
Offshore Information for Area Contingency Planning

Gulf of Mexico

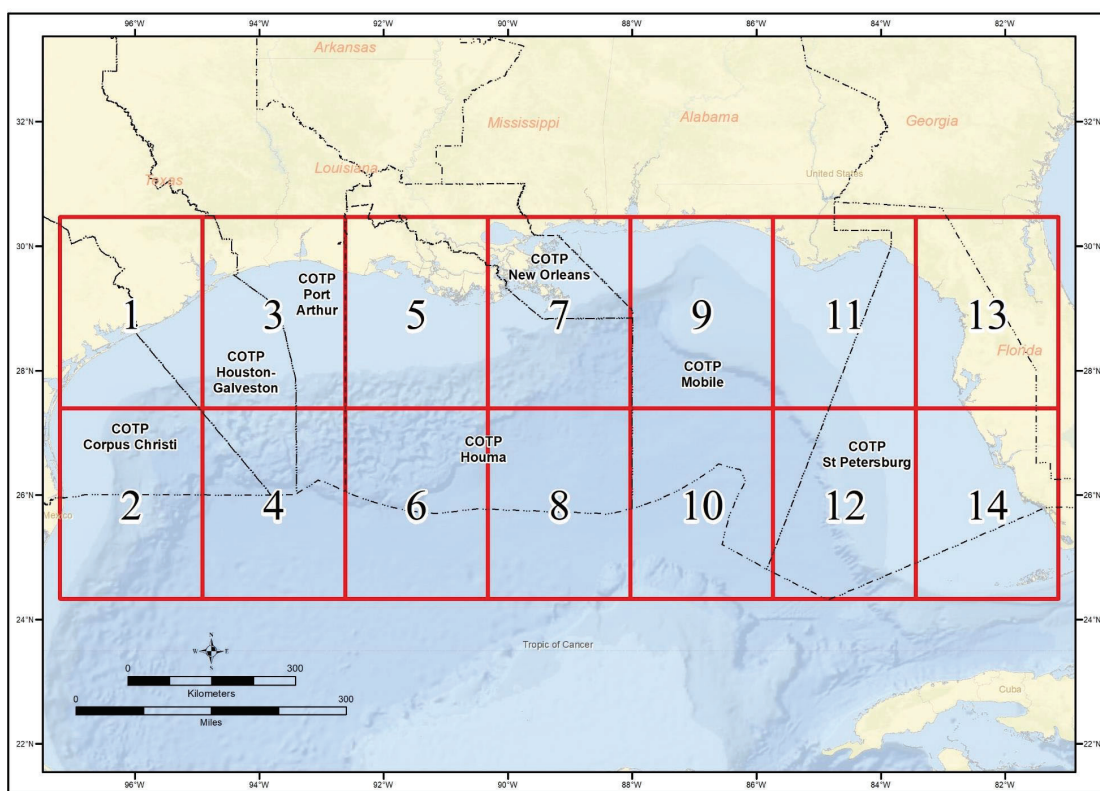
Offshore Environmental Sensitivity Index (ESI) Atlas

Technical Document #6

June 2023

Gulf of Mexico Offshore Environmental Sensitivity Index Maps

A Guide to Marine Resources at Risk to Spilled Oil



**Bureau of Safety and
Environmental Enforcement**

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Gulf of Mexico Offshore Environmental Sensitivity Index

A Guide to Marine Resources at Risk to Spilled Oil

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Gulf of Mexico Offshore Environmental Sensitivity Index Maps

A Guide to Marine Resources at Risk to Spilled Oil

INTRODUCTION

Environmental Sensitivity Index (ESI) maps have been developed for federal waters of the Gulf of Mexico.

The ESI atlas is a compilation of information on sensitive biological resources. Though the data will be useful for many natural resource applications, the goal of the ESI data is to present a concise summary of resources that may be particularly vulnerable to spilled oil. The intent of the data should caveat other uses. As an example, the ESI is not intended to present a catalog or comprehensive listing of species present in an area, rather the focus is on species particularly sensitive to oiling and life stages where vulnerability may increase.

SENSITIVE BIOLOGICAL RESOURCES

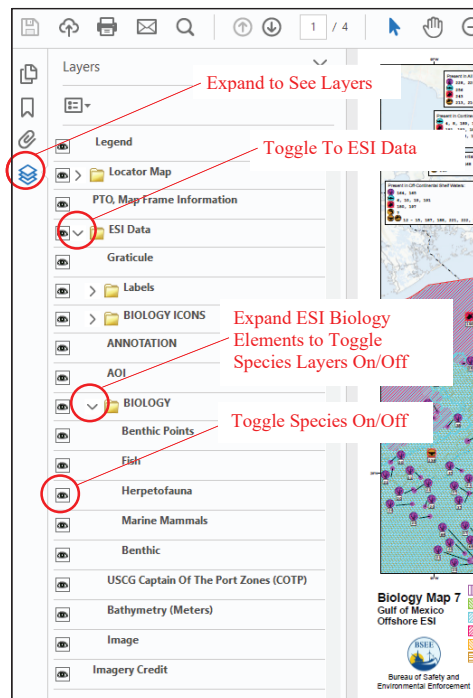
Biological information presented in this atlas was collected, compiled, and reviewed with the assistance of biologists and resource managers from the following agencies:

- United States Fish and Wildlife Service (USFWS)
- United States Geological Survey (USGS)
- NOAA Fisheries (aka, National Marine Fisheries Service (NMFS))
- NOAA National Ocean Service (NOS)
- NOAA National Centers for Coastal Ocean Science (NCCOS)
- NOAA Deep Sea Coral Research and Technology Program (DSCRTP)
- NOAA Flower Garden Banks National Marine Sanctuary (FGBNMS)
- Gulf of Mexico Fishery Management Council (Gulf Council)
- University of South Florida (USF)
- Clemson University
- LGL Ecological Research Associates

The above organizations provided much of the biological information included in the atlas. Other participating organizations will be featured in the sources table and cited in the metadata accompanying the digital product.

The biological resources shown in this atlas were extracted from the ESI GIS data compiled for this region. The biological resources shown on these maps are "layered" in the PDF maps. This allows the user to turn on or off the biological features to create thematic maps or to see more clearly overlapping polygons. Narrative species/taxa profiles that include range maps made from the ESI data accompany this atlas. The range maps in the profiles are layered PDF files, which allow the user to turn on or off selected data layers.

General Instructions on Using Layered PDF



KEY FEATURES ON ESI MAPS

- 1) Animal and plant species that are at risk during oil spills and/or spill response are represented in the database by polygons and points.
- 2) Species have been divided into groups and subgroups based on their behavior, morphology, taxonomic classification, and spill vulnerability and sensitivity. The icons below reflect this grouping scheme.
- 3) There is a Resources at Risk number (RAR#) associated with each polygonal or point feature. The RAR# references a table in the database that contains species names (common and scientific) associated with the feature.

BIRD

- Diving Bird
- Gull/Tern/Bird
- Pelagic

HERPETOFAUNA

- Turtle

MARINE MAMMALS

- Dolphin
- Whale

FISH

- Fish

INVERTEBRATE

- Invertebrate

- Shrimp

BENTHIC

- Coral/Reef/Algae

- 4) Also associated with each species in the table is the federal (F) protected status as threatened (T) or endangered (E) represented on the maps as a red box around the subelement icon shown above, as well as concentration, seasonality, and life-history information. Federal listings were provided by NMFS and USFWS.
- 5) The table includes a Mapping Qualifier with each species record (see table of mapping qualifiers and guidelines below). The mapping qualifier should help users understand vulnerabilities associated with the map data.
- 6) Feature-level source information is included for each species within each RAR#, meaning there is a link to a table containing Geographic (G) and Seasonality (S) sources. Full bibliographic information is included for each source in the sources table. Additionally, feature information is included in the GIS database used to create these maps. The GIS data also provide the extent polygons or points for all mapped features; it can be queried, filtered, and used with other GIS datasets.

Mapping Qualifiers and Guidelines

Element	Qualifier	Guidelines
All	Concentration Area	Areas where concentrations are considerably higher than other records of the same species in the area of interest.
All	General Distribution	Used for broad, general distributions of species that are often mapped to landscape- or habitat-scale features.
All	Vulnerable Occurrence	Intended for records of rare species with discrete occurrences, where the conservation value of the species should be highlighted for spill response.
Birds, Herps, Fish, Inverts	Migration	Used when an area is a known staging area of high importance to the species for birds; and/or areas are potential or known migration corridors in the marine environment for other elements.
Birds	Rafting	Like 'Concentration Area' qualifier, but specific to large on-water concentrations.
Birds	Wintering	Designates known areas of importance to wintering birds.
Benthic	High Ecological Value	For use in areas where benthic organisms provide high ecological services, high quality habitat, or known areas of high biodiversity.
Fish and Inverts	Harvest Area	May be used as a qualifier for distributions in special cases, where the general distribution

Element	Qualifier	Guidelines
		was not mapped and/or is widespread, and the distribution of the harvested resources is used to depict important areas.
Fish and Inverts	Nursery Area	Refers to specific areas of known importance to early life history stages (e.g., larvae, juveniles) of a species.
Fish and Inverts	Spawning Area	Areas where animals are spawning. Spawning is loosely defined as the release of gametes or eggs from the adult. Spawning may also be used to indicate pupping for elasmobranch species.

- 7) The table, Present Throughout Box (PTO), describes how the general geographic location is determined for the PTO boxes displayed on the ESI maps. The individual species status (threatened/ endangered) is the primary filtering criteria for determining what is displayed on the maps versus what is put in the PTO box. Not every species with a status will be shown on the map and may be shown in the PTO box. Additional filtering for PTO includes the spatial extent of the species or species assemblage polygons relative to the area of interest (AOI) on each map. The purpose of the PTO is to declutter the map and increase readability.

Present Throughout Box (PTO)

PTO Designation	Description
Present In All Water	Species or species assemblage polygons that cover most if not all water in the AOI for a map.
Present In Continental Shelf Waters	Species or species assemblage polygons that cover most if not all waters from the state water boundary to the shelf edge in the Gulf of Mexico. A depth of approximately 600-meters was used to help identify the offshore extent of this area.
Present In Continental Shelf Edge Waters	Species or species assemblage polygons that cover most if not all shelf edge or shelf slope waters in the Gulf of Mexico. A depth of approximately 200 to 1,200 meters was used to help define this area.
Present In Off-Continental Shelf Waters	Species or species assemblage polygons that cover most if not all waters from the shelf edge in the Gulf of Mexico out to the Economic Exclusive Zone (EEZ). A depth of approximately 600 meters was used to help identify the offshore extent of this area.
Present In and Around Flower Garden Banks NMS	Benthic habitats located in and around the Flower Garden Banks National Marine Sanctuary.
Present Around This Area	Benthic habitats generally located in and around the black box (graphic) on the map.

Birds

Birds displayed in this atlas include diving birds, gulls, terns, pelagic birds, and waterfowl. Species that are conservation priority are specifically emphasized. Bird occurrence information displayed in this atlas is based on information gathered at workshops and via phone/email correspondence with resource experts from USFWS, USGS, and Clemson University. Additional hardcopy and digital sources are listed below and included in the metadata.

Nearshore birds – Nearshore marine birds were mapped using model data provided by the Gulf of Mexico Marine Assessment Program for Protected Species (GOMMAPPs). GOMMAPPs used aerial survey data collected from the shoreline to 50 nm offshore during winter and summer survey seasons, along with environmental data, to model winter and summer abundances of marine birds in this area. Model output data were divided into three quantiles to designate high, medium, and low ESI concentrations of marine birds throughout the study area. The survey platform was also included in the ESI concentration field to emphasize the difference in data collection and modeling protocols between the GOMMAPPs aerial (nearshore) surveys and vessel (nearshore and

offshore) surveys. Thus, ESI concentrations used for nearshore marine birds are: ‘High-Aerial Survey’, ‘Medium-Aerial Survey’, and ‘Low-Aerial Survey’. Data were available for ‘marine birds as a group’, so these aerial survey data were mapped in the ESI with the common name ‘Marine birds’; data on individual species were not available. For more detailed information about how to interpret the model data, please contact the resource experts listed in the table below.

Nearshore and offshore birds – Birds throughout the northern Gulf of Mexico were mapped using model data provided by GOMMAPPs. GOMMAPPs used vessel survey data collected from throughout the northern Gulf, along with environmental data, to model predicted probability of occurrence (PPO) of seabirds using a MaxEnt model. “MaxEnt is a machine learning technique that uses the maximum entropy approach to estimate the probability of occurrence of a species across a specified area based on occurrence (presence only) observations and a set of covariates (i.e., predictor variables that represent habitat conditions)” (J. Gleason, pers. comm.). Model output data (PPO) were divided into three quantiles to designate high, medium, and low ESI concentrations of seabirds throughout the study area. The survey platform and resulting model metric (PPO) were also included in the ESI concentration field to emphasize the difference in data collection and modeling protocols between the GOMMAPPs aerial (nearshore) surveys and vessel (nearshore and offshore) surveys. Thus, ESI concentrations used for seabird vessel survey modeled data are: ‘High-Vessel Srvy PPO’, ‘Med-Vessel Srvy PPO’, and ‘Low-Vessel Srvy PPO’. Modeled data were available for a cumulative group of 24 species of seabirds, so this dataset shows PPO of seabirds as a general group. Therefore, concentrations were assigned only to the ‘Seabirds’ records in the ESI data. The individual species that comprised the cumulative model were included in the ESI data without concentration values. Individual species model data were not available at the time of ESI atlas publication but will be available by late 2023. For more detailed information about how to interpret the model data and for further information on individual seabird species, please contact the resource experts listed in the table below.

Conservation priority species – Black-capped petrel is proposed federally threatened at the time of publication of this atlas. As a conservation priority, this species has been modeled individually using a combination of GOMMAPPs survey data and Natural Resource Damage Assessment survey data collected to support post-spill injury assessment following the *Deepwater Horizon* oil spill. Like the vessel survey GOMMAPPs data described above, a MaxEnt model was developed to estimate PPO of black-capped petrel in the northern Gulf of Mexico. Model output data were divided into three quantiles to designate high, medium, and low concentrations as described above. For more detailed information about how to interpret the model data for black-capped petrel, please contact the resource experts listed in the table below.

Note that species composition within polygons and particularly concentration values are based on model results using observations made over multi-year periods and are not meant to accurately reflect ‘current’ conditions in the case of an event. Survey and modelling limitations, weather, and other ecological factors contribute to bird concentrations at any given time. Also, note that bird concentrations vary throughout the periods listed in the seasonality table. Please contact resource experts in the event of a spill or if data are to be used for any reason other than spill planning or response.

Expert contacts for Gulf of Mexico birds* are:

Name	Agency	City	Phone/Email	Species
Jeff Gleason	USFWS	Chiefland, FL	352-493-0238 x231	Seabirds
Pat Jodice	USGS	Clemson, SC	864-656-6190	Seabirds
Pam Michael	Clemson University	Clemson, SC	Pamela.e.michael@gmail.com	Seabirds

*Note: this list is not meant to represent all bird experts for the region.

Major Data Sources Used: Birds

Gulf of Mexico Marine Assessment Program for Protected Species (GOMMAPPs). 2022. Birds by season detected on vessel surveys, draft summary table from draft GOMMAPPs final report, document.

GOMMAPPs. 2022. Cumulative habitat suitability index model from pelagic seabird vessel surveys, raster digital data.

GOMMAPPs. 2022. Summer marine bird predictions from aerial surveys, vector digital data.

GOMMAPPs. 2022. Winter marine bird predictions from aerial surveys, vector digital data.

Jodice, P. (USGS) and P. Michael (Clemson University). 2022. Predicted probability of occurrence of black-capped petrel in the northern Gulf of Mexico, raster digital data.

Jodice, P.G.R., P.E. Michael, J.S. Gleason, J.C. Hany, and Y.G. Stage. 2021. Revising the marine range of the endangered black-capped petrel *Pterodroma hasitata*: occurrence in the northern Gulf of Mexico and exposure to conservation threats. *Endangered Species Research* 46:49-65.

Herpetofauna

Herpetofauna depicted in this atlas include federally (F) threatened (T) and endangered (E) sea turtles. Five sea turtle species are known to occur in the Gulf of Mexico: green sea turtle (FT), hawksbill sea turtle (FE), Kemp's ridley sea turtle (FE), leatherback sea turtle (FE), and loggerhead sea turtle (FT). Sea turtle polygons were created based on digital data and expert opinion provided by resource experts at NOAA Fisheries, GOMMAPPs, FGBNMS, and LGL Ecological Resource Associates.

Adult sea turtles – Data for adult green, Kemp's ridley, and loggerhead sea turtles were provided by GOMMAPPs. GOMMAPPs spatial density model output for each species was provided, which consisted of a hexagonal grid with modeled abundance by month per grid cell. Model output data were clipped to U.S. waters, and the maximum monthly value for each grid cell was selected. All grid cells with a maximum monthly value greater than the median for U.S. waters were assigned a concentration of 'High use area', and all grid cells with a maximum monthly value less than the median were assigned a concentration of 'Low use area'. Grid cells with the same concentration were then dissolved to create the final ESI polygons. Data for adult leatherbacks were provided by NOAA Fisheries Species Conservation Branch. Source data consisted of a hexagonal grid indicating high and low use areas for this species, derived from GOMMAPPs spatial density model outputs using the same methods described above for the other sea turtle species. High use areas were included in the atlas with the concentration 'High use area' and low use areas were included in the ESI data with the concentration 'Low use area'. Hawksbill sea turtles are very rare in the Gulf of Mexico, with the only known sightings occurring on a few banks within FGBNMS. Hawksbills were mapped to those banks with the concentration of 'Rare', per expert knowledge. Additional areas where adult sea turtles may occur were mapped using expert knowledge.

Juvenile sea turtles – Juvenile green, Kemp's ridley, leatherback, and loggerhead sea turtles were mapped to the entire AOI, per expert knowledge. Additional juvenile loggerhead concentration areas were mapped using data from a model of juvenile loggerhead probability throughout the Gulf, provided by LGL Ecological Research Associates. Concentration areas of resident loggerhead subadults were mapped in FGBNMS, per expert knowledge.

Expert contacts for Gulf of Mexico herpetofauna* are:

Name	Agency	City	Phone/ Email	Species
Nick Farmer	NOAA	St. Petersburg, FL	727-551-5759	Sea turtles
Lance Garrison	NOAA	Miami, FL	Lance.garris on@noaa. gov	Sea turtles
Jenny Litz	NOAA	Miami, FL	305-361-4224	Sea turtles
Marissa Nuttall	NOAA Sanctuaries	Galveston, TX	409-356-0391	FGBNMS resources
GP Schmahl	NOAA Sanctuaries	Galveston, TX	409-356-0383	FGBNMS resources
Nathan Putman	LGL Ecological Research Associates	Bryan, TX	Nathan.put man@gmail. com	Sea turtles

***Note: this list is not meant to represent all herpetofauna experts for the region.**

Major Data Sources Used: Herpetofauna

Farmer, N. et al. 2022. Protected species data layers for the U.S. Gulf of Mexico, vector digital data.

GOMMAPPs. 2022. Marine mammal and sea turtle spatial density model outputs, vector digital data.

Putman, N. 2022. Loggerhead sea turtle seasonal snapshot of abundance, raster digital data.

Fish

Fish species depicted in this atlas include species of conservation interest, and species of commercial, recreational, or ecological importance. Fish polygons were created based on digital data,

publications, and expert opinion provided by resource experts at NOAA Fisheries, Gulf of Mexico Fishery Management Council, and others.

Protected species – Four federally protected species of fish are known to occur in the Gulf of Mexico AOI: Gulf sturgeon (FT), smalltooth sawfish (FE), giant manta ray (FT), and oceanic whitetip shark (FT). Data for these species were provided by NOAA Fisheries Species Conservation Branch. Source data consisted of a hexagonal grid indicating high and low use areas for each species. High use areas were included in the atlas with the concentration 'High use area' and low use areas are included in the ESI data with no concentration associated.

Spawning areas – Reef fish spawning aggregation areas were mapped based on expert knowledge and information collected for the 'Fish Spawning Aggregations in the Gulf of Mexico' project (<https://geo.gcoos.org/restore/>) and presented in Heyman et al. (2019). Polygons included in the ESI data represent areas that have been definitively identified as sites where spawning aggregations form. Other aggregation sites are likely present in the Gulf of Mexico but have not been identified. General information on spawning seasons is included in the life-history information for the general distribution polygons (see general distributions below).

Additionally, the bluefin tuna habitat area of particular concern, which indicates the extent of spawning, eggs, and larval bluefin tuna in the Gulf of Mexico, was included to represent important spawning habitat for this species.

Concentration areas – Summer aggregation areas were mapped for whale sharks, based on the 95% kernel use density polygon presented in Hoffmayer et al. (2021).

General distributions – Economically and commercially important species were mapped to polygonal areas in the Gulf of Mexico. In order to do this, the Gulf of Mexico was divided by depth and geography (e.g., from east to west) into areas designed to capture biogeographic changes in fish communities. Geographic boundaries used were designed to coincide with state boundaries and NOAA statistical grids. Areas offshore of the 200-m depth contour were divided into two polygons per geographic region based on the 2,000-m depth contour. Polygons representing areas less than 200 m depth varied by geography and are summarized as follows:

- Texas: <50 m & 50-200 m (split into north and south Texas);
- Louisiana: <30 m & 30-200 m;
- Alabama/Mississippi: <50 m & 50-200 m; and
- Florida: <30 m, 30-50 m, & 50-200 m (split into north and south Florida).

The resulting surface was used to aggregate point and polygonal data to a common set of polygons (hereafter 'general distribution ESI polygons').

Highly migratory species were mapped to general distribution ESI polygons where they overlapped with essential fish habitat. Seasonality was assigned based on the EFH documentation where possible. Both seasonality and geographic distribution information was confirmed or supplemented by literature searches to identify more recent information, since the EFH polygons have not been updated since 2016. Please note, in the ESI records for elasmobranchs, seasonality information for pupping is described in the 'Spawning' field and monthly presence for neonates is described in the 'Larvae' field.

Reef fish and coastal species were mapped to general distribution ESI polygons based on compiled fishery dependent and independent sampling datasets available from GRIIDC (Gruss, 2018a and 2018b; Murawski and Vaz 2018). Each dataset gives the spatial location, along with the presence or absence of a particular species or life-history stage. Sampling data were intersected with the general distribution ESI polygons; species were included as present if they occurred in more than 1% of samples for that region. Where a species was present in more than 25% of sampling points for that region, the distribution was noted as 'Common'. Seasonality information was obtained from the Gulf of Mexico Fishery Management Council Essential Fish Habitat Descriptions (Gulf of Mexico Fishery Management Council, 2016).

Expert contacts for Gulf of Mexico fish* are:

Name	Agency	City	Phone/ Email	Species
Jennifer Cudney	NOAA Fisheries	St. Petersburg, FL	727-209-5980	Highly Migratory Species
Nick Farmer	NOAA Fisheries	St. Petersburg, FL	727-551-5759	Protected species
Marissa Nuttall	NOAA Sanctuaries	Galveston, TX	409-356-0391	FGBNMS resources

Name	Agency	City	Phone/ Email	Species
GP Schmah	NOAA Sanctuaries	Galveston, TX	409-356-0383	FGBNMS resources
Lisa Hollensead	Gulf Council	Tampa, FL	813-348-1630 Ext 2300	Gulf Council managed species
Will Heyman	LGL Ecological Research Associates	Austin, TX		Reef fish spawning aggregations
Eric Hoffmayer	NOAA Fisheries	Pascagoula, MS	228 - 549-1691	Whale sharks

***Note: this list is not meant to represent all fish experts for the region.**

Major Data Sources Used: Fish

Farmer, N. et al. 2022. Protected species data layers for the U.S. Gulf of Mexico, vector digital data.

Gulf of Mexico Fishery Management Council. 2016. Final Report: 5-Year Review of Essential Fish Habitat Requirements. Tampa, FL, 502 pages.

Gruss, A. 2018a. Survey data for producing distribution maps for the paper on monitoring programs of the Gulf of Mexico and the Gulf of Mexico Data Atlas. Distributed by: Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC), Harte Research Institute, Texas A&M University–Corpus Christi. doi:10.7266/N7C24TV5.

Gruss, A. 2018b. Survey data for producing distribution maps for the ecosystem model Atlantic-Gulf of Mexico (GOM). Distributed by: Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC), Harte Research Institute, Texas A&M University–Corpus Christi. doi:10.7266/N71J984R.

Heyman, W.D. et al. 2019. Cooperative monitoring, assessment, and management of fish spawning aggregations and associated fisheries in the U.S. Gulf of Mexico. Marine Policy 109:103689.

Hoffmayer, E.R. et al. 2021. Seasonal Occurrence, Horizontal Movements, and Habitat Use Patterns of Whale Sharks (*Rhincodon typus*) in the Gulf of Mexico. Frontiers in Marine Science 7:598515.

Murawski, S.A. and A.C. Vaz. 2018. Catch data from fish collected throughout the Gulf of Mexico from 2011 until 2017. Distributed by: Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC), Harte Research Institute, Texas A&M University–Corpus Christi. doi:10.7266/N7G73C4N.

NOAA Fisheries. 2016. Atlantic Highly Migratory Species Essential Fish Habitat, vector digital data.

NOAA Fisheries. 2016. Final amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat and Environmental Assessment. National Marine Fisheries Service: Office of Sustainable Fisheries. Silver Spring, MD, 442 pages.

Invertebrates

Invertebrates depicted in this atlas include species of conservation interest, or species of commercial, recreational, or ecological importance.

Flower Garden Banks National Marine Sanctuary staff contributed information on spiny lobster and queen conch abundance within the sanctuary. Commercially important species (shrimp and blue crab) were mapped using the methods described for reef fish listed in the fish section, except the threshold for inclusion in the ESI general distribution polygons was set to 10% for invertebrates. Other species were mapped based on descriptions of their essential fish habitat or previous mapping efforts.

Expert contacts for Gulf of Mexico invertebrates* are:

Name	Agency	City	Phone/ Email	Species/ Program
Marissa Nuttall	NOAA Sanctuaries	Galveston, TX	409-356-0391	FGBNMS resources
GP Schmah	NOAA Sanctuaries	Galveston, TX	409-356-0383	FGBNMS resources

***Note: this list is not meant to represent all invertebrate experts for the region.**

Major Data Sources Used: Invertebrates

Gruss, A. 2018a. Survey data for producing distribution maps for the paper on monitoring programs of the Gulf of Mexico and the Gulf of Mexico Data Atlas. Distributed by: Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC), Harte Research Institute, Texas A&M University–Corpus Christi. doi:10.7266/N7C24TV5.

Gruss, A. 2018b. Survey data for producing distribution maps for the ecosystem model Atlantic-Gulf of Mexico (GOM). Distributed by: Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC), Harte Research Institute, Texas A&M University–Corpus Christi. doi:10.7266/N71J984R.

Gulf of Mexico Fishery Management Council. 2016. Final Report: 5-Year Review of Essential Fish Habitat Requirements. Tampa, FL, 502 pages.

Marine Mammals

Marine mammals mapped in the atlas include cetaceans that are ESA-listed, MMPA-listed, or MMPA Strategic Stock. Species mapped include Rice's whale (FE), sperm whale (FE), Atlantic spotted dolphin, beaked whales (*Ziphius* spp. and *Mesoplodon* spp.), blackfish (false killer whale, pygmy killer whale, and melon-headed whale), Clymene dolphin, common bottlenose dolphin, *Kogia* whales (dwarf and pygmy sperm whales), pantropical spotted dolphin, pilot whale, Risso's dolphin, spinner dolphin, and striped dolphin. Cetacean data were provided by NOAA Fisheries Species Conservation Branch. Source data consisted of a hexagonal grid indicating high and low use areas for each species, derived from COMMAPPS spatial density model outputs using the same methods described above for sea turtle species. High use areas were included in the atlas with the concentration 'High use area' and low use areas were included in the ESI data with the concentration 'Low use area'. All species followed this scheme except for Rice's whale, for which there was not enough data to designate high and low use areas. Rice's whale is therefore mapped with a concentration of 'Present' throughout its range.

Expert contacts for Gulf of Mexico marine mammals* are:

Name	Agency	City	Phone/ Email	Species
Nick Farmer	NOAA	St. Petersburg, FL	727-551-5759	Marine mammals
Lance Garrison	NOAA	Miami, FL	Lance.garrison@noaa.gov	Marine mammals
Jenny Litz	NOAA	Miami, FL	305-361-4224	Marine mammals

***Note: this list is not meant to represent all marine mammal experts for the region.**

Major Data Sources Used: Marine mammals

Farmer, N. et al. 2022. Protected species data layers for the U.S. Gulf of Mexico, vector digital data.

COMMAPPS. 2022. Marine mammal and sea turtle spatial density model outputs, vector digital data.

Benthic Habitats

Benthic habitats mapped in the ESI atlas include shallow corals and mesophotic and deep-sea corals and sponges. Additionally, the floating algae *Sargassum* is mapped in the Benthic layer.

Shallow water corals – All shallow water corals in the AOI are found in FGBNMS. Four federally listed species of shallow water corals are present in FGBNMS: boulder star coral (FT), elkhorn coral (FT), lobed star coral (FT), and mountainous star coral (FT). These species were mapped using expert knowledge from FGBNMS staff. Other shallow water corals were included in the same areas under the generic name "Shallow coral communities".

Mesophotic and deep-sea corals and sponges – Mesophotic and deep-sea corals were mapped using both predictive model data and presence data. Deep-sea sponges were also included in the presence dataset. The model data used were provided by NOAA NCCOS and consisted of predicted mesophotic and deep-sea coral genus richness along a 100 m x 100 m grid from the continental shelf to the EEZ. Genus richness was binned, and these bins were used as the ESI concentrations: '0 to 1 genera', '>1 to 2 genera', '>2 to 4 genera', '>4 to 6 genera', '>6 to 8 genera', and '>8 genera'. Grid cells with the same concentration were then dissolved to create the final ESI polygons, with a minimum polygon size of 100,000 m². This model allowed for the mapping of mesophotic and deep-sea corals throughout the offshore Gulf of Mexico and was not limited by sampling or mapping effort in specific geographic areas.

NOAA DSCRTP provided the National Database for Deep-Sea Corals and Sponges, a point database that showed known presence of these taxa throughout the Gulf of Mexico. All records were mapped in the ESI, regardless of age, because these are long-lived organisms that may still be present decades after data collection. Names of coral and sponge taxa in the database were generalized to response-relevant categories (e.g., soft coral, deep sea sponge, sea pens) that were used as the ESI common names. Also, the structural group of each taxon was included in the ESI concentration field as either 'Structure-forming' or 'Solitary'. This designation was made using a crosswalk between taxon name and structural group provided by DSCRTP.

Sargassum – *Sargassum* was mapped using the NOAA designated loggerhead sea turtle Critical Habitat and climatological monthly mean density maps provided by USF. A polygon was drawn around the area covered in the Critical Habitat for loggerhead sea turtle – Northwest Atlantic Ocean DPS (*Sargassum* habitat polygon). An adjacent polygon was drawn around the *Sargassum* spatial extent shown on the density maps to ensure full coverage of the resource.

Expert contacts for Gulf of Mexico benthic habitats* are:

Name	Agency	City	Phone/ Email	Species/ Program
Matt Poti	NOAA NCCOS	Silver Spring, MD	240- 569- 0910	Mesophotic and deep- sea corals
Robert McGuinn	NOAA DSCRTP	Charleston, SC	843- 631- 7202	Deep-sea corals and sponges
Tom Hourigan	NOAA DSCRTP	Silver Spring, MD	tom.ho- urigan @noaa. gov	Deep-sea corals and sponges
Marissa Nuttall	NOAA Sanctuaries	Galveston, TX	409- 356- 0391	FGBNMS resources, shallow and mesophotic corals
GP Schmahl	NOAA Sanctuaries	Galveston, TX	409- 356- 0383	FGBNMS resources, shallow and mesophotic corals
Chuanmin Hu	University of South Florida	St. Petersburg, FL	727- 553- 3987	<i>Sargassum</i>

***Note: this list is not meant to represent all benthic habitat experts for the region.**

Major Data Sources Used: Benthic Habitats

NOAA NCCOS. 2022. Classified predicted deep-sea coral genus richness, vector digital data.

NOAA DSCRTP. 2022. National database for deep-sea corals and sponges (version 20220801-0), tabular digital data.

Schmahl, G.P. and M. Nuttall. 2023. FGBNMS resources, personal communication.

Hu, C. 2022. Climatological monthly mean *Sargassum* density maps, raster digital data.

GEOGRAPHIC INFORMATION SYSTEM

The entire atlas product is stored in digital form in a Geographic Information System (GIS) as spatial data layers and associated databases. The format for the data varies depending on the type of information or features for which the data are being stored.

Under separate cover is a metadata document that details the data dictionary, processing techniques, data lineage, and other descriptive information for the digital datasets and maps that were used to create this atlas. Below is a brief synopsis of the information contained in the digital version. Refer to the metadata embedded in each feature class in the BSEE Gulf of Mexico ESI geodatabase for a full explanation of the data and its structure.

Biological resources are stored as points and polygons. Associated with each feature is a unique identification number that is linked to a series of data tables that further identify the resources. The main biological resource table consists of a list of species identification numbers for each site, the concentration of each species at each site, a mapping qualifier, and identification codes for seasonality and source information. This data table is linked to other tables that describe the seasonality and life-history time periods for each species (at month resolution) for the specified map feature. Other data tables linked to the first table include: the species identification table, which includes common and scientific names; the species status table,

which gives information for federal threatened or endangered listings; and the source database, which provides source metadata at the feature-species level (specific sources are listed for each species occurring at each mapped feature in the biology feature classes).

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The biological data included on the maps were provided by numerous individuals and agencies. The individuals and agencies are listed in detail throughout the introductory pages of the ESI atlas. Staff at these organizations contributed a vast amount of information to this effort, including first-hand expertise, publications, maps, and digital data.

At Research Planning, Inc. in Columbia, South Carolina, numerous scientific, GIS, and graphic staff were involved with different phases of the project. Mark White, GIS Director, and Christine Boring, Biology Dept. Manager, were co-Project Managers. The biological data were collected and compiled onto base maps by Lauren Szathmary, Christine Boring, and Jennifer Weaver. Lee Diveley, Katy Beckham, Mark White, and Jeff Dahlin processed and produced the GIS data and metadata. Mark White, Katy Beckham, Jacqueline Michel, Christine Boring, and Lauren Szathmary prepared the species profiles. Wendy Early produced the final documents.

APPROPRIATE USE OF ATLAS AND DATA

This atlas and the associated database were developed to provide summary information on sensitive natural resources for the purposes of oil and chemical spill planning and response. Although the atlas and database should be very useful for other environmental and natural resource planning purposes, it should **not** be used in place of data held by any contributing agencies. Likewise, information contained in the atlas and database cannot be used in place of consultations with natural resource agencies, or in place of field surveys. Also, this atlas should not be used for navigation.

SPECIES LIST

Common Name	Scientific Name
BENTHIC	
ALGAE	
Sargassum	<i>Sargassum liebmanii</i>
CORAL	
Black coral	<i>Antipathes spp.</i>
Boulder star coral	<i>Orbicella franksi</i>
Deep sea coral	
Elkhorn coral	<i>Acropora palmata</i>
Gorgonian corals	<i>Alcyonacea</i>
Lace coral	<i>Stylasteridae</i>
Lobed star coral	<i>Orbicella annularis</i>
Mountainous star coral	<i>Orbicella faveolata</i>
Sea pens	<i>Pennatulacea</i>
Shallow coral community	
Soft coral	
Stony branching coral	
Stony coral	<i>Scleractinia</i>
Stony cup coral	
REEF	
Deep sea sponge	
BIRDS	
DIVING	
Brown pelican	<i>Pelecanus occidentalis</i>
Common loon	<i>Gavia immer</i>
GULL, TERN	
Black tern	<i>Chlidonias niger</i>
Bonaparte's gull	<i>Larus philadelphia</i>
Bridled tern	<i>Onychoprion anaethetus</i>
Brown noddy	<i>Anous stolidus</i>
Common tern	<i>Sterna hirundo</i>
Herring gull	<i>Larus argentatus</i>
Laughing gull	<i>Leucophaeus atricilla</i>
Royal tern	<i>Thalasseus maximus</i>
Sandwich tern	<i>Thalasseus sandvicensis</i>
Sooty tern	<i>Onychoprion fuscatus</i>
PELAGIC	
Audubon's shearwater	<i>Puffinus lherminieri</i>
Band-rumped storm-petrel	<i>Oceanodroma castro</i>
Black-capped petrel	<i>Pterodroma hasitata</i>
Brown booby	<i>Sula leucogaster</i>
Cory's shearwater	<i>Calonectris diomedea</i>
Great shearwater	<i>Puffinus gravis</i>
Magnificent frigatebird	<i>Fregata magnificens</i>
Marine birds	
Masked booby	<i>Sula dactylatra</i>
Northern gannet	<i>Morus bassanus</i>
Parasitic jaeger	<i>Stercorarius parasiticus</i>
Pomarine jaeger	<i>Stercorarius pomarinus</i>
Seabirds	
Wilson's storm-petrel	<i>Oceanites oceanicus</i>
FISH	
Albacore	<i>Thunnus alalunga</i>
Atlantic sharpnose shark	<i>Rhizoprionodon terraenovae</i>
Bigeye thresher	<i>Alopias superciliosus</i>
Bigeye tuna	<i>Thunnus obesus</i>
Black grouper	<i>Mycteroperca bonaci</i>
Blackfin snapper	<i>Lutjanus buccanella</i>
Blacknose shark	<i>Carcharhinus acronotus</i>
Blacktip shark	<i>Carcharhinus limbatus</i>
Blue marlin	<i>Makaira nigricans</i>
Bluefin tuna	<i>Thunnus thynnus</i>
Bonnethead	<i>Sphyrna tiburo</i>
Bull shark	<i>Carcharhinus leucas</i>
Cobia	<i>Rachycentron canadum</i>
Cubera snapper	<i>Lutjanus cyanopterus</i>
Dusky shark	<i>Carcharhinus obscurus</i>
Gag	<i>Mycteroperca microlepis</i>
Giant manta	<i>Manta birostris</i>
Goliath grouper	<i>Epinephelus itajara</i>
Gray snapper	<i>Lutjanus griseus</i>
Great hammerhead	<i>Sphyrna mokarran</i>

Common Name	Scientific Name
FISH, cont.	
Greater amberjack	<i>Seriola dumerili</i>
Gulf sturgeon	<i>Acipenser oxyrinchus desotoi</i>
King mackerel	<i>Scomberomorus cavalla</i>
Lemon shark	<i>Negaprion brevirostris</i>
Longbill spearfish	<i>Trapturus pfluegeri</i>
Longfin mako	<i>Isurus paucus</i>
Marbled grouper	<i>Dermatolepis inermis</i>
Menhaden	<i>Brevoortia spp.</i>
Mutton snapper	<i>Lutjanus analis</i>
Night shark	<i>Carcharhinus signatus</i>
Oceanic whitetip shark	<i>Carcharhinus longimanus</i>
Queen snapper	<i>Etelis oculatus</i>
Red drum	<i>Sciaenops ocellatus</i>
Red grouper	<i>Epinephelus morio</i>
Red snapper	<i>Lutjanus campechanus</i>
Reef fish	
Sailfish	<i>Istiophorus platypterus</i>
Sandbar shark	<i>Carcharhinus plumbeus</i>
Scalloped hammerhead	<i>Sphyrna lewini</i>
Scamp	<i>Mycteroperca phenax</i>
Shortfin mako	<i>Isurus oxyrinchus</i>
Silk snapper	<i>Lutjanus vivanus</i>
Silky shark	<i>Carcharhinus falciformis</i>
Skipjack tuna	<i>Katsuwonus pelamis</i>
Smalltooth sawfish	<i>Pristis pectinata</i>
Snowy grouper	<i>Hyporthodus niveatus</i>
Spanish mackerel	<i>Scomberomorus maculatus</i>
Speckled hind	<i>Epinephelus drummondhayi</i>
Spinner shark	<i>Carcharhinus brevipinna</i>
Swordfish	<i>Xiphias gladius</i>
Tiger shark	<i>Galeocerdo cuvier</i>
Tilefish spp.	<i>Malacanthidae</i>
Vermilion snapper	<i>Rhomboplites aurorubens</i>
Wahoo	<i>Acanthocybium solandri</i>
Whale shark	<i>Rhincodon typus</i>
White marlin	<i>Kajikia albida</i>
Yellowedge grouper	<i>Hyporthodus flavolimbatu</i>
Yellowfin tuna	<i>Thunnus albacares</i>
Yellowmouth grouper	<i>Mycteroperca interstitialis</i>
HERPETOFAUNA	
TURTLE	
Green sea turtle	<i>Chelonia mydas</i>
Hawksbill sea turtle	<i>Eretmochelys imbricata</i>
Kemp's ridley sea turtle	<i>Lepidochelys kempi</i>
Leatherback sea turtle	<i>Dermochelys coriacea</i>
Loggerhead sea turtle	<i>Caretta caretta</i>
INVERTEBRATES	
CRAB	
Blue crab	<i>Callinectes sapidus</i>
GASTROPOD	
Queen conch	<i>Strombus gigas</i>
LOBSTER	
Caribbean spiny lobster	<i>Panulirus argus</i>
SHRIMP	
Brown shrimp	<i>Farfantepenaeus aztecus</i>
Pink shrimp	<i>Farfantepenaeus duorarum</i>
Royal red shrimp	<i>Pleoticus robustus</i>
White shrimp	<i>Litopenaeus setiferus</i>
MARINE MAMMALS	
DOLPHIN	
Atlantic spotted dolphin	<i>Stenella frontalis</i>
Bottlenose dolphin	<i>Tursiops truncatus</i>
Clymene dolphin	<i>Stenella clymene</i>
Pantropical spotted dolphin	<i>Stenella attenuata</i>
Risso's dolphin	<i>Grampus griseus</i>
Spinner dolphin	<i>Stenella longirostris</i>
Striped dolphin	<i>Stenella coeruleoalba</i>

Common Name	Scientific Name
MARINE MAMMALS, cont.	
WHALE	
Beaked whales	
Blackfish	
Kogia spp.	<i>Kogia spp.</i>
Pilot whales	<i>Globicephala spp.</i>
<u>Rice's Whale</u>	<u><i>Balaenoptera ricei</i></u>
<u>Sperm whale</u>	<u><i>Physeter macrocephalu</i></u>

* Threatened and endangered species are designated by underlining