

Assessing Distribution and Abundance of Priority Species in the Gulf of Mexico: A Seasonal, Spatial, and Taxa Based Approach to Identifying Gaps in Knowledge Shared Through a Story Map

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A Seasonal, Spatial and Taxa Based Approach to Identifying Gaps in Knowledge for GoMMAPPS

The United States (U.S.) Gulf of Mexico is a heavily utilized and industrialized basin, supporting oil and gas exploration and development, commercial and recreational fishing, shipping, military operations, and tourism.



Marine mammals, seabirds, and sea turtle species are priority taxa protected under the US Marine Mammal Protection Act of 1972, Migratory Bird Treaty Act of 1918, and the Endangered Species Act of 1973 that depend on the Gulf of Mexico's environmental resources. However, data coverage, spatially and temporally, across taxa and species within each taxon is currently uneven. In order for the Bureau of Ocean and Energy Management (BOEM) and other agencies to better mitigate and monitor negative impacts on protected species resulting from the development of energy and mineral resources, more data is needed on the distribution, abundance, habitat use, and behavior of these taxa.

Image Source: [Underwater loop by: quantin heuvels](#)

What is GoMMAPPS?

The Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) is an initiative involving multiple collaborators, including BOEM, the National Oceanic and Atmospheric Administration (NOAA), the United States Geological Survey (USGS) and the US Fish and Wildlife Service (USFWS), working together to assess marine mammal, sea turtle, and seabird species distribution and abundance to assess and inform the development of marine energy activities (EED) in the Gulf of Mexico.



A QSI/BOEM story map



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Key Tasks Include:

1. Conducting aerial surveys over continental shelf waters to collect visual line transect data,
2. Conducting ship-board surveys on the shelf and out to the US EEZ,
3. Conducting satellite tracking of tagged animals,
4. Collecting environmental data and passive acoustic data from towed arrays,
5. Performing genetic analyses for composition and connectivity from biopsy samples, and
6. Developing spatially- and temporally-explicit species density and habitat models.

GoMMAPPS will support quantifying and understanding long-term trends in species abundance and distributions as they are related to various anthropogenic and natural stressors. All data products are planned to be available to the public.

Why GoMMAPPS Now?

Continued assessment of the seasonal Atlantic Marine Assessment Program for Protected Species (AMAPPS) which was initiated by BOEM as a collaborative effort with NOAA and the USFWS. The AMAPPS GoMMAPPS will focus on collecting seasonal data on the distribution, abundance and behavior of marine mammals, sea turtles, and seabirds, while providing spatially-explicit information to inform governmental decision makers with national responsibilities to protecting marine resources.



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Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS)

Project Summary

Improved information is needed on living marine resource abundance, distribution, habitat use, and behavior in the Gulf of Mexico to properly mitigate and monitor for potential impacts of human activities, including related to offshore energy development. Understanding of cumulative impacts on protected species in the Gulf from both natural and anthropogenic forcing is required to inform NEPA documents and consultations and rulemaking related to Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and Migratory Bird Treaty Act (MBTA), as well as other statutes that govern bureau activities. The results of this study will provide important information to inform both BOEM and BSEE regulatory needs, as well as other agencies and stakeholders.

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“Developing spatially- and temporally-explicit needs directly and iteratively.”

GoMMAPPS will support quantifying and understanding long-term trends in species abundance and distributions as they are related to various anthropogenic and natural stressors. All data products are planned to be available to the public.

Why GoMMAPPS Now?

GoMMAPPS is modeled after the successful Atlantic Marine Assessment Program for Protected Species (AMAPPS), which was initiated in 2010 as a collaboration among BOEM, NOAA, USFWS, and the US Navy. Like AMAPPS, **GoMMAPPS will focus on collecting seasonal data on the distribution, abundance, and behavior of marine mammals, sea turtles, and seabirds, while providing spatially-explicit information to inform governmental decision makers with mandated responsibilities to protect living marine resources.**

- Research has been conducted on marine mammals, sea turtles, and seabirds in the Gulf of Mexico using a variety of methods which give insight on different aspects of marine species distribution and abundance.
- Numerous workshops after the *Deepwater Horizon* (DWH) oil spill have underscored the need for new baseline information and expanded environmental monitoring, including marine mammals, sea turtles, and seabirds in the Gulf of Mexico.
- Given the highly migratory nature of many protected species in the Gulf, the scientific community has recommended a “Gulf-wide” approach, whenever possible, which considers the entire Large Marine Ecosystem.



Image Source: NOAA Office for Coastal Management

QSI Project Goals

To focus GoMMAPPS research efforts in order to have a complete understanding of the Gulf ecosystem, current gaps in knowledge—both temporally and spatially, needed to be identified. This QSI phase of the larger GoMMAPPS effort, focused on the following goals:

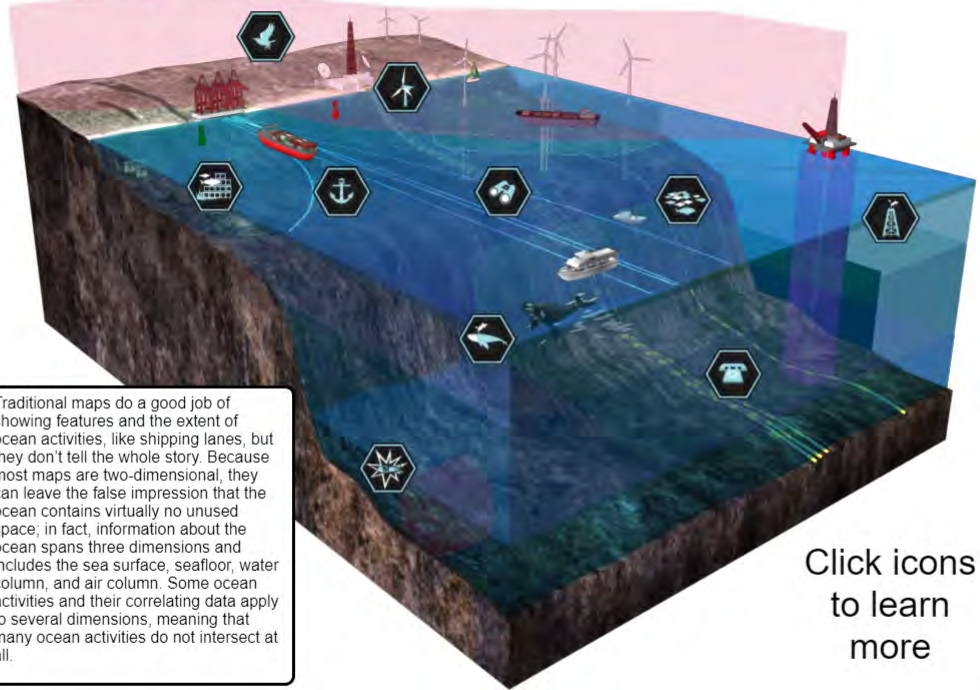
Goal 1: Create a data inventory to inform GoMMAPPS survey design

- Obtain an initial inventory of literature on past studies relevant to the distribution and abundance of marine mammals, sea turtles, and sea birds in the US Gulf of Mexico EEZ.
- Conduct a gap analysis to identify areas where additional data collection is necessary.

Crowded Open Space: A 3D View

MarineCadastr.gov



Traditional maps do a good job of showing features and the extent of ocean activities, like shipping lanes, but they don't tell the whole story. Because most maps are two-dimensional, they can leave the false impression that the ocean contains virtually no unused space; in fact, information about the ocean spans three dimensions and includes the sea surface, seafloor, water column, and air column. Some ocean activities and their correlating data apply to several dimensions, meaning that many ocean activities do not intersect at all.

Click icons to learn more

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QSI Project Goals

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Goal 1: Create a data inventory to inform GoMMAPPS survey design .

- Obtain an initial inventory of literature on past studies relevant to the distribution and abundance of marine mammals, seabirds, and sea turtles in the US Gulf of Mexico EEZ.
- Compile past studies' metadata and create geospatial footprints, by taxa, within a database to link with literature and allow for specific text and spatial queries.

Goal 2: Develop a data management framework and draft data model to support planning and information dissemination.

- Build a prototype data model incorporating literature, metadata, and geospatial footprints that are standardized and organized for assessing and informing the GoMMAPPS research priorities and efforts.

Goal 3: Develop outreach and educational materials for the GoMMAPPS Program,

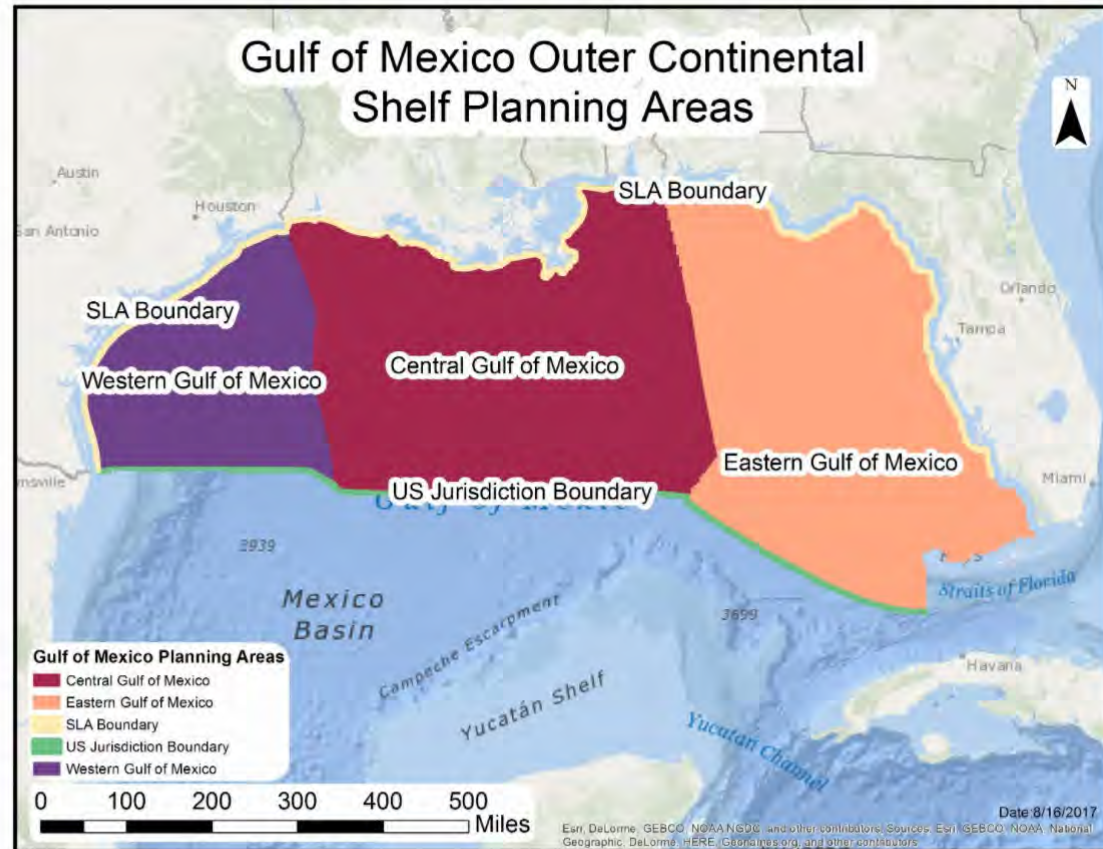
- Outreach and educational materials will be developed to demonstrate the goals and intent of GoMMAPPS and the environmental assessment needs to successfully implement the initiative.

Goal 4: Support and facilitate collaboration across multiple stakeholders (local, state, and Federal) to ensure coordination with Gulf of Mexico restoration efforts in coastal and marine waters.

- Given the numerous parties that have an interest in the development and success of this initiative, coordination with science programs, new Gulf restoration, and restoration-monitoring programs, and State Coastal Zone Management Programs will be critical to informing optimal survey design and determining methodology.

Relevant Gulf of Mexico Species

Many species utilize the Gulf of Mexico during their life cycle; however, GoMMAPPS will focus on a subset of key species deemed relevant to this initiative. Species that will use a wide range of data types.



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Relevant Gulf of Mexico Species

Many species utilize the Gulf of Mexico during their life cycle; however, GoMMAPPS will focus on a subset of key species deemed relevant to this initiative. Studies that included a wide range of data types spanning multiple disciplines, such as visual observations, acoustic recordings, tissue samples, tag telemetry studies, and prey concentrations of these specific species, were prioritized in this inventory.

- A total of 28 marine mammal species that have occurred in the Gulf of Mexico were included. The West Indian Manatee was not included in this inventory because it was determined to have a sufficient amount of data to represent its range and behavior in the context of this effort.
- Although a total of 491 bird species are present in the Gulf, this inventory only focuses on 49 species identified as significantly using the Gulf of Mexico OCS waters and considered as "seabirds," for the Gulf of Mexico research gap analysis.
- All five sea turtle species that occur in the Gulf of Mexico were included.

Image Source: Bureau of Ocean and Energy Management, & NOAA Fisheries

Inventory of Data Sources and Repositories

To identify past studies and create a data inventory to assist in prioritizing research gaps in support of GoMMAPPS, large database collections of Gulf of Mexico marine mammal, seabird, and sea turtle distribution and abundance data were queried to match the specifications below.

- **Temporal focus:** Studies that collected data between 1995 to 2017 and had readily available information specifically for marine mammals, seabirds, or sea turtles.
- **Subject/matter focus:** Keywords were searched (e.g., turtle, a specific species name, "marine mammal" AND "Gulf of Mexico", or "Ocean Conservancy GAP Analysis").
- **Scope of spatial data:** All the data repositories inventoried had the potential to contain records related to the



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- Sources of spatial data: All the data repositories inventoried had the potential to contain products related to the focus of GoMMAPPS and were able to store information, at least in a text format, that enabled user-defined queries.

Databases Inventoried:

1. [BOEM Environmental Studies Program Information System.](#)
2. [NOAA Environmental Response Management Application for the Gulf of Mexico.](#)
3. [Duke University's Ocean Biogeographic Information System - Spatial Ecological Analysis of Megavertebrate Populations.](#)
4. [NOAA National Marine Fisheries Service \(NMFS\) InPort: Enterprise Data Management Program](#)
5. [USFWS Service Catalog](#)
6. [USGS Publications Warehouse](#)

Reviews yielded:

After mining existing data repositories, recently published reviews, and gathering data sets from taxa experts, 44 studies/research projects on the distribution and abundance of marine mammals, seabirds, and sea turtles were discovered, cataloged, and summarized by their study attributes. The results of the inventory should be considered as the first review of past relevant studies that have been conducted within the US Gulf of Mexico outer continental shelf, based on select data repositories hosting similar marine studies and data.

- Six (6) studies had available information on multiple data repositories selected for the gaps analysis, while 33 studies were found in only one repository.

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Directed by Dr. Patrick N. Halpin

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OBIS-SEAMAP Protected Species Database

OBIS-SEAMAP (seamap.env.duke.edu) is a spatially and temporally interactive online database for marine protected species, collecting data from ship/aerial surveys and satellite telemetry as well as acoustic monitoring and PhotoID around the globe. This 10-year and on-going service is made possible by contributions from data providers all over the world. As of 2011, the OBIS-SEAMAP database holds over 4 million records for over 600 species from more than 400 providers and it's ever growing.



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- Six (6) studies had available information on multiple data repositories selected for the gaps analysis, while 33 studies were found in only one repository.
- Except for nine (9) studies, there was available geographic data, in the format of at least one GIS shapefile or table to create footprints for each of the studies that were discovered.
- For the nine (9) studies that did not have any shapefile or table, general polygon footprints were delineated using information gathered during the inventory process.
- Datasets, database repositories, and literature cited within selected, recent reviews and assessments describing marine distribution and abundance in the Gulf of Mexico were also inventoried and included if relevant.
- There was a noticeable gap in finding a large data repository for seabird data, particularly for the Gulf of Mexico.

Lessons Learned

- Large-scale scientific research studies involve multiple partners, project components and objectives, methods, and analysis products, which require a coordinated effort to organize, present, and archive results and outcomes.
- When studies were reviewed for availability and accessibility of products:
 - Smaller-scaled studies could give more information within specialized data repositories.
 - Larger-scaled studies disseminated information across various data repositories depending on the suitability of the data repository to archive data products and objectives of the components within the overall umbrella study.
- Many of the studies relevant to GoMMAPPS involved different institutions, which can result in data being housed in multiple places, as either duplicate copies or unique components.
- Unfortunately, since the methods for identifying relevant past studies relied on large data repositories and recently published reviews, it is highly likely that studies that ranged on the lower side of this scale were not included in this study.

Image Source: Ocean Loop by James Bartholomew

Sampling Methodology Gaps

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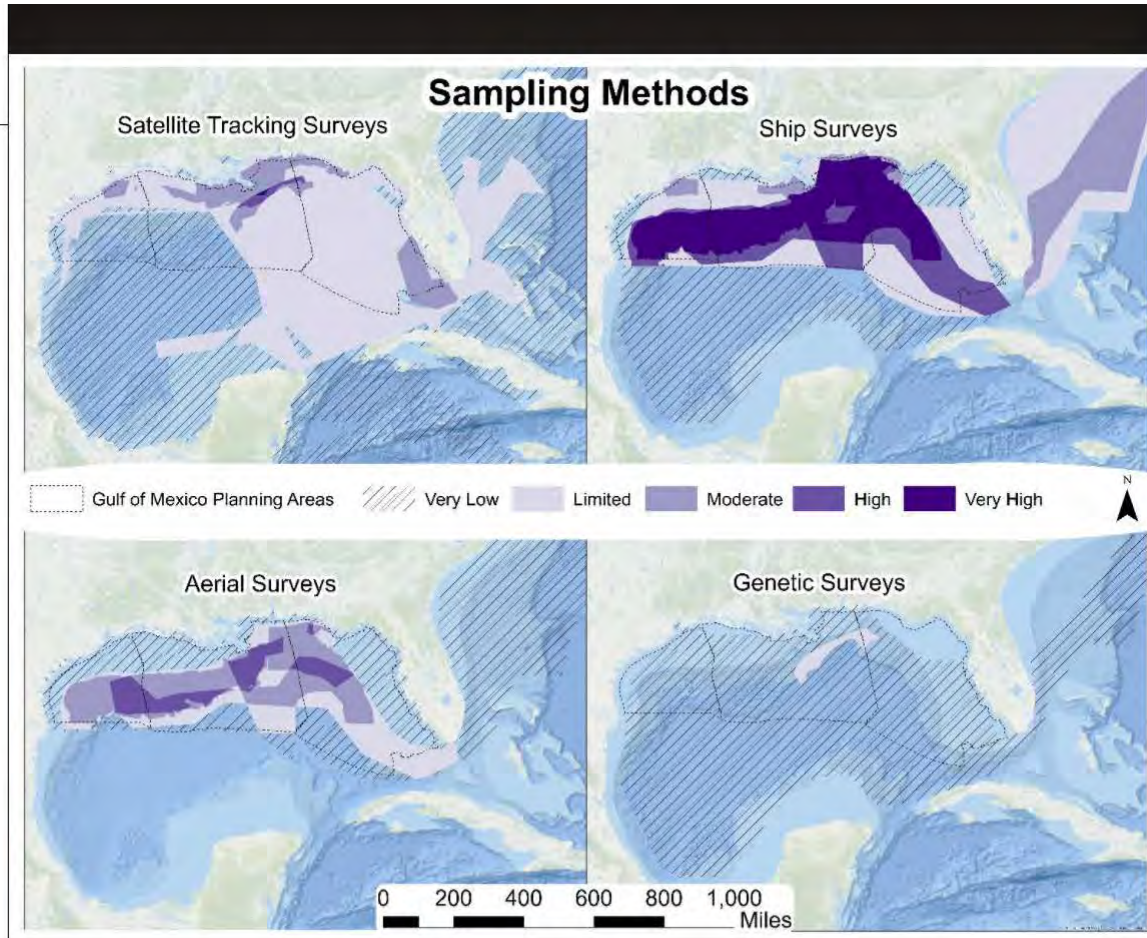
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Sampling Methodology Gaps

- Since 1995, all of the key methods identified for GoMMAPPS have been conducted on all taxa. The exception was towed arrays which were only applicable to marine mammals.
- More information was available on the distribution and abundance of marine mammals and seabirds from aerial and ship-board surveys for density and habitat models than for sea turtles.
- Compared to seabirds and marine mammals, more sea turtle studies were found to use satellite tracking data to investigate distribution and behavior.
- Though survey efforts might be lower for sea turtles more studies have been dedicated to tracking sea turtles with satellite tags to investigate distribution and behavior when compared to the other taxa.
- While seabird and sea turtle sightings from dedicated surveys were sometimes collected along with marine mammals, some were purely opportunistic. As a result density and habitat models using these sightings would not be appropriate.
- The least amount of information came from genetic analyses and models for density and habitats, though this was expected since genetic data was not archived on the repositories inventoried for this gap analysis.



• A very limited number of studies collected data on seabirds across methods, seasons, and regions compared to other



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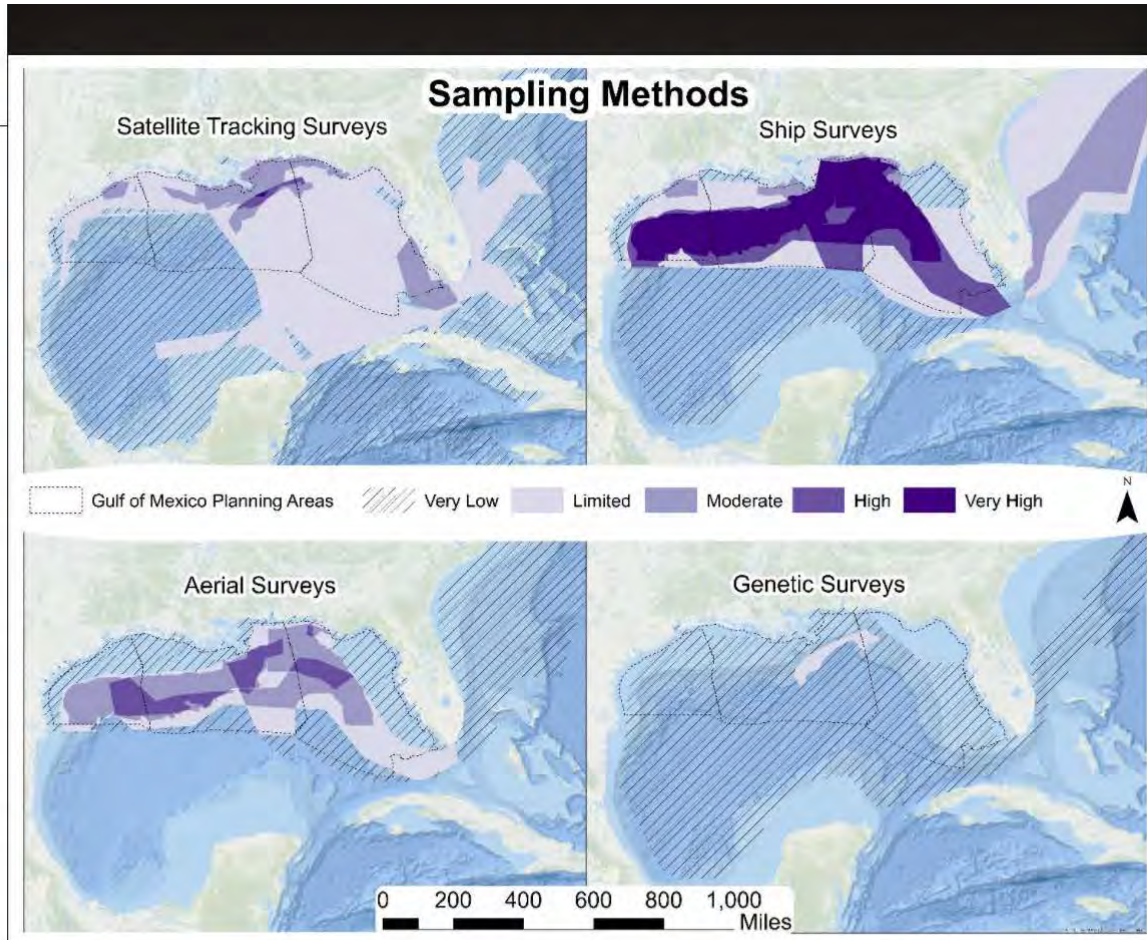


- A very limited number of studies collected data on seabirds across methods, seasons, and regions compared to other taxa, however, there is increased effort dedicated to analyzing distribution and abundance of marine mammals and seabirds via GoMMAPPS survey efforts.
- Studying the distribution and behavior of animals using satellite telemetry tags can frequently result in collecting data that covered all regions and/or seasons but the data was usually limited in assessing abundance.
- A number of factors for determining the best way to collect information on the distribution, abundance, and behavior of animals must be weighed, including the resources available for sampling effort, ecology and biology of the species, and current technology.
- For collecting survey data used to determine distribution and abundance, it was generally more difficult and expensive to sample further offshore, especially for large, highly mobile animals such as marine mammals, seabirds, and sea turtles.

This initial evaluation has shown that while much research has been conducted using the methods planned for meeting the GoMMAPPS' objectives, data have not been collected evenly across taxa, regions, and seasons.

Image Source: NOAA Fisheries

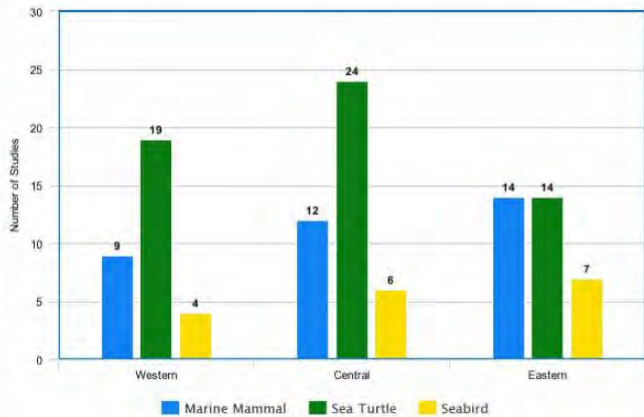
Taxa & Regional Gaps



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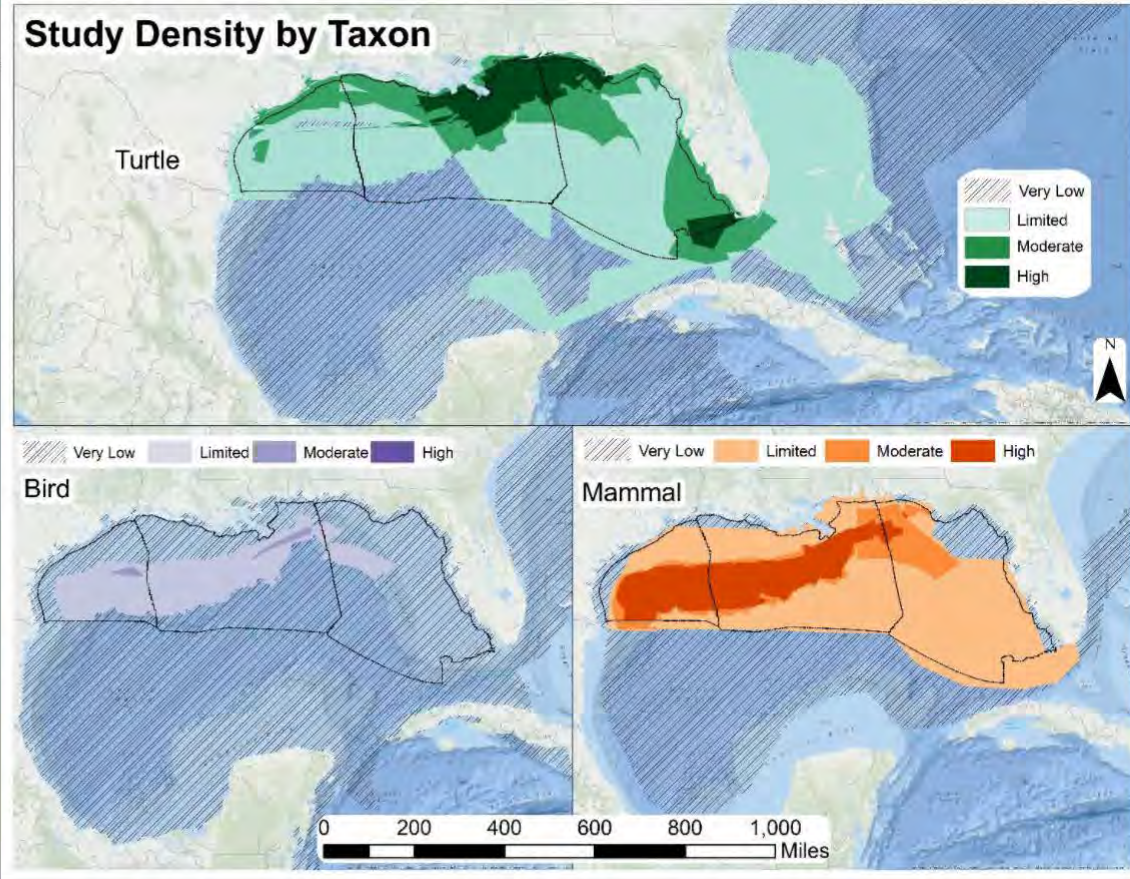
Taxa & Regional Gaps

- Of the 44 studies, regardless of method, study data on sea turtles was collected the most followed by **marine mammals**, and then seabirds.
- There were six(6) studies that collected data for all three taxa, and of these, only four (4) studies were found to collect data on all taxa, within all regions, and over all seasons.
- Many studies overlapped with more than one region in the Gulf of Mexico, with more studies collecting data within the eastern region, followed by the central and western regions.
- More than half of the studies collected marine mammal, seabird, and/or sea turtle data within all three regions of the Gulf of Mexico.
- More studies collected data for **sea turtle species** in the central region and the least number of sea turtle studies were found in the eastern region.
- Across taxa, **seabird** data was the most limited in both the number of studies and the number of species studied; although 11 studies were found to collect data on seabirds, only seven (7) were known to specifically only target seabirds as opposed to collecting data more opportunistically or along with other taxa.



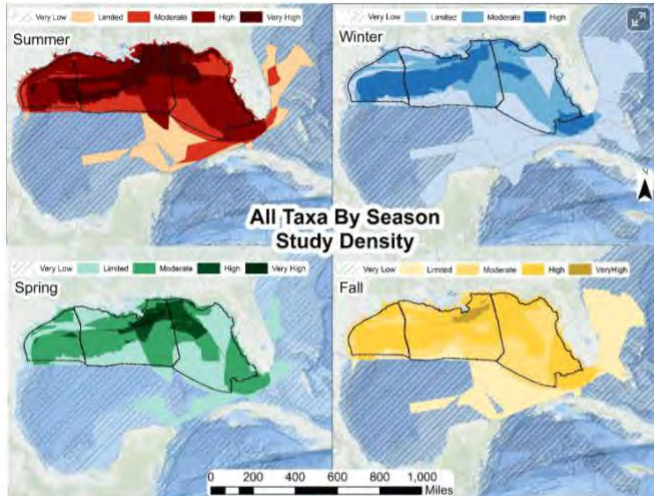
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Study Density by Taxon

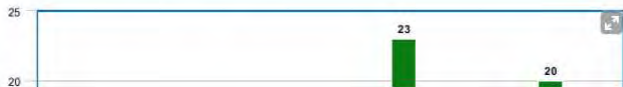


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Seasonal Gaps



- More studies collected data for the Summer followed by the Fall, Spring, and then Winter.
 - Winter: December – February
 - Spring: March – May
 - Summer: June – August
 - Fall: September – November
- This trend was the same across all taxa except for marine mammal studies being equal in fall and spring and seabird studies being equal in winter and spring.



All Taxa-Summer

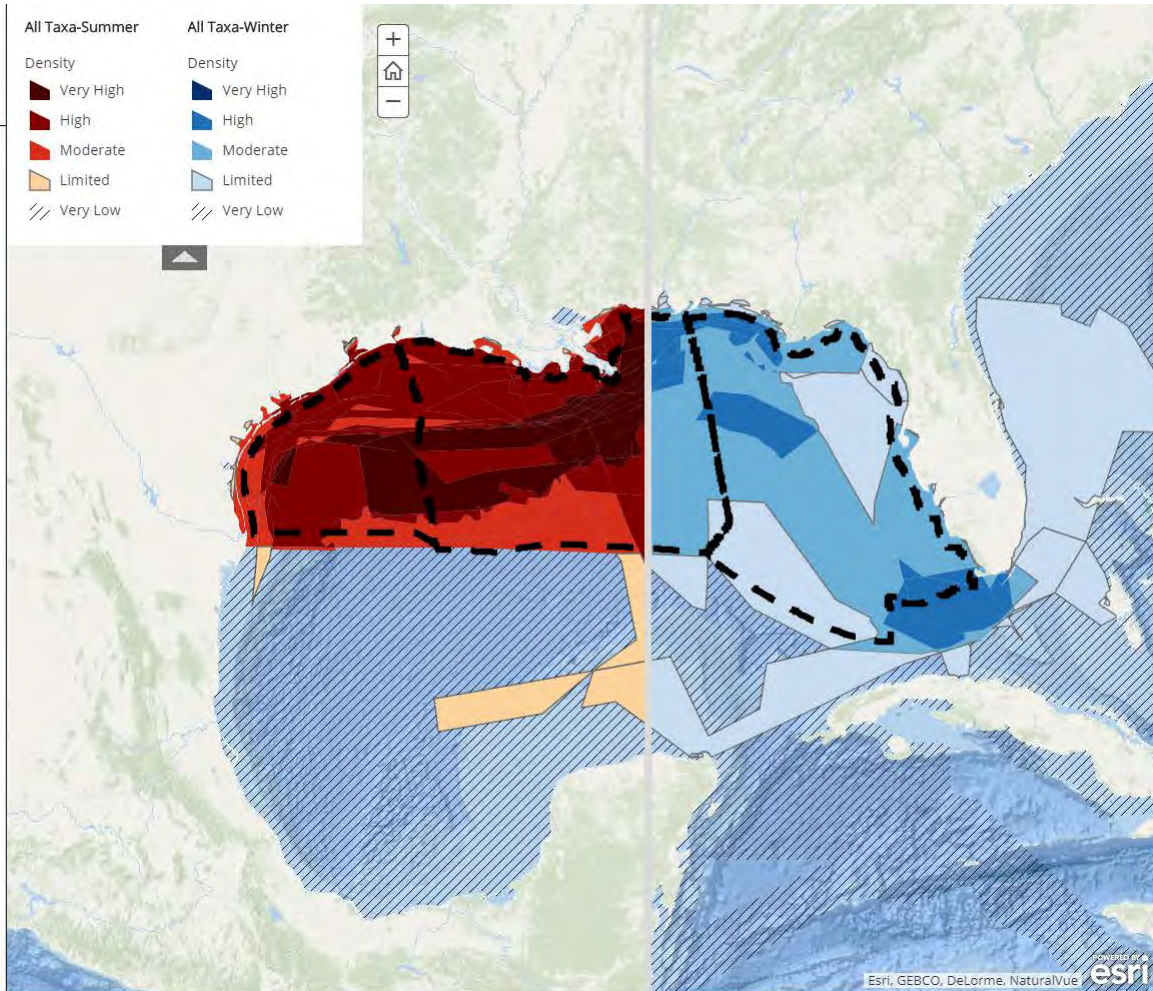
Density

- Very High
- High
- Moderate
- Limited
- Very Low

All Taxa-Winter

Density

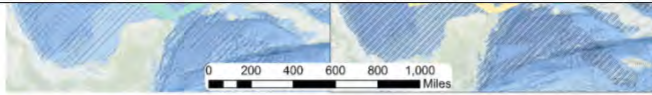
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- High
- Moderate
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- Very Low



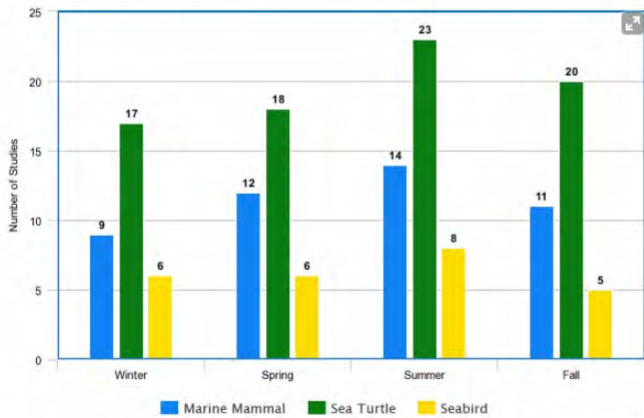
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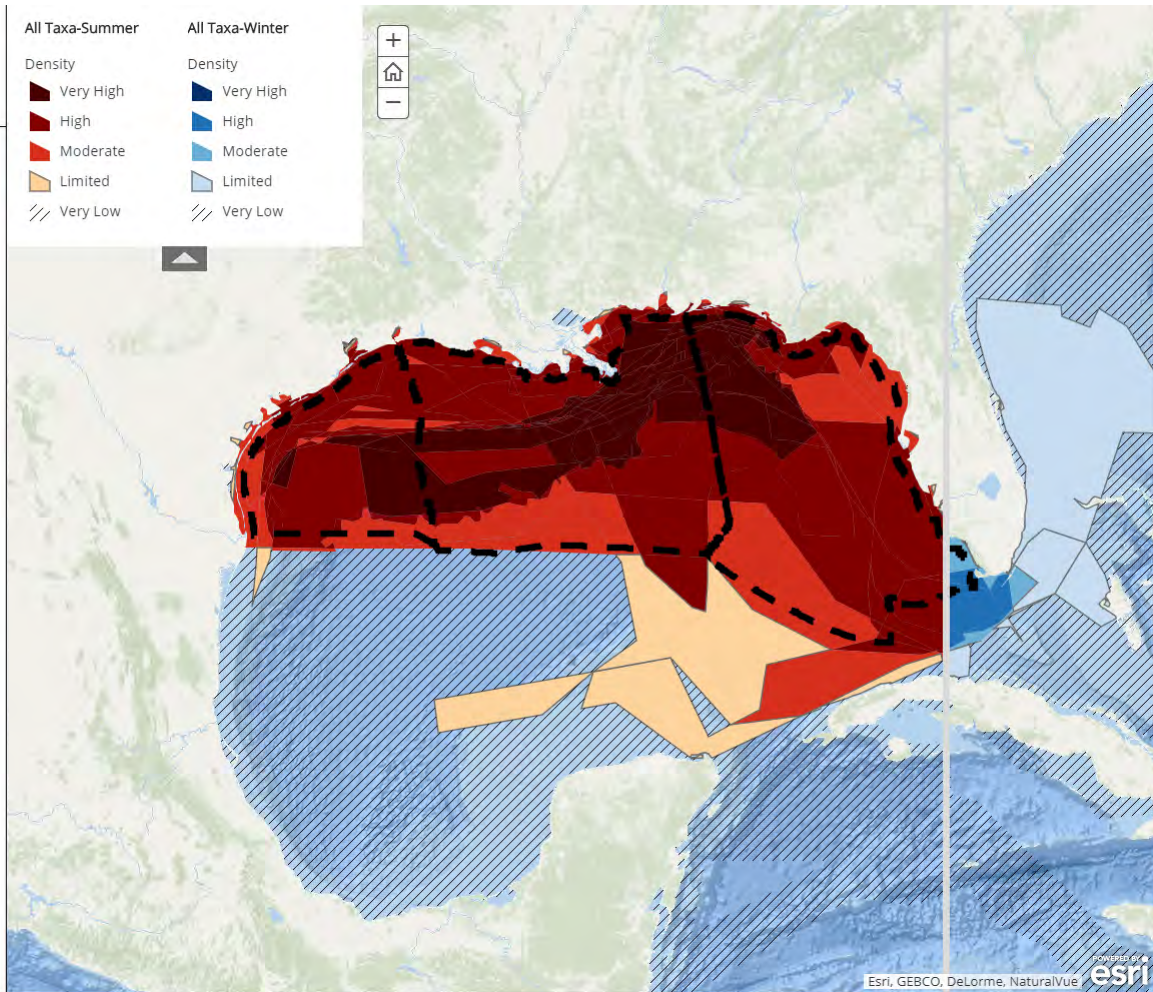
- More studies were found for sea turtles, than for marine mammals and seabirds throughout all seasons, although these studies were less diverse in terms of methodology.
- More than half of the studies collected either marine mammal, seabird, and/or sea turtle data within all four seasons.

All Taxa-Summer

Density
Very High
High
Moderate
Limited
Very Low

All Taxa-Winter

Density
Very High
High
Moderate
Limited
Very Low



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Data Dissemination Recommendations

For studies to be searchable, a moderate amount of effort is required by individual researchers, institutions, partners, and/or other stakeholders beyond just conducting research and analyzing or collating information. The perceived effort that it takes to share data hinders most from sharing, however, scientists are motivated to share because of pressure from publishing journals, other collaborators, and the potential for gaining individual career benefits.

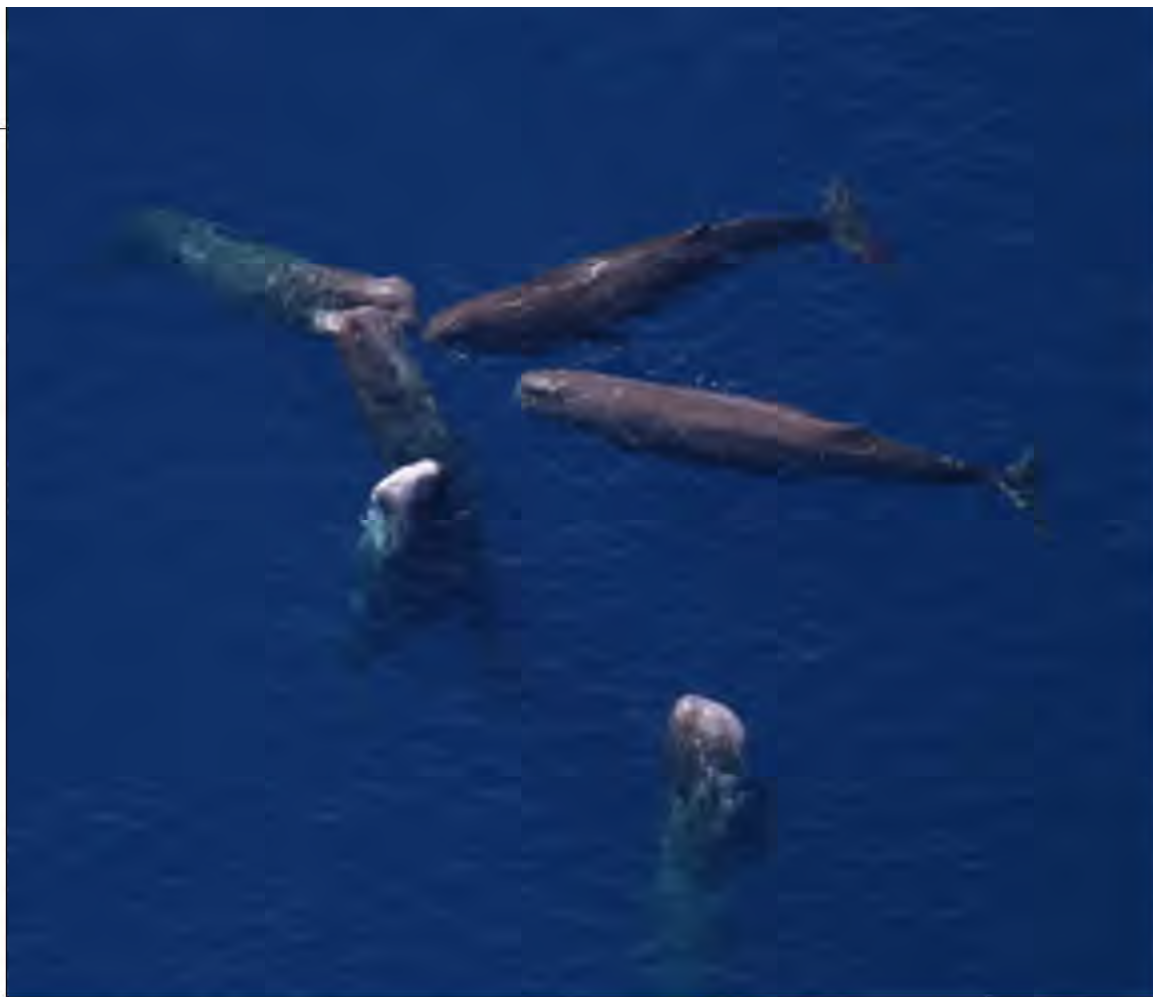
Since the distribution, abundance, and behavior of marine mammals, seabirds, and sea turtles are often studied in a variety of ways, the flexibility of housing data collected by multiple methods within one database was extremely useful for the assessment and conservation of marine populations, saving others much time and effort in searching for information based on a particular geographic, temporal, and/or taxon of interest.

Key factors to look for in a good repository include:

- the potential to offer at least text, references, and weblinks to information,
- Centralize, organized archive for data on different platforms and in multiple formats,
- downloads of data in a spatial or tabular format,
- mechanism to store large, high-resolution data files,
- advanced tools for searching, and
- public access to the highest resolution of data available.

Of the repositories reviewed for this study, the [OBIS-SEAMAP](#) provided the most number of data products with relevant information, containing the highest amount of detail for studies on marine mammals, seabird, and sea turtle distribution, abundance, and behavior in the Gulf of Mexico. This is accomplished by allowing direct access to data contributed by researchers in several standardized formats. NOAA and BOEM's [MarineCadastre.gov](#) contained materials for on-going and completed projects, including related web links to download data, map services, story maps, and web-based and printed outreach materials such as one-pagers and fact sheets. These websites provided more interim products that served as public outreach and educational materials and facilitate collaboration across multiple stakeholders.

In general, the optimal model for submitting high quality information would be to choose a repository that has the most detailed input/engagement from the original data providers at the time of inclusion and where data were



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In general, the optimal model for submitting high quality information would be to choose a repository that has the most detailed input/engagement from the original data providers at the time of inclusion and where data were independently understandable for long-term preservation.

Image Source: National Park Service

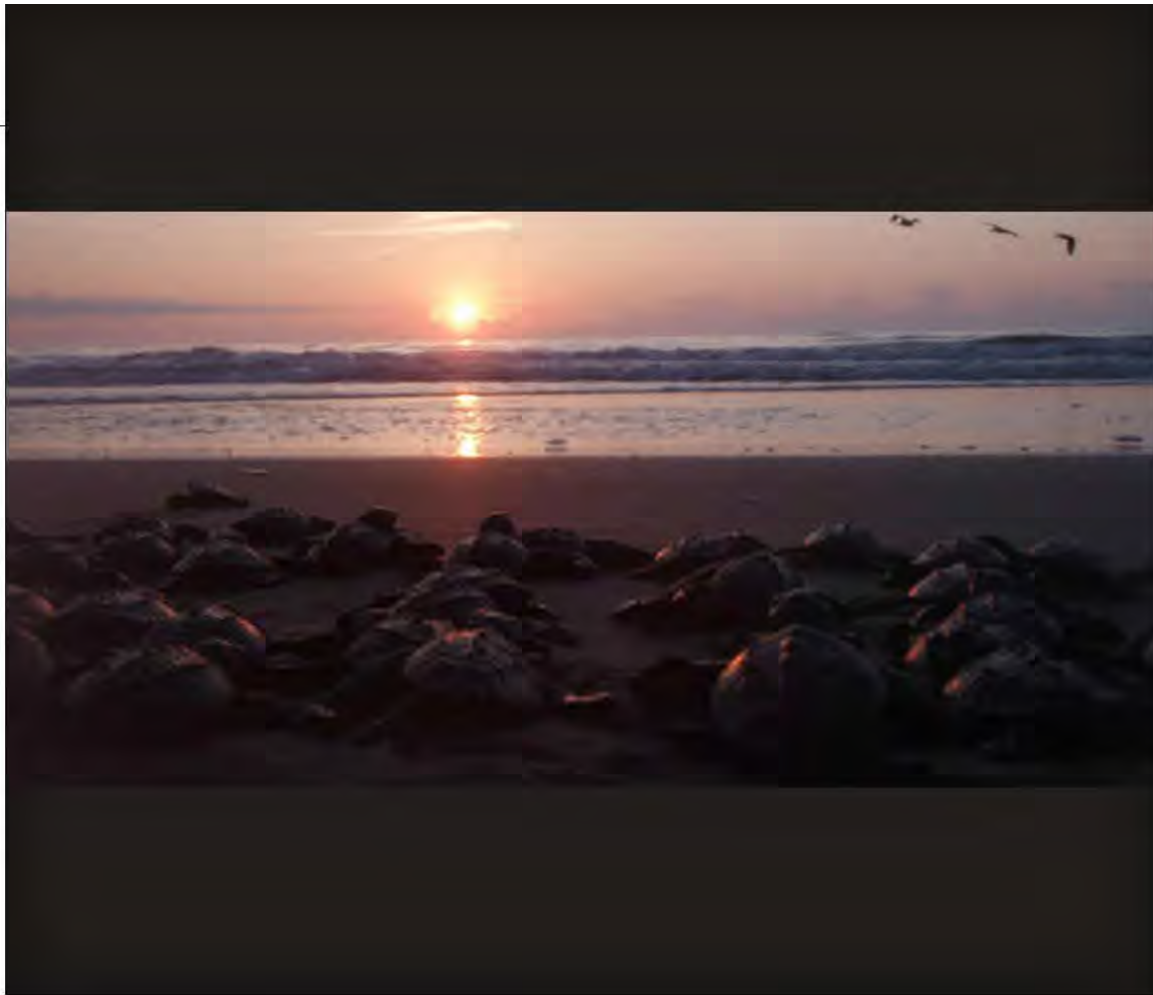
Data Management Recommendations

There are numerous efforts within and across institutions/agencies to standardize project data management protocols so that different types of data can be archived and shared efficiently and accurately. A fundamental way to communicate the results of a study and help prevent loss of valuable information would be:

- Identify a data repository in advance along with a data steward.
- Maintain close communication between the data provider and the data steward (if they are not the same person).
- Document and archive all data in one place that is logical and accessible to others.
- Should multiple repositories be used: list references to link data repositories, along with maintaining the same study title across platforms.
- If data are shared in an accessible repository:
 - Include specific links and/or unique data set identification codes used for online repositories.
 - Include the name of the data repository within all data products (e.g., publications, presentations)
 - Always include complete metadata with any data set that contains the study title and links to any reports/publications linked to the data.
- Some active data repositories, such as the NCEI or OBIS-SEAMAP, can assist principal investigators with developing workflows for efficient project data transfer and archive.

GoMMAPPS' goal for long-term data products storage and preservation could be met by utilizing existing data repositories, which may be maximized when principal investigators/data producers work closely with a data steward to support archive and discovery of data at the highest resolution possible.

Image Source: National Park Service



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Conclusions

In support of the GoMMAPPS planning phase, analyses used to identify geographic, temporal, and taxonomic gaps indicate the following:

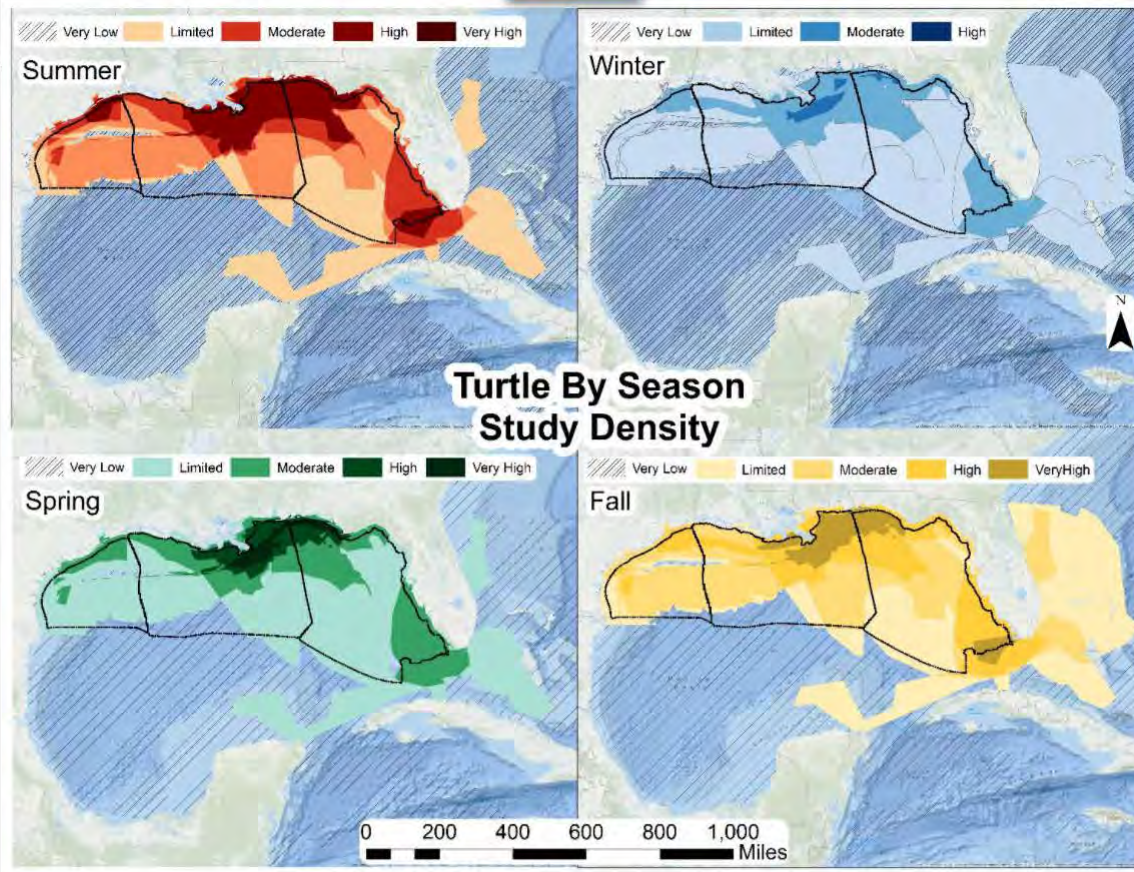
1. Based on this initial evaluation, collecting data on the behavior of marine mammals, the abundance of sea turtles, and any data on the distribution, abundance, or behavior of seabirds would fill major gaps.
2. **When prioritizing by region**, for the studies inventoried here, directing future research towards the western and central regions was recommended for filling existing gaps mainly found for marine mammals and seabirds.
3. **For sea turtles**, more studies were found to have collected data in the central and western Gulf of Mexico regions. These studies were most often in the form of satellite tracking. Line transect surveys in these regions will significantly improve understanding of distribution and abundance of sea turtles.
4. Directing efforts to study the distribution, abundance, and behavior of these taxa during the **winter and spring** would aid in evaluating seasonal movements/migrations, if present, as well as contribute to the development of spatially- and temporally-explicit species density and habitat models.
5. A more thorough investigation of data coverage, especially with the support of taxa experts and the use of **higher resolution spatial data**, would help guide important areas to study within these regions.
6. Maintaining and growing this data inventory can facilitate future in-depth analyses on how, when and where to prioritize research to fill gaps to better inform management and conservation decisions.

Resources & Additional Sources

- <https://marmesalastre.gov/>
- <https://marinemapshare.gov/csois/#/>
- <https://www.hqem.gov/>
- <http://response.restoration.noaa.gov/marine-and-spatial-data/environmental-resources/management-application-ema>
- <http://www.divecon.hawaii.gov/beerwater-barrier-islands-take>



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Resources & Additional Sources

<https://marinecadastre.gov/>

<https://marinecadastre.gov/esps/#/>

<https://www.boem.gov/>

<http://response.restoration.noaa.gov/maps-and-spatial-data/environmental-response-management-application-erma>

<https://www.diver.orr.noaa.gov/deepwater-horizon-nrda-data>



Image Source: [P&Cter Guedella](#)

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A QSI/BOEM story map



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