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Priority Areas Suggested by Stakeholders for Restoration and Protection of Mesophotic and Deep Benthic Communities Injured by the *Deepwater Horizon* Oil Spill

Mapping, Ground-Truthing, and Predictive Habitat Modeling Project

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For more information on MDBC Restoration, please visit:
https://www.gulfspillrestoration.noaa.gov/restoration-areas/open-ocean

https://coastalscience.noaa.gov/project/scientific-support-for-mesophotic-and-deep-benthic-community-restoration-in-the-gulf-of-mexico/

Summary values from this analysis can be downloaded from Zenodo (https://zenodo.org)

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Disclaimer

Deepwater Horizon Mesophotic and Deep Benthic Communities Restoration

This report is part of the NOAA Mesophotic and Deep Benthic Communities (MDBC) Series of publications that share the results of work conducted by the *Deepwater Horizon* MDBC restoration projects.

The 2010 *Deepwater Horizon* oil spill was an unprecedented event. Approximately 3.2 million barrels of oil were released into the deep ocean over nearly three months. The plume of oil moved throughout the water column, formed surface slicks that cumulatively covered an area the size of Virginia, and washed oil onto at least 1,300 miles of shoreline habitats. More than 770 square miles (2,000 square kilometers) of deep benthic habitat were injured by the oil spill, including areas surrounding the *Deepwater Horizon* wellhead and parts of the Pinnacles Trend mesophotic reef complex, located at the edge of the continental shelf.

Under the Oil Pollution Act, state and federal natural resource trustees conducted a Natural Resource Damage Assessment (NRDA). The Trustees assessed damages, quantifying the unprecedented injuries to natural resources and lost services. They also developed a programmatic restoration plan to restore injured resources and compensate the public for lost services.

In April 2016, a settlement was finalized that included up to $8.8 billion in funding for the *Deepwater Horizon* Trustees to restore the natural resource injuries caused by the oil spill as described in their programmatic restoration plan, Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement. The *Deepwater Horizon* Open Ocean Trustee Implementation Group is responsible for restoring natural resources and their services within the Open Ocean Restoration Area that were injured by the oil spill. The Open Ocean Trustees include NOAA, U.S. Department of the Interior, U.S. Environmental Protection Agency, and U.S. Department of Agriculture.

In 2019, the Open Ocean Trustee Implementation Group committed more than $126 million to implement four restoration projects to address the injury to MDBC. The MDBC projects are: Mapping, Ground-truthing, and Predictive Habitat Modeling; Habitat Assessment and Evaluation; Coral Propagation Technique Development; and Active Management and Protection. NOAA and the Department of the Interior are implementing the projects, in cooperation with a range of partners, over eight years.

Together, the projects take a phased approach to meet the challenges involved in restoring deep-sea habitats. Challenges to restoration include a limited scientific understanding of these communities, limited experience with restoration at the depths at which these communities occur, and remote locations that limit accessibility.

More information about *Deepwater Horizon* restoration and the MDBC restoration projects is available at: www.gulfspillrestoration.noaa.gov.

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Executive Summary

A vast area of the Gulf of Mexico's Mesophotic and Deep Benthic Communities (MDBC) was affected by the 2010 Deepwater Horizon oil spill. Efficiently implementing restoration and protection for the oil spill as described in the 2016 Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Programmatic Environmental Impact Statement (PDARP/PEIS) requires that priority areas be identified for restoring and protecting MDBCs in the northern Gulf of Mexico. To support planning for the 2022–2027 Implementation Phase of the MDBC restoration projects, the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Coastal Ocean Science (NCCOS) and MDBC Project Teams (Mapping, Ground-truthing, and Predictive Habitat Modeling; Habitat Assessment and Evaluation; Coral Propagation Technique Development; and Active Management and Protection) developed a map framework, process, and online application to gather input from stakeholders about their spatial priorities for the collection of new mapping, ground-truthing, and modeling information and products to support MDBC restoration and protection.

To identify stakeholder priorities consistent with the objectives of the MDBC portfolio, an online participatory Geographic Information System (pGIS) was developed to collect standardized recommendations from regional experts. A 25 x 25 km grid was overlaid on the northern Gulf of Mexico between 27°N latitude and the 50 m isobath. Sixty-four individuals from federal, state, academic, and non-governmental organizations provided their recommendations. Each respondent placed 100 virtual coins across the grid to denote the location and urgency of their priorities. Respondents also indicated what data and modeling products they recommended for each cell using a list of choices to support the 2022–2027 Implementation Phase of the MDBC projects. These ranged from delineation of large landscape features such as pinnacles and escarpments, to identification of individual coral species and their condition. Lastly, participants justified their priorities by indicating which aspects of the MDBC portfolio their recommendations supported. A Digital Atlas consisting of presently available datasets (e.g., oil extent, bathymetry, predictive models) was provided to help participants understand gaps in existing information as they considered future priorities.

Results were compiled and mapped to identify priority locations for implementing MDBC project activities according to stakeholders. The largest concentrations of high priority cells were located in two groups, one in the vicinity of the Deepwater Horizon/Macondo wellhead site, and another along the topography associated with the Flower Garden Banks National Marine Sanctuary. Isolated or smaller groups of high priority cells occurred elsewhere in the study region and included South Texas Banks; parts of the Mississippi, DeSoto, and Green Canyons; the northern edges of the Sigsbee and West Florida Escarpments; and also, Madison-Swanson and Steamboat Lumps on the West Florida Shelf. Many of these locations are either part of existing marine protected areas (MPAs), have been considered for designation as MPAs (e.g., NOAA National Marine Sanctuaries or Habitat Areas of Particular Concern), include large topographic features such as domes and escarpments, or are in close proximity to the Deepwater Horizon/Macondo wellhead.

Identifying these high priority areas for stakeholders is among the first steps in planning the 5-year Implementation Phase of the MDBC portfolio. Specific locations for implementing project activities will be identified based on this analysis as well as additional information such as the size and depth of seafloor features, presently available data as determined through gap analysis, requirements for new data acquisitions including model resolution and accuracy, as well as available ship time and survey equipment. Furthermore, priority areas identified here are subject to change as initial objectives are met, new information becomes available during implementation, and to accomplish the goals of specific projects.

Collectively, these efforts reflect the diversity of locations and activities to support the objectives of the overall MDBC portfolio. Some injured areas may be restored and monitored, undamaged areas may be used as donor sites for coral transplant and as reference sites for monitoring natural changes, still other locations may have other threats mitigated or receive enhanced management as part of the overall objective of restoring, enhancing, and protecting MDBCs following the Deepwater Horizon oil spill.

1. Introduction

Mesophotic and deep benthic communities (MDBC) are vast and complex ecosystems on the ocean floor that exist at or beyond the very edge of sunlight penetration underwater. These dimly lit or completely dark habitats are a foundation of Gulf of Mexico food webs and include many rare and slow growing species of corals and associated animals such as fish, anemones, sponges, sea stars, crustaceans, and sea cucumbers (Brooke and Schroeder 2007; Boland et al. 2017; Gil-Aguledo et al. 2020). More than 770 square miles of deep-sea habitat and 4 square miles of mesophotic habitat were injured by the *Deepwater Horizon* (DWH) oil spill which began on April 20, 2010 and became the largest marine oil spill in history (Fisher et al. 2014; DWH NRDA Trustees 2016; Etnoyer et al. 2016; www.gulfspillrestoration.noaa.gov; Figure 1.1). In 2019, the Open Ocean Trustee Implementation Group approved a portfolio of four restoration projects to restore MDBC injured by the *Deepwater Horizon* oil spill in the Final Open Ocean Restoration Plan 2/Environmental Assessment: Fish, Sea Turtles, Marine Mammals, and Mesophotic and Deep Benthic Communities (Open Ocean Trustee Implementation Group 2019). The MDBC portfolio is implemented by NOAA and the Department of the Interior through team members representing a range of expertise and experience with MDBC.

The abundance and distribution of MDBCs across the Gulf of Mexico are not completely known, particularly in deeper waters. This complicates evaluation of DWH oil spill injuries and recovery, and presents challenges for decision-making regarding restoration, management, and protection (Fisher et al. 2014; Etnoyer et al. 2016). Due to the vast area potentially affected by the DWH oil spill, it is not possible to completely map, ground-truth, and model all of the MDBCs throughout the entire region. Smaller areas must be prioritized wherein the limited resources for restoration and monitoring activities can be applied. Identifying these priority areas represents one of the foremost challenges to implementing the restoration and protection goals of the National Resources Damage Assessment (NRDA) in the Final *Deepwater Horizon* Programmatic Damage Assessment and Restoration Plan/Programmatic Environmental Impact Statement (DWH NRDA Trustees 2016). Therefore, the MDBC projects requested a process to collect and compile input from a diversity of regional experts on their priorities for restoring, enhancing, and managing MDBCs in the northern Gulf of Mexico.

To meet this need, NOAA's National Centers for Coastal Ocean Science (NCCOS) created an online, participatory Geographic Information System (pGIS) to help groups of scientists and managers to collaborate, share suggestions, and prioritize the spatial allocation of their limited resources (Buja and Christensen 2005; Figure 1.1). The pGIS application has been utilized for similar projects throughout the US EEZ and Great Lakes (Battista et al. 2017; Kendall et al. 2018; 2021; Costa et al. 2019; Gouws et al. 2021). The interface can be customized to address regionally relevant issues and scaled both in terms of the number of individuals taking part, as well as the spatial extent and resolution of the resulting priorities. The interface is designed to collect information from participating respondents on 4 general questions. These are where, what, why, and when information products are needed in a region of interest (Kendall et al. 2018). First, locations where data are needed are identified using a grid-based spatial framework overlaid on a project area that participants can use to denote locations of interest. Second, respondents indicate their desired products (e.g., delineations of specific bottom types, models of habitat suitability for corals) for each priority area using pull down menus to standardize responses. Third, using another pull down menu, respondents will indicate why they chose the priorities that they did. Lastly, a scoring system, comprised of virtual coins placed on the grid, is used to denote the level of urgency when data products are needed by placing more coins in higher priority areas.

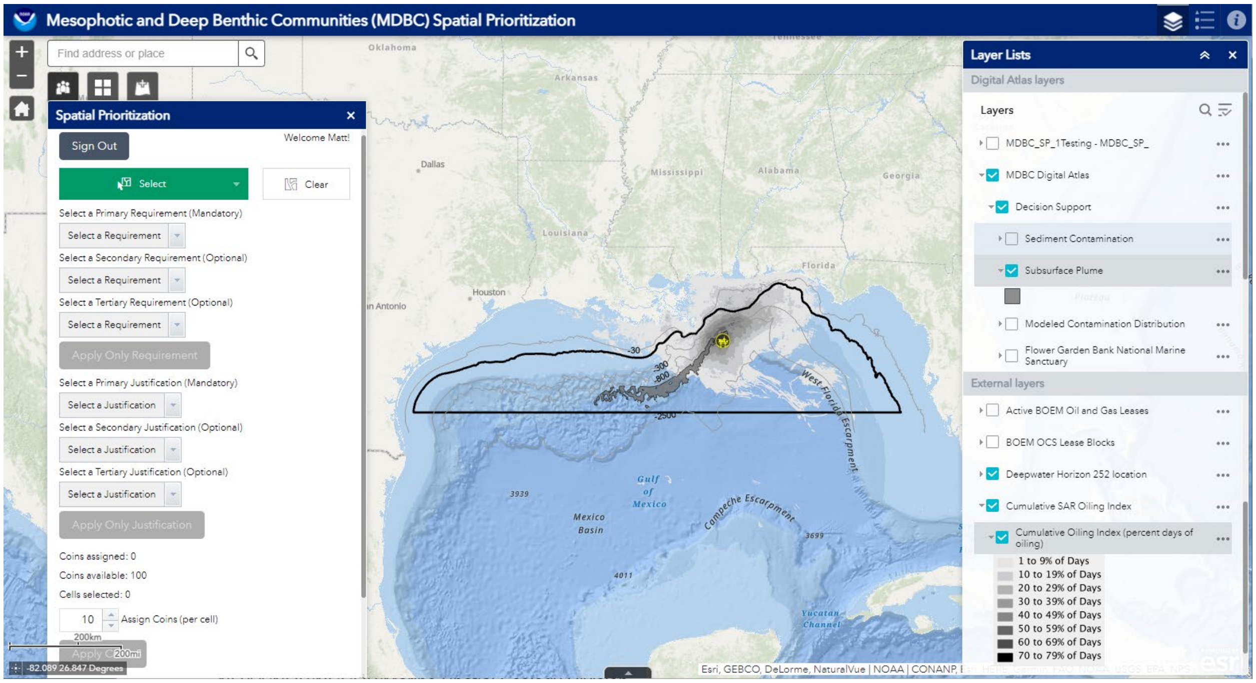

Figure 1.1. The participatory GIS (pGIS) interface for the Mesophotic and Deep Benthic Communities (MDBC) prioritization. The black polygon shows the geographic extent of the MDBC Prioritization. The northern edge of the study extent is on the 50 m isobath and the southern edge is on 27°N latitude. Bathymetry, the Deepwater Horizon (DWH) spill site, cumulative days under a surface slick, and the extent of area within which the subsurface oil plume could have intersected the bottom, are shown for context. The Spatial Prioritization menu is shown at left. A Digital Atlas with links to existing data is at right.

In 2021, NOAA NCCOS and its partners in the MDBC restoration portfolio implemented this established spatial prioritization process in the northern Gulf of Mexico. The goal was to identify and summarize spatial priorities for seafloor mapping, ground truthing, and modeling to assist with planning the 2022–2027 implementation phase of the MDBC portfolio. The prioritization activity was designed to fit seamlessly with the needed inputs of the other MDBC project tasks. The overall MDBC portfolio consists of four projects: 1) mapping, ground-truthing, and predictive habitat modeling (MGM), 2) habitat assessment and evaluation (HAE), 3) coral propagation technique (CPT) development, and 4) active management and protection (AMP). These four complementary projects are designed to work together to restore, protect, and manage regional MDBCs following the DWH oil spill. This may include not only active restoration of sites impacted by oil, but also activities in locations that were likely unimpacted and could serve as reference, coral donor, or outplant locations for coral restoration, monitoring, or enhanced protection (DWH NRDA Trustees 2016).

Specifically, the pGIS facilitated gathering the following information:

- Where are the priority areas for mapping, ground-truthing, and modeling in the northern Gulf of Mexico to support the MDBC portfolio?
- What are the specific data requirements in those areas?
- Why are those the priorities and how do they relate to the MDBC portfolio?
- When are the data needed during the five-year implementation phase for MDBC field operations (2022–2027)?

This report describes the methods and processes that were part of the MDBC spatial prioritization process including: 1) creation of the Prioritization User Guidance Team who provided advice on customizing the pGIS to meet the specific needs of the MDBC portfolio, 2) the rationale for the spatial scope (footprint) and selection framework (grid) used by participants to denote priority areas, 3) how participating individuals were identified and contacted, 4) instructions provided to participants for using the online prioritization interface, 5) existing datasets available to respondents to understand gaps in coverage, 6) how this information was analyzed, 7) a summary and composite maps of the group's spatial priorities, and 8) how results were made available to support implementation planning for the MDBC portfolio.

2. Developing the Prioritization pGIS Application

2.1. Prioritization User Guidance Team

An essential first step in this project was to identify a group of advisors with subject matter expertise in NRDA objectives and MDBC issues including mapping, modeling, restoration, and habitat management. Individuals were selected to represent different project teams from the MDBC portfolio (i.e., MGM, HAE, CPT, AMP; Table 2.1). This group, the Prioritization User Guidance Teams (PUGs), was established to ensure that the pGIS was customized to directly address the needs of the MDBC portfolio. The PUGs established the spatial scope and resolution of the project area, recommended locally relevant datasets to aid respondents in setting priorities, set standardized options for respondents to select in the pGIS menus, and helped identify suitable respondents to participate.

Table 2.1. Prioritization User Guidance Team members.

Name	Title/Expertise	Affiliation
Tim Battista	Oceanographer/Mapping	NOAA/NOS/National Centers for Coastal Ocean Science (NCCOS)
Kristopher Benson	Marine Habitat Resource Specialist/Restoration ecology	NOAA/NMFS/Office of Habitat Conservation (OHC)
Amanda Demopoulos	Benthic Ecologist/Infauna	USGS/Wetland and Aquatic Research Center
Peter Etnoyer	Marine Biologist/Deep sea coral	NOAA/NOS/NCCOS
Charles Menza	Marine Ecologist/Mapping	NOAA/NOS/NCCOS
Avery Paxton	Research Associate/Mapping	NOAA/NOS/NCCOS
Chris Taylor	Ecologist/Mapping	NOAA/NOS/NCCOS
G.P. Schmahl	Sanctuary Superintendent/Management	NOAA/NOS/Office of National Marine Sanctuaries (ONMS)/Flower Gardens Bank National Marine Sanctuary (FGNMS)
Arliss Winship	Quantitative Ecologist/Modeling	CSS Inc. under contract to NOAA/NOS/NCCOS

NOS – National Ocean Service; NMFS – National Marine Fisheries Service; USGS – U.S. Geological Survey

2.2. Spatial Scope (Footprint) and Selection Framework (Grid)

Several options for the spatial scope of the prioritization activity were considered, including: areas designated as (or under consideration for designation) Habitat Areas of Particular Concern (HAPCs), areas with documented surface oil or submerged hydrocarbon plumes, or the entire US Exclusive Economic Zone (EEZ) in the Gulf of Mexico. The PUGs determined that the spatial scope of the prioritization should be consistent with the area selected for the MGM Data Inventory task, that is, from 27°N latitude northward to the 50 m depth contour (Figure 1.1). The rationale was that it included: 1) the DWH spill site, 2) much of the extent of the surface oil slick and bottom plumes, 3) areas of potential MDBC habitats that could be impacted and in need of restoration, and 4) locations within the same biogeographic realm that are likely unimpacted and could serve as reference, donor, or outplant locations for coral restoration, monitoring, or enhanced protection.

Spatial resolution of the pGIS refers to the cell size of a grid overlaid on the prioritization area. Individual grid cells are the smallest unit of area that can be selected during the prioritization process. The PUGs considered the tradeoffs between: 1) the prioritization footprint, 2) the size of the physical features subject to restoration, monitoring, or protection (e.g., coral caps, pinnacles, scarps, valleys), 3) the needs of the field work and modeling tasks in the implementation phase of the MDBC portfolio, and 4) the efficiency and burden of the cell size for getting the needed information from respondents. It was determined that the spatial framework should be a grid with 25 by 25 km cells aligned to the U.S. Geological Survey (USGS) 3D Elevation Program (Gouws et al. 2021; Figure 2.1). This resulted in a prioritization grid on the study area with 421 cells.

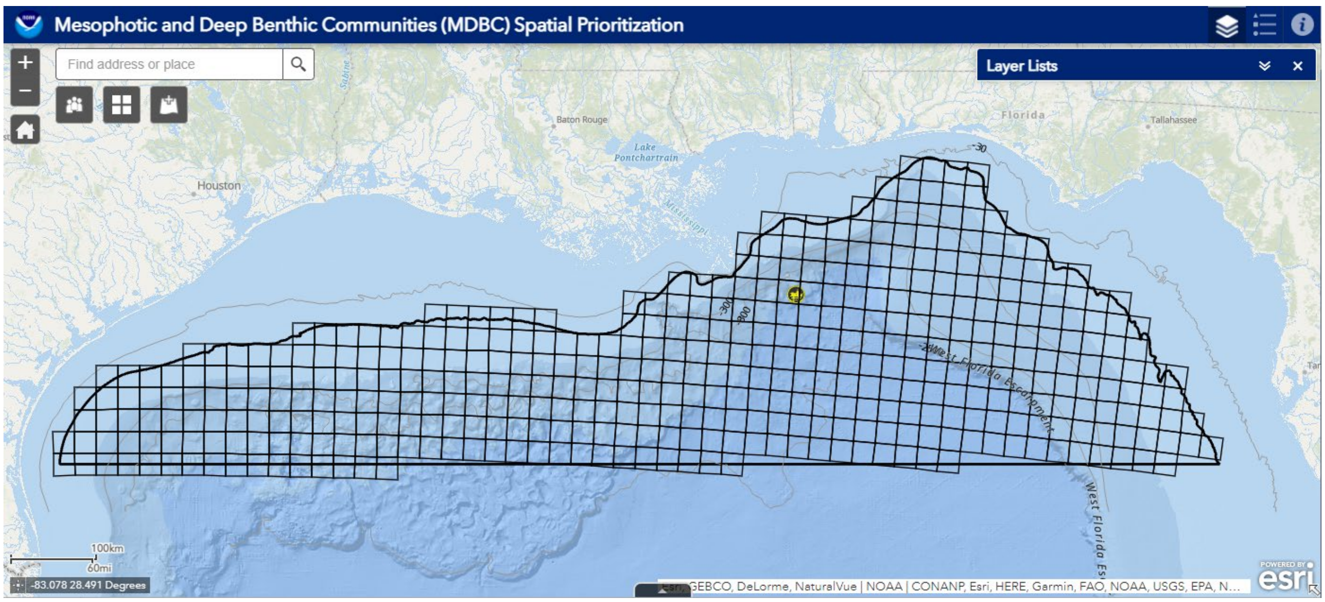

Figure 2.1. The selection grid with 25 by 25 km cells used in the pGIS interface.

2.3. Potential Respondents

The criterion for being a respondent was that the individual *"must have some expertise, stake, or interest in one or more aspects of the MDBC portfolio"*. The PUGs generated a list of potential respondents beginning with approximately 60 individuals identified by the MDBC portfolio and then adding or deleting names during an outreach process to identify appropriate and interested experts. This draft list of potential respondents was reviewed by the MGM Project Management Team, MDBC Technical Team, and MDBC Steering Committee who made additional suggestions of possible participants. Respondents were chosen to span a diversity of fields including mesophotic and deep-sea ecology, hard and soft bottom benthic communities, fisheries, geology, oceanography, marine protected areas, and minerals management. They were variously affiliated with federal and state government organizations, universities, non-governmental organizations, and other entities. Each participating respondent was asked to provide their own set of recommendations for spatial (where to map) and topical (what data are needed and why) priorities.

Everyone on the final list of 130 potential respondents was contacted to gauge their interest in participating in the prioritization. Multiple outreach messages were sent to potential respondents including an initial generic invitation describing the process. This was followed by personalized invitations from the PUGs or other MDBC team members well known to the Gulf of Mexico science and management communities to encourage maximum participation. Of those contacted, 90 responded with an initial interest in participating, and 64 ultimately completed the process of recommending their spatial priorities (Appendix).

2.4. Entering Priorities

Each respondent was provided a link to the pGIS application and a unique login ID to their own ArcGIS online account. Respondents could access the application at their convenience from any computer with an internet connection. During webinars conducted on October 7 and 12, 2021, respondents were provided an overview of the MBDC project portfolio, the objectives of the prioritization, and several demonstrations. Demonstrations instructed respondents on how to: 1) log into their accounts, 2) view and manipulate the layers in the Digital Atlas (see below), and 3) make and edit their recommendations using the pGIS interface.

Once logged into the application, respondents first selected the cell (or cells) they wished to prioritize. Next, they conveyed what types of information they deemed important in each selected cell (Figure 2.1). Simple pull-down menus were pre-set with several types of information products from which to choose, called "Requirements" (Table 2.2, Figure 1.1). Requirements were identified by the MGM project managers to support relevant aspects of the 2022–2027 Implementation Phase of the portfolio. This list was comprised of products that can be modeled or derived from mapping and ground-truthing data at various scales that would be needed to support the MDBC portfolio during the field implementation phase. The list spanned multiple scales of information from characterization of broad geographic features to detailed information about individual corals. Respondents had to indicate a primary requirement and could optionally designate a secondary, and tertiary requirement from the same list.

Table 2.2. Information Requirements in the pGIS interface based on MGM operations planning.

Requirement Choices
1. Delineations of large topographic features (e.g., pinnacles, escarpments, valleys, basins)
2. Delineations of hard vs. soft bottom
3. Delineations of substrate types (e.g., sand, mud, rock outcrops, coral caps, pavement)
4. Models of habitat suitability for key taxa or communities
5. Modeled or calculated presence/absence or density of corals
6. Identification of species of corals and their local environments (e.g., rugosity, slope)
7. Documentation of condition (e.g., injury) of individual corals

Next, respondents had to indicate why they chose each cell and requirement, using pull-down menus pre-set with a list of "Justifications" (Table 2.3, Figure 1.1). These were chosen to directly relate to the projects in the MDBC portfolio (i.e., MGM, HAE, CPT, and AMP). Respondents were asked to select a primary Justification and could optionally select a secondary and tertiary rationale from the same list.

Table 2.3. Justifications in the pGIS interface based on the MDBC portfolio.

Justification Choices
1. Protection or management (e.g., moorings, oil/gas infrastructure remediation, fisheries, enforcement)
2. Collect specimens for restoration
3. Restoration site evaluation/selection
4. Selection of monitoring sites (e.g., reference sites, and coral recruitment sites)
5. Exploration to identify new MDBC areas
6. Threat mitigation/removal

Respondents were urged to contact the prioritization team if none of the requirement or justification options were suitable for their needs; however, no one expressed any limitations of the pre-set menus during the prioritization response period.

Lastly, respondents were asked to indicate the urgency of their priorities in each grid cell using a virtual coin method. Respondents each received a set of 100 virtual coins to "spend" on the grid as they would value their priorities. More coins in a cell meant that it was a more urgent priority within the 5-year implementation phase of the MDBC portfolio (i.e., 8–10 coins in a cell = needed in 2022, 1–2 coins = needed by 2027). Rules imposed on coin placement were that each respondent must allocate all of their 100 coins to ensure that everyone's opinion was equally weighted, and that no more than 10% of a respondent's coins could be placed in any one grid cell. Therefore, respondents had to choose at least 10 cells, but no more than 100, to denote their priorities across the region. As coins were assigned, the pGIS tracked and displayed the number of coins remaining to be allocated.

Respondents were given 2–3 weeks to complete their recommendations with a deadline of November 4, 2021. During the data entry period, NCCOS provided technical assistance and answered questions respondents had regarding any aspects of the process. A reminder was sent to respondents not yet finished with their recommendations by the last week of the response period and to determine if there were any questions or technical issues. Once respondents completed their priorities, they notified the prioritization team and their individual accounts were locked to preserve their recommendations for analysis.

2.5. The Digital Atlas

When recommending priority locations to implement project activities, it was important for respondents to understand the extent, quality, and gaps in existing seafloor data and models that are already available. Therefore, the pGIS worked in tandem with an inventory of existing seafloor data and related information. This was provided to respondents in a Digital Atlas that was part of the pGIS and could be viewed while respondents considered their priorities. Eleven categories of information were included in the Digital Atlas (Table 2.4).

Table 2.4. Categories of information that were displayed in the Digital Atlas.

Category	Example Layers
Decision Support	Managed areas: Essential Fish Habitat (EFH), Flower Garden Banks National Marine Sanctuary (FGBNMS), HAPCs, BOEM lease blocks, other Marine Protected Areas (MPAs)
	Oil layers: Macondo well site, maximum extent of surface slick, submerged plume, modeled contaminant distribution, sediment contamination, oil infrastructure
Ground Truthing	Collections: Biological and Geological
	Surveys: Submersible, autonomous underwater vehicle (AUV), and remotely operated vehicle (ROV) videos
	Database: Deep sea coral and sponge locations
Seafloor Mapping	Multibeam sonar
	Side-scan sonar
	Fisheries multibeam echosounder
	Seismic profiler
Predictive Habitat Modeling	Species and habitat distribution predictions from 9 studies

BOEM – Bureau of Ocean Energy Management

3. Prioritization Analysis

3.1. Quality Control and Data Compilation

A total of 64 respondents entered recommendations into the on-line pGIS application. The 421 grid cells and corresponding priorities from the 64 respondents were compiled into a single table consisting of 26,944 rows in R Version 4.1.0 (R Core Team 2021). Each row therefore consisted of a single respondent's priorities for a given cell with columns noting the number of coins assigned with up to three Justifications and Requirements. Several quality control measures were implemented. First, the pGIS automatically enforced the rule that a maximum of 10 coins could be placed into any single cell. Next, scripts checked that all 100 coins were spent by each respondent and that at least a primary Justification and Requirement were selected in cells with coins. Duplicate entries for Justifications or Requirements within the same cell were eliminated (e.g., if "Threat mitigation/removal" was selected at both primary and secondary levels in the same cell by a respondent, the secondary instance was removed). Lastly, cells with no coins but that had a Justification and Requirement were cleared of all attributes. Respondents were notified if any further entries or clarifications were needed from them before analysis. These steps ensured completeness of all entries and that the data structure was ready for analysis.

3.2. Which 'Justifications' and 'Requirements' Were Most Commonly Used?

To determine which Justifications were most commonly selected by respondents, the total number of coins associated with primary, secondary, and tertiary Justifications were tallied separately and their relative proportions were visualized in stacked bar format. Similarly, the total number of coins associated with primary, secondary, and tertiary Requirements were tallied and graphed. Additionally, the frequency of Justifications and Requirements selected by specific groups of respondents were determined. These groups represented the Bureau of Ocean Energy Management (BOEM), the Flower Garden Banks National Marine Sanctuary (FGBNMS), the Gulf of Mexico Fishery Management Council (GMFMC), MDBC team members, and non-MDBC team members (Appendix). For these groups, coins were summed across primary, secondary, and tertiary selections.

3.3. Where Are Cells of Highest Priority?

Composite values within the grid of 421 cells were compiled and plotted in several ways to identify recommended hotspots of relatively high priority for aspects of the 2022–2027 MDBC Implementation Phase. Data were summarized to examine how the respondents allocated coins overall and within each of the Justifications and Requirements. First, general values incorporating all the responses were computed. For this, we calculated the simple sum of all the coins by all respondents in each grid cell, the number of respondents assigning at least one coin in each grid cell, and the number of different Justifications and Requirements that occurred in each cell. These represent measures of overall importance across all respondents. We then partitioned the responses into a variety of subsets to understand which variables were responsible for the overall patterns of high priority. For this, we plotted the total number of coins per cell based on each of the different Justification and Requirement choices available to respondents. In addition, we summarized the recommendations from the five subgroups of respondents including BOEM, FGBNMS, GMFMC, MDBC team members, and non-MDBC team members.

Hotspots representing the highest priorities for future needs were identified from each of these different maps. The top 10% of cells based on total number of coins were identified using the *quantile* function in R, and labeled as "high priority" cells. Only cells with coins were included during this calculation. The top 5% of cells was identified in the same way and labeled as "highest priority" cells.

3.4. Archiving the Results

Practices that ensure the prioritization data are thoroughly organized, maintained, described with metadata, and are accessible have been established through previous prioritization processes in other areas (Battista et al. 2017; Kendall et al. 2018; Kendall et al. 2021; Costa et al. 2019). Data from respondents are initially stored securely with ArcGIS Online and then are compiled into a geodatabase for analysis. Final datasets will be archived through Zenodo (https://zenodo.org). All response layers and summary analysis layers will be available in geodatabase or other appropriate format and provided to the Data Integration Visualization Exploration and Reporting (DIVER) website for use by the MDBC portfolio and others (https://www.diver.orr.noaa.gov/).

4. Results

A total of 64 respondents entered suggestions into the pGIS application and allocated a combined total of 6,400 coins into the 421 grid cells to denote their suggestions for implementing the MDBC portfolio in 2022–2027. Some respondents made selections entirely on their own whereas others informally consulted with various colleagues prior to making their selections. It is unknown how many respondents may have used the information in the Digital Atlas, independent datasets, or colleagues to assist with their selections.

4.1. Which 'Requirements' and 'Justifications' Were Most Commonly Selected?

The most commonly suggested Requirement categories at the primary level were "Identification of species of corals and their local environments" (28% of all coins) followed by "Delineations of large topographic features" (19% of coins; Figure 4.1a). Nearly 90% of coins were assigned a secondary Requirement and 61% were assigned a tertiary Requirement. "Models of habitat suitability for key taxa or communities" comprised the largest share of coins that were assigned a tertiary requirement.

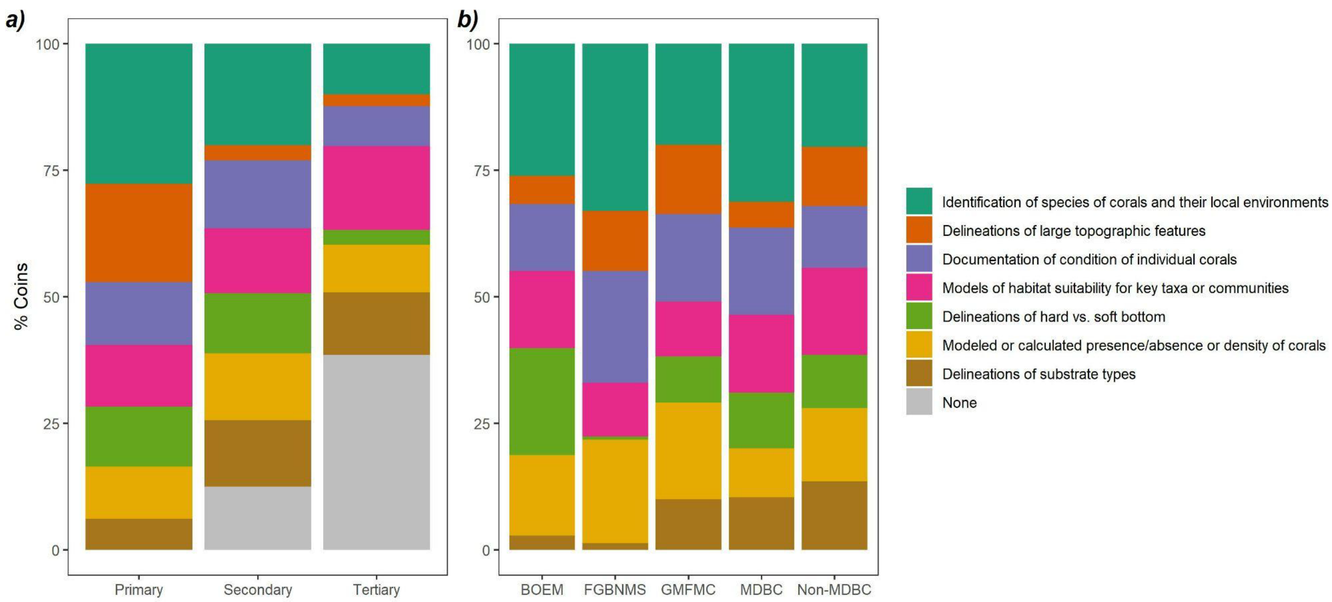

Figure 4.1. The proportion of coins attributed by Requirements among the (a) primary, secondary, and tertiary level, and (b) within sub-groups of participants.

Three of the six options for primary choice of Justification were used much more frequently than the others. These were "Protection or management", "Selection of monitoring sites", and "Exploration to identify new MDBC areas", which accounted for nearly 90% of the coins assigned at the primary level (Figure 4.2a). The least commonly chosen Justification at the primary level was "Threat mitigation/removal". The proportion of coins associated with "Threat mitigation/removal" increased to being one of the most used Justifications at the tertiary level. Only 72% of the coins were assigned a secondary Justification and only 45% were assigned a tertiary Justification.

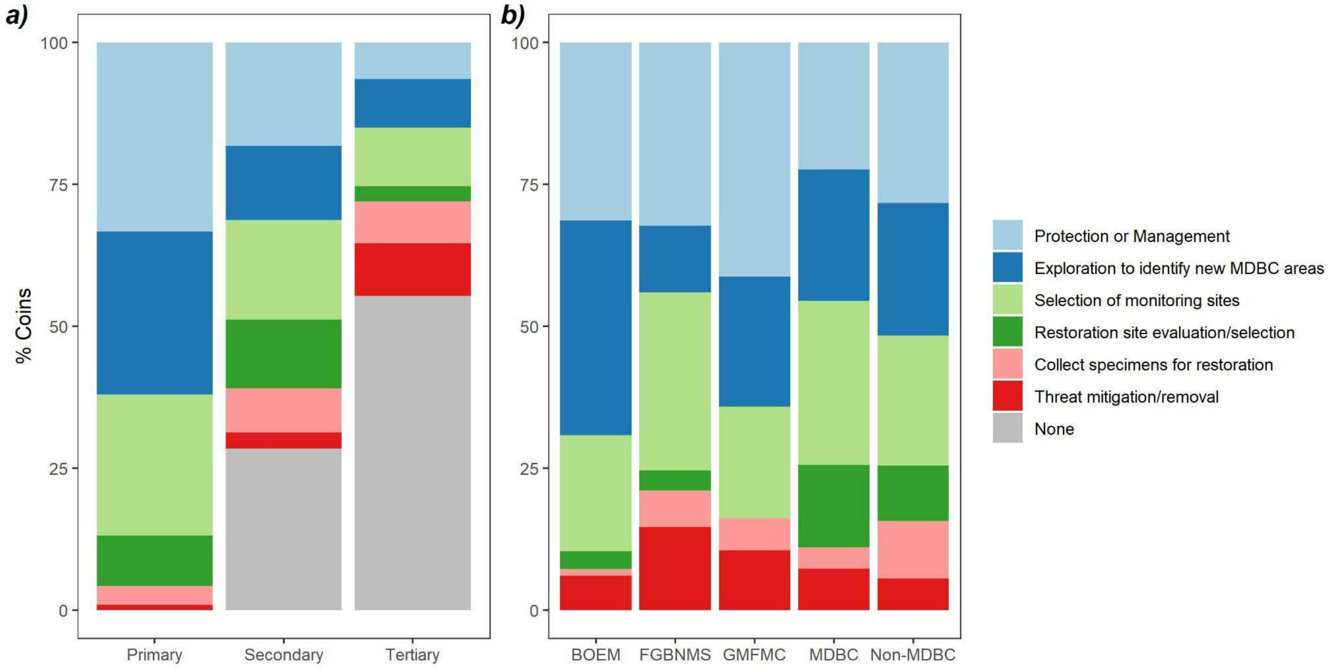

Figure 4.2. The proportion of coins attributed by Justifications among all respondents at the (a) primary, secondary, and tertiary level, and (b) within sub-groups of participants.

Respondents from BOEM most commonly requested “Protection or management” and “Exploration to identify new MDBC areas” as Justifications (Figure 4.2b) and “Identification of species of corals and their local environments” and “Delineations of hard vs. soft bottom” as main Requirements (Figure 4.1b). Respondents from FGBNMS requested “Protection or management” and “Selection of monitoring sites” as Justifications (Figure 4.2b) and “Identification of species of corals and their local environments” and “Collect specimens for restoration” as main Requirements (Figure 4.1b). Respondents from GMFMC primarily requested “Protection or management” and to a lesser degree “Selection of monitoring sites” and “Exploration to identify new MDBC areas” as Justifications (Figure 4.2b). Unlike all other groups, they did not choose “Restoration site evaluation/selection” as a Justification. GMFMC requested “Modeled or calculated presence/absence or density of corals” and “Identification of species of corals and their local environments” as the main Requirements (Figure 4.1b). Respondents that were MDBC team members had similar patterns to the other groups except the Justification “Restoration site evaluation/selection” was used more frequently, whereas non-MDBC team members selected “Collect specimens for restoration” somewhat more frequently than the other groups.

4.2. Where Are Cells of Highest Priority for Stakeholders for the MDBC Implementation Phase?

Locations of highest priority differed depending on whether the input of the respondents was considered holistically or was partitioned by Justification, Requirement, or agency/group. Cells with the highest total number of coins among all respondents (i.e., top 5%) occurred primarily in the vicinity of the DWH spill site and the banks surrounding it (Figure 4.3a). There was also a line of high priority cells all along the banks of the FGBNMS. There was one additional high-priority cell located near the southern edge of the Mississippi Canyon along the Henderson Ridge (HAPC AT357 [GMFMC 2018, NOAA ONMS 2020]) in the region potentially within the submerged oil plume. Cells with coin totals in the top 10% of all respondents were more widely distributed including cells adjacent to the highest priorities as well as some more isolated locations. These included features such as the Madison Swanson sites and a spot at the base of the West Florida Shelf Escarpment, South Texas Banks, Green Canyon, and the northeastern segment of the Sigsbee Escarpment.

Cells with the most respondents (>14) also occurred around the DWH spill site and along the banks of FGBNMS (Figure 4.3b). There was also a group of important cells (top 10%) for many respondents (10–14) on the West Florida Shelf. High priority areas based on the number of different Justifications showed a similar although somewhat more diffuse pattern with many top cells in the vicinity of the spill and FGBNMS but also at more locations on the West Florida Shelf and its Escarpment, the northeastern tip of the Sigsbee Escarpment and along Green Canyon, and offshore of south Texas (Figure 4.3c). This reflects diverse reasons for mapping those areas across multiple aspects of the MDBC portfolio. High priority areas based on the number of Requirements were even more widely distributed (Figure 4.3d). These indicate locations where multiple activities should be coordinated during the implementation phase. Note that plots for both the number of Justifications and Requirements had many cells ranked equally highly and therefore the top 5 and 10% of cells were combined.

Not only do these four figures convey areas of high priority by respondents, but they also show large parts of the study area where there was little interest in MDBCs. None of the 64 respondents placed a single coin in the deep waters south of the Mississippi Canyon and the Sigsbee Escarpment. There were also no coins spent south of the DeSoto Canyon and West Florida Escarpment or in the region of domes and basins south of FGBNMS.

Examining each of the Justifications separately revealed some additional patterns of interest. High priority areas for the "Protection or management" category was along the features extending northeast of the spill site, along the banks of FGBNMS, and two isolated locations on Henderson Ridge south of the Mississippi Canyon (HAPCs AT357 and AT047 [GMFMC 2018, NOAA ONMS 2020]; Figure 4.4a). The Justification "Exploration to identify new MDBC areas" had a different distribution, with the most important locations being on the banks off south Texas, along the eastern edge of the FGBNMS, at the heads of the Mississippi and DeSoto Canyons, at the southern end of Green Canyon (specifically site GC852 [GMFMC 2018]), and around the spill site (Figure 4.4b). The "Selection of monitoring sites" Justification had two main groups of highly important cells, one around the spill site, and another along FGBNMS (Figure 4.4c). The Justification "Restoration site evaluation/selection" was clearly concentrated in the cells around the spill site (Figure 4.4d). Cells including the FGBNMS were also ranked highly in this Justification despite not being within the region impacted during the spill. The "Collect specimens for restoration" Justification had highest coin totals along the banks of the FGBNMS, at two sites at the eastern edge of the study area on the West Florida Shelf, and one location on the western edge of the West Florida Escarpment (Figure 4.4e). Cells around the spill site were also identified with this Justification despite being the most likely to have oil impacts. Lastly, the "Threat mitigation/removal" Justification was used mostly around the spill site, but also along the FGBNMS, and seldom anyplace else (Figure 4.4f).

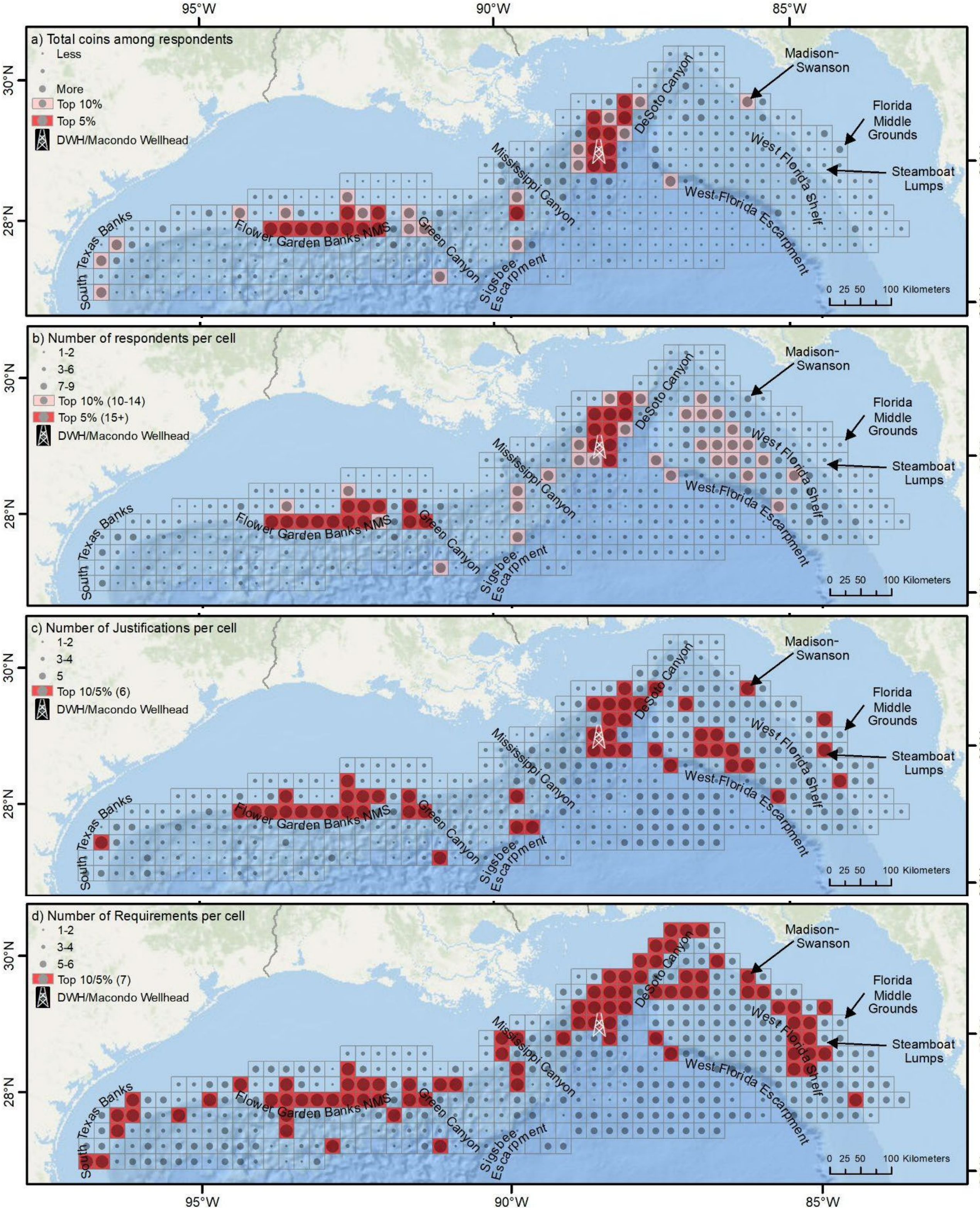

Figure 4.3. Sum of all coins among (a) all respondents in each cell; (b) number of respondents allocating at least one coin in each cell; (c) total number of different Justifications used in each cell; and (d) total number of different Requirements used in each cell.

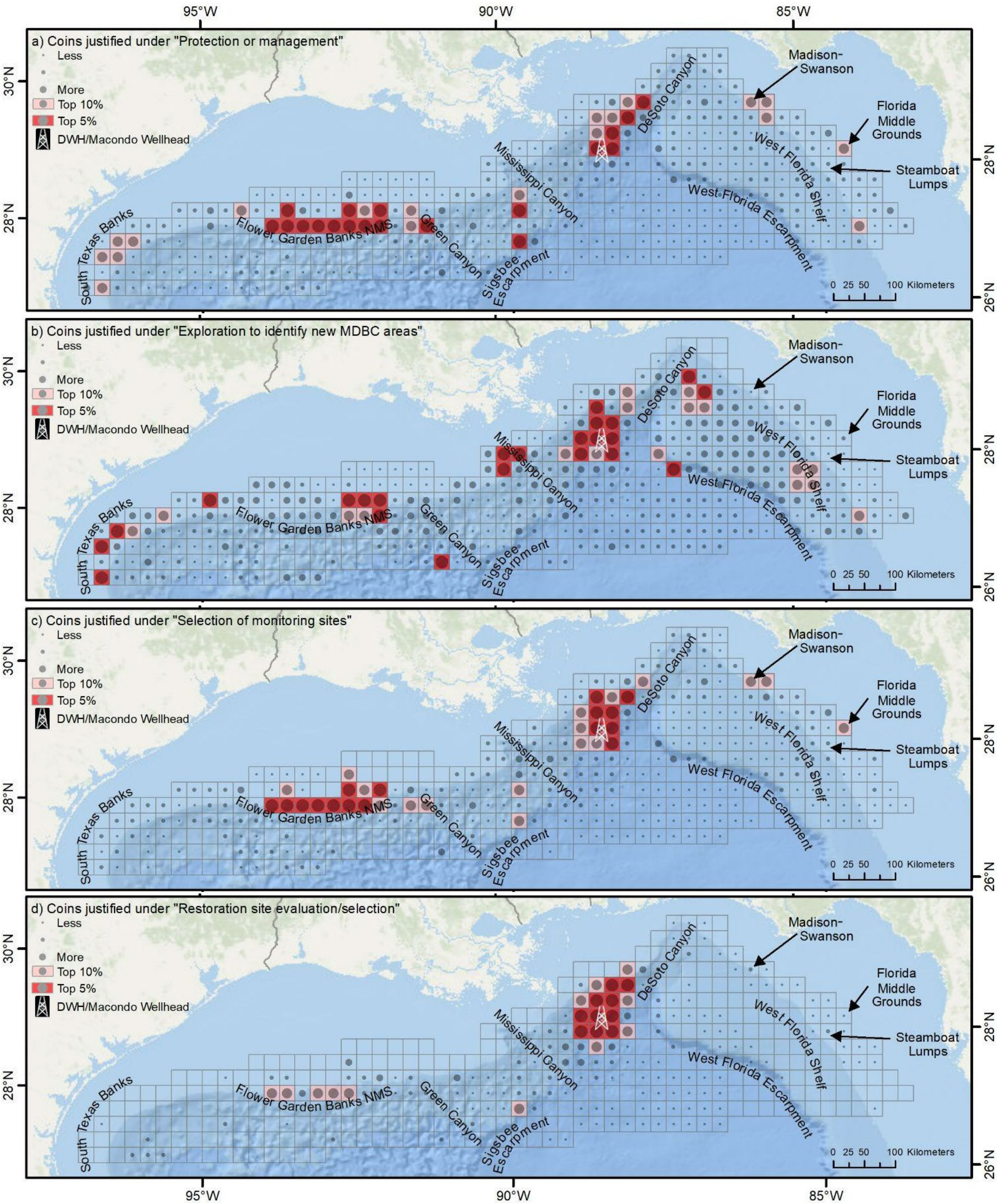

Figure 4.4. Sum of all coins in each cell Justified under (a) “Protection or management”, (b) “Exploration to identify new MDBC areas”, (c) “Selection of monitoring sites”, and (d) “Restoration site evaluation/selection”.

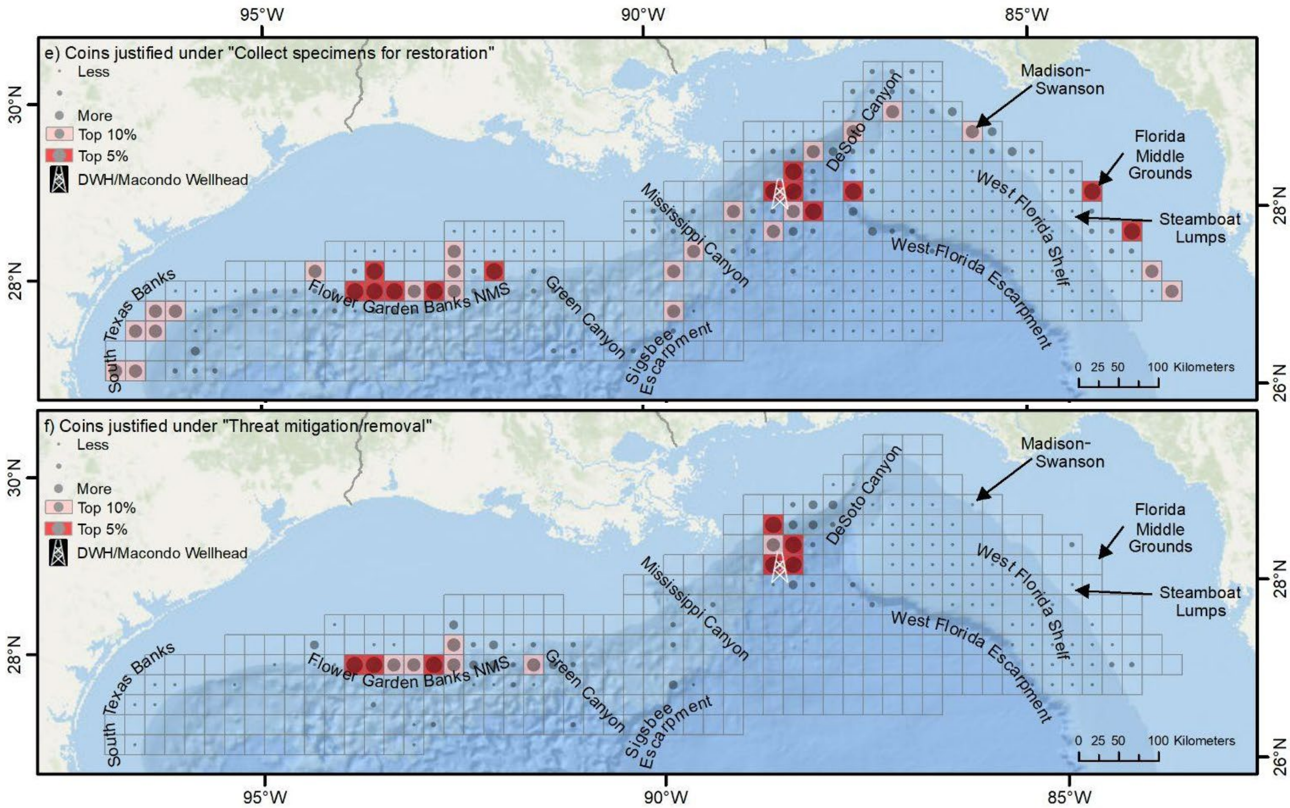

Figure 4.4. Continued. Sum of all coins in each cell Justified under (e) "Collect specimens for restoration", and (f) "Threat mitigation/removal".

When we partitioned the responses based on individual Requirements, additional patterns became apparent (Figures 4.5a–g). The Requirement "Identification of species of corals and their local environments" had a concentration of highest values around the spill site, along the FGBNMS, and along the southern edge of the Mississippi Canyon (Figure 4.5a). Highest ranking cells linked to the Requirement "Delineations of large topographic features" were located singly or in small groups around the spill site and along the FGBNMS, but also in some less common areas (Figure 4.5b). These were in the southeastern corner of the study area on the West Florida Shelf and another location west of Stetson Bank off Texas. The "Documentation of condition (e.g., injury) of individual corals" Requirement was clustered just around the spill site and FGBNMS (Figure 4.5c). The Requirement "Models of habitat suitability for key taxa or communities" was again clustered around the spill site and FGBNMS, but also used frequently on the South Texas Banks (Figure 4.5d). The "Delineations of hard vs. soft bottom" Requirement was most used around the spill site and adjacent salt domes, as well as two clusters of cells located centrally on the West Florida Shelf, and a couple cells in the area of banks off south Texas and FGBNMS (Figure 4.5e). In contrast, the Requirement "Modeled or calculated presence/absence or density of corals" was largely focused on the banks off south Texas and FGBNMS but only one cell near the spill site (Figure 4.5f). The Requirement "Delineations of substrate types" had areas of greatest importance at cells near the spill site, the north edge of DeSoto Canyon, and in isolated cells along the South Texas Banks, Sigsbee Escarpment, and FGBNMS (Figure 4.5g).

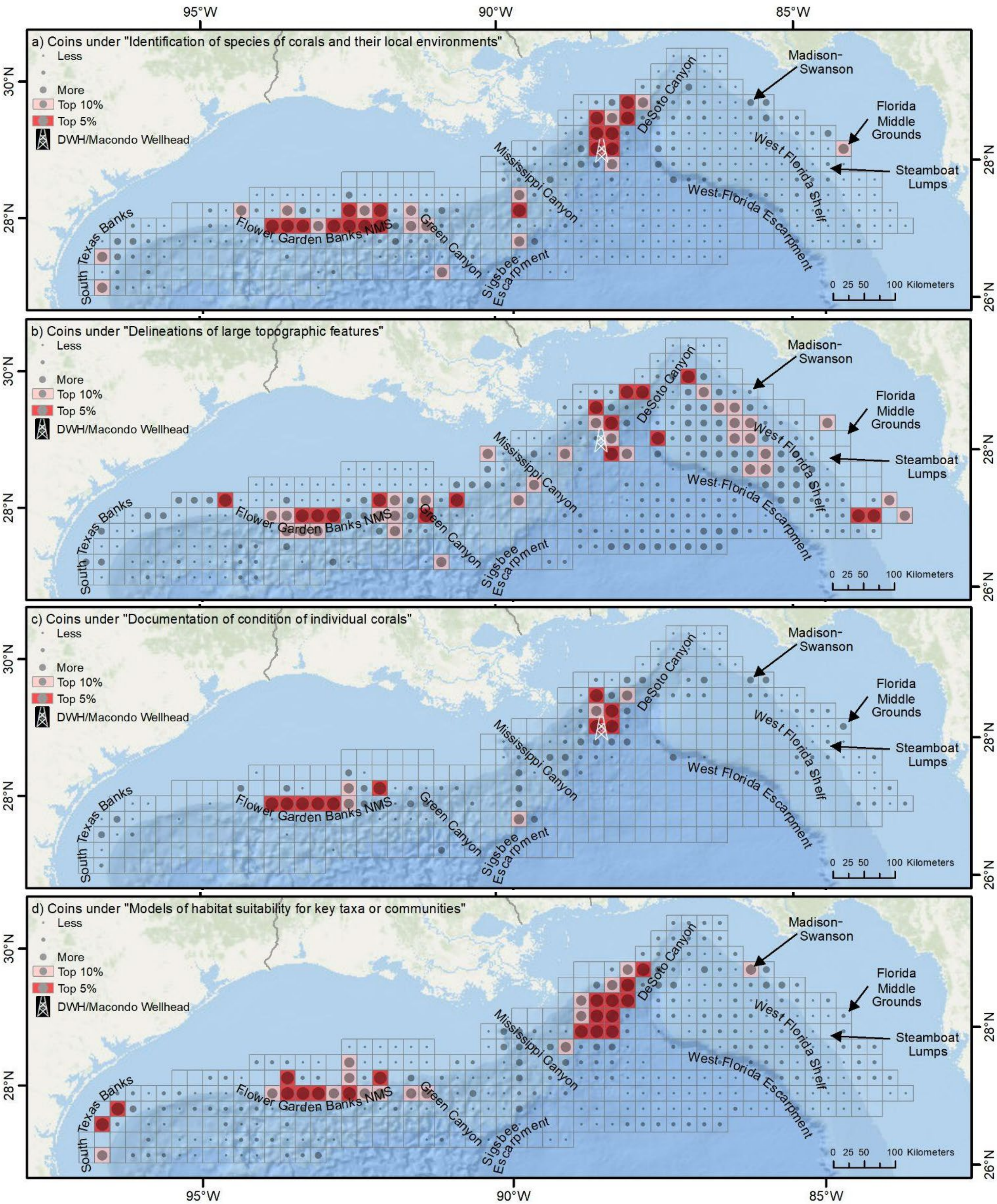

Figure 4.5. Sum of all coins in each cell associated with the Requirement (a) “Identification of species of corals and their local environments”, (b) “Delineations of large topographic features”, (c) “Documentation of condition (e.g., injury) of individual corals”, and (d) “Models of habitat suitability for key taxa or communities”.

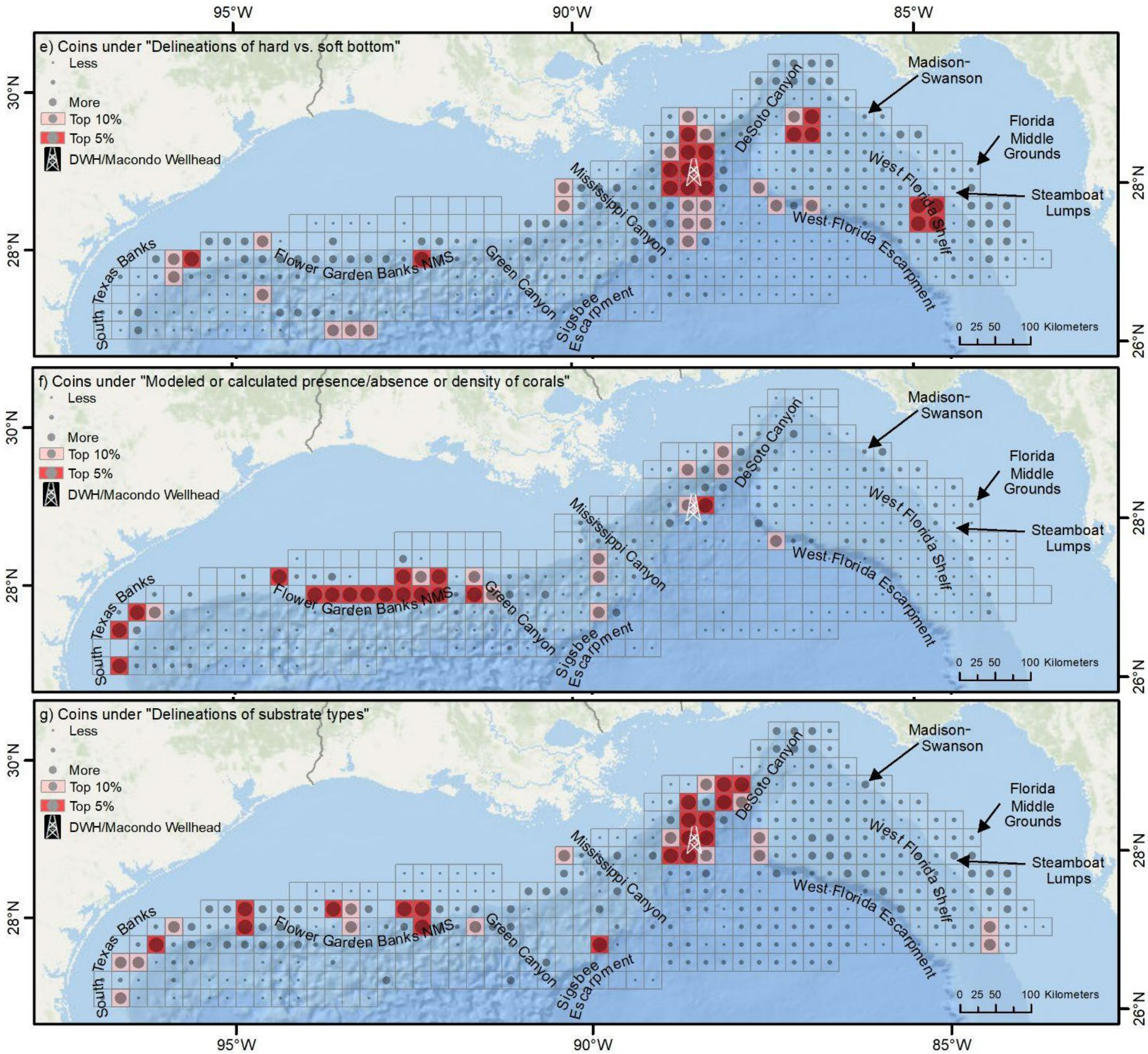

Figure 4.5. Continued. Sum of all coins in each cell associated with the Requirement (e) “Delineations of hard vs. soft bottom”, (f) “Modeled or calculated presence/absence or density of corals”, and (g) “Delineations of substrate types”.

When analyses of results were constrained to participants from the five individual agencies or groups including BOEM, FGBNMS, GMFMC, and the MDBC team members and non-team members, the spatial patterns were more distinct compared to when all respondents were pooled. For respondents from BOEM, the top cells were located around the spill site and adjacent salt domes, along the West Florida Escarpment, and in two groups of cells on the West Florida Shelf (Figure 4.6a). For respondents from FGBNMS, the top cells were unsurprisingly located along the banks of FGBNMS (Figure 4.6b). In contrast, for respondents from GMFMC, top cells were located along the eastern edge of the study area closest to the Florida coast including the Madison Swanson site and Florida Middle Grounds (Figure 4.6c). Whether respondents were MDBC team members or not, their top spatial priorities were somewhat consistent with sites around the spill site and FGBNMS being ranked highly (Figure 4.6d–e). The MDBC respondents also had greater interest in locations between the northeastern edge of Sigsbee Escarpment and the

Mississippi Canyon and Madison Swanson (Figure 4.6d), whereas non-MDBC respondents were more interested in multiple locations along FGBNMS and South Texas Banks (Figure 4.6e).

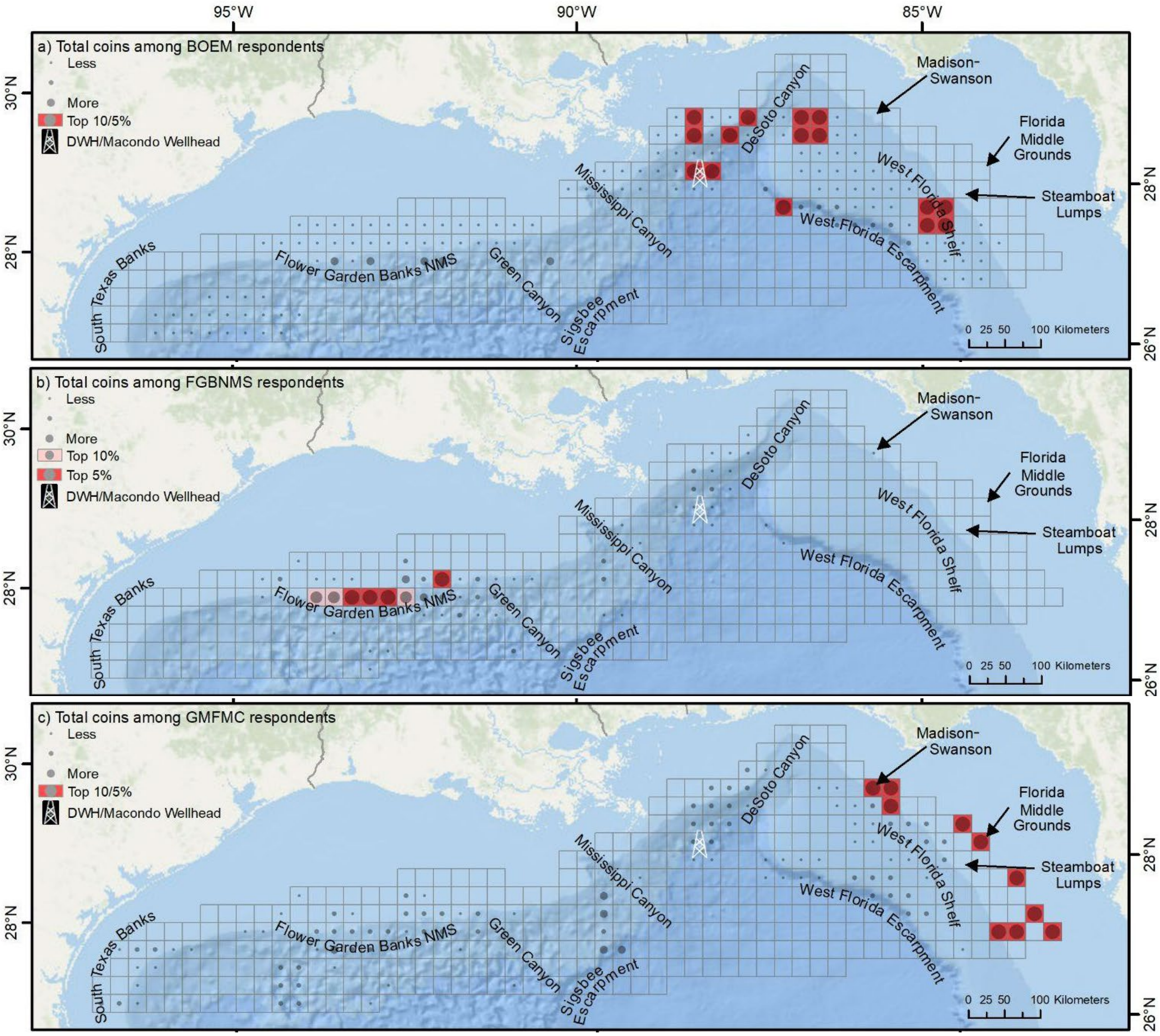

Figure 4.6. Sum of all coins in each cell assigned by respondents from (a) BOEM, (b) FGBNMS, and (c) GMFMC.

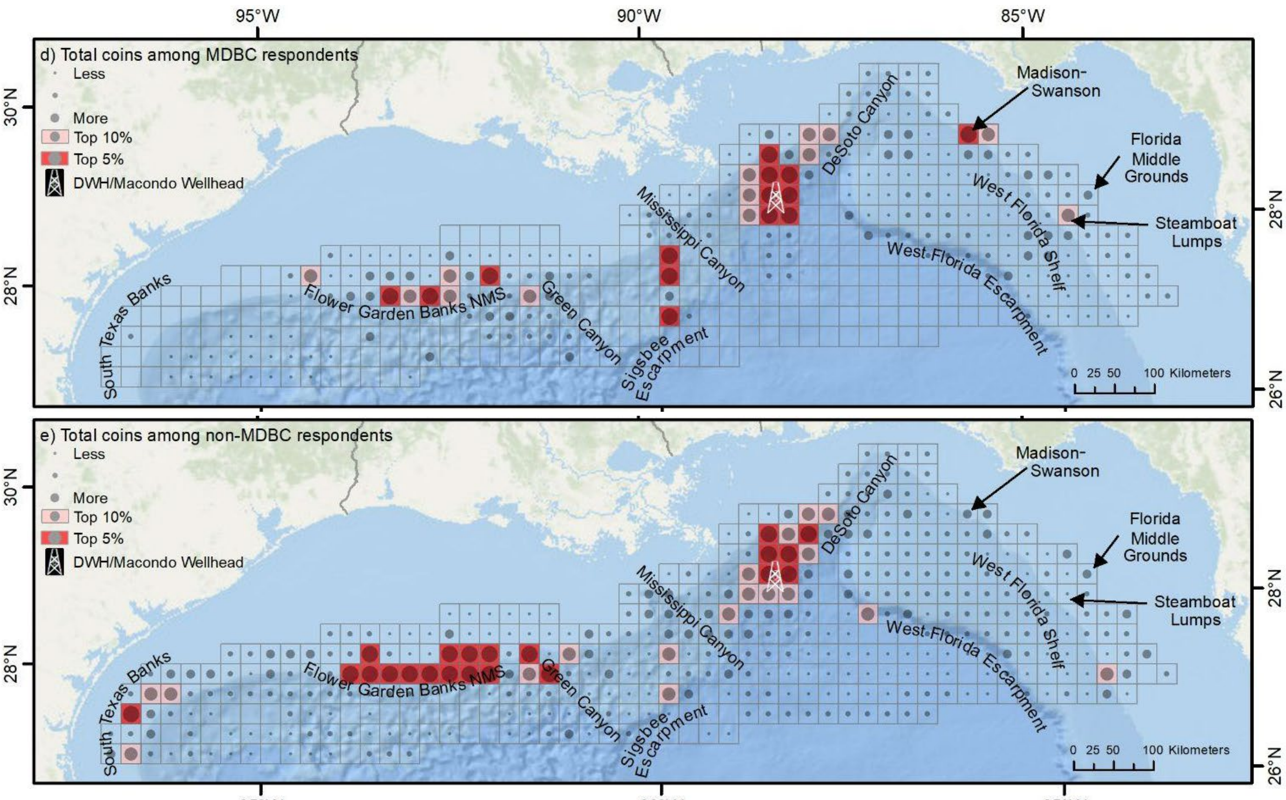

Figure 4.6. Continued. Sum of all coins in each cell assigned by respondents from (d) MDBC team members and (e) non-MDBC team members.

5. Discussion

We used the online pGIS application to gather input from 64 experts regarding their priorities for aspects of the 2022–2027 implementation phase of the MDBC portfolio. The pGIS allowed respondents to indicate where data are required, the types of information that are needed, the urgency of the need within the implementation period, and a rationale to justify their recommendations. Based on analysis of the responses, a few groups of cells emerged as the highest overall priorities for participants. The largest concentrations of high priority cells based on composite variables such as total numbers of coins, respondents, Justifications, and Requirements, were located in two large groups, one in the vicinity of the DWH spill site, and another along the continental shelf-edge topography south of the Texas/Louisiana border comprising the FGBNMS. Smaller groups or isolated cells of high priority occurred elsewhere in the study region depending on the composite variables considered but often included the South Texas Banks, Green Canyon, the edges of the Mississippi and DeSoto Canyons, the northern edges of the Sigsbee and West Florida Escarpments, and Madison-Swanson and Steamboat Lumps on the West Florida Shelf. Many of these locations are either part of existing MPAs (US DOC 2012), have been designated as HAPCs by Amendment 9 to the Fishery Management Plan for the Coral Reefs of the Gulf of Mexico (GMFMC 2018; Figure 5.1), include large topographic features such as domes and escarpments, or are in close proximity to the DWH spill site. Collectively, the set of priorities recommended by respondents represents a first step in identifying the diversity of locations and activities to support the objectives of the overall MDBC portfolio (DWH NRDA Trustees 2016). Some injured areas may be restored and monitored, undamaged areas may be used as donor sites for coral transplant and as reference sites for monitoring natural changes, still other locations may have other threats mitigated or receive enhanced management as part of the overall objective of restoring, enhancing, and protecting MDBCs following the *Deepwater Horizon* oil spill.

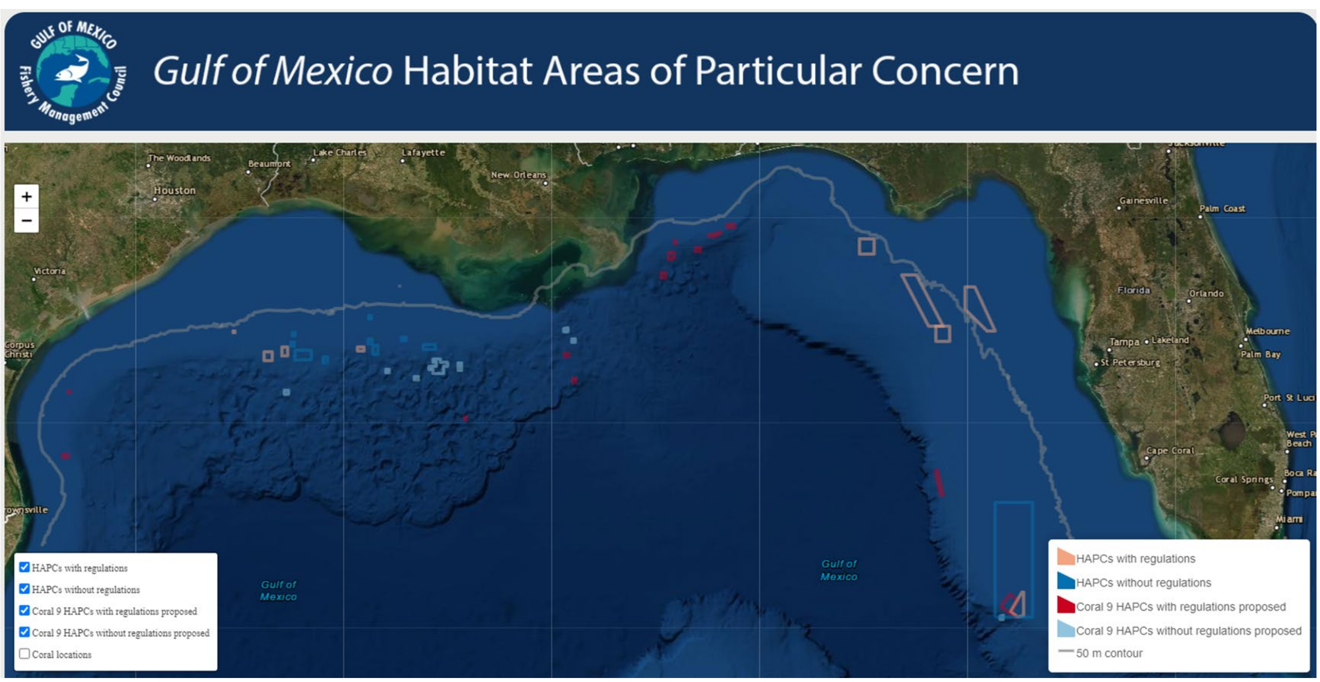

Figure 5.1. Habitat Areas of Particular Concern (HAPC) from the Gulf of Mexico Fishery Management Council's online HAPC explorer (https://portal.gulfcouncil.org/coralhapc.html).

Plotting the responses in various ways allowed us to disentangle the reasons that different areas were highly prioritized. First, considering the spatial distribution of the recommended Requirements individually, it is clear that data needs differed spatially across the region. This information will be especially useful when planning how to efficiently deploy field assets and where to focus modeling effort during the implementation phase. Most, if not all, of the banks along FGBNMS were highly recommended for every Requirement category except for "Delineations of Hard vs. Soft Bottom". It is possible that those attributes are already known for most of that area or that such variables are just less of a priority than the other Requirement choices that were available to respondents. Many cells in the area around the DWH spill site were highly important for all Requirements except for "Modeled or calculated presence/absence or density of corals". That Requirement was used more sparingly around the spill site compared to the other choices. Such modeling was still important in the area, perhaps just not as high of a priority need compared to other Requirements in the area that was likely impacted. In the affected area, other information needs may be more important and were selected more frequently such as understanding the type of substrate available for restoration activities like transplanting corals or predicting the habitat suitability of the area for receiving them. Noting those locations where multiple Requirements are requested is also important since those represent some of the best opportunities for efficient data collection. In many cases, more than one type of survey instrument can be deployed concurrently on the same survey vessel to collect multiple data streams for different types of map data. For example, multibeam, side-scan, and split-beam sonar systems can be deployed all at once to map bathymetry, surface types, and fish populations.

Considering the Justifications individually, it is clear that "Restoration site evaluation/selection" was concentrated in the cells around the spill site. However, cells across the FGBNMS were also ranked secondarily in this Justification despite not being within either the submerged oil plume or maximum extent of the surface slick during the spill. It could be that those banks were being considered more broadly in the context of restoring or enhancing the regional ecosystem (DWH NRDA Trustees 2016). Similarly, the "Threat mitigation/removal" Justification was used mostly around the spill site, but also along the FGBNMS. This may reflect participants' priorities for both directly mitigating the effects of the spill or mitigating other stressors in locations outside the spill to more generally enhance the MDBCs across the region. The "Selection of monitoring sites" Justification had those same two main groups of highly important cells around the spill site and along FGBNMS. This would be useful because it is important to not only monitor impacted sites that are recovering naturally or are being actively restored, but also important to monitor unimpacted sites in order to distinguish between changes and growth rates in natural communities versus those involved in spill recovery. The "Collect specimens for restoration" Justification was a high priority at FGBNMS and a few smaller sites on the West Florida Shelf. These may be good locations to collect healthy specimens not impacted by the oil for transplant or propagation. In contrast, specimen collection was also indicated in cells around the spill site which would be potentially impacted by oil. This may reflect participants' desire to expand the scope of the limited samples available in that area. High priority areas for the "Protection or management" category included some areas outside presently established MPAs but also, many locations already with managed area status (DOC 2012; GMFMC 2018). This may reflect participants' recommendation for additional protections or management measures in those locations. As expected, the Justification "Exploration to identify new MDBC areas" had a more diverse and widely spread distribution including many of the HAPCs (GMFMC 2018) and at the ends of the major submarine canyons as priority areas for new discoveries (e.g., St. Tammany Basin Rim/GC 852).

Conducting additional analysis by certain agencies or groups indicated that they had a more constrained distribution of high priority areas. Most obviously, FGBNMS respondents indicated that their own managed area was a top priority. Respondents from the GMFMC clearly prioritized locations centrally on the West Florida Shelf over all other parts of the Gulf of Mexico study area. This could reflect their interest in additional information on several locations that lacked sufficient data for recent HAPC designations (GMFMC 2018). In contrast, respondents from BOEM highly prioritized the spill site, some shelf edge features around it, and two conspicuous groups of cells in their Eastern Planning Area on the West Florida shelf. In a recent study, these two locations were predicted to have potentially high species richness, however, additional sampling was recommended to improve model performance (Goyert et al. 2021). Filling in these areas with additional ground validation and environmental data would provide a more complete understanding of this potentially important habitat on the West Florida Shelf. There were fewer distinct differences between the priority areas chosen by respondents on MDBC teams and those respondents that were not. This may reflect the broad and similar expertise represented in both of these groups. One noticeable exception was that MDBC team members generally did not prioritize the banks off south Texas that were farthest from the DWH spill site and instead were more interested in the areas south of the Mississippi Canyon including the Henderson Ridge sites (HAPCs at AT357 and AT047 [GMFMC 2018, NOAA ONMS 2020]).

Identifying these high priority cells from stakeholders is only one of the first steps in planning the 5-year implementation phase of the MDBC portfolio. It is important to note that outcomes of this prioritization activity should only be used to understand priorities at the scale of the smallest selectable unit in the pGIS (i.e., individual grid cells). The top 5 and 10% of cells in various categories are highlighted here to illustrate general patterns, with the expectation that more specific cutoffs and locations will be identified based on additional information. For example, the large areas around FGBNMS and the spill site included clusters of approximately 9–15 cells which is the equivalent of approximately 6000–9000 km^2 of seafloor. It is almost certainly not required to survey or model those entire areas. The size and shape of actual features on the seafloor, not the grid cells, will dictate many decisions. The needed products, depth, acquisition logistics, ship time, available survey equipment, and staff time will dictate what can be accomplished and how quickly. The size of priority areas can be linked to the anticipated ship-time in each implementation year for the desired products that require field work. It is important to note, even though the Digital Atlas was available to help respondents understand what information was already available in the region, the existing information within priority areas should be carefully evaluated for gaps and other limitations to confirm that new data acquisitions are required. A cursory analysis of overlap between high priority cells and existing data showed that some cells already have extensive survey data. Future surveys should exclude any high priority areas that have already been mapped unless additional data types, including higher resolution or more recently collected data, are needed. Modeling will be subject to analogous considerations such as needed resolution, environmental data to support development of models, and required processing time.

At the conclusion of each project year during the 2022–2027 implementation phase, stakeholder priorities will be revisited to ensure their continued relevance in light of new information that becomes available each year. Updates will most likely require only simple modifications via group discussion, may be possible through re-analysis of the prioritization data layers compiled here, or may require additional use of the pGIS. On this point, several areas received very few or no coins at all from any of the respondents. This doesn't necessarily mean that those areas are completely unimportant. Respondents may be less interested in them or merely less familiar with those areas. It is also possible that once higher priorities are addressed or new information is discovered, different locations than those suggested here may become of interest. It does however, indicate that this particular group of regional experts at the onset of the implementation phase, finds that other parts of the study area are a much higher priority.

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Appendix

Table A.1. Respondent List. This table lists the individuals and their organizations that participated in the spatial prioritization process.

Name	**Organization**	**MDBC Team(s)**
Adams, Caitlin	NOAA/Office of Atmospheric Research (OAR)/Office of Exploration and Research (OER)	None
Baco-Taylor, Amy	Florida State University	None
Baguley, Jeffrey	University of Nevada-Reno	None
Barry, James	Monterey Bay Aquarium Research Institute	None
Basher, Zeenatul	Gulf of Mexico Fishery Management Council (GMFMC)	None
Benson, Kristopher	NOAA/NMFS/OHC	AMP, CPT, HAE, MGM
Boland, Greg	Bureau of Ocean Energy Management (BOEM)	None
Brooke, Sandra	GMFMC/Florida State University	None
Campbell, Matt	NOAA NMFS Southeast Fisheries Science Center (SEFSC)	None
Cancelmo, Jesse	FGBNMS Sanctuary Advisory Council (SAC)	None
Cantrell, Shane	FGBNMS SAC	None
Cantwell, Kasey	NOAA/OAR/OER	None
Caporaso, Alicia	BOEM	HAE, MGM
Chappell, Ashley	NOAA/NOS/Office Coast Survey (OCS)	None
Chaytor, Jason	USGS Wetland and Aquatic Research Center	MGM
Clark, Randy	NOAA/NOS/NCCOS	HAE, Steering Committee (SC)
Cockrell, Marcy	Florida Department of Agriculture and Consumer Services	None
Cooksey, Cindy	NOAA/NMFS	None
Cordes, Erik	Temple University	None
David, Andrew	NOAA/NMFS/SEFSC	Technical Team (TT)
Demopoulos, Amanda	USGS Wetland and Aquatic Research Center	AMP, CPT, HAE, MGM
Easton, Erin	University of Texas Rio Grande Valley	None
Emmert, Jake	FGBNMS/Moody Gardens	None
Gardner, Chris	NOAA/NMFS/SEFSC	None
Girard, Fanny	Monterey Bay Aquarium Research Institute	None
Gittings, Steve	NOAA/NOS/ONMS/FGBNMS	None
Hamdan, Leila	University of Southern Mississippi	None
Hanson, Chad	Pew Environment	None
Harter, Stacey	NOAA/NMFS/SEFSC	CPT, HAE, MGM
Herrera, Santiago	Lehigh University	None
Herting, Jennifer	NOAA/NMFS/SEFSC	HAE, MGM

Table A.1. Continued. Respondent List.

Name	Organization	MDBC Team(s)
Hickerson, Emma	NOAA/NOS/ONMS/FGBNMS	AMP
Hicks, David	University of Texas Rio Grande Valley	None
Holstein, Dan	Louisiana State University	None
Hourigan, Tom	NOAA/NMFS/OHC	TT
Hyland, Jeffrey	NOAA (ret)	None
Johnston, Michelle	NOAA/NOS/ONMS/FGBNMS	AMP
Joye, Samantha	University of Georgia	None
Keenan, Sean	Florida Fish and Wildlife Conservation Commission (FWC)/ Fish and Wildlife Research Institute (FWRI)/Fisheries-Independent Monitoring (FIM)	None
Koss, Jen	NOAA/NOS/OCM	None
Lobeker, Meme	NOAA/OAR/OER	None
Macelloni, Leonardo	University of Southern Mississippi	None
Malik, Mashkoor	NOAA/OAR/OER	None
Medley, Rachel	NOAA/OAR/OER	None
Mendez-Ferrer, Natasha	GMFMC	None
Montagna, Paul	Texas A&M Corpus Christi	None
Mueller, Mark	BOEM	MGM
Nash, Harriet	NOAA/NOS/OCM	None
Nizinski, Martha	NOAA/NMFS/National Systematics Laboratory (NSL)	HAE
Nuttall, Marissa	NOAA/NOS/ONMS/FGBNMS	AMP
Odonnell, Kelli	NOAA/NMFS/Southeast Regional Office (SERO)	None
Patterson, Will	University of Florida	None
Puglise, Kimberly	NOAA/NOS/NCCOS	None
Quattrini, Andrea	Smithsonian Museum of Natural History	None
Ross, Steve	University of North Carolina Wilmington	None
Ruzicka, Richard	GMFMC and FWC	None
Schmahl, GP	NOAA/NOS/ONMS/FGBNMS	AMP
Schwing, Patrick	University of South Florida	None
Shirley, Thomas	Texas A&M Corpus Christi	None
Sinclair, James	Bureau of Safety and Environmental Enforcement (BSEE)	AMP
Steinhaus, Joanie	FGBNMS SAC	None
Voss, Josh	Florida Atlantic University	None
Wang, Lu	NOAA/OAR/OER	None
Winship, Arliss	CSS Inc. under contract to NOAA/NOS/NCCOS	MGM

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