate with ongoing efforts by other restoration types to design projects that maximize benefits across injured resources. Additionally, coordination will allow the Trustees to account for these benefits and adjust project planning to ensure the maximum restoration benefit across species.

Regional coordination with conservation and management initiatives

Restoration for FWCI resources will overlap with the many conservation and restoration efforts ongoing within the region. These efforts include ongoing DWH restoration efforts, federal and state management initiatives, and conservation initiatives. Additionally, continued engagement and coordination with stakeholders is essential for successful restoration.

Many governmental and non-governmental organizations are conducting natural resource conservation and management projects across the region. Additionally, other initiatives are ongoing to restore various entities for damages due to DWH, such as RESTORE act funding. Projects selected for restoration of FWCI resources may work collaboratively with these groups. This approach allows for a better understanding of localized fishery goals for specific user groups, maximizes restoration value, and minimizes fishing disruptions.

Restoration planning for FWCI will seek opportunities to coordinate with research, management, fisheries, and non-profit programs and entities to support technique development and implementation for mutual benefit.

Stakeholder engagement and communication

Stakeholder engagement is essential to the success of DWH restoration. Stakeholders should continue to be engaged through ongoing communication. Additionally, projects should be designed to include stakeholder engagement, throughout the planning and implementation process, through means such as citizen science and partnerships for applied science. Ensuring public awareness of opportunities for participation during future restoration planning is also important to maximize stakeholder engagement and communication.

In the restoration context, the partnering of scientists with members of the fishing industry and other stakeholders to collect fisheries information and develop new tools to support restoration of FWCI resources benefits stakeholders and restoration planners. Partnerships can provide the stakeholder community with opportunities to contribute to the science and restoration processes, increasing community support for restoration projects while providing vital information for project planning and evaluation and developing new restoration techniques.

Communication plans for FWCI will support both planning and implementation efforts and identify additional options for participatory restoration planning. Plans should identify target audiences and develop messaging strategies to support communication and collaboration and describe opportunities for partnerships for applied science in the restoration process.

Scale of projects

Project scale refers to the size of the project in terms of funding, duration, and geographic area. Project scale is outlined as part of the project scope. The geographic scale will ultimately vary by restoration objective and project; however, matching scales to fisheries management zones (e.g., eastern or western Gulf) can facilitate communication with stakeholders and collaboration with regional entities. Projects should focus on stocks that were impacted by the DWH spill, but can occur across the GOM or internationally, if they benefit injured populations. Also, matching the scale of restoration to the scale of injury is an important consideration in determining the appropriate scale of restoration. Fewer, but larger projects may help reduce overall stakeholder fatigue and help maximize stakeholder involvement. Ensuring that larger projects have been successfully proven at the pilot scale, and phased to allow adaptive management, can help mitigate project risks.

FWCI restoration will seek opportunities to focus on large scale (regional) restoration projects that maximize stakeholder involvement. Restoration will support technique development through pilot scale projects when necessary, but use approaches that have been proven at smaller scales and scale up for techniques that have been proven in principle.

Restoration project objectives

The OOTIG requires that restoration projects have project objectives. Objectives for each restoration project should be "SMART objectives", defined as:

- Are **Specific** and clearly define what the restoration effort will achieve
- Provide a **Measurable** target for restoration success
- Have targets identified by resource experts as **Achievable**
- Have measures that are **Relevant** to restoration objectives
- Are **Timely** with appropriate timeline for quantifying progress

FWCI restoration projects will incorporate the principles of SMART objectives for each project to support evaluation of project performance and adaptive management.

Monitoring and adaptive management

The Trustees' goal to "Provide for Monitoring, Adaptive Management, and Administrative Oversight to Support Restoration Implementation" supports each Restoration Type and informs overall decision-making within the Trustees' adaptive management framework.

Monitoring can refer to monitoring of project performance (Performance monitoring) or restoration progress across species (Resource-level monitoring). Performance monitoring will be conducted to track restoration projects and determine if projects, individually and together, are meeting restoration objectives such as reducing bycatch rates, reducing bycatch mortality, and achieving voluntary reductions in catches. Performance monitoring may measure parameters such as participation in and compliance with incentive-based programs, aggregated counts and dispositions of target or bycatch species, measures of fishing effort product grades, and economic and market conditions. Monitoring and adaptive management of water column restoration projects will rely heavily on existing and expanded fishery observer programs and other fishery-dependent data, given the connection between this Restoration Type and existing fishery management efforts. Data may be collated and aggregated from existing fishery observer and logbook programs and supplemented as required with additional data collected by project-specific observers on vessels participating in voluntary restoration projects. Resource-level monitoring may be required to support planning, implementation, and evaluation of FWCI restoration. Monitoring and scientific support may be conducted to improve understanding of the status and trends of key water column resources and to better define the effectiveness of bycatch reduction and bycatch mortality reduction approaches for species intended for restoration. In addition to providing information needed to adaptively manage restoration actions, these additional data

collection efforts may provide fisheries managers with better information on which to base management decisions, which could provide further benefit to the species targeted for restoration.

Adaptive management is a process involving fine-tuning both the restoration projects and the entire restoration program over time, based on monitoring results and improved scientific understanding. Adaptive management will improve the likelihood of restoration success by addressing critical scientific uncertainties through monitoring and other targeted scientific support.

The process of monitoring and adaptive management creates a knowledge base that may be mutually beneficial to both DWH restoration projects and other fishery management projects in the GOM. Information on the life-history parameters of species targeted for restoration and the structures of the communities in which they live can improve restoration outcomes. A more in-depth understanding of population dynamics, such as age structure, growth rates, fecundity, and connectivity, may be important to understanding the status and trends of key water column resources and would influence restoration project design and evaluation. Enhanced fishery-independent data collection methods, such as increased spatial and temporal efforts for fishery-independent surveys and enhanced sampling of information on life history, trophic position, reproductive biology, and habitat associations could improve restoration outcomes. These types of fishery-dependent and fishery-independent information are similar to data required for fisheries management of injured species. Collected information that increases our understanding of densities of organisms in geography and over time, ecosystem functioning, and trophic relationships can be used to inform restoration project planning, design, and evaluation. Moreover, because densities of water column species can vary significantly across geographies and over time, particularly for large, mobile predators, the ability to accurately assess the impact of restoration would be improved by these additional data. Information and data gaps specific to FWCI resources were identified by the Team meetings and during stakeholder engagement sessions (Appendix A).

FWCI restoration planning and implementation will seek opportunities to address critical information and data gaps and share this information to the extent possible with other FWCI conservation and management efforts.

Emerging threats and stressors

The GOM ecosystem is changing over time due to environmental fluctuations, ecological changes, shifts in anthropogenic activity, and other factors. These fluctuations may affect the ecology and behavior of both the species that comprise the ecosystem and the fisheries that depend on the GOM ecosystem. Monitoring data should be examined not only to track restoration progress and project performance, but also to identify additional restoration opportunities.

FWCI restoration planning will seek opportunities to track emerging threats and stressors throughout the restoration process to identify additional restoration opportunities.

Additional injury information

Additional injury information may become available as restoration progresses and could be used to inform future species prioritizations. In the ten years since the DWH spill, many research projects have been completed, which describe effects to FWCI resources. Synthesizing this information will allow future restoration planning efforts to take these studies into account.

FWCI restoration planning will seek opportunities to review and synthesize new information on DWH impacts to FWCI to facilitate incorporation of this information into future restoration planning.

Section 7: Conclusions

The Open Ocean FWCI restoration strategy will be used to guide multiple future restoration plans for the FWCI Restoration Type. Incorporating stakeholder input, it establishes priority species and restoration objectives for the near and long-term restoration of FWCI resources that build on the restoration type goals established in the Trustees' comprehensive programmatic restoration plan. These restoration objectives improve the OO TIG's ability to achieve effective and efficient restoration of FWCI resources injured by the Deepwater Horizon oil spill, with the approximately $320 million remaining of the funding allocation. They also promote information sharing, collaborative restoration planning, and public input to identify opportunities for restoration during future restoration planning efforts.

The Open Ocean FWCI strategic plan includes an adaptive planning process for identifying strategies, priorities, and objectives for FWCI restoration and executes the process based on available data. It is a living document that can be updated periodically to account for new information and restoration progress as needed by the Trustees. For example, new information can be used to update prioritization criteria, such as catch statistics, threats, and vulnerabilities. New threats, new information about impacted FWCI, or newly developed restoration approaches and/or techniques, may make it appropriate for the Trustees to update restoration priorities and objectives.

The Open Ocean Trustees are committed to continued engagement with stakeholders to ensure their ideas are considered during the restoration process. Stakeholders can anticipate additional opportunities to provide input for future restoration plans. We encourage those who are interested in FWCI restoration planning to use the gulfspillrestoration.noaa.gov website to stay informed about future restoration planning opportunities and to provide input.

Section 8: References

Aiken, K.A., Collette, B., Dooley, J., Kishore, R., Marechal, J., Pina Amargos, F. & Singh-Renton, S. 2015. Lopholatilus chamaeleonticeps. The IUCN Red List of Threatened Species 2015: e.T16545046A16546277. https://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T16545046A16546277.en. Downloaded on 23 September 2021.

Anderson, W., Claro, R., Cowan, J., Lindeman, K., Padovani-Ferreira, B. & Rocha, L.A. 2015. Lutjanus campechanus (errata version published in 2017). The IUCN Red List of Threatened Species 2015: e.T194365A115334224. https://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T194365A2322724.en. Downloaded on 23 September 2021.

Arthur, C., S. Friedman, J. Weaver, D. Van Nostrand, and J. Reinhardt. 2020. Estimating the Benefits of Derelict Crab Trap Removal in the Gulf of Mexico. Estuaries and Coasts 43:1821–1835.

Benaka, L.R., D. Bullock, A.L. Hoover, and N.A. Olsen (editors). U.S. National Bycatch Report First Edition Update 3. 2019. U.S. Dept. of Commerce, NOAA. NOAA Technical Memorandum NMFS-F/SPO-190, 95 p.

Bourgeois, M., Marx, J., and Semon, K. 2014. Louisiana Blue Crab Fishery Management Plan. Louisiana Department of Wildlife and Fisheries (LDWF), Office of Fisheries, 122 pages.

Bureau of Ocean Energy Management (BOEM) (formerly Minerals Management Service (MMS)). 2007. Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf Final Environmental Impact Statement. Volume B: Chapter 5. OCS EIA/EA MMS 2007-046. U.S. Department of the Interior. 342 pages. Available at: http://www.boem.gov/Renewable-Energy-Program/Regulatory-Information/Alt_Energy_FPEIS_Chapter5.aspx

Butler, C. B., and T. R. Matthews. 2015. Effects of ghost fishing lobster traps in the Florida Keys. ICES Journal of Marine Science 72:i185–i198.

Camara, K.D., Carpenter, K.E., Djiman, R., Nunoo, F., Sagna, A., Sidibé, A, Sylla, M., de Morais, L., Jelks, H., Tolan, J., Vega-Cendejas, M., Espinosa-Perez, H., Chao, L., Moretzsohn, F. & Sparks, J.S. 2019. Mugil cephalus. The IUCN Red List of Threatened Species 2019: e.T135567A127923853. http://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T135567A127923853.en

Castro, M.G., Vieira, J.P., Albieri, R.J., Mendonca, E., Villwock de Miranda, L., Fadré, N.N., Brick Peres, M., Padovani-Ferreira, B., da Silva, F.M.S., Rodrigues, A.M.T. & Chao, L. 2019. Mugil curema. The IUCN Red List of Threatened Species 2019: e.T190168A82660284. http://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T190168A82660284.en

Cave, E. J., and S. M. Kajiura. 2018. Effect of Deepwater Horizon Crude Oil Water Accommodated Fraction on Olfactory Function in the Atlantic Stingray, Hypanus sabinus. Scientific Reports 8:1–8.

Chao, L., Espinosa-Perez, H. & Barbieri, L. 2020. Cynoscion nebulosus. The IUCN Red List of Threatened Species 2020: e.T193266A82666764. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T193266A82666764.en. Downloaded on 23 September 2021.

Chagaris, David and Dylan Sinnickson. 2018. An Index of Red Tide Mortality on red grouper in the Eastern Gulf of Mexico. SEDAR61-WP-06. SEDAR, North Charleston, SC. 16 pp.

Cheung, W. W. L., T. J. Pitcher, and D. Pauly. 2005. A fuzzy logic expert system to estimate intrinsic extinction vulnerabilities of marine fishes to fishing. Biological Conservation 124:97–111.

Collette, B., Acero, A., Amorim, A.F., Boustany, A., Canales Ramirez, C., Cardenas, G., Carpenter, K.E., de Oliveira Leite Jr., N., Di Natale, A., Die, D., Fox, W., Fredou, F.L., Graves, J., Guzman-Mora, A., Viera Hazin, F.H., Hinton, M., Juan Jorda, M., Minte Vera, C., Miyabe, N., Montano Cruz, R., Nelson, R., Oxenford, H., Restrepo, V., Salas, E., Schaefer, K., Schratwieser, J., Serra, R., Sun, C., Teixeira Lessa, R.P., Pires Ferreira Travassos, P.E., Uozumi, Y. & Yanez, E. 2011a. Makaira nigricans. The IUCN Red List of Threatened Species 2011: e.T170314A6743776. https://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T170314A6743776.en. Downloaded on 23 September 2021.

Collette, B., Amorim, A.F., Boustany, A., Carpenter, K.E., de Oliveira Leite Jr., N., Di Natale, A., Fox, W., Fredou, F.L., Graves, J., Viera Hazin, F.H., Juan Jorda, M., Minte Vera, C., Miyabe, N., Nelson, R., Oxenford, H., Teixeira Lessa, R.P. & Pires Ferreira Travassos, P.E. 2011b. Scomberomorus cavalla. The IUCN Red List of Threatened Species 2011: e.T170339A6755835. https://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T170339A6755835.en. Downloaded on 23 September 2021.

Collette, B., Grubbs, D., Pezold, F., Simons, J., Carlson, J., Caruso, J., McEachran, J.D., Brenner, J., Tornabene, L., Robertson, R. & Chakrabarty, P. 2015. Brevoortia patronus. The IUCN Red List of Threatened Species 2015: e.T191208A1972860. http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T191208A1972860.en

Collette, B.B., Boustany, A., Fox, W., Graves, J., Juan Jorda, M. & Restrepo, V. 2021. Thunnus albacares. The IUCN Red List of Threatened Species 2021: e.T21857A46624561. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T21857A46624561.en. Downloaded on 23 September 2021.

Coleman, F. and C. Koenig. 2010. The effects of fishing, climate change, and other anthropogenic disturbances on red grouper and other reef fishes in the Gulf of Mexico. Itegr. Comp. Biol. 50(2):201-12.

Deepwater Horizon Natural Resource Damage Assessment (NRDA) Trustees. (2016). Deepwater Horizon oil spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement. Retrieved from http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan

Dell'Apa, A., K. Carney, T. M. Davenport, and M. V. Carle. 2018. Potential medium-term impacts of climate change on tuna and billfish in the Gulf of Mexico: A qualitative framework for management and conservation. Marine Environmental Research 141:1–11.

Di Mauro, R., M. J. Kupchik, and M. C. Benfield. 2017. Abundant plankton-sized microplastic particles in shelf waters of the northern Gulf of Mexico. Environmental Pollution 230:798–809.

Dunstan, D., G. Tsui, E. Chu, T. Cashion, B. Derrick, B. Doherty, H. Harguth, A. McCrea Strub, W. Figueira L.D. Jenkins and V. Relano. 2020. Marine fisheries catch reconstructions for the continental USA: update to 2018, p. 144-158. In: B. Derrick, M. Khalfallah, V. Relano, D. Zeller and D. Pauly (eds).

Updating to 2018 the 1950-2010 Marine Catch Reconstructions of the Sea Around Us. Part B: The Americas and Asia-Pacific. Fisheries Centre Research Report 28(6).

Flaherty, K. E., and J. H. Landsberg. 2011. Effects of a Persistent Red Tide (Karenia brevis) Bloom on Community Structure and Species-Specific Relative Abundance of Nekton in a Gulf of Mexico Estuary. Estuaries and Coasts 34:417–439.

Foley, C., Z. Feiner, T. Malinich, and T. Hook. 2018. A meta-analysis of the effects of exposure to microplastics on fish and aquatic invertebrates. Sci. Total Environ. 631-632:550-559.

Gulf States Marine Fisheries Commission (GSMFC) 2000. The Flounder Fishery of the Gulf of Mexico, United States: A Regional Management Plan. VanderKooy, S.J. (Ed). GSMFC #83, Ocean Springs, MS. 323 pages.

Heink, U., and I. Kowarik. 2010. What are indicators? On the definition of indicators in ecology and environmental planning. Ecological Indicators 10:584–593.

IUCN. 2012. IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.

IUCN 2021. The IUCN Red List of Threatened Species. Version 2021-1. https://www.iucnredlist.org.

Jacoby, D., Casselman, J., DeLucia, M. & Gollock, M. 2017. Anguilla rostrata (amended version of 2014 assessment). The IUCN Red List of Threatened Species 2017: e.T191108A121739077. https://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T191108A121739077.en. Downloaded on 23 September 2021.

Lindeman, K., Anderson, W., Claro, R., Cowan, J., Padovani-Ferreira, B., Rocha, L.A. & Sedberry, G. 2016. Rhomboplites aurorubens. The IUCN Red List of Threatened Species 2016: e.T190138A1941553. https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T190138A1941553.en. Downloaded on 23 September 2021.

Lovett, H.B., S.B. Snider, K.R. Gore, R.C. Muñoz, Editors. 2016. Gulf of Mexico Regional Action Plan to Implement the NOAA Fisheries Climate Science Strategy. NOAA Technical Memorandum NMFS-SEFSC-699. 40 p. Available at: https://www.st.nmfs.noaa.gov/Assets/ecosystems/climate/documents/raps/tech_memos/GOM_Regional_Action_Plan.pdf

McCrea-Strub, A. 2015. Reconstruction of total catch by U.S. fisheries in the Atlantic and Gulf of Mexico: 1950-2010. Fisheries Centre Working Paper #2015-79, University of British Columbia, Vancouver, 46 p. (Full text)

Munroe, T. 2015. Paralichthys lethostigma. The IUCN Red List of Threatened Species 2015: e.T202632A46958684. https://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T202632A46958684.en. Downloaded on 23 September 2021.

NOAA Fisheries 2019. Summary of the annual report of the United States to ICCAT. U.S. Department of Commerce, NOAA Fisheries. 43 pages. Available at: https://media.fisheries.noaa.gov/dam-migration/2019_us_annual_report_to_iccat.pdf

NOAA Fisheries. 2021a. 2020 Stock Assessment and Fishery Evaluation Report: Atlantic Highly Migratory Species. U.S. Department of Commerce, National Oceanic and Atmospheric Association, National Marine Fisheries Service, 275 pages. Available at:

https://www.fisheries.noaa.gov/atlantic-highly-migratory-species/atlantic-highly-migratory-species-stock-assessment-and-fisheries-evaluation-reports

NOAA Fisheries. 2021b. Report to congress: Improving international fisheries management. August 2021. U.S. Department of Commerce, National Marine Fisheries Service. 78 pages. Available at: https://media.fisheries.noaa.gov/2021-08/2021ReporttoCongressonImprovingInternationalFisheriesManagement.pdf

NOAA Marine Debris Program (MDP) 2021. "Microplastic Marine Debris Fact Sheet". Available at: https://marinedebris.noaa.gov/fact-sheets/microplastic-marine-debris-fact-sheet. Accessed September 22, 2021.

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Peters, C. A., P. A. Thomas, K. B. Rieper, and S. P. Bratton. 2017. Foraging preferences influence microplastic ingestion by six marine fish species from the Texas Gulf Coast. Marine Pollution Bulletin 124:82–88.

Phillips, M. B., and T. H. Bonner. 2015. Occurrence and amount of microplastic ingested by fishes in watersheds of the Gulf of Mexico. Marine Pollution Bulletin 100:264–269.

Prince, E. D., J. Luo, C. Phillip Goodyear, J. P. Hoolihan, D. Snodgrass, E. S. Orbesen, J. E. Serafy, M. Ortiz, and M. J. Schirripa. 2010. Ocean scale hypoxia-based habitat compression of Atlantic istiophorid billfishes: Hypoxia-based habitat compression of billfishes. Fisheries Oceanography 19:448–462.

Pulster, E. L., A. Gracia, M. Armenteros, G. Toro-Farmer, S. M. Snyder, B. E. Carr, M. R. Schwaab, T. J. Nicholson, J. Mrowicki, and S. A. Murawski. 2020. A First Comprehensive Baseline of Hydrocarbon Pollution in Gulf of Mexico Fishes. Scientific Reports 10:1–14.

Richardson, K., B. D. Hardesty, and C. Wilcox. 2019. Estimates of fishing gear loss rates at a global scale: A literature review and meta-analysis. Fish and Fisheries 20:1218–1231.

Roberge, J.-M., and P. Angelstam. 2004. Usefulness of the Umbrella Species Concept as a Conservation Tool. Conservation Biology 18:76–85.

Southeast Data Assessment and Review (SEDAR). 2020. SEDAR 70: Gulf of Mexico Greater Amberjack. North Charleston, SC, 189 pages. Available at: https://sedarweb.org/sedar-70-gulf-mexico-greater-amberjack-final-stock-assessment-report

Smith-Vaniz, W.F., Pina Amargos, F., Brown, J., Curtis, M. & Williams, J.T. 2015. Seriola dumerili (errata version published in 2017). The IUCN Red List of Threatened Species 2015: e.T198643A115341394. https://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T198643A16644002.en. Downloaded on 23 September 2021.

Sutton, Tracey; Milligan, Rosanna; Cook, April; Frank, Tamara; Moore, J.; Murawski, S.; Vecchione, M.; and Youngbluth, M., "A Summary of Post-Deepwater Horizon Oil Spill Open-Ocean Faunal Population Dynamics: Vulnerability, Resilience, Data Gaps, and Management Implications" (2020), Gulf of Mexico Oil Spill and Ecosystem Science Conference, Tampa Bay, Florida. Available at: https://www.google.com/url?q=https://nsuworks.nova.edu/occ_facpresentations/692&sa=D&s

ource=editors&ust=1631828818623000&usg=AOvVaw3rY8sGxJ-zZQYiORTqi7AX, ORCID ID 0000-0002-5280-7071; ResearcherID W-8662-2019

Wessel, C., K. Swanson, T. Weatherall, and J. Cebrian. 2019. Accumulation and distribution of marine debris on barrier islands across the northern Gulf of Mexico. Marine Pollution Bulletin 139:14–22.

Appendix A: FWCI information and data gaps

Category	Key Words	Data Gap	Stakeholder Engagement Meeting (Date)
Taxonomy	Species grouping	Taxonomic grouping of many species can be improved	NGO Roundtable (5/12/21)
Species Ecology	Southern Flounder	Incomplete understanding of species ecology - Research to improve and support better stock assessments (e.g. regional population dynamics) to establish species specific baselines	Planning/Evaluation Objectives
Species Ecology	Blue Marlin	Larval distribution - Identify larval distribution mechanisms, important habitats, and factors influencing recruitment to develop additional restoration opportunities	Planning/Evaluation Objectives
Species Ecology	Cephalopod	Cephalopod ecology - Improve knowledge of deepwater species' ecology to enhance deepwater fish resilience to future disturbances, describe linkages to other injured taxa, and identify restoration opportunities	Core Fish Team (8/30/21) Planning/Evaluation Objectives
Species Ecology	Cnidarian	Cnidarian ecology is poorly understood which makes identifying restoration priorities challenging	Core Fish Team (9/27/21)
Species Ecology	Blue crab and other Crustaceans	How blue crab and other crustacean ecology and behavior may result in exposure to oil and/or dissolved PAHs is poorly understood	Academic Roundtable (5/12/21)
Species Ecology	Red Crab	Data synthesis of red crab sampling efforts would help better understand other crustaceans, specifically the effect exposure has on reproduction and larval survival in generation following spill	Academic Roundtable (5/12/21)
Species Ecology	Elasmobranch	Elasmobranch ecology is poorly understood which makes identifying restoration priorities challenging	Core Fish Team (9/27/21)
Species Ecology	Grouper	Non-fishing impacts on groupers and their habitats	NGO Roundtable (4/15/21)
Species Ecology	Snapper	Snapper ecology - Movement and diet studies are an important part of understanding this species role within the ecosystem in the Gulf of Mexico. Predator-prey and competitive interactions between vermillion and red snapper will be critical in the context with ecosystem-based management and multiple stressors	NGO Roundtable (4/15/21) Planning/Evaluation Objectives

Category	Key Words	Data Gap	Stakeholder Engagement Meeting (Date)
Species Ecology	Lionfish	Lionfish ecology in the Gulf of Mexico and their impacts on target species survival and distribution	NGO Roundtable (4/15/21)
Species Ecology	Deepwater	Deepwater fish ecology - Improve knowledge of deepwater species' ecology to enhance deepwater fish resilience to future disturbances, describe linkages to other injured taxa, and identify restoration opportunities	Core Fish Team (7/26/21) Planning/Evaluation Objectives
Species Ecology	Golden Tilefish	Vulnerability during spawning events to identify restoration opportunities	
Species Ecology	Fundulus	Overall Fundulus ecology is poorly understood which makes identifying restoration priorities challenging	Core Fish Team (9/27/21)
Species Ecology	Gastropod	An increased understanding of gastropod ecology may warrant the species group being addressed by different restoration groups	Core Fish Team (7/26/21)
Oil Toxicity	Oil	Chronic impacts and population level effects of oiling can be improved	Academic Roundtable (5/12/21)
Migration	Jacks; Mackerels	Migration patterns of small migratory fish such as jacks and mackerels	Academic Roundtable (5/12/21)
Habitats	Sargassum	Sargassum distribution/ecology and its role in fisheries populations and habitat provisions	NGO Roundtable (4/15/21) Academic Roundtable (5/12/21)
Habitats	Sargassum	Role of sargassum in early life histories (ELH) of Sargassum-associated species is not well understood (i.e., how dependent are ELH on Sargassum)	Academic Roundtable (5/12/21)
Habitats	Sargassum	The link between Sargassum and associated species with marine debris	Academic Roundtable (5/12/21)
Habitats	Multiple	Identify impacts of plastics, micro-plastics, and other marine debris on priority species and sargassum habitats, including ghost fishing gear	Planning/Evaluation Objectives
Habitats	Sargassum	Sargassum distribution/ecology and its role in fisheries populations is poorly known	Core Fish Team (7/4/21)
Habitats	Spawning	Spawning areas and other habitat uses for many species is unknown	NGO Roundtable (5/12/21) Core Fish Team (8/17/21)

Category	Key Words	Data Gap	Stakeholder Engagement Meeting (Date)
Habitats	Habitat use	A lot of interesting areas cannot be trawled (e.g., in SEAMAP data); data gaps exist in our understanding of habitat spatial distribution and composition	NGO Roundtable (5/12/21) Core Fish Team (8/17/21)
Habitats	Pipelines	There are 18,000 miles of abandoned pipelines for which data gaps exist	Public Meeting (5/13/21)
Climate Change	Climate Change	Improve understanding of combined impacts from climate change and other stressors to identify future restoration opportunities, including impacts on fish ecology due to temperature changes	NGO Roundtable (4/15/21) Planning/Evaluation Objectives
Fisheries/Populations	Non-game	Population dynamics and bycatch impacts of non-game fish species is poorly understood	GSMFC Meeting (3/17/21) NGO Roundtable (4/15/21)
Fisheries/Populations	Mackerel	King mackerel stock fluctuations occur; cause/effects of mercury contamination	Core Fish Team (8/30/21)
Fisheries/Populations	Economics	Species that are data poor are not as economically valuable but can be ecologically important; More data is needed to manage them properly	GSMFC Meeting (3/17/21) Core Fish Team (7/4/21)
Fisheries/Populations	Yellowfin Tuna	Incomplete knowledge of population dynamics - Identify larval distribution mechanisms, important habitats, and factors influencing recruitment	Planning/Evaluation Objectives
Fisheries/Populations	Multiple	Efficiency – understanding of the factors that influence fishery efficiency (including catch and bycatch)	Planning/Evaluation Objectives
Fisheries/Populations	Recreational	Impacts of recreational fishing release mortality on populations	Planning/Evaluation Objectives
Ecosystem Dynamics	Diet; Genetic Barcoding	Diet of many fish species; Genetic barcoding of fish tissue can be used to fill in data gaps	Academic Roundtable (5/12/21)
Ecosystem Dynamics	Zooplankton	Role of gelatinous zooplankton in open ocean diets	Academic Roundtable (5/12/21)

Category	Key Words	Data Gap	Stakeholder Engagement Meeting (Date)
Ecosystem Dynamics	Population dynamics	Gaps in knowledge of ecosystem dynamics that could be improved to inform management, including information on data poor stocks or ecosystem factors on population dynamics of some species.	NGO Roundtable (4/15/21)
Ecosystem Dynamics	Carrying capacity	Carrying capacities of some managed species is unknown	Core Fish Team (7/4/21)
Ecosystem Dynamics	Forage fish	Onshore/offshore pelagic forage fish habitat connectivity	Core Fish Team (8/17/21) Planning/Evaluation Objectives
Benthic Biota	Benthic	Benthic invertebrate baseline conditions	Public Meeting (5/13/21)

Appendix B. Multi-Attribute Restoration Prioritization Process (MARPP) methods and results

Multi-Attribute Restoration Prioritization Process for Fish and Water Column Invertebrate Species Restoration Prioritization following the Deepwater Horizon (DWH) Oil Spill

This appendix describes the Multi-Attribute Restoration Prioritization Process (MARPP), a decision analysis tool that was developed to provide a standardized framework for prioritizing species for DWH restoration for the Fish and Water Column Invertebrates restoration type. The MARPP provides transparency to the decision-making process, provides a clear and consistent rationale for outcomes, has reasonable data requirements, and can be updated for future use. This tool is flexible and can be updated with additional data or metrics as needed to guide priorities throughout the DWH restoration process. This tool can be used to prioritize species to target for restoration projects over the next 5+ years, and can also be updated with new information and re-used as the restoration proceeds over the remainder of the DWH Natural Resources Damage Assessment program.

Methods

Species list and groups

The species list was developed during DWH injury assessment efforts, which identified FWCI species occurring in the Gulf of Mexico and categorized them into 22 groups for assessment purposes based on taxonomy and expert consultation. This list does not correspond to groups used for fisheries management. Species groups were adapted slightly for FWCI restoration planning as shown in Table B-1. Prioritization was undergone to select species within groups.

Table B-1. Species groups used for prioritization

Taxonomic Species Groups		
Billfish	Cephalopods	Crabs and Lobsters
Drums and Seatrout	Elasmobranchs	Flatfish
Forage Fish	*Fundulus* family	Gastropods
Jacks	Jellies and other Cnidaria	Shrimp
Sea Basses and Groupers	Snappers	Tunas and Mackerels
Other Species Groups	**Grouping Methodology**	
Other Crustaceans	Consisting of those taxonomic levels that do not fit in with any of the other crustacean groups (i.e., shrimp, crabs and lobsters).	
Other Deepwater Fish	These groups are categorized by habitat preference and include different taxonomic groups within each group.	
Other Demersal Fish		
Other Reef-Associated		

The species list was cross-referenced with the list of injured species resulting from the injury assessment conducted by the Trustees[12] to generate a list of species to consider for prioritization.

Injury

The degree of taxonomic specificity was not consistent across the injury list. Some species were identified to the species level and some taxonomic groups were only identified to a family or genus. This was due to the fact that the injury assessment was based on larval distribution across the Gulf of Mexico, and larvae of related fish species may be indistinguishable below a certain age. Thus, there was a need to partition injury from higher taxonomic levels to species on the list to calculate a score for individual species. For this iteration of the tool, family/genus injury levels were split equally among all fish species in that family/genus. For example, injury determined for the fish family Achiridae will be partitioned among the four species listed in the species grouping tool: *Achirus lineatus*, *Gymnachirus melas*, *Gymnachirus texae*, and *Trinectes maculatus*. Future iterations of the tool could incorporate a more sophisticated method of assigning injury, for example assigning injury based on relative abundance.

Injury is calculated using two methods: direct injury quantifies biomass of larvae killed by the spill, and production foregone quantifies future biomass that was lost due to the death of early life stages (i.e., production added to the ecosystem from fish growth and reproduction). Production foregone was only calculated for a subset of species groups because it requires detailed information on life history parameters (e.g., mortality rates and growth rates) that was not available for all species. Direct injury and production foregone are included as separate parameters in the MARPP, representing the injury criteria in the decision framework.

Other prioritization criteria

In addition to including criteria associated with injury, the following additional criteria were included to provide metrics of importance, and restoration opportunity (see Table B-2). The following parameters were included:

1. Recreation and commercial catch. Social and economic importance is an indicator of natural resource value. We used the rationale that given equal levels of injury, restoration of species with higher natural resource value is preferred. Parameters that serve as proxies for natural resource value include commercial and recreational catch.
2. Species Vulnerability and Conservation status. Because the purpose of the FWCI group is to address sources of mortality, we wanted to consider species vulnerability and IUCN status as a measure of restoration opportunity. Using this rationale, we assume that given equal injury it is better to restore the species that is more vulnerable or has greater risk to threats and stressors. For both metrics, higher scores indicate higher vulnerability.
3. Restoration opportunity. We included criteria that indicated estuarine habitat association because we wanted to focus on species that are less likely to be restored through ongoing and planned coastal habitat restoration projects (e.g., marsh creation projects). Species that are more dependent on estuarine habitats received lower scores.

For criteria where data were obtained as factors (i.e., IUCN conservation status and estuarine dependency), each possible value was ordered to assign a relative value. Missing or 'NA' values were treated as zeroes. We tested for correlations between the parameters because we did not want to include parameters that had redundant information (Table B-3). We considered a number of additional parameters that failed to meet inclusion criteria but may be considered for future rounds of prioritization. Other changes may be made to future prioritization runs, including adjusting the injury by restoration progress to account for restoration projects already completed.

Table B-2. Description of parameters used to prioritize fish species for restoration projects following the Deepwater Horizon (DWH) oil spill.

12 https://www.fws.gov/doiddata/dwh-ar-documents/830/DWH-AR0195958.pdf

Criteria	Parameter	Description	Range of values in dataset
Injury	Biomass injury (kg)	Estimated fish injury biomass sustained during the DWH oil spill, obtained from the injury assessment conducted by the Trustees (PDARP, chapter 4).	0 – 67,835 kg
	Production Foregone (kg)	Estimated production foregone sustained during the DWH oil spill, obtained from the injury assessment conducted by the Trustees (PDARP, chapter 4).	0 – 2,144,054 kg
Vulnerability	Vulnerability to fishing	Score ranging from 0-100, assigned based on life-history traits, e.g., large, slow-growing, long-lived, late-reproducing species are most vulnerable (Cheung et al., 2005), available at fishbase.org.	10 - 84.78
Conservation status	IUCN Red List of Threatened Species™ Conservation Status	Categorical risk of species' extinction based on assessment of available literature regarding trends in population size and geographic range (IUCN 2012). Available at https://www.iucnredlist.org/ (IUCN 2021). None of the species in this dataset are designated 'critically endangered'.	DD (Data deficient) - NA NE (Not evaluated) - NA LC (least concern) - 1 NT (near threatened) - 2 VU (vulnerable) - 3 EN (endangered) – 4 CR (critically endangered) - None in dataset
Commercial Importance	Catch information from the Sea Around Us (kg)	Reconstructed catches from the Gulf of Mexico Large Marine Ecosystem (LME), which includes the EEZ for USA (Gulf), Cuba, and Mexico (Atlantic) and summed over 4 years (2013-16) were downloaded from the Sea Around Us Project (www.seaaroundus.org). This source includes industrial, artisanal, and subsistence fisheries. For methods see McCrea-Strub, 2015 and Dunstan et al., 2020.	0 – 5,533,082 kg
Recreational Importance	Recreational catch from MRIP (individuals)	Annual average total catch reported to the marine recreational information program (MRIP) was calculated for injured species from 2013 – 2017 for all modes and geographic areas in the Gulf of Mexico. Data were obtained by personal communication from National Marine Fisheries Service, Fisheries Statistics Division. [12/11/2019].	15 – 52,434,625 individuals

Criteria	Parameter	Description	Range of values in dataset
Restoration Opportunity	Estuarine Dependence	Categorical factor that describes the degree of dependence on estuarine habitat for a fish species based on the injury assessment efforts.	Values include: Estuarine Dependent - 1 Estuarine Obligate - 2 Estuarine Facultative – 3 Unknown – 4 Not Estuarine - Possible Stray - 5 Not estuarine - 6

Table B3. Matrix of spearman's rank correlation tests of raw data values for parameters used during prioritization.

	Comm. Catch	Rec. Catch	Estuarine	IUCN Status	Biomass injury	Production foregone	Vulnerability
Comm. Catch	NA	0.6	-0.25	0.25	0.17	0.48	0.29
Rec. Catch	0.6	NA	-0.34	0.17	0.05	0.39	0.35
Estuarine	-0.25	-0.34	NA	-0.1	-0.07	-0.07	0
IUCN Status	0.25	0.17	-0.1	NA	0.04	0.16	0.27
Biomass injury	0.17	0.05	-0.07	0.04	NA	0.21	-0.17
Production foregone	0.48	0.39	-0.07	0.16	0.21	NA	0.11
Vulnerability	0.29	0.35	0	0.27	-0.17	0.11	NA

Analytical steps

All calculations were completed using functions from the MODA package (Deehr et al., 2018) in R (R Core team, 2021). Raw data values for each metric are first normalized into scores that have the same scale across metrics (i.e., range from 0-1). In this iteration of the MARPP, raw data are normalized according to a negative exponential function to reduce the influence of large values. Future runs may explore normalizing within each group to better differentiate between species within groups.

The priority score (P_i) is calculated by taking a weighted average of the normalized metric scores. In all, seven metrics were included. Equal weights (0.15) were applied for each metric except for "Estuarine" which was set at 0.10. The priority score of species *i* is the sum of the product of the metric weight, *w,* and the species-specific normalized metric value ($\tilde{v}_i$) for that criterion, as shown in Equation 1.

$$eq.1.\ P_i = \sum_{j=1}^{n} w_j \tilde{v}_{ij}$$

A sensitivity analysis was performed to assess the implications of the assigned criteria weights. For the top four species in each group, scores were re-run multiple times adjusting the weight of one criterion to range between 0-1 while holding all other criteria proportionally constant. This was done for all seven criteria included in the score. The output was inspected visually to assess the robustness of species' ranks, provide insights into effects of missing data, and help determine what inputs are most important in determining priority scores.

Results

Raw data and the resulting prioritization scores are provided below. Tabular results are shown in Table B-4 and graphical results are presented in the main document text.

Table B-4. Table of raw values and calculated prioritization score for each species considered by species group.

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
Billfish	blue marlin	*Makaira nigricans*	226	276	79	108,897	51.70	3	6	0.44
	swordfish	*Xiphias gladius*	298	7,378	187	2,144,054	71.96	1	6	0.44
	sailfish	*Istiophorus albicans*	163	NA	79	108,897	64.62	NA	6	0.40
	white marlin	*Kajikia albida*	49	840	79	108,897	41.31	3	6	0.42
Drums and Seatrout	freshwater drum	*Aplodinotus grunniens*	NA	1,397	31	692	37.12	1	6	0.20
	silver perch	*Bairdiella chrysoura*	NA	477,989	35	692	20.52	1	2	0.23
	sand seatrout	*Cynoscion arenarius*	281	9,203,164	1,537	11,303	36.25	1	2	0.46
	spotted seatrout	*Cynoscion nebulosus*	7,540	35,849,305	1,551	11,424	58.44	1	2	0.62
	silver seatrout	*Cynoscion nothus*	NA	116,836	1,537	11,303	37.60	1	6	0.48
	jack-knifefish	*Equetus lanceolatus*	NA	NA	31	692	21.61	NA	6	0.16
	spotted drum	*Equetus punctatus*	NA	NA	31	692	22.80	1	6	0.16
	banded drum	*Larimus fasciatus*	NA	NA	187	692	15.79	1	3	0.10
	spot	*Leiostomus xanthurus*	1,837	238,897	253	976	29.15	1	2	0.34
	southern kingfish	*Menticirrhus americanus*	3,599	2,481,202	217	692	36.20	1	2	0.40
	Gulf kingfish	*Menticirrhus littoralis*	2,795	2,251,618	217	692	32.54	1	3	0.40
	northern kingfish	*Menticirrhus saxatilis*	322	17,191	217	692	26.05	1	2	0.16

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	Atlantic croaker	*Micropogonias undulatus*	621,251	11,514,371	130	936	34.09	1	2	0.43
	high-hat drum	*Pareques acuminatus*	NA	NA	36	692	19.33	1	6	0.15
	blackbar drum	*Pareques iwamotoi*	NA	830	36	692	25.24	1	6	0.17
	cubbyu	*Pareques umbrosus*	NA	NA	36	692	21.61	1	6	0.16
	black drum	*Pogonias cromis*	30,973	1,888,152	31	692	61.72	1	2	0.47
	red drum	*Sciaenops ocellatus*	7,114	11,684,588	675	21,385	42.92	1	2	0.59
	American stardrum	*Stellifer lanceolatus*	NA	NA	416	692	16.13	1	2	0.10
Flatfishes	angelfin whiff	*Citharichthys gymnorhinus*	NA	NA	263	0	10.00	1	6	0.12
	gray flounder	*Etropus rimosus*	NA	NA	861	0	12.93	1	6	0.18
	slender sole	*Lyopsetta exilis*	NA	NA	2	0	46.95	1	6	0.21
	southern flounder	*Paralichthys lethostigma*	NA	919,077	21	0	43.52	2	2	0.31
	California tonguefish	*Symphurus atricaudus*	NA	NA	1,082	0	30.19	NA	6	0.25
	hogchoker	*Trinectes maculatus*	NA	NA	5	0	36.78	1	2	0.12
	Lined sole	*Achirus lineatus*	NA	NA	5	0	28.76	1	2	0.10
	three-eye flounder	*Ancylopsetta dilecta*	NA	NA	12	0	23.36	1	6	0.15
	Gulf of Mexico ocellated flounder	*Ancylopsetta ommata*	NA	NA	12	0	23.36	1	6	0.15
	eyed flounder	*Bothus ocellatus*	NA	NA	2,489	0	25.07	1	6	0.28

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	twospot flounder	*Bothus robinsi*	NA	NA	2,489	0	30.46	1	6	0.30
	Gulf Stream flounder	*Citharichthys arctifrons*	NA	NA	263	0	16.49	1	6	0.15
	horned whiff	*Citharichthys cornutus*	NA	NA	263	0	10.00	1	6	0.12
	spotted whiff	*Citharichthys macrops*	NA	NA	263	0	19.46	1	6	0.16
	bay whiff	*Citharichthys spilopterus*	NA	NA	263	0	28.15	1	2	0.12
	Mexican flounder	*Cyclopsetta chittendeni*	NA	NA	465	0	20.10	1	6	0.18
	spotfin flounder	*Cyclopsetta fimbriata*	NA	NA	465	0	27.75	1	6	0.21
	American spiny flounder	*Engyophrys senta*	NA	NA	1,544	0	15.39	1	6	0.22
	fringed flounder	*Etropus crossotus*	NA	NA	861	0	10.00	1	2	0.09
	shelf flounder	*Etropus cyclosquamus*	NA	NA	861	0	11.03	1	6	0.17
	smallmouth flounder	*Etropus microstomus*	NA	NA	861	0	12.93	1	6	0.18
	North American naked sole	*Gymnachirus melas*	NA	NA	5	0	28.31	1	6	0.17
	Gulf of Mexico fringed sole	*Gymnachirus texae*	NA	NA	5	0	21.97	1	6	0.15
	American fourspot flounder	*Hippoglossina oblonga*	NA	NA	12	0	31.51	NA	6	0.18
	deepwater flounder	*Monolene sessilicauda*	NA	NA	1,582	0	25.07	1	6	0.26

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	Gulf flounder	*Paralichthys albigutta*	NA	721,183	21	0	46.78	1	2	0.29
	broad flounder	*Paralichthys squamilentus*	NA	NA	21	0	33.60	1	2	0.11
	curlfin sole	*Pleuronichthys decurrens*	NA	NA	2	0	41.03	NA	6	0.20
	deepwater dab	*Poecilopsetta beanii*	NA	NA	67	0	24.92	1	6	0.16
	shoal flounder	*Syacium gunteri*	NA	NA	2,110	0	20.19	1	3	0.21
	channel flounder	*Syacium micrurum*	NA	NA	2,110	0	31.08	1	4	0.26
	dusky flounder	*Syacium papillosum*	NA	500	2,110	0	25.87	1	6	0.28
	offshore tonguefish	*Symphurus civitatium*	NA	NA	1,082	0	26.96	NA	2	0.17
	spottedfin tonguefish	*Symphurus diomedeanus*	NA	NA	1,082	0	31.06	1	6	0.25
	tonguefish	*Symphurus marginatus*	NA	NA	1,082	0	29.99	1	6	0.25
	pygmy tonguefish	*Symphurus parvus*	NA	NA	1,082	0	16.55	1	2	0.13
	blackcheek tonguefish	*Symphurus plagiusa*	NA	NA	1,082	0	32.09	1	2	0.18
	spottail tonguefish	*Symphurus urospilus*	NA	NA	1,082	0	32.24	1	6	0.26
	sash flounder	*Trichopsetta ventralis*	NA	NA	985	0	27.03	1	6	0.24
Forage Fish	Alabama Shad	*Alosa alabamae*	NA	NA	810	0	47.40	2	2	0.22
	bay anchovy	*Anchoa mitchilli*	NA	NA	22,826	33,852	23.10	1	2	0.36
	longnose anchovy,	*Anchoa nasus*	NA	NA	22,826	33,852	10.00	1	6	0.38

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	bignose anchovy									
	gizzard shad	*Dorosoma cepedianum*	5,086	3,052	810	0	30.28	1	2	0.29
	threadfin shad	*Dorosoma petenense*	NA	4,204	810	0	31.35	1	2	0.17
	dwarf round herring	*Jenkinsia lamprotaenia*	NA	NA	810	0	10.00	1	2	0.09
	little-eye herring	*Jenkinsia majua*	NA	NA	810	0	10.00	1	2	0.09
	rough silverside	*Membras martinica*	NA	NA	2	0	15.01	1	2	0.05
	inland silverside	*Menidia beryllina*	NA	NA	2	0	18.38	1	2	0.06
	tidewater silverside	*Menidia peninsulae*	NA	NA	2	0	18.38	1	2	0.06
	striped mullet	*Mugil cephalus*	104,960	7,002,200	102	6,011	53.12	1	2	0.50
	American harvestfish (butterfish)	*Peprilus paru*	106	NA	494	0	20.48	1	3	0.14
	skipjack shad	*Alosa chrysochloris*	NA	117,983	810	0	46.51	1	3	0.34
	Cuban anchovy	*Anchoa cubana*	NA	NA	22,826	33,852	10.00	1	3	0.33
	striped anchovy	*Anchoa hepsetus*	980	6,608	22,826	33,852	14.62	1	2	0.39
	shortfinger anchovy	*Anchoa lyolepis*	NA	NA	22,826	33,852	12.01	1	6	0.39
	Poey's anchovy	*Anchoviella perfasciata*	NA	NA	22,826	33,852	11.03	1	6	0.39
	Finescale menhaden	*Brevoortia gunteri*	NA	NA	978	1,467	33.80	1	2	0.20

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	Gulf menhaden	*Brevoortia patronus*	5,533,082	6,934,855	978	1,467	30.70	1	2	0.49
	yellowfin menhaden	*Brevoortia smithi*	NA	3,978	978	1,467	36.06	1	2	0.21
	silver anchovy	*Engraulis eurystole*	NA	NA	22,826	33,852	14.62	1	6	0.40
	scaled herring	*Harengula jaguana*	1,217	52,434,625	25,619	0	20.83	1	3	0.45
	shortband herring	*Jenkinsia stolifera*	NA	NA	810	0	10.00	1	2	0.09
	Atlantic silverside	*Menidia menidia*	NA	NA	2	0	13.34	1	2	0.04
	white mullet	*Mugil curema*	50,711	1,192,791	102	6,011	59.24	1	2	0.51
	Atlantic threadfin herring	*Opisthonema oglinum*	8,104	10,198,538	29,420	0	23.84	1	3	0.55
	Gulf butterfish	*Peprilus burti*	NA	126	346	0	12.47	1	6	0.14
	butterfish	*Peprilus triacanthus*	NA	25,873	55	0	19.07	NA	3	0.13
	round herring	*Etrumeus teres*	NA	NA	1,051	0	NA	NA	6	0.18
	harvestfish (butterfish)	*Peprilus alepidotus*	NA	NA	55	0	NA	NA	2	0.03
Fundulus family	golden topminnow	*Fundulus chrysotus*	NA	NA	0	0	12.01	1	6	0.11
	starhead topminnow, northern starhead topminnow	*Fundulus dispar*	NA	NA	0	0	10.00	1	6	0.10
	mummichog	*Fundulus heteroclitus*	NA	NA	0	0	16.22	1	2	0.05

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	mosquitofish	*Gambusia affinis*	NA	NA	0	0	38.36	1	1	0.09
	eastern mosquitofish	*Gambusia holbrooki*	NA	NA	0	0	24.10	1	1	0.05
	least killifish	*Heterandria formosa*	NA	NA	0	0	11.53	1	3	0.06
	blue-fintop minnow, bluefin killifish	*Lucania goodei*	NA	NA	0	0	10.00	1	6	0.10
	rainwater killifish	*Lucania parva*	NA	NA	0	0	10.00	1	6	0.10
	sailfin molly	*Poecilia latipinna*	NA	268	0	0	32.09	1	2	0.10
	diamond killifish	*Adinia xenica*	NA	NA	0	0	10.00	NA	2	0.03
	pike killifish	*Belonesox belizanus*	NA	NA	0	0	35.08	1	2	0.11
	goldspotted killifish	*Floridichthys carpio*	NA	NA	0	0	32.40	1	2	0.10
	Gulf killifish	*Fundulus grandis*	NA	20,350	0	0	23.67	1	2	0.11
	saltmarsh topminnow	*Fundulus jenkinsi*	NA	NA	0	0	10.00	3	2	0.08
	striped killifish	*Fundulus majalis*	NA	129,920	0	0	20.93	1	6	0.26
	bayou killifish	*Fundulus pulvereus*	NA	NA	0	0	10.00	1	2	0.03
	longnose killifish	*Fundulus similis*	NA	NA	0	0	16.13	1	2	0.05
	flagfish	*Jordanella floridae*	NA	NA	0	0	28.51	NA	2	0.09
	sheepshead minnow	*Cyprinodon variegatus*	NA	397,666	0	0	NA	1	3	0.20
Jacks	African pompano	*Alectis ciliaris*	6	5,634	57	0	68.96	1	NA	0.15
	blue runner	*Caranx crysos*	81,442	15,203,604	1,295	0	34.26	1	6	0.57

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	ladyfish	*Elops saurus*	16,964	12,231,695	103	0	37.86	1	2	0.43
	leatherjacket	*Oligoplites saurus*	NA	367,884	79	0	25.31	1	2	0.24
	gaff-topsail pompano	*Trachinotus goodei*	NA	NA	57	0	31.61	1	NA	0.08
	yellow jack	*Carangoides bartholomaei*	NA	NA	57	0	50.31	NA	3	0.17
	crevalle jack	*Caranx hippos*	1,608	7,373,572	1,295	0	58.36	1	2	0.46
	horse-eye jack	*Caranx latus*	0	1,516	1,295	0	56.83	1	3	0.26
	black jack	*Caranx lugubris*	NA	207	1,295	0	60.08	1	NA	0.22
	Atlantic bumper	*Chloroscombrus chrysurus*	1,926	734,023	10,976	0	29.10	1	2	0.47
	mackerel Scad	*Decapterus macarellus*	NA	NA	57	0	22.51	1	6	0.15
	round scad	*Decapterus punctatus*	NA	4,583,695	1,761	0	33.63	1	6	0.44
	rainbow runner	*Elagatis bipinnulata*	0	NA	1,255	0	50.69	1	6	0.30
	bluntnose jack	*Hemicaranx amblyrhynchus*	NA	NA	57	0	31.61	1	1	0.08
	pilot-fish	*Naucrates ductor*	NA	2,509	57	0	23.82	1	6	0.16
	bluefish	*Pomatomus saltatrix*	956	2,860,950	31	319	57.63	3	2	0.41
	cobia	*Rachycentron canadum*	5,114	261,701	129	4,712	43.66	1	2	0.45
	bigeye scad	*Selar crumenophthalmus*	713	12,632	2,633	0	25.84	1	3	0.29
	Caribbean Moonfish	*Selene brownii*	NA	NA	467	0	23.63	1	6	0.19

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	Atlantic moonfish	*Selene setapinnis*	0	12,066	467	0	35.01	1	2	0.17
	lookdown	*Selene vomer*	3	172,553	467	0	31.10	1	2	0.27
	greater amberjack	*Seriola dumerili*	3,981	525,484	125	19,116	53.95	1	6	0.60
	lesser amberjack	*Seriola fasciata*	NA	8,710	125	19,116	45.96	1	6	0.34
	Almaco jack	*Seriola rivoliana*	NA	43,596	125	19,116	73.55	1	6	0.42
	banded rudderfish	*Seriola zonata*	NA	145,478	125	19,116	42.17	1	6	0.44
	Florida pompano	*Trachinotus carolinus*	809	1,219,425	57	0	37.04	1	2	0.31
	permit	*Trachinotus falcatus*	NA	73,921	57	0	42.40	1	2	0.22
	rough scad	*Trachurus lathami*	NA	2,498	1,213	0	37.06	1	6	0.28
	Cottonmouth Jack	*Uraspis secunda*	NA	NA	57	0	31.61	1	6	0.18
	bar jack	*Carangoides ruber*	NA	NA	57	0	NA	NA	6	0.10
	bonefish	*Albula vulpes*	NA	23,521	919	0	42.66	2	3	0.28
	Tarpon	*Megalops atlanticus*	50	187,790	103	0	75.86	3	2	0.37
Other demersal fish	saddled grenadier	*Coelorinchus caelorhincus*	NA	NA	0	0	62.01	1	6	0.23
	Gulf chimera	*Hydrolagus alberti*	NA	NA	0	0	46.79	1	6	0.21
	red porgy	*Pagrus pagrus*	1,175	651,395	21	0	66.42	1	NA	0.34
	robust assfish	*Bassozetus robustus*	NA	NA	186	0	54.48	1	6	0.24
	swordsnout grenadier	*Coelorinchus occa*	NA	NA	0	0	54.74	1	6	0.22
	blackfin goosefish	*Lophius gastrophysus*	NA	NA	50	0	51.25	1	6	0.22

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	longspine snipefish	*Macroramphosus scolopax*	NA	NA	8	0	26.56	1	6	0.16
	western softhead grenadier	*Malacocephalus occidentalis*	NA	NA	0	0	50.11	1	6	0.21
	North Pacific hake	*Merluccius productus*	NA	NA	0	0	59.90	1	3	0.18
	spinycheek scorpionfish	*Neomerinthe hemingwayi*	NA	954	220	0	58.28	1	6	0.25
	grey cutthroat eel	*Synaphobranchus affinis*	NA	NA	550	0	80.00	1	6	0.29
	cutthroat eel	*Synaphobranchus oregoni*	NA	NA	550	0	58.75	1	6	0.27
	tricorn batfish	*Zalieutes mcgintyi*	NA	NA	40	0	28.80	1	6	0.17
	bony-eared assfish	*Acanthonus armatus*	NA	NA	186	0	41.79	1	6	0.22
	Gilbert's halosaur	*Aldrovandia affinis*	NA	NA	0	0	45.30	1	6	0.21
	Agassiz slickhead	*Alepocephalus agassizii*	NA	NA	0	0	68.85	1	6	0.24
	smalleye smoothhead	*Alepocephalus productus*	NA	NA	0	0	54.16	1	6	0.22
	dotterel filefish	*Aluterus heudelotii*	NA	NA	28	0	46.00	1	6	0.21
	American Eel	*Anguilla rostrata*	NA	3,813	228	0	83.42	4	2	0.30
	stout eelblenny	*Anisarchus medius*	NA	NA	11	0	45.40	NA	6	0.21
	deepbody boarfish	*Antigonia capros*	NA	NA	95	0	16.27	1	6	0.14
	striated argentine	*Argentina striata*	NA	NA	0	0	30.36	1	6	0.17
	silver-rag driftfish	*Ariomma bondi*	NA	NA	908	0	17.95	1	6	0.20

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	gafftopsail catfish	*Bagre marinus*	NA	4,964,036	0	0	56.45	1	2	0.30
	bullseye grenadier	*Bathygadus macrops*	NA	NA	0	0	54.74	1	6	0.22
	Vaillant's grenadier	*Bathygadus melanobranchus*	NA	NA	0	0	54.74	1	6	0.22
	tripod spiderfish	*Bathypterois grallator*	NA	NA	0	0	68.07	1	6	0.24
	blackfin spiderfish	*Bathypterois phenax*	NA	NA	0	0	49.27	1	6	0.21
	highfin lizardfish	*Bathysaurus mollis*	NA	NA	0	0	50.72	1	6	0.21
	Koefoed's smooth-head	*Bathytroctes macrolepis*	NA	NA	0	0	53.72	1	6	0.22
	smallscale smooth-head	*Bathytroctes microlepis*	NA	NA	0	0	46.08	1	6	0.21
	shortfin searobin	*Bellator brachychir*	NA	NA	57	0	14.21	1	6	0.12
	streamer searobin	*Bellator egretta*	NA	NA	57	0	24.79	1	6	0.16
	horned searobin	*Bellator militaris*	NA	NA	57	0	17.31	1	6	0.14
	duckbill flathead	*Bembrops anatirostris*	NA	NA	207	0	44.09	1	6	0.22
	goby flathead	*Bembrops gobioides*	NA	NA	207	0	36.06	1	6	0.21
	grass porgy	*Calamus arctifrons*	NA	171,896	21	0	32.80	1	3	0.26
	whitebone porgy	*Calamus leucosteus*	NA	45,042	21	0	38.48	1	6	0.26
	Atlantic goldeye tilefish	*Caulolatilus chrysops*	0	NA	59	0	48.76	1	6	0.22

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	toadfish	*Chaunax suttkusi*	NA	NA	40	0	17.82	1	6	0.14
	shortnose greeneye	*Chlorophthalmus agassizi*	NA	NA	3,001	0	32.11	1	6	0.31
	blackfin grenadier	*Coelorinchus caribbaeus*	NA	NA	0	0	50.11	1	6	0.21
	worm eel	*Coloconger meadi*	NA	NA	228	0	30.09	NA	6	0.19
	longfin smooth-head	*Conocara macropterum*	NA	NA	0	0	47.24	1	6	0.21
	Mediterranean grenadier	*Coryphaenoides mediterraneus*	NA	NA	0	0	61.44	1	6	0.23
	Mexican grenadier	*Coryphaenoides mexicanus*	NA	NA	0	0	46.13	1	6	0.21
	rudis rattail	*Coryphaenoides rudis*	NA	NA	0	0	71.07	1	6	0.24
	thickbeard grenadier	*Coryphaenoides zaniophorus*	NA	NA	0	0	46.13	1	6	0.21
	rosy dory	*Cyttopsis rosea*	NA	NA	0	0	21.98	1	6	0.15
	Atlantic batfish	*Dibranchus atlanticus*	NA	NA	40	0	59.35	1	6	0.23
	digitate cusk eel	*Dicrolene introniger*	NA	NA	186	0	31.07	1	6	0.19
	brotulas	*Diplacanthopoma brachysoma*	NA	NA	194	0	20.13	1	6	0.16
	fat sleeper	*Dormitator maculatus*	NA	NA	11	0	56.84	1	2	0.15
	shortbelly eel	*Dysomma anguillare*	NA	NA	550	0	26.12	1	6	0.21
	spinycheek sleeper	*Eleotris pisonis*	NA	NA	11	0	30.46	1	2	0.10
	four-bearded rockling	*Enchelyopus cimbrius*	NA	NA	0	0	46.04	1	6	0.21

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	bigeye cardinalfish	*Epigonus pandionis*	NA	NA	131	0	37.67	1	6	0.20
	tidewater mojarra	*Eucinostomus harengulus*	NA	NA	190	0	17.75	1	2	0.08
	beardless codling	*Gadella imberbis*	NA	NA	43	0	34.66	1	6	0.19
	doublethread grenadier	*Gadomus arcuatus*	NA	NA	0	0	58.22	1	6	0.22
	threadfin grenadier	*Gadomus longifilis*	NA	NA	0	0	38.20	1	6	0.19
	blacktail moray eel	*Gymnothorax kolpos*	NA	NA	646	0	38.67	1	6	0.25
	ocellated moray	*Gymnothorax saxicola*	NA	NA	646	0	34.86	1	1	0.14
	western roughy	*Hoplostethus occidentalis*	NA	NA	5	0	51.70	1	6	0.22
	blacktail pike-conger	*Hoplunnis diomediana*	NA	NA	1,092	0	24.46	1	6	0.23
	freckled pike-conger	*Hoplunnis macrura*	NA	NA	1,092	0	31.21	1	6	0.25
	spotted pike-conger	*Hoplunnis tenuis*	NA	NA	1,092	0	27.46	1	6	0.24
	pelagic basslet	*Howella brodiei*	NA	NA	540	0	15.76	NA	6	0.17
	rattail	*Hymenocephalus billsam*	NA	NA	0	0	25.07	1	6	0.16
	glasshead grenadier	*Hymenocephalus italicus*	NA	NA	0	0	32.40	1	6	0.18
	deepsea tripod fish	*Ipnops murrayi*	NA	NA	0	0	40.55	1	6	0.20
	lancer stargazer	*Kathetostoma albigutta*	NA	NA	124	0	31.12	1	6	0.19

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	Morid codling	*Laemonema goodebeanorum*	NA	NA	39	0	45.44	1	6	0.21
	pinfish	*Lagodon rhomboides*	NA	30,406,217	21	0	34.40	1	2	0.26
	shortbeard cusk-eel	*Lepophidium brevibarbe*	NA	NA	186	0	33.48	1	6	0.20
	barred cusk-eel	*Lepophidium staurophor*	NA	NA	186	0	33.48	1	6	0.20
	Grenadier smooth-head	*Leptoderma macrops*	NA	NA	0	0	39.21	1	6	0.19
	American angler	*Lophius americanus*	NA	NA	50	0	76.87	NA	6	0.25
	softhead grenadier	*Malacocephalus laevis*	NA	NA	0	0	58.28	1	6	0.23
	offshore hake	*Merluccius albidus*	NA	NA	0	0	29.69	1	6	0.17
	silver hake	*Merluccius bilinearis*	NA	NA	0	0	53.70	2	3	0.19
	Blackhead slickhead	*Narcetes stomias*	NA	NA	0	0	63.43	1	6	0.23
	twospot brotula	*Neobythites gilli*	NA	NA	186	0	20.74	1	6	0.16
	large-scaled lantern fish	*Neoscopelus macrolepidotus*	NA	NA	29	0	37.68	1	6	0.19
	shortfin neoscopelid	*Neoscopelus microchir*	NA	NA	29	0	42.56	1	6	0.20
	common Atlantic grenadier	*Nezumia aequalis*	NA	NA	0	0	43.96	1	6	0.20
	cyrano grenadier	*Nezumia cyrano*	NA	NA	0	0	41.46	1	6	0.20
	suilla grenadier	*Nezumia suilla*	NA	NA	0	0	33.24	1	6	0.18

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	longnose batfish	*Ogcocephalus corniger*	NA	NA	40	0	39.88	1	6	0.20
	slantbrow batfish	*Ogcocephalus declivirostris*	NA	NA	40	0	34.40	1	6	0.19
	spotted batfish	*Ogcocephalus pantostictus*	NA	NA	40	0	50.88	1	6	0.22
	polka-dot batfish (radiatus)	*Ogcocephalus radiatus*	NA	5,475	40	0	57.68	NA	6	0.24
	striped cusk-eel	*Ophidion marginatum*	NA	NA	186	0	24.93	1	6	0.17
	Gulf toadfish	*Opsanus beta*	NA	299,192	0	0	19.35	1	2	0.21
	pigfish	*Orthopristis chrysoptera*	971	2,230,745	38	269	50.68	1	3	0.36
	polka-dot cusk-eel	*Otophidium omostigma*	NA	NA	186	0	16.49	1	6	0.14
	greeneye	*Parasudis truculenta*	NA	NA	3,001	0	13.16	1	6	0.24
	slender searobin	*Peristedion gracile*	NA	NA	108	0	30.38	1	6	0.18
	alligator searobin	*Peristedion greyae*	NA	NA	108	0	37.25	1	6	0.20
	armored searobin	*Peristedion miniatum*	NA	NA	59	0	39.40	1	6	0.20
	rimspine searobin	*Peristedion thompsoni*	NA	NA	59	0	34.37	1	6	0.19
	Atlantic threadfin	*Polydactylus octonemus*	NA	30,005	11	0	15.77	1	2	0.10
	rendezvous fish	*Polymetme corythaeola*	NA	NA	10,650	0	16.20	1	6	0.28
	beardfish	*Polymixia lowei*	NA	NA	25	0	37.06	1	6	0.19

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	stout beardfish	*Polymixia nobilis*	NA	NA	25	0	42.87	1	6	0.20
	longspine scorpionfish	*Pontinus longispinis*	NA	4,433	220	0	37.81	1	6	0.22
	Atlantic midshipman	*Porichthys plectrodon*	NA	NA	0	0	31.94	1	3	0.13
	slender cusk eel	*Porogadus miles*	NA	NA	186	0	28.12	1	6	0.18
	spiny searobin	*Prionotus alatus*	NA	NA	57	0	23.67	1	6	0.16
	northern searobin	*Prionotus carolinus*	NA	NA	57	0	34.58	1	3	0.14
	bigeye searobin	*Prionotus longispinosus*	NA	NA	57	0	34.24	1	2	0.11
	Gulf of Mexico barred searobin	*Prionotus martis*	NA	NA	57	0	23.67	1	6	0.16
	Mexican searobin	*Prionotus paralatus*	NA	NA	57	0	23.67	1	6	0.16
	bluespotted searobin	*Prionotus roseus*	NA	NA	57	0	24.79	1	6	0.16
	blackwing searobin	*Prionotus rubio*	NA	NA	57	0	31.76	1	1	0.08
	leopard searobin	*Prionotus scitulus*	NA	1,567	57	0	28.95	1	2	0.10
	shortwing searobin	*Prionotus stearnsi*	NA	NA	57	0	23.67	1	6	0.16
	bighead searobin	*Prionotus tribulus*	NA	527	57	0	34.24	1	2	0.12
	abyssal smooth-head	*Rinoctes nasutus*	NA	NA	0	0	34.67	1	6	0.18
	madeiran smooth-head	*Rouleina maderensis*	NA	NA	0	0	45.95	1	6	0.21

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	longfin scorpionfish	*Scorpaena agassizii*	NA	NA	220	0	35.08	1	6	0.21
	channeled rockfish	*Setarches guentheri*	NA	NA	8	0	13.16	1	6	0.11
	marbled puffer	*Sphoeroides dorsalis*	NA	NA	125	0	16.13	1	6	0.14
	least puffer	*Sphoeroides parvus*	NA	552	125	0	12.93	1	2	0.05
	luminous hake	*Steindachneria argentea*	NA	NA	2,640	0	27.81	1	6	0.29
	longspine porgy	*Stenotomus caprinus*	NA	NA	21	0	17.68	1	6	0.13
	pricklefish	*Stephanoberyx monae*	NA	NA	0	0	36.99	1	6	0.19
	blackmouth bass	*Synagrops bellus*	NA	NA	208	0	34.57	1	6	0.20
	keelsheek bass	*Synagrops spinosus*	NA	NA	208	0	19.04	NA	6	0.16
	Antillean smooth-head	*Talismania antillarum*	NA	NA	0	0	31.27	1	6	0.17
	bristly grenadier	*Trachonurus sulcatus*	NA	NA	0	0	54.74	1	6	0.22
	Gulf hake	*Urophycis cirrata*	NA	NA	0	0	55.50	1	6	0.22
	southern codling	*Urophycis floridana*	NA	323	0	0	33.35	1	2	0.11
	spotted codling	*Urophycis regia*	NA	NA	0	0	36.00	1	3	0.14
	witch eel	*Venefica procera*	NA	NA	1,092	0	52.34	NA	6	0.30
	longbeard grenadier	*Ventrifossa macropogon*	NA	NA	0	0	50.11	1	6	0.21
	freckled stargazer	*Xenocephalus egregius*	NA	NA	124	0	34.90	1	6	0.20

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	dory	*Zenopsis conchifer*	NA	NA	0	0	59.81	1	6	0.23
	singlespot frogfish	*Antennarius radiosus*	NA	NA	40	0	NA	NA	6	0.10
	palefin dragonet	*Foetorepus goodenbeani*	NA	NA	253	0	NA	NA	6	0.12
	large-eyed rabbitfish	*Hydrolagus mirabilis*	NA	NA	0	0	40.75	1	6	0.20
	devil anglerfish	*Lophius vomerinus*	NA	NA	50	0	60.18	2	6	0.26
Other Reef-associated	red hogfish	*Decodon puellaris*	NA	NA	1,220	0	34.51	1	6	0.27
	cherubfish	*Centropyge argi*	NA	NA	25	0	12.93	1	6	0.11
	bicolor angelfish	*Centropyge bicolor*	NA	NA	25	0	23.01	1	6	0.15
	spiny boxfish	*Chilomycterus schoepfii*	NA	NA	28	0	14.84	1	2	0.05
	Bermuda blue angelfish	*Holacanthus bermudensis*	NA	NA	25	0	43.84	1	6	0.21
	stoplight parrotfish	*Sparisoma viride*	NA	1,075	5,804	0	31.37	1	6	0.32
	Atlantic needlefish	*Strongylura marina*	NA	37,712	275	0	57.79	1	2	0.23
	bluehead	*Thalassoma bifasciatum*	NA	NA	1,220	0	19.56	1	3	0.17
	rosy razorfish	*Xyrichtys martinicensis*	NA	NA	1,220	0	24.47	1	6	0.24
	pearly razorfish	*Xyrichtys novacula*	NA	NA	1,220	0	36.27	1	6	0.27
	scrawled cowfish	*Acanthostracion quadricornis*	NA	NA	4	0	31.74	1	2	0.10
	key worm eel	*Ahlia egmontis*	NA	NA	1,544	0	25.43	1	6	0.26
	unicorn leatherjacket filefish	*Aluterus monoceros*	NA	644	28	0	63.21	1	6	0.23

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	orange filefish	*Aluterus schoepfii*	NA	NA	28	0	57.38	1	6	0.23
	scrawled filefish	*Aluterus scriptus*	NA	4,770	28	0	70.49	1	6	0.25
	black margate	*Anisotremus surinamensis*	NA	9,950	38	269	56.47	NA	6	0.25
	tusky eel	*Aplatophis chauliodus*	NA	NA	1,544	0	39.06	1	6	0.29
	bridle cardinalfish	*Apogon aurolineatus*	NA	NA	173	0	10.00	1	2	0.04
	flamefish	*Apogon maculatus*	NA	NA	173	0	10.53	1	6	0.12
	twospot cardinalfish	*Apogon pseudomaculatus*	NA	NA	173	0	10.53	1	6	0.12
	sheepshead	*Archosargus probatocephalus*	7,124	6,773,047	21	0	36.43	1	2	0.40
	hardhead catfish	*Ariopsis felis*	NA	NA	0	0	56.46	1	3	0.17
	bandtooth conger	*Ariosoma balearicum*	NA	NA	3,305	0	30.59	1	6	0.31
	starry goby	*Asterropteryx semipunctata*	NA	NA	3,105	0	12.01	1	6	0.24
	southern stargazer	*Astroscopus y-graecum*	NA	534	124	0	41.06	1	2	0.14
	avocet snipe eel	*Avocettina infans*	NA	NA	228	0	38.68	1	6	0.21
	gray triggerfish	*Balistes capriscus*	155	1,959,870	17	232	31.56	3	3	0.34
	Gill's cusk eel	*Bassogigas gillii*	NA	NA	186	0	54.96	1	6	0.24
	slender frostfish	*Benthodesmus tenuis*	NA	NA	236	0	66.09	1	6	0.26
	ragged goby	*Bollmannia communis*	NA	NA	3,105	0	30.38	1	1	0.20

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	bearded brotula	*Brotula barbata*	22	26	186	0	52.44	1	6	0.24
	jolthead porgy	*Calamus bajonado*	83	86,275	21	0	55.84	1	3	0.28
	saucereye porgy	*Calamus calamus*	NA	15,403	21	0	55.84	1	3	0.20
	knobbed porgy	*Calamus nodosus*	NA	38,546	21	0	49.65	1	6	0.27
	sheepshead porgy	*Calamus penna*	NA	5,639	21	0	46.23	1	6	0.22
	littlehead porgy	*Calamus proridens*	NA	172,204	21	0	43.18	1	6	0.34
	shorttail snake eel	*Callechelys guineensis*	NA	NA	1,544	0	49.74	1	6	0.31
	blotched snake eel	*Callechelys muraena*	NA	NA	1,544	0	33.58	1	6	0.28
	chivo	*Cantherhines pullus*	NA	713	20	0	29.65	1	6	0.17
	rough triggerfish	*Canthidermis maculata*	NA	NA	13	128	44.41	1	6	0.21
	ocean triggerfish	*Canthidermis sufflamen*	NA	4,922	144	128	49.63	1	6	0.24
	pearlfish	*Carapus bermudensis*	NA	NA	186	0	10.00	1	6	0.12
	Gulf bareye tilefish	*Caulolatilus intermedius*	NA	NA	59	0	51.88	1	6	0.22
	grey tilefish	*Caulolatilus microps*	NA	11,685	59	0	58.02	NA	6	0.25
	Atlantic spadefish	*Chaetodipterus faber*	89	889,916	33	0	36.89	1	3	0.30
	bridled boxfish	*Chilomycterus antennatus*	NA	NA	28	0	20.00	1	2	0.07

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	American conger	*Conger oceanicus*	NA	NA	3,305	0	83.91	1	2	0.31
	spotted goby	*Coryphopterus punctipectophorus*	NA	NA	3,105	0	18.23	1	6	0.27
	flying gurnard	*Dactylopterus volitans*	NA	3,264	22	0	30.57	1	6	0.18
	spotted dragonet	*Diplogrammus pauciradiatus*	NA	NA	253	0	10.00	1	6	0.12
	slender sharksucker	*Echeneis naucrates*	NA	124,061	32	0	54.09	1	6	0.34
	whitefin sharksucker	*Echeneis neucratoides*	NA	143,781	32	0	45.01	NA	6	0.33
	spotted spoon-nose eel	*Echiophis intertinctus*	NA	NA	1,544	0	69.33	1	NA	0.23
	stippled spoon-nose eel	*Echiophis punctifer*	NA	NA	1,544	0	69.33	1	NA	0.23
	spotfin mojarra	*Eucinostomus argenteus*	843	11,814	190	0	16.13	1	2	0.13
	silver jenny	*Eucinostomus gula*	NA	127,027	190	0	25.24	1	2	0.22
	red cornetfish	*Fistularia petimba*	NA	NA	179	0	71.00	1	4	0.23
	cornetfish	*Fistularia tabacaria*	NA	31	179	0	71.00	1	4	0.23
	violet goby	*Gobioides broussonnetii*	NA	NA	3,105	0	60.24	1	6	0.36
	highfin goby	*Gobionellus oceanicus*	NA	NA	3,105	0	37.25	1	2	0.25
	naked goby	*Gobiosoma bosc*	NA	NA	3,105	0	14.21	1	2	0.18
	spotted moray	*Gymnothorax moringa*	NA	2,960	646	0	76.55	1	6	0.30
	blackedge moray	*Gymnothorax nigromarginatus*	NA	NA	646	0	49.85	1	1	0.17

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	tomtate grunt	*Haemulon aurolineatum*	416	1,154,505	38	269	37.49	1	3	0.32
	white grunt	*Haemulon plumierii*	0	NA	38	269	61.75	1	3	0.19
	blue-striped grunt	*Haemulon sciurus*	NA	103,511	38	269	35.33	1	3	0.25
	pancake batfish	*Halieutichthys aculeatus*	NA	NA	40	0	28.80	1	6	0.17
	false pichard	*Harengula clupeola*	NA	44,182	25,619	0	17.07	1	2	0.27
	redear sardine	*Harengula humeralis*	NA	NA	25,619	0	14.26	1	2	0.20
	ballyhoo	*Hemiramphus brasiliensis*	4,097	354,009	145	0	26.97	1	6	0.44
	sargassumfish	*Histrio histrio*	NA	NA	40	0	10.00	1	6	0.10
	barred blenny	*Hypleurochilus bermudensis*	NA	NA	88	0	20.93	1	6	0.15
	crested blenny	*Hypleurochilus geminatus*	NA	NA	88	0	20.93	1	2	0.08
	smooth puffer	*Lagocephalus laevigatus*	NA	15,074	125	0	52.36	1	2	0.18
	mottled cusk-eel	*Lepophidium jeannae*	NA	NA	186	0	35.82	1	6	0.20
	Atlantic tripletail	*Lobotes surinamensis*	55	142,490	15	0	34.52	1	2	0.24
	swordtail jawfish	*Lonchopisthus micrognathus*	NA	NA	112	0	10.00	1	6	0.11
	golden tilefish	*Lopholatilus chamaeleonticeps*	1,551	32,689	59	0	59.86	4	6	0.44
	clown goby	*Microgobius gulosus*	NA	NA	3,105	0	18.23	1	2	0.19

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	fringed filefish	*Monacanthus ciliatus*	NA	NA	19	0	29.65	1	2	0.10
	yellow goatfish	*Mulloidichthys martinicus*	NA	NA	111	0	31.82	1	NA	0.09
	red goatfish	*Mullus auratus*	NA	NA	111	0	25.10	1	3	0.12
	polka-dot batfish (cubifrons)	*Ogcocephalus cubifrons*	NA	NA	40	0	57.68	1	6	0.23
	shortnose batfish	*Ogcocephalus nasutus*	NA	NA	40	0	56.61	1	1	0.13
	roughback batfish	*Ogcocephalus parvus*	NA	NA	40	0	28.80	1	6	0.17
	shrimp eel	*Ophichthus gomesii*	NA	NA	1,544	0	41.55	1	1	0.20
	king snake eel	*Ophichthus rex*	NA	NA	1,544	0	74.39	1	6	0.34
	blotched cusk-eel	*Ophidion grayi*	NA	NA	186	0	28.12	1	6	0.18
	band cusk-eel	*Ophidion holbrookii*	NA	NA	186	0	28.12	1	6	0.18
	Crested cusk-eel	*Ophidion josephi*	NA	NA	186	0	24.93	1	2	0.10
	mooneye cusk-eel	*Ophidion selenops*	NA	NA	186	0	11.53	1	6	0.12
	yellowhead jawfish	*Opistognathus aurifrons*	NA	NA	112	0	10.00	1	6	0.11
	leopard toadfish	*Opsanus pardus*	NA	5,500	0	0	37.21	1	6	0.20
	seaweed blenny	*Parablennius marmoreus*	NA	NA	88	0	17.13	1	6	0.14
	Portuguese blenny	*Parablennius ruber*	NA	NA	88	0	22.60	1	6	0.16

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	margintail conger	*Paraconger caudilimbatus*	NA	NA	3,305	0	39.27	1	6	0.33
	margintail conger	*Paraconger caudilimbatus*	NA	NA	3,305	0	39.27	1	6	0.07
	Atlantic bigeye	*Priacanthus arenatus*	NA	3,864	211	0	24.62	1	6	0.18
	bandtail searobin	*Prionotus ophryas*	NA	NA	57	0	30.27	1	6	0.18
	short bigeye	*Pristigenys alta*	NA	2,942	11	0	20.48	1	6	0.15
	spotted goatfish	*Pseudupeneus maculatus*	NA	787	111	0	35.29	1	3	0.15
	common remora	*Remora remora*	NA	231,560	11	0	47.51	1	6	0.35
	yellow conger	*Rhynchoconger flavus*	NA	NA	3,305	0	76.02	1	6	0.38
	Spanish sardine	*Sardinella aurita*	54	1,484,062	5,201	0	35.95	1	3	0.44
	Brazilian lizardfish	*Saurida brasiliensis*	NA	NA	1,386	0	17.79	1	6	0.22
	smallscale lizardfish	*Saurida caribbaea*	NA	NA	1,386	0	12.93	1	6	0.20
	shortjaw lizardfish	*Saurida normani*	NA	NA	1,386	0	28.34	1	6	0.26
	barbfish	*Scorpaena brasiliensis*	NA	NA	220	0	50.42	1	6	0.23
	smooth-head scorpionfish	*Scorpaena calcarata*	NA	NA	220	0	30.94	1	6	0.19
	spotted scorpionfish	*Scorpaena plumieri*	NA	NA	220	0	62.15	1	6	0.25
	southern puffer	*Sphoeroides nephelus*	NA	730,208	125	0	24.56	1	2	0.24

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	bandtail puffer	*Sphoeroides spengleri*	NA	NA	125	0	24.56	1	6	0.17
	checkered puffer	*Sphoeroides testudineus*	NA	NA	125	0	21.61	1	1	0.06
	great barracuda	*Sphyraena barracuda*	NA	256,648	365	0	78.57	1	2	0.35
	northern sennet	*Sphyraena borealis*	NA	1,911	365	0	33.14	1	2	0.14
	Guachanche barracuda	*Sphyraena guachancho*	6	6,351	365	0	79.24	1	2	0.22
	barracuda	*Sphyraena sphyraena*	NA	NA	365	0	48.64	1	6	0.24
	cocoa damselfish	*Stegastes variabilis*	NA	NA	200	0	24.15	NA	6	0.17
	planehead filefish	*Stephanolepis hispidus*	NA	NA	24	0	29.59	NA	2	0.10
	pygmy filefish	*Stephanolepis setifer*	NA	NA	175	0	29.65	1	6	0.19
	chain pipefish	*Syngnathus louisianae*	NA	NA	146	0	30.89	NA	2	0.11
	inshore lizardfish	*Synodus foetens*	NA	1,479,503	1,386	0	37.11	1	2	0.36
	sand diver	*Synodus intermedius*	NA	5,666	1,386	0	28.77	1	6	0.27
	offshore lizardfish	*Synodus poeyi*	NA	NA	1,386	0	17.79	1	6	0.22
	diamond lizardfish	*Synodus synodus*	NA	NA	1,386	0	23.90	1	3	0.20
	Atlantic cutlassfish	*Trichiurus lepturus*	2,308	5,511	4,109	0	51.06	1	6	0.45
	goldband goldfish	*Upeneus moluccensis*	NA	NA	111	0	21.92	1	6	0.16

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	dwarf goatfish	*Upeneus parvus*	NA	NA	111	0	26.94	1	6	0.17
	gargoyle cusk	*Xyelacyba myersi*	NA	NA	186	0	47.46	1	6	0.23
	bigtooth cardinalfish	*Apogon affinis*	NA	NA	173	0	NA	NA	6	0.12
	sharptail goby	*Gobionellus hastatus*	NA	NA	3,105	0	NA	NA	4	0.20
	angelfish	*Holocanthus bermudensis*	NA	15	5	0	NA	NA	6	0.10
	Bermuda chub	*Kyphosus sectator*	NA	NA	45	0	NA	NA	6	0.10
	honeycomb cowfish	*Lactophrys polygonia*	NA	NA	4	0	NA	NA	6	0.10
	palespotted eel	*Ophichthus punticeps*	NA	NA	1,544	0	NA	NA	6	0.20
	snakefish	*Trachinocephalus myops*	NA	74	1,386	0	NA	1	6	0.19
	lined seahorse	*Hippocampus erectus*	NA	NA	146	0	31.20	3	2	0.17
	hogfish	*Lachnolaimus maximus*	13,606	342,759	1,220	0	67.10	3	3	0.62
Sea Basses and Groupers	Atlantic Goliath grouper	*Epinephelus itajara*	NA	36,923	464	2,990	69.54	3	2	0.34
	gag	*Mycteroperca microlepis*	6,121	2,614,310	464	2,990	68.06	3	2	0.57
	scamp	*Mycteroperca phenax*	1,922	153,226	464	2,990	68.23	NA	6	0.51
	yellowfin bass	*Anthias nicholsi*	NA	NA	464	2,990	28.60	1	6	0.24
	yellowtail bass	*Bathyanthias mexicanus*	NA	NA	464	2,990	20.93	1	6	0.21
	bank sea bass	*Centropristis ocyurus*	NA	33,113	464	2,990	31.32	1	6	0.29

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	rock sea bass	*Centropristis philadelphica*	NA	5,691	464	2,990	31.32	1	3	0.20
	black sea bass	*Centropristis striata*	1,315	3,316,801	464	2,990	31.39	1	2	0.38
	dwarf sand perch	*Diplectrum bivittatum*	NA	157	464	2,990	28.60	1	NA	0.14
	sand perch	*Diplectrum formosum*	1,728	1,747,274	464	2,990	14.62	1	NA	0.31
	longtail bass	*Hemanthias leptus*	NA	2,808	464	2,990	40.85	1	6	0.27
	freckled soapfish	*Rypticus bistrispinus*	NA	NA	464	2,990	20.93	1	6	0.21
	whitespotted soapfish	*Rypticus maculatus*	NA	2,868	464	2,990	24.63	1	6	0.23
	pygmy sea bass	*Serraniculus pumilio*	NA	NA	464	2,990	10.53	1	3	0.12
	blackear bass	*Serranus atrobranchus*	NA	NA	464	2,990	24.19	1	6	0.22
	brown comber	*Serranus hepatus*	NA	NA	464	2,990	31.09	1	6	0.24
	saddle bass	*Serranus notospilus*	NA	NA	464	2,990	13.79	1	6	0.18
	Tattler's basslet	*Serranus phoebe*	NA	39	464	2,990	24.63	1	6	0.22
	streamer bass	*Hemanthias aureorubens*	NA	NA	464	2,990	NA	NA	6	0.17
	red barbier	*Hemanthias vivanus*	NA	NA	464	2,990	NA	NA	6	0.17
	red grouper	*Epinephelus morio*	38,714	4,257,561	464	2,990	62.59	3	6	0.65
	black grouper	*Mycteroperca bonaci*	779	90,622	464	2,990	62.99	2	3	0.41

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	yellowedge grouper	*Hyporthodus flavolimbatus*	5,036	NA	464	2,990	57.76	3	6	0.47
	snowy grouper	*Hyporthodus niveatus*	1,332	NA	464	2,990	64.14	3	6	0.41
Snappers	queen snapper	*Etelis oculatus*	132	2,677	256	2,424	33.75	NA	6	0.24
	northern red snapper	*Lutjanus campechanus*	80,951	7,749,858	2,343	118,873	55.11	3	6	0.85
	grey snapper	*Lutjanus griseus*	6,185	19,192,962	646	7,385	39.82	1	2	0.52
	lane snapper	*Lutjanus synagris*	11,344	1,938,496	412	7,385	38.46	2	3	0.56
	yellowtail snapper	*Ocyurus chrysurus*	35,822	2,978,359	256	2,424	64.92	NA	NA	0.48
	wenchman	*Pristipomoides aquilonaris*	NA	NA	695	2,424	40.02	1	6	0.27
	goldflag jobfish	*Pristipomoides auricilla*	NA	NA	695	2,424	32.81	1	6	0.26
	vermilion snapper	*Rhomboplites aurorubens*	37,660	1,954,502	1,019	33,610	49.58	3	6	0.78
	mutton snapper	*Lutjanus analis*	1,053	420,168	412	7,385	46.96	2	2	0.45
Tunas and Mackerels	king mackerel	*Scomberomorus cavalla*	70,384	951,797	832	102,407	68.99	1	6	0.75
	Spanish mackerel	*Scomberomorus maculatus*	113,146	12,458,032	1,632	1,860	39.27	1	6	0.61
	yellowfin tuna	*Thunnus albacares*	4,141	13,537	1,417	614,431	45.75	1	6	0.59
	Dolphinfish	*Coryphaena hippurus*	1,398	1,494,211	217	479,518	39.24	1	6	0.57
	Blackfin Tuna	*Thunnus atlanticus*	113	119,837	1,417	614,431	41.34	1	6	0.56
	bigeye tuna	*Thunnus obesus*	13	433	1,417	614,431	55.53	3	6	0.52

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	skipjack tuna	*Katsuwonus pelamis*	17	34,172	2,787	109,518	36.74	1	6	0.52
	Atlantic bluefin tuna	*Thunnus thynnus*	23	NA	1,895	1,243,570	82.35	1	6	0.51
	albacore tuna	*Thunnus alalunga*	2	NA	1,417	614,431	71.11	1	6	0.48
	little tunny	*Euthynnus alletteratus*	166	577,234	3,651	0	56.97	1	NA	0.42
	Atlantic bonito	*Sarda sarda*	21,339	28,644	299	0	32.68	1	6	0.40
	Pompano Dolphinfish	*Coryphaena equiselis*	NA	NA	217	479,518	34.75	1	6	0.35
	bullet mackerel	*Auxis rochei*	NA	NA	2,927	0	34.46	1	6	0.31
	striped escolar	*Diplospinus multistriatus*	NA	NA	2,009	0	32.78	1	6	0.29
	Frigate mackerel	*Auxis thazard*	NA	NA	2,927	0	26.08	1	6	0.29
	escolar	*Lepidocybium flavobrunneum*	491	21	13	0	84.78	1	6	0.27
	black gemfish	*Nesiarchus nasutus*	NA	NA	341	0	71.29	1	6	0.27
	Atlantic chub mackerel	*Scomber colias*	NA	NA	843	0	41.60	1	6	0.26
	snake mackerel	*Gempylus serpens*	NA	NA	323	0	61.25	1	6	0.26
	domine	*Epinnula magistralis*	NA	NA	266	0	61.25	1	6	0.25
	castor oil fish	*Ruvettus pretiosus*	44	NA	13	0	84.63	1	6	0.25
	roudi escolar	*Promethichthys prometheus*	NA	NA	150	0	57.30	1	6	0.24
	chub mackerel	*Scomber japonicus*	NA	17,530	289	0	30.73	1	6	0.23
	wahoo	*Acanthocybium solandri*	596	18,408	610	0	46.16	1	NA	0.22
	American sackfish	*Neoepinnula americana*	NA	NA	67	0	23.53	1	6	0.16

Species group	Common name	Species name	Commercial catch (tons)	Rec. catch (Individuals)	Biomass injury (kg)	Production Foregone injury (kg)	Vulnerability	IUCN Status	Estuarine dependence	Prioritization score
	longfin escolar	*Scombrolabrax heterolepis*	NA	NA	57	0	16.00	1	6	0.13

References

Josh Deehr, Christopher Smith, Jason Freels and Emily Meyer (2018). DecisionAnalysis: Implementation of Multi Objective Decision Analysis. R package version 0.1.0.

Dunstan, D., G. Tsui, E. Chu, T. Cashion, B. Derrick, B. Doherty, H. Harguth, A. McCrea Strub, W. Figueira L.D. Jenkins and V. Relano. 2020. Marine fisheries catch reconstructions for the continental USA: update to 2018, p. 144-158. In: B. Derrick, M. Khalfallah, V. Relano, D. Zeller and D. Pauly (eds). Updating to 2018 the 1950-2010 Marine Catch Reconstructions of the Sea Around Us. Part II: The Americas and Asia-Pacific. Fisheries Centre Research Report 28(6).

McCrea-Strub, A. 2015. Reconstruction of total catch by U.S. Fisheries in the Atlantic and Gulf of Mexico: 1950-2010. Working paper #2015-79. 47 pages.

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Appendix C. Prioritization scores by species group

Species Group	Mean score	Median score	Median of top 4 scores	Mean of top 4 scores	Maximum score
Billfish	0.42	0.42	0.42	0.42	0.44
Drums and Seatrout	0.30	0.23	0.53	0.54	0.62
Flatfish	0.19	0.18	0.29	0.29	0.31
Forage Fish	0.26	0.22	0.51	0.51	0.55
Jacks	0.30	0.28	0.52	0.53	0.60
Other Deepwater Fish	0.21	0.21	0.33	0.33	0.35
Other Demersal Fish	0.20	0.20	0.32	0.33	0.36
Other Reef-Associated	0.22	0.21	0.45	0.49	0.62
Sea Basses and Groupers	0.30	0.24	0.54	0.55	0.65
Snappers	0.49	0.48	0.67	0.68	0.85
Tunas and Mackerels	0.37	0.30	0.60	0.63	0.75

Appendix D. Restoration objectives and planning needs

Table D-1. Restoration objectives, detailed threats and potential actions listed by species and group. Potential Actions are presented below as examples to illustrate projects that could contribute to a Restoration Objective. Their inclusion below does not imply that they have been chosen to be implemented or are specific proposed projects or actions. Projects would be evaluated under Oil Pollution Act to determine restoration benefits and to meet Natural Resource Damage Assessment requirements.

Restoration Objective	Target Species Group	Priority species	General Threat	Threat detailed	Potential Action (s)
Reduce bycatch of FWCI resources	Snappers	Red snapper	Fishing impacts	Regulatory discards from commercial vessels due to lack of IFQ shares	Reduce regulatory discards from commercial vessels.
	Drums/seatrouts, Flatfishes, Tunas/Mackerels	Spotted seatrout, southern flounder, king mackerel	Fishing impacts	Mortality in commercial shallow nearshore shrimp trawl fishery	Improve efficiency of current bycatch reduction technologies
	Groupers	Red grouper	Fishing impacts	Bycatch in reef fish bottom longline fishery	Reduce bycatch in GOM commercial fisheries
	Jacks	Greater amberjack	Fishing impacts	Bycatch in vertical line fishery	Reduce bycatch in GOM commercial fisheries
	Snappers	Red snapper	Fishing impacts	Juvenile mortality due to commercial shallow nearshore shrimp trawl fishery	Develop and/or improve bycatch reduction technology
	Snappers	Vermilion snapper	Fishing impacts	Bycatch in commercial vertical line fishery	Reduce non-regulatory discards from commercial vessels
	Many	Many	Fishing impacts	Bycatch in domestic and international fisheries	Increase utilization of bycatch reduction technologies in domestic and international fisheries.
	Many	Many	Fishing impacts	Bycatch in recreational fisheries	Reduce incidental or non-target catch in recreational fisheries
Reduce IUU fishing of FWCI resources	Snappers	Red snapper	Fishing impacts	Unpermitted charters in GOM	Reduce illegal fishing in U.S. waters by providing tools or resources to resource managers; Educate stakeholders to increase awareness and compliance with existing laws.
	Snappers	vermilion snapper, red snapper	Fishing impacts	Foreign vessels (Lanchas) fishing in U.S. waters illegally	Reduce illegal fishing in U.S. waters by providing tools or resources to resource managers.

Restoration Objective	Target Species Group	Priority species	General Threat	Threat detailed	Potential Action (s)
Develop and implement tools and techniques to reduce uncertainty in restoration and provide best practices to stakeholders and fishing communities for reduction of fisheries impacts	Billfish	Blue marlin	Fishing impacts	High levels of fishing mortality to GOM stocks in international waters	Implement projects to reduce unintentional fishing impacts occurring in international waters to highly migratory species
	Tunas/Mackerels	Yellowfin tuna	Fishing impacts	Increasing fleet efficiency, specifically use of fish aggregating devices (FADs), leading to increasing vulnerability of fished stocks, especially in the Eastern Atlantic	Develop techniques to reduce juvenile mortality of yellowfin tuna in international fisheries targeting other tunas, such as techniques related to the number of sets made on mixed-species schools targeting skipjack tuna
	All	All	Fishing impacts	Lack of information	Provide fishermen and stakeholders tools, techniques, and information.
Decrease the threat of marine debris to FWCI resources	All	Most	Marine Debris	Mortality and sublethal effects due to ingestion of plastic debris	Develop new or encourage the use of existing methods to reduce or remove marine debris accumulation in the GOM.
	All	Most	Marine Debris	Mortality and sublethal effects due to ingestion of plastic debris	Remove plastic and/or microplastic from the marine environment;
	All	Most	Marine Debris	Mortality and sublethal effects due to ingestion of plastic debris	Prevent entry of plastics and/or microplastic into the marine environment using current technologies.
	Crabs/Lobsters, Drums/seatrout , Flatfishes	Blue crab, Spotted seatrout, Southern flounder	Marine Debris	Ghost fishing by derelict crab traps	Locate and remove ghost fishing gear (traps, nets, lines) from the GOM.
	All	Most	Marine Debris	Mortality and sublethal effects due to ingestion of plastic debris	Educate the public regarding threats from marine debris
Reduce post-release mortality of FWCI resources	Billfish	Blue marlin	Fishing impacts	Post-release mortality in recreational Caribbean billfish fishery	Increase angler awareness of best practices for catch and release practices to reduce fishing mortality
	Drums/seatrouts	Spotted seatrout	Fishing impacts	Population levels are declining in some areas in the GOM	Increase angler awareness of best practices for catch and release practices to reduce fishing mortality

Restoration Objective	Target Species Group	Priority species	General Threat	Threat detailed	Potential Action (s)
	Flatfishes	Southern flounder	Fishing impacts	Population declines noted in the GOM, specifically the population is overfished or experiencing overfishing in Florida and Louisiana recreational fisheries	Reduce release mortality in recreational fishery
	Snappers	Red snapper	Fishing impacts	High rates of discard mortality in recreational reef fish fishery	Increase successful use of barotrauma mitigation techniques
	All	all	Fishing impacts	Post-release mortality in recreational fisheries	Support work on Gulf-wide discard mortality reduction projects via innovations in best practices in the recreational fishery.
Reduce risks from invasive species to FWCI resources	Snappers, other reef fish	Red snapper, vermilion snapper	Invasive species	Lionfish population expansion has a negative impact on native fish populations	Implement lionfish removal activities
	All	All	Invasive species	Potential impacts from future invasions	Educate and train marine stakeholders on invasive species risks and prevention measures.
Reduce risks to FWCI from energy development and production activities	Snappers	Red snapper, vermilion snapper	Other direct threats	Explosive decommissioning of oil rigs	Develop and implement practices to reduce mortality during removal of infrastructure.
Reduce mortality to FWCI resources due to HABs	Groupers, Drums/Seatrout, Forage fish	Red grouper, spotted seatrout, mullets, and Gulf menhaden	Water quality	Mortality of adult and juvenile red grouper due to red tides can be substantial; other nearshore species (e.g. spotted seatrout) also impacted by mortality from red tide	Develop methods to reduce impacts of red tide events to priority species in coastal waters
Enhance Sargassum and other pelagic habitats	None	*Sargassum*	Multiple	NA	NA

Table D-2. Planning Needs by Restoration Objective

Restoration Objective	Group	Priority species	General Threat	Detailed Threat	Planning needs
Multiple	All	All	Climate change	Climate change may jeopardize restoration project success	Understand combined impact from climate change and other stressors to identify future restoration opportunities.
	All	All	Climate change	Climate change may cause impacts which will provide restoration opportunity	Identify species-specific impacts to identify current restoration opportunities.
	Billfish	Blue marlin	Multiple	NA	Identify larval distribution mechanisms, important habitats, and factors influencing recruitment to develop additional restoration opportunities
	Elasmobranchs	NA	Multiple	NA	Synthesize information on injury, identify other threats and stressors, and identify restoration opportunities for these species
	Jellies/cnidaria	NA	Multiple	NA	Support projects which increase understanding of population dynamics and ecological role of these species which will allow for targeted restoration projects to be identified.
	Other demersal fish	American eel	Multiple	NA	Identify and implement activities that would contribute to restoration given population dynamics, connectivity, and threats to populations that mature in Gulf of Mexico watersheds
	Snappers	Vermilion snapper	Multiple	NA	Movement and diet studies are an important part of understanding this species role within the ecosystem in the Gulf of Mexico. Predator-prey and competitive interactions with red snapper will be critical in the context with ecosystem-based management and multiple stressors

Restoration Objective	Group	Priority species	General Threat	Detailed Threat	Planning needs
Develop and implement tools and techniques to reduce uncertainty in restoration and provide best practices to stakeholders and fishing communities for reduction of fisheries impacts	Billfish	Blue marlin	Fishing impacts	Imprecise population estimates	Develop methods to incorporate blue marlin habitat/environmental covariate information into catch per unit effort standardization
	Billfish	Blue marlin	Fishing impacts	Incomplete understanding of fishing behavior	Understand the factors that influence fishery efficiency (including catch and bycatch) to support the identification of restoration opportunities
	Billfish	Blue marlin	Fishing impacts	Increasing use of FADs leading to increased vulnerability of fished stocks, especially in the Caribbean	Understand fishing behavior related to FADs in order to identify restoration opportunities.
	Flounders	Southern flounder	Fishing impacts, others	Incomplete understanding of species ecology	Understand species ecology (e.g. regional population dynamics) to establish species specific baselines
	Other reef-associated fish	Golden tilefish	Fishing impacts	Fishing impacts	Understand vulnerability during spawning events to identify restoration opportunities
	Other reef-associated fish	Golden tilefish	Fishing impacts	Incomplete understanding of species ecology	Establish population baselines for restoration
	Tunas/Mackerels	King mackerel	Fishing impacts	Inconsistent management approaches in international fisheries	Obtain and analyze data on Mexican catches for better identification of eastern and western stock components to guide restoration opportunities.
	Tunas/Mackerels	Yellowfin tuna	Fishing impacts, others	Incomplete knowledge of population dynamics	Identify larval distribution mechanisms, important habitats, and factors influencing recruitment

Restoration Objective	Group	Priority species	General Threat	Detailed Threat	Planning needs
	Tunas/Mackerels	Yellowfin tuna	Fishing impacts	Large catches by non-U.S. fleets, specifically the expansion of fishery in Eastern Atlantic	Identify methods to reduce fishing impacts occurring in international waters, particularly for undersized fish
	All	All	Fishing impacts, others	Mortality due to combined threats	Develop models to evaluate population changes and stressors to FWCI resources.
Decrease the threat of marine debris to FWCI resources	All	All	Marine Debris	Mortality and sublethal effects due to ingestion of plastic debris	Identify impacts of plastics, micro-plastics, and other marine debris on priority species and sargassum habitats
	All	All	Marine Debris	Ghost fishing by derelict gear (traps, nets, and lines)	Identify and develop new opportunities to reduce mortality to fish and water column invertebrates based on ghost gear type or geography
Reduce post-release mortality of FWCI resources	Drums/seatrouts	Spotted seatrout	Fishing impacts	High recreational catches	Understand impacts of recreational fishing release mortality on populations
	Jacks	Greater amberjack	Fishing impacts	Discard mortality in recreational fishery	Support work on Gulf-wide discard mortality comparing the use of artificial versus live baits using consistent techniques in order to develop projects to implement best practices in the recreational fishery to identify appropriate restoration opportunity
Reduce risks to FWCI from energy development and production activities	Deepwater species	NA	Other direct impacts	Impacts from future spills	Establish better baseline distribution and abundance distribution data to inform future impact assessments

Restoration Objective	Group	Priority species	General Threat	Detailed Threat	Planning needs
Enhance Sargassum and other pelagic habitats	*Sargassum*	NA	Multiple	NA	Support investigation into sargassum and other pelagic habitats to better understand the species they support and habitat characteristics they provide, which will allow the FWCI to potentially identify approaches that could be used to improve and protect this habitat in the offshore environment for priority species from other groups.
Future restoration planning efforts	Cephalopods	NA	Multiple	NA	Improve knowledge of cephalopod species ecology to identify restoration opportunities.
	Deepwater species	NA	Multiple	NA	Improve knowledge of deepwater species' ecology to enhance deepwater fish resilience to future disturbances, describe linkages to other injured taxa, and identify restoration opportunities.
	Forage fish	NA	Multiple	NA	Increase understanding of onshore/offshore habitat connectivity in pelagic forage fishes, to identify restoration opportunities