Mid-Atlantic Regional Human Use Data Synthesis (HUDS) Project









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Executive Summary

The Mid-Atlantic Regional Council on the Ocean (MARCO) contracted with RPS Applied Science Associates and SeaPlan (The Team) to develop synthesized spatial products characterizing human use in the Mid-Atlantic (Mid-A) region. This Human Use Data Synthesis (HUDS) effort supports ocean planning priorities and goals, builds on existing datasets and web-based ocean planning tools, ensures credibility by vetting HUDS products through stakeholder engagement, and uses a consistent, transparent approach for addressing data limitations.

The Team completed an assessment of over 100 data layers, settling on including just over 60 existing human use spatial data products in the analysis. The Team created synthesized grids that summarized the distribution of both human activity and a variety of infrastructure types and regulated areas. SeaPlan led the data gathering and data assessment phase to characterize the scope of data availability, currency, authority, completeness, caveats, and gaps, in addition to information on new and forthcoming uses of ocean space. The outcome of this assessment informed the composition and interpretation of the final synthetic products, and helps prioritize future data collection efforts. RPS ASA led the data synthesis effort, which integrated pertinent information (identified in the assessment) into 10 km² grid cells and summarized the data both cumulatively and across a set of logical groupings (e.g., Maritime, Shipping, Infrastructure) to assess regional trends. The Team developed a human use mapping approach that borrowed from existing efforts while honoring the goals of MARCO and constraints inherent to the available data.

The HUDS products characterized many aspects of human use in the Mid-A on a detailed, spatially-explicit level. These aspects included data availability, areas of overlapping uses, amount and type of use, and in some cases intensity of human activity. Maps of data presence (a simple count of layers) and use intensity (a scaled, relative classification for lower and higher concentrations of use) revealed complementary patterns of data collection and human use activities. The data presence metric captured the distribution of datasets as a whole while the use intensity metric captured variations within datasets and select dataset groupings. RPS ASA and SeaPlan delivered the HUDS grids with accompanying metadata, a set of layer files for online publishing, individual fact sheets for each source dataset that outline the results of the data assessment, and this final report. The HUDS grids were designed to maximize compatibility with the Mid-Atlantic Ocean Data Portal (http://portal.midatlanticocean.org/), an interactive ocean mapping and information site focused on the five-state MARCO region of New York, New Jersey, Delaware, Maryland and Virginia. HUDS data posted on the Portal will be available for viewing and download by policymakers, scientists, stakeholders, and the general public. Users of the

portal can query specific grid cells to obtain more detailed statistical and text descriptions of the underlying, root datasets summarized at that location.

The HUDS products paint a clear picture of data availability in the Mid-A and reveal data collection biases and gaps that are important to recognize for ocean planning. This project represents the first time such data have been synthesized in a comprehensive manner, and indicates much about what we do and do not know about ocean use. It is a step toward a quantitative, as opposed to anecdotal, understanding of human use in the Mid-A, but far from complete. Human uses that are more heavily regulated (e.g., commercial shipping and fishing) tended to have more data available, whereas uses without reporting requirements (e.g., recreation) were less represented. Key data gaps (i.e., missing or incomplete data for the entire Mid-A region) highlighted by this analysis are for state-permitted fisheries, recreational boating and fishing, non-federal sand/gravel borrow sites, coastal activities such as inshore aquaculture, cultural and tribal uses, and infrastructure data for unexploded ordnance and shipwrecks.

Bearing these gaps in mind, the HUDS grids indicate the greatest amount of data presence in the Port of New York/New Jersey and along coastal and near-coastal waters, while there is a lower concentration of data and human activity further offshore. The entire region is covered by vessel traffic, with the heaviest shipping concentrations in ports, bays, and shipping lanes. Fishing activity exhibits wide coverage within continental shelf waters, especially in the New York/New Jersey Bight. Little to no fishing data from coastal areas such as the Chesapeake and Delaware bays were included in the analysis, highlighting an important data gap. Recreational activity has a strong coastal signal; while recreating does not have reporting requirements, coastal areas do experience high user volumes. Most infrastructure and regulated areas occur nearshore, with the exception of offshore submarine cables and naval operational areas.

Density-based activity data and infrastructure-based data with clear, compact “footprints” that implied relatively even, consistent use provided the most interpretable use intensity results. At the group level, these types of data principally comprised the Maritime and Fishing groupings. In the Maritime cumulative use intensity grid, the shipping lanes and precautionary areas exhibited a strong signal. In the Fishing cumulative use intensity grid, high use intensity spanned a broad region within the New York/New Jersey Bight, off the coast of Long Island, and in some canyons.

Ultimately, the HUDS project provided valuable insight into the status of available data, important data gaps, and trends in the quantity and distribution of data throughout the region. While these products are not a substitute for site-specific assessment, the HUDS grids provide a useful guide to human use of the Mid-A region.

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1 Introduction

In response to an RFP issued by the Mid-Atlantic Regional Council on the Ocean (MARCO), RPS Applied Science Associates (dba RPS ASA) was contracted in partnership with SeaPlan to develop synthesized spatial products characterizing human use in the Mid-Atlantic (Mid-A) region. This project was referred to as the Human Use Data Synthesis (HUDS).

The HUDS products are intended to support ocean planning priorities and goals as laid out in the draft Regional Ocean Action Plan (OAP) Framework for the Mid-A region (Mid-A RPB, 2014), defined as New York to Virginia from the coast out to the Exclusive Economic Zone (EEZ). The HUDS products depict different social and economic uses, highlight locations where multiple uses occur, identify patterns of data availability, and use intensity of certain activity types.

The HUDS project included an assessment of existing human use data and knowledge gaps for the region. Data available on the Mid-Atlantic Ocean Data Portal ("the portal", http://portal.midatlanticocean.org), as well as other relevant datasets for the Mid-A region, were researched and obtained where possible. Sixty-four vetted human use spatial data layers were synthesized into various gridded products. These individual human use spatial data layers are publicly available on the portal, an interactive ocean mapping and information site focused on the coasts of New York, New Jersey, Delaware, Maryland and Virginia. The new HUDS data joined a collection of existing human use datasets that are available for viewing and download through the Portal's Marine Planner mapping feature, such as layers related to recreation, renewable energy, security, commercial fishing and shipping. Coordination with the MARCO board, the Mid-Atlantic Regional Planning Body (Mid-A RPB), the Mid-Atlantic Ocean Data Portal Team (DPT), and the Mid-A Data Synthesis Workgroup (DSWG) occurred throughout all phases of the HUDS project.

The report herein describes the background, impetus, and goals for the HUDS project. The data assessment, analysis, and results are described in Section 1 and Section 1. Section 1 provides insight into interpretive value and data limitations for users of the HUDS grids. Section 1 also discusses the trends observed in the HUDS products, and contains suggestions for future tool iterations and integration of new data. Supporting metadata and dataset fact sheets for the HUDS grids are provided in Appendices A and B. Appendix C provides guidance for use of the HUDS grids as deployed on the data portal.

1.1 HUDS Team

The Team was led by RPS ASA, which provides a unique suite of services in ocean sciences, ocean engineering, geographic information systems (GIS), and computer programming. RPS ASA has extensive experience in supporting data management, marine data analysis, and ocean planning projects. Primary teaming partner SeaPlan is a nonprofit advancing the science and stakeholder engagement of ocean planning that balances conservation and development. Together, The Team has extensive experience in supporting ocean planning coordination efforts and marine spatial data projects, including the Mid-A OAP, Interjurisdictional Coordination (IJC), and the Northeast Ocean Data Portal.

1.2 Ocean Planning in the Mid-Atlantic

The Mid-Atlantic Ocean will become an increasingly crowded place in the coming decades. Offshore renewable energy installation, oil and gas exploration, increased sand and mineral mining, deepening of shipping channels to accommodate “Post-Panamax” vessels, and expanded tourism and recreation industries are just some of the developments contributing to this change. These overlapping demands on space and resources must be accommodated within an existing seascape of human uses, such as commercial fishing, pleasure boating, traditional tribal activities, national defense, and many others. MARCO has taken the lead in proactive, regional planning to facilitate sustainable, responsible, and productive interactions between these various interests.

MARCO was established in 2009 as a partnership between New York, New Jersey, Delaware, Maryland, and Virginia. These states share four regional ocean priorities: climate change adaptation, protection of important marine habitats, offshore renewable energy development, and water quality improvement. In addition, MARCO works to convene stakeholders representing diverse interests, foster productive dialogue, and collect important ocean use information. These efforts occur collaboratively with the Mid-A RPB where possible. The Mid-A RPB was created in 2013 in response to a Presidential Executive Order establishing a National Ocean Policy to guide the protection, maintenance, and restoration of America’s oceans and coasts.

1.3 Current and Forthcoming Human Uses of the Mid-Atlantic Ocean

The waters of the Mid-A offer abundant economic and environmental services to local communities, states, and the nation. In 2012, over 34 million people inhabited Mid-A coastal counties, and economic output from the Mid-A region accounted for 14% ($47 billion) of the entire U.S. GDP (Mid-A RPB, 2015). The pattern and scale of these uses will likely evolve with climate change, growing demand for energy, expanding national security interests, and other shifting, external factors on the regional, national, and global scale. Additionally, new and emerging uses will seek their share of Mid-A ocean resources. The following paragraphs describe some of the current and forthcoming uses of the Mid-A Ocean.

1.3.1 National Security

The Mid-A is home to the world’s largest naval base (Norfolk, VA) and associated military facilities throughout the Hampton Roads area. The base is located within the world’s largest natural deep water harbor, which has the additional benefit of remaining ice-free throughout the year. Restricted areas and danger zones established within these waters provide crucial grounds for U.S. military operations, including air-to-air, air-to-surface, and surface-to-surface naval fleet training, submarine and antisubmarine training, and Air Force exercises. The U.S. Navy expects to increase their activities in the region during this decade (USDON, 2013). Also, NASA expects continued use of the area off of the Wallops Island Flight Facility for strategic and civilian space programs (BOEM, 2014).

1.3.2 Energy

Areas off the shores of Delaware, Maryland, Virginia, and New Jersey have been leased for commercial development of wind energy, and areas offshore New York are under consideration in response to active wind energy proposals (BOEM, n.d.). As the U.S. works to diversify its energy supply, the use of the ocean for other types of renewable power generation (e.g., tidal and wave-based) may increase as well (NE Maritime Commerce White Paper). Portions of the Atlantic Outer Continental Shelf (OCS) are also the subject of active requests for Geological and Geophysical permits for oil and gas surveys (Mid-A RPB, 2015). Although most of the Mid-A is not included in the Bureau of Ocean Energy Management's (BOEM) Outer Continental Shelf Leasing Draft Proposed Program for oil and gas development from 2017-2022, the waters off the coast of Virginia are included, with possible leasing planned in 2021 (BOEM, 2015a).

There is also interest in using the ocean for energy distribution in addition to production. A liquefied natural gas (LNG) import terminal has been approved for Baltimore, MD (BOEM, 2014) and the LNG export facility at Cove Point in Maryland has proposed an expansion to its export facilities (FERC, 2014). Other shore-based energy developments will potentially increase demand for ocean space as well. For example, a proposal for carbon sequestration (geosequestration) would pipe carbon dioxide from onshore coal burning power plants about 70 miles offshore where it would be pumped approximately 8,000 ft into the seabed (BOEM, 2014). These types of projects may become more attractive depending on US energy policy and regulations related to climate change.

1.3.3 Commercial Fishing

By any metric, commercial fishing is a major use of Mid-A waters. For example, in 2012, Mid-A commercial fishermen landed 751 million pounds of finfish and shellfish and earned $488 million in landings revenue (Mid-A RPB, 2015). That same year, several ports in the Mid-A had among the highest commercial fishing revenues in the U.S. (NOAA NMFS, n.d.). From 2000 to 2010, fishery landings in the Mid-A grew 35.8% (NOEP, 2014). Finally, the Mid-A is unique among fishery regions in the country in that no stocks are considered overfished (NOAA, 2014). Now and into the future, changing climate will affect marine ecosystems, possibly influencing the behavior of commercial fishing fleets (Link et al., 2015). Some stocks have already experienced poleward range shifts in response to changing ocean temperatures and circulation patterns (Nye et al., 2009).

1.3.4 Maritime Commerce and Transportation

In 2010, three of the top five states with greatest employment in the marine transportation sector were located in the Mid-A (NOEP, 2014). U.S. Coast Guard data show that in 2003 and 2004, U.S. Atlantic coast arrivals of vessels at or above 150 gross registered tons amounted to over 25,000 each year (NOAA NMFS, 2008). Major container ports along the Mid-A coast include the ports of New York/New Jersey, Virginia, Baltimore, and Philadelphia. Already some of the busiest in the U.S, these ports stand to become even busier in the wake of a third, much larger traffic lane in the Panama Canal. This lane is expected to open in April 2016, and will allow for the transit of “Post-Panamax” ships with over twice the cargo capacity of existing “Panamax” ships.

To prepare for taller and deeper-draft Post-Panamax vessels, East Coast ports have undertaken a number of dredging and bridge-raising projects (Mid-A RPB, 2015), which may lead to additional dredge spoil disposal. Additionally, the US Maritime Administration has promoted the idea of “short-sea shipping” (i.e., coastal marine highways) as a way of relieving congestion along interstate highways (Kite-Powell, 2013). This congestion may only increase due to higher-volume (but less frequent) Post-Panamax deliveries. Much of this short-sea shipping may be in the form of Articulated Tug-Barge (ATB) traffic (Field and Longley-Wood, 2015). Similarly, other effects from increased Post-Panamax traffic may not be distributed evenly between vessel types (MARCO, 2014a).

In addition to shipping traffic, passenger vessel traffic may also increase with the expansion of the cruise ship industry (Field and Longley-Wood, 2015). Wind energy development in the region may affect shipping traffic, particularly in the tug and barge industry, possibly leading to changes in the typical routes used by these vessels (MARCO, 2014a). Finally, construction during development will lead to localized increases in traffic and congestion (Field and Longley-Wood, 2015).

1.3.5 Sand and Gravel Resources

Barrier islands line most of the Mid-A coast and provide recreational areas, unique habitats, protection for areas further inland, and home for energy, defense, and public infrastructure. Lagoons between the barrier islands and mainland provide a low energy environment for fishing, kayaking, boating, and wildlife viewing (BOEM, 2014). To combat erosion, many of these islands receive supplementary sand and gravel from “borrow sites” along the sea floor. Pursuant to the Rivers and Harbors Act of 1899 and the Clean Water Act, section 404, the U.S. Army Corps of Engineers is responsible for permitting sand and gravel extraction activities in navigable waters of the United States, including marine waters out to three nautical miles from shore (Federal Register, 2011). Due to depleted sand and gravel resources in state waters, there is an increased demand for sand from the Outer Continental Shelf (areas greater than 3nm from shore). The Bureau of Ocean Energy Management (BOEM) is responsible for managing sand and gravel extraction in federal waters and has executed 48 leases, with more than 109 million cubic yards of material authorized for extraction as of October 2015 (BOEM, 2015b). BOEM is currently undertaking two projects (described further in Section 2.3.2.1) that aim to provide information on sand and gravel resources to support shoreline restoration projects in the face of sea level rise and more intense storms (BOEM, 2015).

1.3.6 Recreational Activities

Popular recreational activities in the Mid-A include fishing, beach going, sightseeing, biking, hiking, photography, surfing, scuba diving, and beachcombing. Many of these uses are hard to quantify economically, since the result is often only enjoyment and a sense of well-being. However, in 2012, over 2.3 million recreational anglers took 14 million fishing trips in the Mid-A, supporting 31,000 jobs (Mid-A RPB, 2015). In 2011, Mid-A coastal counties supported more than half a million tourism and recreation jobs and generated $27.5 billion in tourism and recreation-related GDP.

1.3.7 Tribal Uses

Currently, there are 27 state or federally recognized Tribal Nations in the Mid-A (Mid-A RPB, 2015), three of which have been active participants in the Mid-Atlantic planning process (Mid-A RPB, 2015a). There are also other indigenous communities in the region without formal recognition. Throughout their history, these peoples have derived spiritual, economic, and historical value from the ocean and coast, and continue to pass on this place-based knowledge to future generations.

1.3.8 Undersea Infrastructure

Communication cables line the seafloor of the Mid-A and facilitate global communications, national defense, and economic transactions. Between 97 and 99% of international communications traffic relies on these cables (MARCO, 2014). Other seafloor infrastructure includes acoustic monitoring networks and current profilers for research purposes. The submarine cable industry foresees an increase in activity due to both a continued need for high-speed trans-Atlantic connections (BOEM, 2014) and increasing offshore wind energy development (MARCO, 2014). For example, the proposed Atlantic Wind Connection[1] seeks to connect wind energy areas and provide energy to the onshore grid (ESS Group, Inc. 2013). Additionally, the practice of leaving telecommunications cables in place when they are taken out of service may be changing, as states are beginning to require provisions for removal in contracts (MARCO, 2014).

[1] http://atlanticwindconnection.com/awc-projects/atlantic-wind-connection

1.3.9 Archaeological sites

European voyagers began exploring the Atlantic seaboard in approximately A.D. 1000, but it was not until the 16th century that expeditions reached the Mid-A region (BOEM, 2014). Thus, shipwrecks in the region date from the 16th century to modern times. Submerged, prehistoric sites dating between 30,000 and 3,000 before present (B.P.) may also be present within this region.

1.3.10 Aquaculture

Although aquaculture exists in Mid-A waters, current activities are located either onshore or in the nearshore environment. There are presently no offshore aquaculture activities. However, offshore aquaculture in the Mid-A is an Objective of the Sustainable Ocean Uses goal in the Mid-A OAP, and there has been interest expressed in development of such facilities (Mid-A RPB, 2015). In the Northeast, there have been two recent US Army Corps of Engineers[2] permits granted for offshore aquaculture facilities (ELI, 2015). Prompted by these Northeast activities, the regulatory framework for aquaculture should solidify and the Mid-A may see more proposals. Also, permanent infrastructure, such as wind farms in the Northeast may allow for unique co-developments with Mid-A states (Mid-A RPB, 2015).

1.4 Motivation for the HUDS Project

In this increasingly crowded offshore environment, maps provide essential context for decisions on resource allocation, project siting, and general policymaking. Lots of map data are already available on the portal. These map "layers" are the products of stakeholder engagement, data exchange among the scientific, government, and fishing communities, and other data gathering and synthesis efforts. The portal lets government, industry, and the general public visualize ocean resources and human uses in the Mid-A.

Many different spatial data types (e.g., points representing shipwrecks, lines representing undersea cables, polygons representing military danger zones, and density grids representing vessel traffic) are available on the portal. It is easy to visualize two or three of these disparate types in tandem, but as users of the portal add more and more layers, it becomes increasingly difficult to interpret areas of overlap. Thus, MARCO contracted the RPS ASA/SeaPlan team ("The Team") to develop HUDS products to address this challenge. These products allow users to investigate level of data presence and level of use intensity in an area. Additionally, users are able to investigate HUDS layers at specific locations for more detailed, supporting information.

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[2] USACE has authorities under the Rivers and Harbors Act and under the Clean Water Act. Additionally, USACE must satisfy additional legal requirements by coordinating with other federal agencies, states, and others including, for example, NOAA NMFS to satisfy provisions of the Magnuson-Stevens Fishery Conservation Management Act (NOAA NMFS Permitting Factsheet for USACE).

1.5 Review of Past Spatial Data Synthesis Efforts

There are a number of existing human use synthesis efforts and impact mapping projects at both the regional and global scale. For example, Halpern et al. (2008) developed a cumulative impact model of human use for global marine ecosystems. They assembled spatial, globally available data for various anthropogenic “drivers” (e.g., artisanal fishing, pollution, commercial shipping) on a 1 km by 1 km grid. These gridded data were then log[x+1] transformed to reduce the weight of extreme, potentially inaccurate values, and rescaled to 0-1 to allow direct comparisons of drivers with different scales of measurement. Next, each driver was spatially associated with various underlying habitat types (mapped at the same 1 km by 1 km scale), and these combinations were scored based on expert opinion on the vulnerability of each habitat type to a particular use. Finally, these scores were summed to derive a global, cumulative impact map.

Halpern et al. (2009) and Kappel et al. (2012) applied a nearly identical cumulative impact mapping methodology to regional datasets offshore California and Massachusetts, respectively. Intermediate map products associated with these efforts included a simple count of all co-occurring human uses within a given grid cell and “intensity” maps of the degree of human use within each cell (Figure 1). Similarly, Ban and Alder (2008) created maps of the number of overlapping human activities and the intensity of human use (again based on expert rankings for each activity) offshore British Columbia, Canada. Finally, the California Coastal Uses Atlas Project (NOAA, 2010) mapped the number of overlapping uses by various sectors. These sectors (also knowns as “themes”) are often a useful way to categorize and think about ocean uses. Koehn et al. (2013) offer a nested, hierarchical “typology” of use categories that may be applied to ocean use mapping (Table 1). As Kittinger et al. (2014) note, a subset of uses may be most relevant to the goals and objectives of a specific initiative. However, St.Martin and Hall-Arber (2008) caution that GIS-based systems for environmental decision making are necessarily limited by the data available. Links to publications and datasets associated with the studies referenced in this section are available in the full reference list in Section 5.

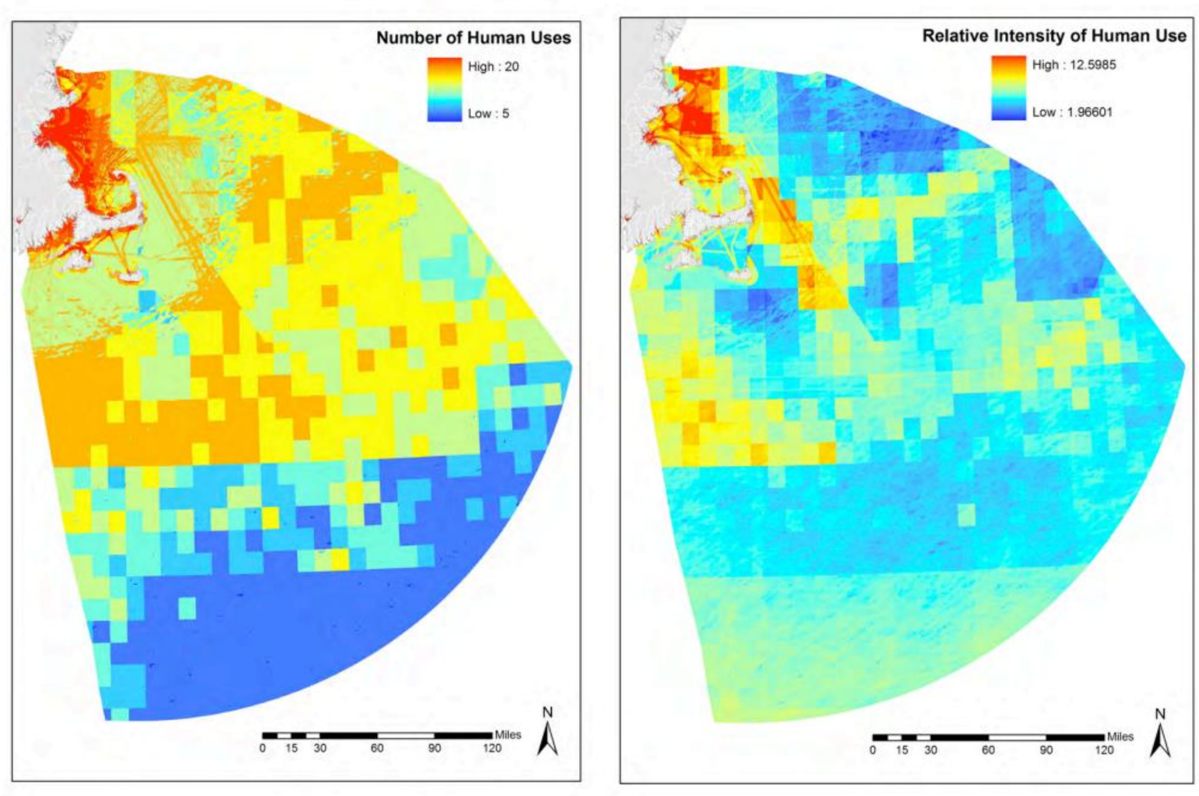


Figure 1. The number of co-occurring human stressors (left) and the summed intensity of human stressors (right) offshore Massachusetts (Kappel et al., 2012).

Table 1. Nested typology of ocean uses, from Koehn et al. (2013) and Dahl et al. (2009).

A. Fishing	A1. Commercial A2. Non-commercial (recreational/subsistence/cultural)
B. Recreation	B1. Non-motor/sailing B2. Motorized watercraft B3. Wildlife watching B4. Surfing B5. Kiteboarding/windsurfing B6. Diving/snorkeling B7. Paddling/rowing/kayaking or similar B8. Coastal leisure/tourism
C. Transportation	C1. Shipping Lanes C2. Ferry routes C3. Cruise ship facilities
D. Energy	D1. Oil & gas development D2. Wind farms D3. Wave/tide/current
E. Ports and Harbors	E1. Facilities E2. Industrial infrastructure
F. Marine protected areas	F1. No-take reserves F2. Multi-use marine parks
G. Cultural and maritime heritage areas	G1. Maritime archeology sites G2. Cultural heritage sites G3. Tribal/indigenous sacred sites
H. Mining and Dredging Sites	
I. Aquaculture	I1. Coastal/shoreline operations I2. Offshore installations
J. Cables and Pipelines	
K. Other	

1.6 The HUDS Approach

The Team developed a human use mapping approach that borrows from these existing efforts while honoring the goals of MARCO and constraints inherent to the available data. At the outset of the project, the DSWG (who served as the HUDS project steering committee) made the collective decision to avoid applying expert ranking or weighting schemes since they would involve subjective decisions about use intensity. In addition, The Team and the DSWG realized early in the project's formation that the variety of data types and scales to be analyzed (e.g., point, polygon, gridded, infrastructure, activity, nearshore, offshore) would make credible weighting difficult, especially in the face of data gaps. Thus, The Team did not incorporate this particular aspect of previous approaches (e.g., Halpern et al., 2008, Halpern et al., 2009, Kappel et al., 2012, and Ban and Alder, 2008). Instead, The Team chose to develop a "data presence" metric which focuses on the number of use layers having data present in a given grid cell. Although the presence of data in a given cell is potentially related to use intensity, there are caveats to this interpretation that should be noted (Section 4.1). Rather, the main goal was to identify concentrations of available data for further analysis.

This “data presence” metric is analogous to the counts presented in Halpern et al. (2009), Kappel et al. (2012), Ban and Alder (2008), and NOAA (2010). However, The Team also incorporated ancillary information into each grid cell beyond a simple count of uses. This information includes statistics on the areal, linear, or point coverage for every use layer within each cell, descriptions of various activities and infrastructure occurring in each cell, and other metrics to provide additional context to the count information. The Team subdivided the count layers into some of the sectors/typologies proposed by Koehn et al. (2013) and Dahl et al. (2009), which are also themes used on the portal. Furthermore, The Team conducted an assessment of data gaps, spatial/temporal coverage, sampling effort, and many other attributes to aid in interpreting the map products. Finally, The Team created a “use intensity” metric for certain themes partly based on the 0-1 scaling employed by Halpern et al. (2008), Halpern et al. (2009) and Kappel et al. (2012). This and other methods are described in detail in Sections 1 and 1.

1.7 HUDS Project Goals

The goals of the HUDS project were to:

- Assist MARCO and the Mid-A RPB in compiling and synthesizing human use spatial data to advance ocean planning priorities in the Mid-A region.
- Integrate the HUDS products with the existing portal and build on existing datasets.
- Support decision-makers’ consideration of use data through coordination among MARCO, the Mid-A RPB and related workgroups, and the DPT.
- Ensure credibility by vetting newly developed human use data sets, synthesis methods/tools, and spatial data products through MARCO stakeholder engagement.
- Develop a consistent, transparent approach for addressing data gaps, data quality, positional uncertainty, etc.

2 Data Assessment

The first, foundational step of the HUDS project was to collect, organize, and characterize available spatial data related to human use. Guided by the Mid-A RPB and MARCO, The Team worked with the data portal team (DPT) to examine over 100 data layers resulting in the inclusion 64 data layers spanning five themes: Fishing, Maritime, Recreation, Renewable Energy, and Security. This data assessment process was composed of two separate but linked aspects: an inventory and a characterization (Figure 2). Information from the assessment process was compiled in a single matrix, which formed the basis for factsheet development (Appendix B), completeness scoring (Section 2.2.2), and internal discussions on methodology and dataset selection.

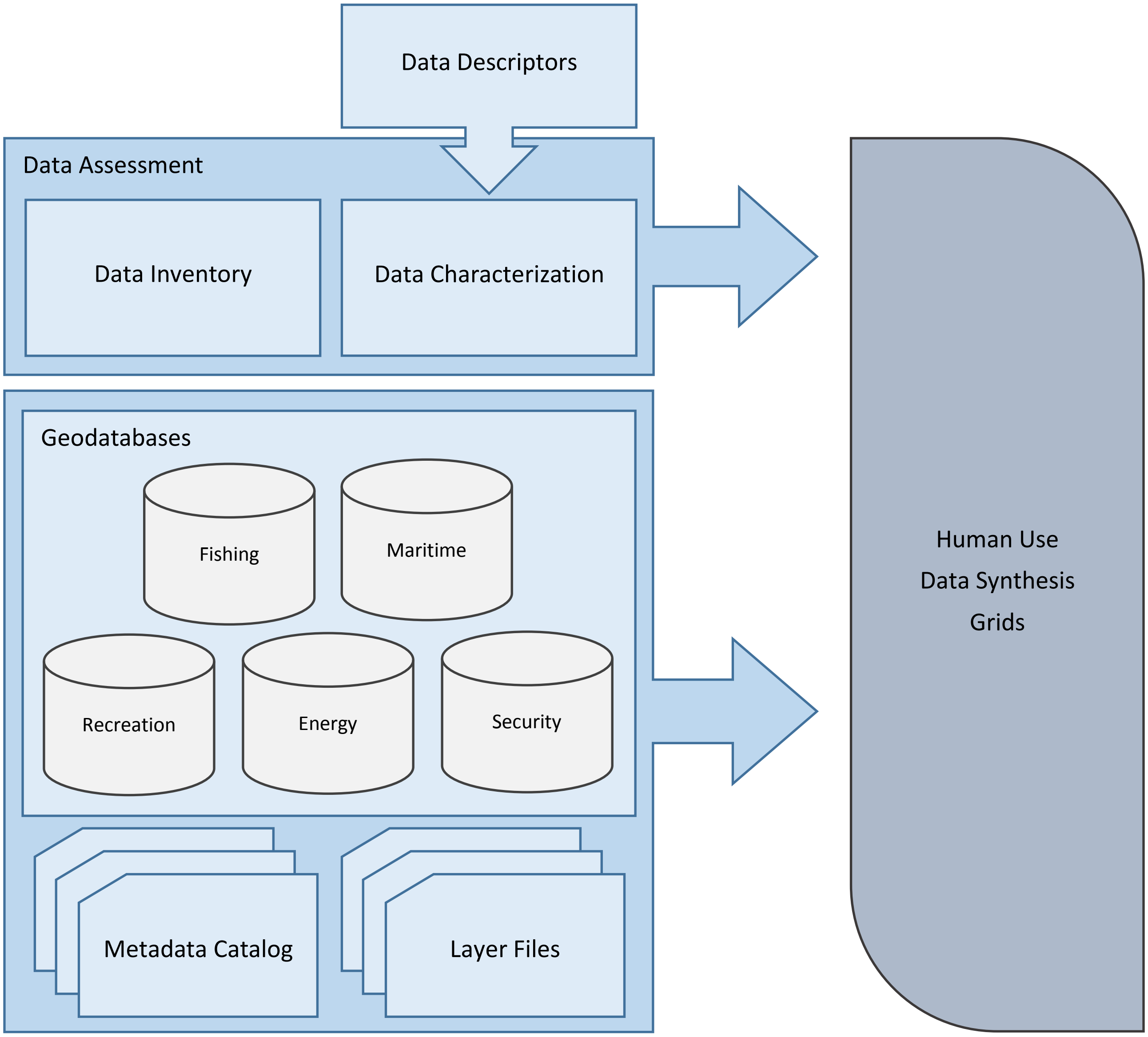


Figure 2. Schematic of the data assessment and collection process.

The goal of the inventory aspect was to collect all the existing human use spatial data and metadata available on the portal and Marine Cadastre (Marine Cadastre, 2015), as well as newly developed and supporting data from other sources (Section 2.1). The goal of the characterization aspect was to compile and summarize information for each dataset that supports the interpretation of the HUDS grids (Section 2.2). During this process, The Team considered the qualities of each dataset, guided by a set of descriptors (Table 2). These descriptors were based on the portal's Spatial Data Quality Criteria[3]. The results of the inventory and characterization are summarized in Section 2.3. A subset of the information The Team compiled is included in dataset-specific factsheets (see Appendix B), which are available to the users of the HUDS grids for more information pertaining to specific datasets.

During the assessment process, The Team investigated known gaps in current human use data, focusing on priorities identified by the DSWG (Section 2.3.2.1). Consideration of additional human use data limitations and gaps is provided in Section 2.3.2.2. Continued research can help fill these gaps to provide a clearer picture of human use in the region and support ongoing planning efforts. Moreover, emerging and future uses of the ocean will compete in an already busy environment, and understanding those activities will be equally as important as traditional uses. More complete information on these topics is provided in the Regional Ocean Assessment (ROA) (Shumchenia et al., 2016), a concurrent effort funded by MARCO.

2.1 Data Inventory and Documentation

With guidance from the DPT, and leveraging human use data they previously collected and vetted, the inventory process focused on cataloging and organizing geospatial data identified by MARCO and the Mid-A RPB as priorities for inclusion in the HUDS project. Building on the DPT's framework for data organization, The Team organized data into five geodatabases mirroring the five human use data "themes" on the portal: Fishing, Maritime, Recreation, Energy, and Security. During the collection of spatial data, related metadata and symbology (e.g., color schemes for display) were collected and catalogued in analogous folder structures as the spatial data. The Team also developed a working inventory document to help maintain information on the status of dataset and metadata collection at each phase of the process.

For each dataset:

- The availability of the root GIS data was determined.
- If root GIS data were easily available, they were downloaded and organized into the database structure.
- If the data were only available through a web service or were otherwise unobtainable, The Team worked with the DPT to either acquire these data or identify the appropriate person to contact

[3] Spatial Data Quality Criteria - The Mid-Atlantic DPT has defined the following criteria when evaluating candidate datasets for inclusion on the portal: Relevance for Regional Planning, Methodological Rigor, Data and Metadata Standards, Geographic Extent, and Currency. Datasets must satisfy the first two, Relevance for Regional Planning and Methodological Rigor, while the latter are more discretionary in nature.

in an outside organization. In one case, The Team chose to manually digitize data from a web service.

Despite these efforts, The Team was unable to obtain certain datasets and had to work within limitations posed by these gaps.

2.2 Data Characterization

After the data inventory, The Team began the data characterization. This process involved gathering and organizing descriptive information for each dataset. Much of the information was contained in the associated metadata, while some of it was supplied by the DPT and other experts. The Team summarized this information in dataset-specific factsheets (Appendix B). These factsheets provide transparent, easily accessible information about each dataset to the user of the HUDS grids. They also allow the user to understand what is driving regional trends in data presence and provide a measure of confidence for interpreting data presence as a proxy for human use intensity. Finally, The Team used the DPT's Spatial Data Quality Evaluation and Criteria (see footnote #2) as a basis to develop more specific descriptors. These descriptors evolved over the course of the characterization; the final set is summarized in Table 2.

Table 2. Summary of descriptors derived from the DPT's Spatial Data Quality Evaluation and Criteria and used in the characterization. If topics were modified from the DPT's Criteria, the original name of the criterion is provided in parenthesis.

Topic	Descriptor	Guiding Questions
Relevance for Regional Planning	Mid-Atlantic Priorities	Do the data fall into the categories of priority data for MARCO and for the Mid-Atlantic RPB (particularly its Sustainable Ocean Uses goal)?
	Priorities for Adjacent Planning Initiatives	Are the data important for planning initiatives in neighboring regional planning areas? Do the data complement existing or in-development data for neighboring planning initiatives?
Methodological Rigor	Geometry Type	What form do the data take? Are the source data vector data (point, line, polygon) or raster data?
	Scale / Information Density	Do the data include related attributes to use, or do they simply form a footprint of use? Are associated data quantitative or qualitative?
	Granularity / Precision	What is the resolution of the data? If the data are composed of points / lines / polygons, what is the confidence in their precision?
	Collection Method	Is data collection standardized? What are the implicit biases in the collection method? How rigorous is the design of the sampling scheme?
	Degree of Certainty	Are there secondary sources that support the data? Are the data compiled from multiple, complementary sources? What estimates of accuracy do we have? What are sources of bias in the data?
	Industry / Stakeholder Acceptance	Have the data been vetted by stakeholders / industry representatives? Were the data sourced from stakeholder / industry derived sources, peer-reviewed sources?
Data and Metadata Standards	Spatial Standards	Do the data conform to Federal Geographic Data Committee's (FGDC) National Standard for Spatial Data Accuracy?
	Metadata Standards	Does the metadata conform to the FGDC Metadata Standards?
	Use Limitations	Are there confidentiality concerns? Are there other limitations?
	Compatibility with Other Datasets	How well will the data mesh with other data to form synthesized products?
Spatial Coverage (Geographic Extent)	Area	Do the data cover the whole planning area or only a portion? If they only cover a portion, what is its size? And where are the data located?
	Uniformity	Is uncertainty in the data uniform over its extent or is there spatial heteroscedasticity in the data? Does the density of sampling change with relation to other variables, such as distance from shore? Are there substantial gaps within the extent of the data?
	Vertical Impact	Does the use occur on the surface of the water, in or throughout the water column, on the bottom, or under the seabed?
	Spatial Character	Do the data truly represent human activity? Or do they represent physical or regulatory infrastructure?
Temporal Coverage (Currency)	Currency	Are the data current?
	Length of Coverage	Over what time period were the data collected?
	Seasonality / Temporal Resolution	Do the data take into account differences in use depending on the time of year? Are those differences measured by month, season, or over some other period?
	Uniformity	What periods do the data cover? Are there significant gaps?
	Reoccurrence / Frequency	Are data collected regularly? If so, what is the frequency of collection activities?

One descriptor in particular helped inform organization of and subsequent thinking in the project: spatial character. A dataset's spatial character may either be activity or infrastructure. Infrastructure can be further classified as either physical or regulatory in nature.

- Activity datasets truly represent the activity of ocean users. Examples of activity datasets include the Communities at Sea fishing data and the Coastal Recreational Survey data.
- Regulatory infrastructure datasets define authoritative boundaries, which tend to influence the types and patterns of use in those areas. Examples of these include the BOEM active wind energy leasing areas and the danger zones and restricted areas datasets.
- Physical infrastructure datasets represent relatively permanent structures in the ocean, which either guide or influence activity (e.g., artificial reefs, aids to navigation) or are otherwise representative of human interest in an ocean space (e.g., submarine cables).

Thus, the spatial character descriptor helps the user understand and interpret the type of information contained in each dataset.

Throughout the characterization process, The Team investigated each dataset and recorded relevant information in the assessment matrix. Information was first compiled from metadata and other publically accessible sources, such as technical reports. The team also investigated any available spatial data in the ArcGIS environment to gather Information about attributes (e.g., name of a feature, description, etc.) and spatial extent (e.g., the entire Mid-A planning region, federal waters only, etc.). Other descriptive information was provided by DPT members or others knowledgeable about specific datasets. Collecting this broad variety of descriptive information allowed The Team to summarize and present a cohesive and comparable set of priority attributes for each dataset in a set of factsheets.

The priority attributes included in the factsheets are described in the first page of Appendix B. The Team developed this set of attributes in response to concerns expressed by the Mid-A RPB and others at the September 2015 Stakeholder Workshop and throughout the process about the challenges of interpreting the data presence nature of the HUDS grids. The attributes show the user information about each dataset that is applicable across its extent. These attributes contain information either from an individual descriptor or were synthesized from multiple descriptors. Two attributes The Team developed, which support interpretation of the HUDS grid, were “Stakeholder Involvement” and “Data Completeness”.

2.2.1 Stakeholder Involvement Categorization

Stakeholder Involvement is an attribute that was developed in conjunction with the DPT. In response to inquiries at the September 2015 Mid-A Stakeholder Workshop and RPB Meeting, The Team included information about the role of stakeholders in the data development process. This attribute takes on one of five values:

- Direct Generation – Stakeholders with authority in their group created the data and have provided it (e.g., NASCA Submarine Cables)
- Facilitated Generation – Stakeholders contributed their knowledge through a participatory process to build the dataset (e.g., PGIS recreation data)
- Reviewed – Data were independently generated; stakeholders were approached for review of the data and their input was used to make adjustments in analysis and confirm the reliability of the data (e.g., Communities at Sea)
- Defined by Authority – Most often regulatory infrastructure data, data represent information defined and provided by regulatory authorities (e.g., BOEM Wind Planning Areas).
- Compiled from Agency Sources – These are datasets most commonly created by agencies drawing from multiple, possibly disparate, sources of information. Often, the sources of the data are internal to the agency or from other government entities (e.g., shipwreck locations or offshore discharge flow data).

2.2.2 Data Completeness Categorization

The Team assigned each data layer a "Data Completeness" category, which describes how representative a given dataset is relative to the full extent of the entire Mid-A region. For example, most of the data layers included in this project were samples of some larger population. Thus, the quality of the data could range from a near-perfect census obtained from an authoritative source (e.g., US Coast Guard aids to navigation) to limited short-term survey results (e.g., coastal recreational boater activities). It is important to note that The Team used the best available data where possible and that in cases these data are limited in nature. A low "completeness" category was not meant to discount the utility of these data in the planning process, particularly when they are the best available or only available data, but rather to provide context and caveats of the individual data layers used for the synthesized HUDS grid products. Caveats and comments for these qualitative assignments were provided alongside each layer and meant to assist users while interpreting the gridded products. The category was a distillation of the broader information gathered through data assessment descriptors for each layer (Table 2).

Categories were defined as follows:

- Complete - The data represent a complete census, no omissions have been made. The source data are authoritative and exact, at least at the scale of the grid cells.
- Near Complete - Only a handful of omissions or questionable records exist, which do not affect the representativeness and utility of the overall pattern.
- Partially Complete - Gaps and/or uncertainties exist which may affect the representativeness and/or utility of these data.

- Incomplete - Substantial gaps and/or uncertainties exist and the data should be used with considerable caution for planning purposes.

2.3 Existing Human Use Data and Data Gaps

The results of the data assessment process are summarized below. Data compiled under the DPT's thematic framework also correspond to the Objectives of Goal 2: Sustainable Ocean Uses in the Regional Ocean Action Plan. Following the summary of existing data, there is a discussion of forthcoming data and data gaps.

2.3.1 Existing Data

Data collected and processed as part of the HUDS project was sourced from the portal, the Marine Cadastre, and directly from organizations and contractors analyzing and producing data products (e.g., Communities at Sea data). These data were organized into five themes: Fishing, Maritime, Recreation, Renewable Energy, and Security. A summary of the data in each of the themes is provided below.

2.3.1.1 Fishing

As one of the Goal 2 Objectives, Commercial and Recreational Fishing are important activities in the Mid-Atlantic Ocean. Commercial fishing activity was captured through two complementary datasets, Communities at Sea (CAS) based on federal Vessel Trip Report (VTR) data, and those derived from Vessel Monitoring Systems (VMS) data. Additionally, in this theme there were data representing the locations of artificial reefs in Mid-Atlantic waters. Some recreational fishing information was captured under the Recreation theme below (Section 2.3.1.3); however the available data were likely to be insufficient in representing all important areas for recreational fishing.

CAS fishing data replace older, coarser representations of fishing effort based solely on VTR. Operators of all federally permitted vessels are required to fill out VTRs for every fishing trip, with the exception of vessels that possess only a lobster permit (NOAA NMFS, n.d.(a)), The VTRs include details on trip location, gear type, catch, and crew information. The CAS data are unique in that the underlying information obtained from VTR provides both gear-type used and information related to the port the fishers use; communities were defined through combinations of gear-group and port. Thus, there is the opportunity for a multitude of visualizations that show the link between communities and the areas of the ocean important to them. Data were obtained from NMFS for the years 2011-2013. In this analysis, The Team uses nine regional products based on gear groupings that have integrate all localities. The products are density maps based on a metric of fisher days at sea, which is calculated from the number of crew aboard and hours spent at a site to show labor hours. The CAS data were vetted with the individual fishing communities in ports throughout the Mid-A that they represent.

The VMS products were derived from raw VMS records obtained from NMFS for the years 2011-2014. VMS is a satellite surveillance system used to monitor approximately 4,000 commercial fishing vessels in the U.S. Exclusive Economic Zone (EEZ), which transmits vessel position approximately once per hour (NOAA NMFS, n.d. (b)). The VMS data are represented by five products that differentiate between target species or species groups based on Northeast Fisheries Management Plans, namely multispecies, monkfish, herring, scallop, and surfclam/ocean quahog. These data layers were primarily developed by the Northeast Regional Ocean Council (NROC) and NROC contractors, and have been delivered to the Mid-A RPB and MARCO as part of the HUDS scope. These layers are based on raw VMS data from 2011-2014 which were obtained from NMFS. Activity is measured as the density of reported vessel positions, which are transmitted by a satellite surveillance system, typically one signal per hour, to monitor commercial fishing vessels. These data were reviewed and vetted by stakeholders and commercial fishermen in the Northeast and were refined based on feedback and information gleaned over the course of 50 regional community meetings.

Since both the VMS and VTR were obtained from NMFS, they underwent a screening process to adhere to the criteria mandated by NMFS known as the “rule of three” to mask out individually identifiable vessel positions. Therefore the density grids represent data where three or more VTR or VMS records are represented at a given location.

These two activity datasets were complementary but also can be duplicative and incomplete. For example, both types of data have layers that measure the activity related to fishing for groundfish:

- Communities at Sea – Groundfish fishing in waters deeper than 65 meters
- Communities at Sea – Groundfish fishing in waters shallower than 65 meters
- VMS – Multispecies (derived groundfish fishing activity)

Additionally, because the VMS data depict activity data based on fishery while CAS data represent gear types used, in some cases these datasets show the same or similar activity in two different ways. For example, the activity represented by the VMS data for herring fisheries may be captured within the CAS data for seine and gillnet fishing, which were both used to target herring (NOAA GARFO, n.d.). Both VMS and VTR derived data are inherently incomplete as they do not include state-permitted fisheries that do not require federal permits, and thus may not include important coastal fishing activity (see Section 2.3.2.2 - Other Data Gaps).

The only infrastructure dataset in the fishing theme was related to the location of Artificial Reefs. These data were collected from the five coastal states in the Mid-A and were included because of their importance in providing habitat and supporting fisheries in the region.

2.3.1.2 Maritime

The Maritime theme contains a broad variety of data, much of which is related to OAP Goal 2 Objectives:

- Maritime Commerce and Transportation related datasets include shipping and Maritime Commerce and Shipping Activity Data derived from Automated Identification System (AIS) data (USCG, 2014) and physical and regulatory infrastructure including Aids to Navigation, Anchorage Grounds, and Maintained Channels.
- Offshore Sand Management related data is limited and included in this theme in the Federal Outer Continental Shelf Sand and Gravel Borrow (Lease) Areas dataset.
- Undersea Infrastructure related data includes Submarine Cables Data and Shipwreck Locations.

Maritime commerce and shipping were captured in the latest set of Automated Identification System (AIS) derived data from 2013. These datasets break apart activity by vessel type into nine groups: tug-tow vessels, tanker vessels, cargo vessels, passenger vessels, fishing vessels, military vessels, pleasure vessels, vessels whose type was unavailable, and all other vessels. These data measured activity as the density of tracklines derived from vessel tracking points. The primary limitation of these data is that they do not capture small vessel traffic since AIS is only required on vessels of 300 gross tonnage and above (IMO, 2015).

The maritime theme contains various infrastructure datasets, which represent either regulatory boundaries or physical constructed features. These include:

- Aids to Navigation
- Anchorage Grounds
- Maintained Channels
- North Atlantic Right Whale Seasonal Management Areas
- Ocean Disposal Sites
- Offshore Discharge Flow Locations
- Pilot Boarding Areas
- Routing Measures
- Port Facilities

Data related to sand and gravel resources and use were limited in availability. The only data available have been integrated in the analysis and include Federal Outer Continental Shelf Sand and Gravel Borrow (Lease) Areas. These data showed the locations of all active and former lease sites in federal waters from 3-8 nautical miles from shore used for sand and gravel extraction. More information related to efforts to acquire and compile related data is provided in Section 2.3.2 below.

Critical undersea infrastructure was represented in the maritime theme in the Submarine Cables dataset, derived from National Ocean and Atmospheric Administration (NOAA) Electronic Navigational Charts. This dataset was supplemented with manually digitized information from the NASCA Submarine Cable dataset available on the portal. Descriptive information incorporated into the synthesis grids outlined whether the cables derived from the NOAA ENC or NASCA sources.

Finally, some shipwreck data was integrated into the analysis. The Team used the NOAA Automated Wreck and Obstruction Information System and Electronic Navigational Chart shipwreck data. The Team opted to use these data rather than the density grid of shipwrecks compiled by BOEM because of the significant limitations of that dataset, including its lack of coverage of state waters (See Section 2.3.2 Data Gaps for more information on the limitations of these data).

2.3.1.3 Recreation

The Recreation theme included data relevant to the OAP Goal 2 Objectives: Recreation and the latter half of Commercial and Recreational Fishing. Comprehensive recreational use data was difficult to obtain and the available data for the Mid-A consist of three complementary datasets: Coastal Recreational Survey data, Recreational Boating Survey data, and Participatory Geographic Information System (PGIS) derived data.

Coastal Recreational Survey information covers activity in the Mid-A from mid-2012 through 2013. These data were collected through an online, opt-in survey and included 16 different non-consumptive recreational activity types with 50 or more responses regionally. The survey did not gather information about fishing or other consumptive activities. The activities were sorted into four categories of use, which define the data layers The Team used in the analysis (Surfrider Foundation et al., 2014):

- Shore-based activities (e.g., beach going, swimming or body surfing, and collection of non-living resources / beachcombing)
- Surface water activities (e.g., surfing, skim boarding, and kayaking)
- Underwater activities (e.g., free diving / snorkeling and SCUBA)
- Wildlife and sightseeing activities (e.g., scenic enjoyment / sightseeing and photography)

The point data collected were processed to show the number of points for each of these groups of activities and each individual activity in 1km square grid cells.

Recreational Boater Survey information was collected in a similar manner as the Coastal Recreational Survey information from June to December of 2013. These data describe both specific activities undertaken during recreational boating, including fishing, as well as the routes that recreational boaters reported to have taken. In the metadata, users are cautioned from considering these data as representative of recreational boating activity in the region generally because of the low response rate of the survey.

Participatory GIS (PGIS) Derived Recreational Use Data was collected through a series of meetings held along the Mid-A coast. During these meetings, stakeholders identified areas on a map where they did various recreational activities including, charter and recreational fishing, SCUBA diving, paddling, and wildlife viewing, among others. In the states of Virginia, Maryland, Delaware, and New Jersey, stakeholders identified the general footprint of each use and the dominant area for each use. Additionally in New Jersey, stakeholders identified areas important specifically to recreational fishing and the target species for each of those areas. In New York, stakeholders identified important recreational areas but did not differentiate between dominant use areas and footprints.

2.3.1.4 Energy

Data in the Energy theme relate to the OAP Goal 2 Objective Ocean Energy (for consideration of oil and gas development in the Mid-A, see Section 1.3.2). The Energy theme was populated with data that describe the areas BOEM has designated for development, including those with active leases; areas off the shores of Virginia identified for research activities; and the energy facilities along the coast, which may be linked into any future renewable energy development in the Mid-A Ocean.

BOEM Wind Planning Areas, Active Lease Areas, and Virginia Lease Areas were all subsets of the larger grid of BOEM outer continental shelf lease blocks. Location of leasing areas was refined by the designation of aliquots, which were 1/16th subsections individual lease blocks. The migration of wind planning areas to active lease blocks occurs as BOEM conducts lease sales. One recent lease sale that has not yet been integrated in the current data is the sale of the wind energy area off the coast of New Jersey, which occurred on November 9, 2015 (BOEM, n.d.(a)).

2.3.1.5 Security

The Security theme contains data relevant to the OAP Goal 2 Objective National Security. This theme contained three datasets: Danger Zones and Restricted Areas, Unexploded Ordnances, and a suite of data related to United States Navy Operations.

Danger Zones and Restricted Areas data generally describe areas of U.S. military activity but also included areas restricted for other government use, including, for example, an area extending from the coast of Wallops Island, VA for use by NASA. This dataset was current as of July 2012 and was compiled by NOAA.

Unexploded Ordnance or UXO data were current as of February 2014 and were represented by polygons of varying sizes. This demonstrates the underlying uncertainty in the locations of known UXO. These materials can be quite small in nature and have the tendency to shift in position over time. Additionally, as noted in the metadata, these data were not a complete inventory of explosive materials on the seafloor.

U.S. Navy Operations Data were provided by the Department of Defense and contain 13 data layers:

- Atlantic City Airspace Corridor
- Military Installation Location
- Military Range Complex
- Mine Warfare Area
- Naval Undersea Warfare Center
- OPAREA Boundary
- Ship Shock Trial Area
- Sink Exercise
- Submarine Transit Lanes
- VACAPES Airspace Corridors
- VACAPES Restricted Areas
- Wallops Test Track
- Warning Areas

2.3.2 Data Gaps

Proper interpretation of the analysis depends on an understanding of the limitations of the underlying data that were sampled in the HUDS grids and the data that were missing from the analysis. For data included in the analysis, Section 2.3.1 provides notes on key limitations and the 'Completeness' designation assigned to each dataset (see Appendix B). There were also a number of gaps in data related to human uses, which could not be included in the analysis. There were gaps related to a number of current OAP Sustainable Ocean Uses Goal Objectives and other priorities identified by Mid-A leadership. These include data related to: offshore sand management, national security, tribal uses, and shipwreck location and data sensitivity. Additional gaps related to human use data exist including: cultural use of the ocean, spatially explicit socio-economic data, and gaps within the existing datasets. Finally, there is little information to support consideration of emerging and future uses, including aquaculture, which is identified by the OAP as a Sustainable Ocean Uses Goal Objective.

2.3.2.1 Priority Gaps Identified by Mid-Atlantic Leadership

The Mid-A RPB and MARCO have identified significant gaps and limitations in data related to offshore sand management, national security, and tribal uses, each of which is identified as an objective under the Sustainable Ocean Uses Goal in the OAP. Additionally, the DSWG identified shipwreck location information as a priority data gap in the region and sensitivity of access to that information to protect important cultural resources was an important limitation in filling this gap. These data gaps and limitations are described further below.

2.3.2.1.1 Offshore Sand Management

Data related to offshore sand management come in two forms: information related to the resource itself and information related to use of the resource. The Team performed initial research with the intention of working to fill this gap but decided any limited, interim datasets would be surpassed by the results of a number of federal and state efforts already underway to collect and compile data related to both facets of this topic. Federal efforts are integrated through the Bureau of Ocean Energy Management's Marine Minerals Program Geographic Information System (BOEM MMPGIS) project. This three year project's intentions are two-fold: to collect and organize outer continental shelf (3-8nm offshore) resource and use information and to build a consistent data structure into which federal information can be integrated. It is important to note that these efforts will not catalog information related to extraction in state waters – this continues to be a significant data gap.

The MMPGIS project will draw OCS resource information from another BOEM project, the Atlantic Sand Assessment Project (BOEM, 2015). Over the spring and summer of 2015, bathymetry, side scan sonar, sub-bottom profile, and magnetometer data was collected from 3-8 nm offshore along the Atlantic coast to characterize potential borrow sites. The second component of this project is the collection of sediment samples to analyze for texture and composition. Completion of the MMPGIS project is expected near the end of 2017 (Turner and Miner, 2015 and personal communication with Lora Turner). The first published result of the MMPGIS effort has been included in the HUDS grids: a geographic summary of active and formerly active sand and gravel lease areas on the federal outer continental shelf (see Section 2.3.1.2 Maritime).

2.3.2.1.2 National Security

The available data related to national security interests and Department of Defense activities include Danger Zones and Restricted Areas, Unexploded Ordnances, and Navy Operational Areas datasets. As discussed above, there are concerns about the accuracy of the location of UXO data (see Section 2.3.1.5 Security). This unclear understanding of where UXO exist on the seabed represents a priority gap expressed by members of the Mid-A RPB. Navy Operational Areas datasets represent a significant advance in national security data and were delivered to MARCO near the end of this project's timeline; however, they still lack detailed attribute information related to the particular uses and areas most important to military use.

2.3.2.1.3 Tribal Uses

Representation of tribal uses of the ocean has been identified as a priority gap by the Mid-A RPB and MARCO. The Team was advised by MARCO and the DSWG not to include tribal use data in the HUDS project as there are concurrent efforts to address these needs. The Mid-A RPB has identified the development of a research agenda to address tribal use data gaps as an Interjurisdictional Coordination (IJC) Action for inclusion in the OAP. MARCO is currently undertaking efforts to begin filling this data gap and improve the representation of tribes and their interests in the regional planning process through participatory GIS workshops and tribal listening sessions.

2.3.2.1.4 Shipwrecks

Mid-A authorities and stakeholders continue to be interested in the balance between more complete and accessible information related to shipwrecks and the protection of the cultural value of these sites. Current information describing known shipwreck locations at the regional scale is limited to two sources:

1. Combined NOAA Automated Wrecks and Obstructions Information System (AWOIS) and NOAA Electronic Navigational Charts (ENC) – included in the analysis (see Section 2.3.1.2 Maritime).
2. The Atlantic Shipwreck Database (ASD), which was developed under a BOEM contract.

Both of these are non-exhaustive sources and have specific limitations including varying accuracy of identified locations. These limitations are compounded with the need to comply with the National Historic Preservation Act which serves to protect sensitive cultural sites from looting and pillaging.

BOEM sought to address these issues by developing a density grid of shipwrecks based on the outer continental shelf lease blocks. Because neither the underlying ASD data nor limits of the BOEM lease block data extend into state waters, the density grid is limited to federal waters. Additionally, the metadata strongly cautions against the use of these data for decision making or planning purposes. For these reasons The Team did not include this dataset in the analysis.

2.3.2.2 Other Data Gaps

Beyond the priority data gaps identified by the Mid-A RPB and MARCO, there are a number of other human use data gaps, some of which are not unique to the Mid-A planning area. These include an understanding of cultural use, data on areas important to individual communities, and spatially explicit socioeconomic information. Additionally, even within the data that exists for the region there are specific gaps and opportunities to improve the richness of the information available. One example is the consideration of temporal variance in the data, such as seasonality.

2.3.2.2.1 Cultural Use

In addition to economic benefits derived from the ocean and maritime activity, communities along the coast find important cultural value in ocean spaces. As described above, we have a poor understanding of what places are important to the cultural traditions of tribes in the region. Efforts to fill this gap are being conducted by MARCO and are highlighted as an important aspect of the OAP (see Section 2.3.2.1, Priority Gaps Identified by Mid-Atlantic Leadership). More generally, we have a poor understanding and an insufficient way of conveying the places important to specific coastal populations. These connections are important to understand, both for their market and non-market values because impacts on areas critical to individual communities can have unequal impacts on those populations. One dataset The Team included in the analysis, Communities at Sea, demonstrates the beginnings of such linked thought (See Section 2.3.1.1 Fishing). In developing these datasets, communities were defined by the combination of port (home port and landing port) and gear group. One continuing challenge is representing these kinds of connections on the regional scale, thus The Team's choice in using the regional, non-community based datasets for the analysis.

2.3.2.2.2 Socio-economic Value

Just as the cultural, non-market value of ocean space is important, so is the market value of specific ocean areas. As it stands, there is little spatially explicit information that links areas of the ocean with socio-economic data. There are many estimates developed that relate individual activities in the ocean to their socio-economic impact, for example, estimates of the value of coastal recreation (NOEP, 2015). However, these do not map those impacts onto the ocean spaces from which they were derived. Some challenges in the development of spatially-explicit socio-economic data include:

- Working within the limitations of the information available describing human activity in the oceans (e.g., there are statistics for commercial fisheries value and maps of commercial fishery activity; however there are no maps explicitly showing the volume of catch for each fishery at the location of the catch to link these two types of information).
- Rectifying the variety of estimates produced related to a single activity due to varied methods and underlying data.

2.3.2.2.3 Gaps within Current Data

Even within data included in the analysis there were gaps. For example, both the VTR and VMS derived fishing data cover only certain federal fisheries and do not cover state-specific fisheries. Or, often The

Team may have the spatial footprint of activity or infrastructure, but no robust associated information captured within the data's attributes. For example, many of the features in the Danger Zones and Restricted Areas dataset only describe the particular restriction but did not provide information on why that particular restriction is there. Other times there is information that existed within data that had not yet been harnessed. An example is the development of seasonal or monthly shipping and maritime commerce datasets using time stamps of the underlying AIS data. Generally, these types of temporal analyses have not been done and there is little opportunity to consider seasonality in the planning process using the existing data.

3 Human Use Synthesis Grids

HUDS grid products were designed to enable users (decision makers and the public) to view and query synthesized spatial human use information in a user-friendly framework. These products allow users to investigate areas of low to high availability of data. This "data presence" metric focuses on the number of spatially coincident use layers present in a given grid cell. The grids were generated from underlying or "root" data layers (Figure 3) which are accessible individually on the portal. Although the number of use layers in a given cell is potentially related to use intensity, there are important limitations to this assumption which are discussed in Sections 3.3.4 and **Error! Reference source not found.**. Thus, the main goal of the data presence metric is to identify concentrations of available data for further analysis and consideration. Furthermore, users are able to query the grids at specific locations for more detailed information on the root data contained in a given cell.

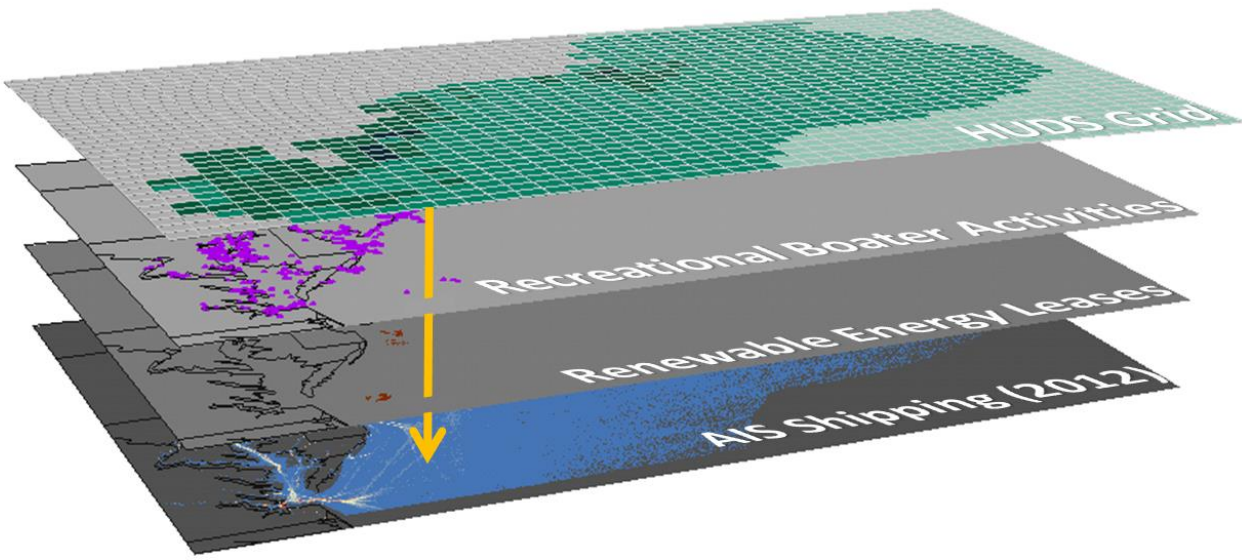


Figure 3. Root data layers are stacked and counted within a given HUDS grid cell.

The final HUDS grids are presented on the portal as heat maps showing patterns of low to high human use data presence across the region. Scoping out the framework of the portal's web platform was a critical step in guiding grid structure and generation, and designing the overall user experience. The Team leveraged the portal's built-in "Identify" tool which enables a user to view attribute information when clicking on a given feature. The Team designed the grids to contain both high level and more detailed information, to be presented in two formats:

- A “master” grid showing the total number of layers present in each grid cell out of the full suite of 60+ root layers. When clicking on a cell of interest in the master grid, the user can view these totals, optionally broken down by theme (see Section 3.1).
- A set of “theme” and “character” grids showing the total number of layers present in each grid cell within a certain theme or character (see Section 3.1). When clicking on a cell of interest in one of these grids, the user can view additional descriptive and statistical attributes for the root layers.

The attribute information included in each theme or type grid was vetted during the data assessment. While HUDS products contain a select set of pertinent and spatially-explicit information for each root dataset, supplemental fact sheets further document key root dataset descriptors and limitations and help users interpret and judge the synthesized maps.

3.1 Typology/Classification by Theme

As noted in Section 1.5, it is often useful to categorize ocean uses into “themes.” Thus, the Team approached the data synthesis process on a group level for five different themes (as already established in the portal): Fishing, Maritime, Recreation, Energy, and Security. The Team also grouped data into four “characters”: Activity, Infrastructure (all non-Activity layers), Physical Infrastructure, and Regulatory Infrastructure. These nine groupings allow users to explore and analyze patterns across industries, economic sectors, stakeholder groups, and data types.

Table 3 shows a matrix of the root layers broken out by theme and character. Table rows are populated based on the Maritime, Fishing, Recreation, Energy, and Security themes and table columns are populated based on the Activity, Physical Infrastructure, and Regulatory Infrastructure characters. Note that data listed within the Physical and Regulatory Infrastructure columns were also integrated together in a separate comprehensive Infrastructure grid.

Table 3. Categorization of root datasets by theme and character.

Theme	Activity	Physical Infrastructure	Regulatory Infrastructure	Total
Maritime	AIS Vessel Density 2013 Cargo Fishing Military Passenger Pleasure Tug/Tow Tanker All Others Not Available	Aids to Navigation Maintained Channels Wrecks & Obstructions Submarine Cables Routing Measures Port Facilities Offshore Discharge Locations	Anchorage Grounds Federal OCS Sand/Gravel Borrow Lease Areas Pilot Boarding Areas N. Atl. Right Whale SMAs Ocean Disposal Sites	21
Fishing	Communities at Sea Dredge Groundfish 65ft+ Gillnet Groundfish 65ft- Lobster Longline Pots/Traps Seine Shrimp Vessel Monitoring Systems Herring Monkfish Multispecies Scallop Surfclam/Ocean Quahog	Artificial Reefs		15
Recreation	Coastal Recreation Survey Surface Water activities Shore Based activities Underwater activities Wildlife/Sightseeing activities PGIS NJ Sport-fishing VA to NJ Recreational Uses NY Recreational Uses Recreational Boater Survey Boater Activities Boater Routes			9
Energy		Coastal Energy Facilities	BOEM Wind Energy Areas BOEM Wind Planning Areas Virginia Energy Areas	4
Security		Unexploded Ordnances Military Installation Locations	Danger Zones & Restricted Areas Navy Operational Areas Atlantic City Airspace Corridor Mine Warfare Area Sink Exercise Submarine Transit Lanes VACAPES Airspace Corridors VACAPES Restricted Areas Wallops Test Track	15
Total	32	10	22	64

The Maritime theme contains a total of 21 layers, dispersed across the designations for Activity, Physical Infrastructure, and Regulatory Infrastructure. The Fishing theme contains a number of Activity layers and one Physical Infrastructure layer, totaling 15 layers. The Recreation theme only contains Activity layers, while the Energy and Security themes include both Physical and Regulatory Infrastructure layers. There are a total of 32 Infrastructure layers (Physical + Regulatory) and 32 Activity layers.

3.2 Grid Dimensions and Resolution

An important step early in the analysis was the design of the overarching grid. This required identifying its resolution, extent, and coordinate system. The Team and the DPT discussed cell resolutions of 20 km, 10 km, and 5 km, and agreed that 10 km was appropriate for this regional-scale analysis. The Team received a shapefile from the DPT designating general boundaries for the Mid-A region which was used to demarcate the grid extent. Due to parallel efforts to map marine organism distribution and abundance from the Marine-life Data Analysis Team (MDAT), The Team matched the grid's alignment to that of the marine mammal products produced by MDAT, which also had a 10 km resolution. The Team also matched the grid's initial projection to that used by MDAT, namely an Albers equal area projection based on the WGS 1984 coordinate system and datum, customized to better suit the study area.

Specifically, The Team acquired a representative marine mammal raster product from MDAT and converted it to a gridded polygon. The Team subsequently identified all cells which intersected the Mid-A region boundary layer and exported a new 10 km grid product (Figure 4) in the Web Mercator projection (necessary for display on the portal). Because some positional transformations occurred as a result of this re-projection, the Team manually added some cells to the exported grid to improve visual display.

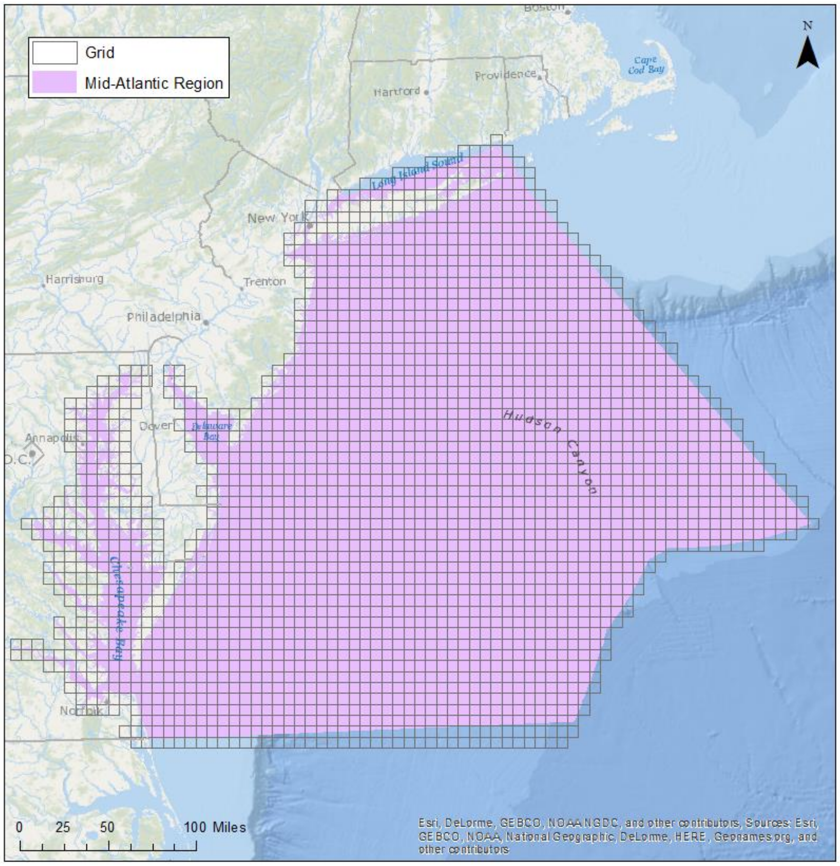


Figure 4. Extent and resolution (10 km by 10 km) of the HUDS grids. The Mid-Atlantic Region polygon was acquired from the DPT.

3.3 Grid Generation and Synthesis Methods

This section outlines the geospatial processing steps The Team undertook to create the HUDS grids. Overall, they included:

- Pre-processing of root data
- Generation of individual gridded datasets from each root layer
- Application of consistent attribute structure across all gridded datasets
- Implementation of a “use intensity” methodology
- Aggregation of gridded layers into synthesized products

All processing and pre-processing occurred in ArcGIS and Python environments.

3.3.1 Pre-Processing of Spatial Data

3.3.1.1 Vector Data Pre-Processing

Prior to aggregating the data within the regional 10 km grid, the Team performed pre-processing on a number of vector datasets to ensure data were organized as efficiently as possible to streamline the analysis. In some cases The Team performed a geospatial dissolve or summary on some datasets to compress the information of interest. A number of polygon recreational layers were converted to point centroids from polygon features after examining the data structure and attribute information in order to improve the gridding process. In these cases retaining the original polygon structure would have complicated data summarization, and although using point centroids introduced the assumption that the activity occurred in the center of the polygon, it eliminated the possibility of double-counting activities. Furthermore, in some cases (e.g., VA-NJ Recreational Uses) the data were originally points but had been transformed to polygons for display purposes. Thus, it was necessary for the Team to transform these data back to points for analysis purposes. Additional modifications included removal of some duplicate records and changing field types from text to integer to allow for mathematical calculations.

Most source datasets used the coordinate system Web Mercator Auxiliary Sphere, and any point, line, and polygon data not in this system were projected to match it. In contrast, all raster data were projected to match the custom WGS 1984 Albers equal area coordinate system (employed by MDAT) to ensure areal statistics were calculated properly. Due to processing steps discussed in the next section, the vector data were not required to be stored in WGS 1984 Albers before being combined with the main grid.

3.3.1.2 Raster Data pre-processing

There were three sets of raster data used in the analysis: Automated Identification System (AIS), Vessel Monitoring System (VMS), and Communities at Sea (CAS). The AIS and CAS rasters stored original densities (of ship tracks and fisher days, respectively) with all values above or equal to zero. Where necessary, all zero records (representing absence of data) were converted to null values so that summary statistics were not skewed by the zeroes. The VMS required additional processing since these data were transformed from the original density values into standard deviations with negative and positive values. Therefore, the Team leveraged the classification system devised by the Northeast Regional Ocean Council (NROC, the data originator) and employed on the Northeast Ocean Data Portal. NROC binned the standard deviation values into five quantitative classes and presented them using qualitative categories of Low, Medium-Low, Medium-High, High, and Very High (i.e., below -1, -1 to 0, 0 to 1, 1 to 2, and above 2 standard deviations, respectively). In order to treat these data consistently across regional ocean planning efforts, the Team took these data bins and assigned them a value of 1 to 5, with 1 representing "Low" values and 5 representing "Very High" values. Further processing occurred on these reclassified values.

All data layers included in the analysis were organized in a single geodatabase, with a prefix in the layer name for their associated theme designation.

3.3.2 Generation of Gridded Datasets

Once pre-processing was complete, The Team addressed the challenges presented by disparities in both data geometry and content. Different processing techniques were used for data with point, line, polygon, or raster format, and this required designing specific workflows to account for these different geometries. Additionally, datasets communicated different content whether or not they shared the same geometry type. For example, both recreational activities and port facilities were represented by points, but a single point could represent multiple activity types (for the recreational data) or a single facility (for the port data). Therefore, while many datasets contained similar types of information, the way that information was summarized in the HUDS grids attribute tables varied. Table 4 shows examples of this range of geometries, descriptive content, and statistical metrics.

Table 4. Examples of available information (descriptive and statistical) for the various data types included in the HUDS grids attribute tables.

Date Type	Sample Dataset	Descriptive Information	Statistical Information
Point	Recreational Activities	Activity types	Count of survey records
Point	Port Facilities	Commodity	Count of locations
Line	Submarine Cables	Source of cable data	Length (km)
Polygon	BOEM Wind Planning Area	Name of area	Area (km^2)
Raster	AIS Vessel Traffic	Percentile range of raster values	Area (km^2)

For example, the statistical information associated with point data might identify the number of surveyed activities or facility locations, in contrast to the length of a submarine cable or the area of a wind planning area. While the specific nature of this information varies, it all indicates how much of a given layer is present in a cell. To capture this and other metrics in a uniform way across all datasets, additional global attributes were added to store the necessary descriptive and statistical information.

3.3.2.1 Vector Data (Points, Lines, Polygons)

Processing techniques varied based on the different data structures discussed above. In the case of vector data, each root data layer was spatially joined with the regional 10 km grid using a one-to-many relationship to account for multiple records within a grid cell. The subsequent gridded layer was then summarized to identify the number of features that occur within each cell, and for some data it was also possible to summarize additional statistics for certain key attributes, (e.g., count of recreational activities). For line and polygon data additional statistics were obtained on the area or length of features present in order to identify how features were distributed within and across cells. This gridding process produced data with a coordinate system that matched the regional 10 km grid (WGS 1984 Albers equal area), and so subsequent calculations (e.g., summing area of features within a grid cell) were consistent with the regional grid cell's 10km by 10km area. The Team then added pertinent descriptive attribute information identified by the data assessment as necessary to include in each gridded dataset. In a number of cases additional editing of these attributes was required to optimize both clarity and presentation for the portal.

3.3.2.2 Raster Data

All raster data were projected to match the regional 10 km grid's coordinate system (WGS 1984 Albers equal area) and the subsequent rasters were analyzed to obtain statistics within each 10 km grid cell for area, count, minimum, maximum, mean, and sum. The area metric reflects the count of all raster pixels present within a 10 km grid cell multiplied by the raster's inherent areal resolution. Minimum, maximum, and mean reflect the lowest, highest, and average values within the 10 km grid cell, respectively. While these were not included in the HUDS grids, they provided valuable reference information when reviewing the results. Sum is an important metric which accounts for both the count of raster cells within a grid cell and the intensity of the data values. Similar to the vector data, the area and sum statistics were joined to individual gridded datasets for each layer. The Team then identified percentile ranges based on the sum statistic for the following classes: <10^{th} percentile, 10-25^{th} percentile, 25-50^{th} percentile, 50-75^{th} percentile, 75-90^{th} percentile, and >90^{th} percentile.

3.3.3 Application of Consistent Attribute Structure

The result of these steps for both raster and vector data were gridded datasets that contained various attributes of statistical and descriptive information specific to the source layer. For example, Figure 5 shows relevant attributes for two disparate data products from different themes; the Maintained Channels layer (left) contains unique information on channel depth and the area within a cell occupied by all channels, while the Recreational Boater Activities layer (right) contains data on the type of recreational activity and the number of records surveyed.

Maritime_MaintainedChannels

Minimum Depth Range	Area (m)
0.6 - 2.1	723371.408204
2.1 - 12.1	716707.307162
7.1 - 7.8	714831.533619
10.6 - 11.1	627527.4274
1.2 - 10.6	616368.554411
not provided	558728.161677
0.3 - 3.5	558130.715711
7.2 - 7.8	549970.600542

1 (0 out of 2390 S

Maritime_MaintainedChannels

Recreation_RecreationalBoaterActivities

Activity Types	Count Survey Records
viewing	4 survey records
swimming, scenic viewing	4 survey records
swimming, relaxing, scenic viewing	9 survey records
swimming, relaxing, scenic viewing	9 survey records
swimming, relaxing	2 survey records
swimming	5 survey records
swimming	4 survey records
swimming	1 survey record

0 (0 out of 2390 Selected)

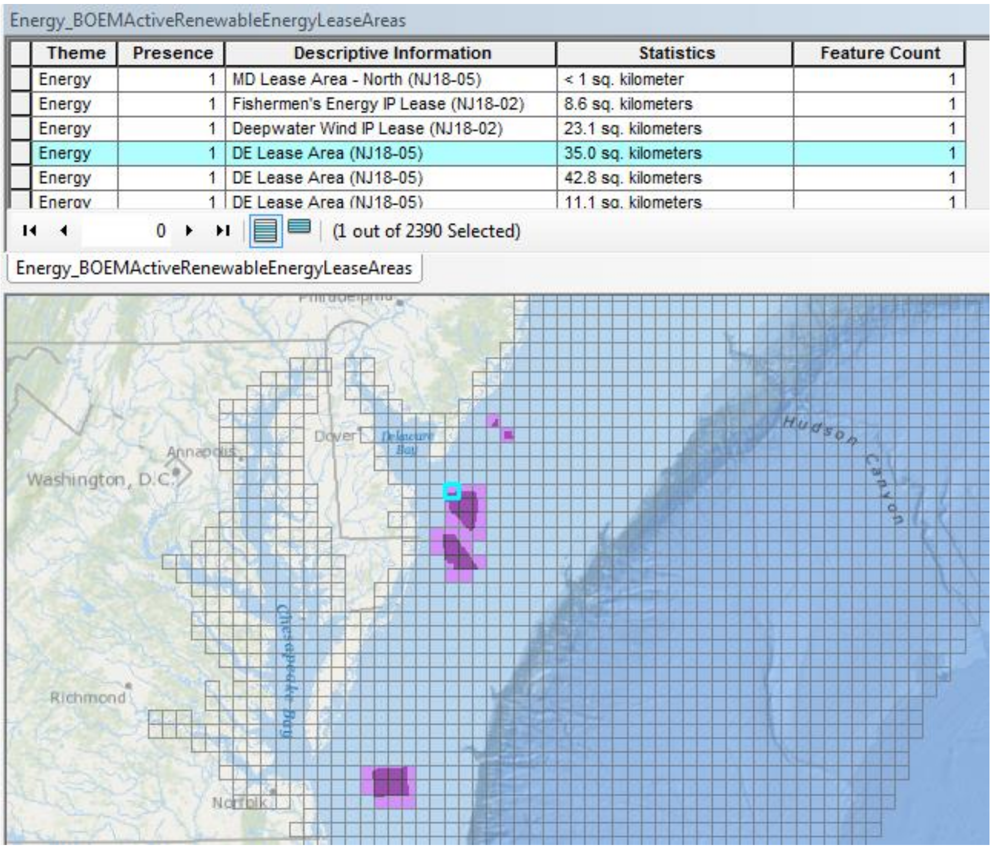
Recreation_RecreationalBoaterActivities

Figure 5. Comparison of GIS attribute tables for two layers from two different themes: Maintained Channels (left, maritime theme) and Recreational Boater Activities (right, recreation theme).

To standardize and consolidate the disparate suite of attributes from all layers, a set of uniform attribute headings (i.e., “fields”) were added to each gridded dataset. These included:

- A *presence* field denoting whether a layer occurred within a cell using 0 (absent) or 1 (present).
- *A descriptive* field to characterize pertinent information identified in each dataset.
- A *statistics* field to record the associated area, length, or count of features.
- A *feature count* field to store how many features occur within each cell.

Figure 6 shows an example grid with these attributes for the BOEM Renewable Energy Active Lease Areas layer. The attribute table displays the fields outlined above. The map shows the original BOEM Lease Areas in dark purple beneath its corresponding grid, which shows lighter purple grid cells where the presence metric is 1 and empty grid cells where the presence metric is 0. The highlighted blue cell on the map corresponds to the highlighted row in the table and demonstrates that within that particular cell, there is one feature that belongs to the Delaware Lease Area (protraction diagram NJ18-05) and covers 35 square kilometers.


Energy_BOEMActiveRenewableEnergyLeaseAreas

Theme	Presence	Descriptive Information	Statistics	Feature Count
Energy	1	MD Lease Area - North (NJ18-05)	< 1 sq. kilometer	1
Energy	1	Fishermen's Energy IP Lease (NJ18-02)	8.6 sq. kilometers	1
Energy	1	Deepwater Wind IP Lease (NJ18-02)	23.1 sq. kilometers	1
Energy	1	DE Lease Area (NJ18-05)	35.0 sq. kilometers	1
Energy	1	DE Lease Area (NJ18-05)	42.8 sq. kilometers	1
Energy	1	DE Lease Area (NJ18-05)	11.1 sq. kilometers	1

Figure 6. Example grid for the BOEM Renewable Energy Active Lease Areas layer and attribute table with standardized fields for data presence, descriptive information, area occupied within a cell, and number of features in a cell. The source data is shown in dark shading beneath a corresponding grid that has transparent purple cells for wherever lease area data were present.

For some products the descriptive field was left empty due to lack of information (e.g., Aids to Navigation, Recreational Boater Routes). For some point data, the statistics and feature count field were the same, and in these cases the feature count field was dropped when uploading the final layers to the portal. Also during the uploading process, the 'Statistics' attribute field was assigned a more informative name to account for area, length, or count metrics.

3.3.4 Use Intensity

One limitation of the data presence metric is that it eliminates information on the amount of use; either a cell has data or it does not. This does not account for variation in the distribution of data within and across cells. For example, shipping is treated as an all-or-nothing event, whereas in reality the density of tracklines and their coverage changes from cell to cell, indicating different levels of shipping use. Similarly, a cell with 2 km of submarine cable and a cell with 20 km of submarine cable are considered equal, even though the length of cable in each cell indicates a different degree of use. Thus, the Team implemented a method to retain more of the signal in the original datasets without reducing it to 0 (absence) or 1 (presence) by instead scaling it from 0 to 1. The result is a more nuanced view of ocean use that more nearly relates to use "intensity."

The Team identified specific metrics within each dataset to best quantify use intensity. For example points were counted within a cell, or the length of polylines or area of polygons within a cell was summed. Typically this corresponded to information from the "Statistics" field discussed in the prior section (see Appendix A for an outline of all layers). The steps below detail the use intensity methodology:

1. Identify the maximum value for the select statistic across all grid cells
2. Divide each grid cell summation by the maximum value to scale all cells from 0 to 1 (cells with 0 indicate no use intensity, while cells with 1 indicate the highest use intensity)
3. Classify the scaled 0 to 1 values into bins using the 20^{th}, 40^{th}, 60^{th}, and 80^{th} percentile breaks and assign them a qualitative classification (Table 5).

Table 5. Qualitative classifications assigned to the use intensity metric based on percentiles.

Percentile Ranges for Scaled Values	Use Intensity Classification
< 20	Very Low
20 – 40	Low
40 – 60	Medium
60 – 80	High
80 – 100	Very High

For the use intensity products, this required an additional two fields to store the attribute information in conjunction with the uniform attributes outlined in Section 3.3.3 above:

- A *use intensity* field to store the quantitative scaled 0 to 1 values.
- A *categorical use intensity* field to store the qualitative descriptions based on percentiles.

Figure 7 shows how this method was applied to various data types (point, line, polygon, and raster) throughout the analysis. Each example (displayed as a hypothetical grid containing 4 cells) demonstrates how data distribution varies across cells, and how a sum was calculated for each cell. The cells contain differences in the number of points, the length of line features, the area of polygon features, and the amount and sum of raster values. In each case, the maximum is outlined in a red box (Figure 7, top). Within each dataset, grid cell summation values are divided by this maximum which results in a scaled range from 0 to 1 (Figure 7, bottom).

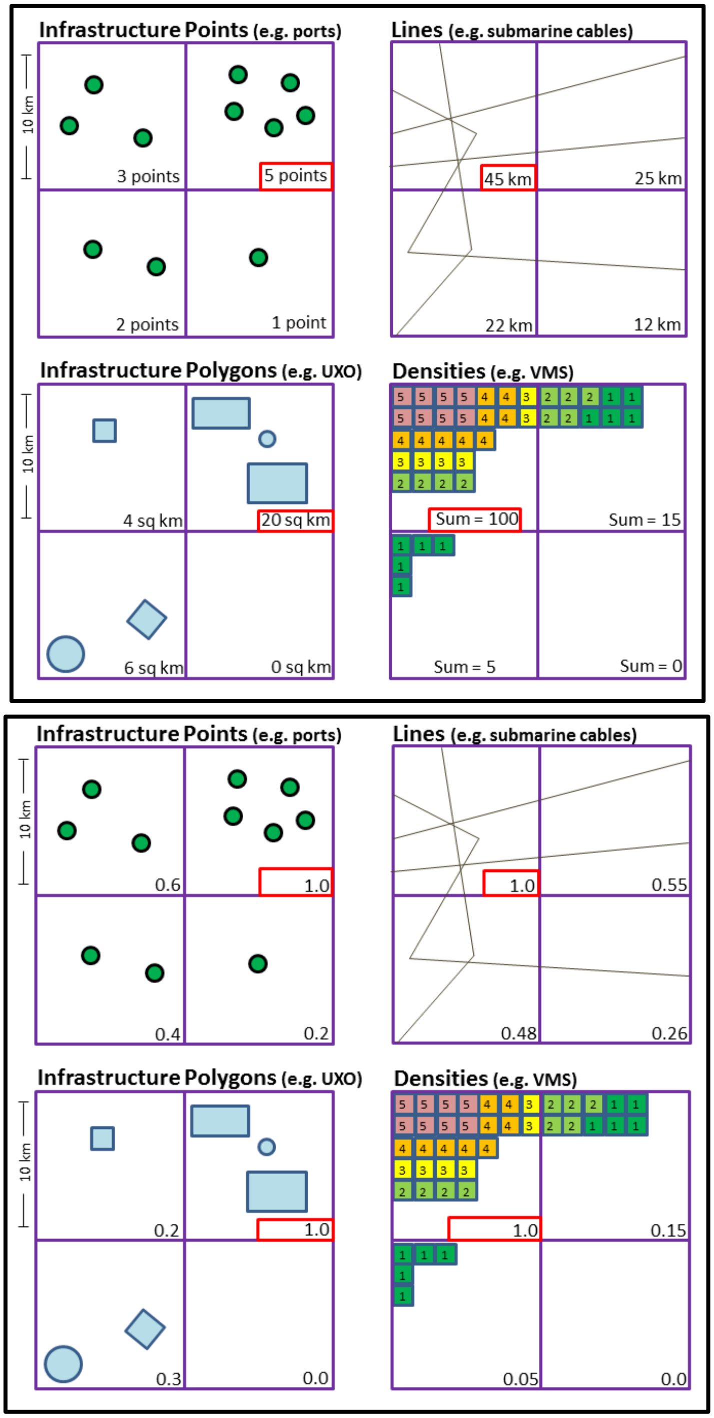


Figure 7. Example grids with summed metrics for point, line, polygon, and raster data types within each grid cell (top). These sums are then scaled from 0 to 1 (bottom) by dividing by the maximum value.

It should be noted that the typical formula for performing 0 -1 scaling is:

$$Scaled\ Value\ for\ a\ Given\ Cell = \frac{Individual\ Cell\ Value - Min.Value\ of\ All\ Grid\ Cells}{Max.Value\ of\ All\ Grid\ Cells - Min.Value\ of\ All\ Grid\ Cells}$$

In this case, by assuming a minimum value of 0 for a given dataset, the above formula reduces to:

$$Scaled\ Value\ for\ a\ Given\ Cell = \frac{Individual\ Cell\ Value}{Max\ \ Value\ of\ All\ Grid\ Cells}$$

The validity of this assumption varies somewhat depending on the layer of interest. For example, there are likely 10 km grid cells far offshore with truly zero recreational sightseeing activity. However, it is unlikely that there are one or more 10 km grid cells in the study area with truly zero shipping activity. Nonetheless, in the face of missing data, assuming a minimum value of zero is conservative in that any amount of data or activity is preserved as being greater than 0 in the output of the scaling calculation. This is especially important when totaling scaled intensity values together, as the next paragraph details.

The Team calculated cumulative use intensity for the full suite of 64 data layers as well as for each theme. This entailed summing the different use intensity values together and identifying quantile bins to classify data into the same high to low categories outlined above in Table 5. Figure 8 shows an example of this process for a simplified version of the Maritime theme. Note that a grid cell could contain a cumulative value above 1 if it demonstrated high use intensity across multiple layers.

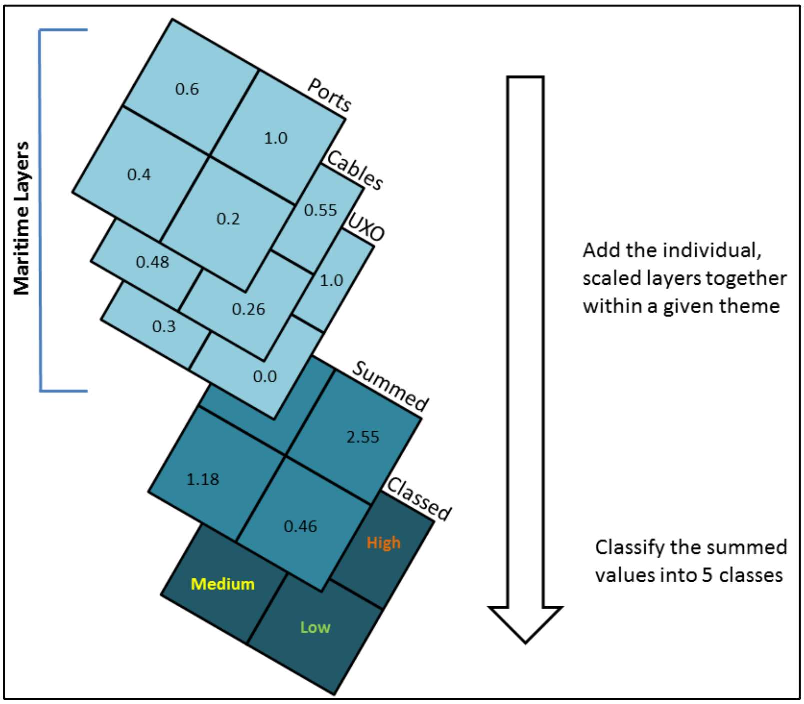


Figure 8. Calculation of cumulative use intensity and subsequent classification into categories (high to low) using a simplified version of the Maritime theme.

3.3.5 Synthesized Grids

The Team integrated the 64 layers into one master dataset which contained all of the processed fields outlined in Section 3.3.3 and 3.3.4 including 1) data presence; 2) descriptive information; 3) spatial or quantitative statistics; 4) count of features; 5) scaled use intensity from 0 to 1, and; 6) use intensity category. The layer name comprises the base of the field name to which the attribute type is appended. From this master dataset, 12 grid products were generated for display on the portal.

Table 6 lists the HUDS grids produced and a description of the information each contains.

Table 6. Summary of the final HUDS grids.

Grid Name	Layer Count	Description
Master Data Presence	64	Master grid, all human use layers, data presence totals by theme and by data character
Energy Data Presence	4	Theme grid generated from Energy layers, interrogate a cell for statistics and descriptive information
Fishing Data Presence	15	Theme grid generated from Fishing layers, interrogate a cell for statistics and descriptive information
Maritime Data Presence	21	Theme grid generated from Maritime layers, interrogate a cell for statistics and descriptive information
Recreation Data Presence	9	Theme grid generated from Recreation layers, interrogate a cell for statistics and descriptive information
Security Data Presence	15	Theme grid generated from Security layers, interrogate a cell for statistics and descriptive information
Activity Data Presence	32	Character grid generated from Activity layers
Infrastructure Data Presence	32	Character grid generated from Infrastructure layers
Physical Infrastructure Data Presence	10	Character grid generated from Physical Infrastructure layers
Regulatory Infrastructure Data Presence	22	Character grid generated from Regulatory Infrastructure layers
Maritime Use Intensity	21	Theme grid generated from Maritime layers, interrogate a cell for statistics and descriptive information
Fishing Use Intensity	15	Theme grid generated from Fishing layers, interrogate a cell for statistics and descriptive information

3.4 Results

3.4.1 Data Presence

The master HUDS grid which combined all 64 layers into a single data presence product is presented in Figure 9. The color ranges are based on quantiles (such that each color is mapped to the same number of cells) and grid cells with a value of zero are blank. As the master grid indicates, there are more data layers closer to shore and large port areas, and fewer data layers in offshore areas beyond the shelf break. Some grid cells that fall mostly on land have low data presence, such as on Long Island and in the Chesapeake Bay, and this is likely due to low amounts of data that exist at the edge of the study area boundary. Almost half of the layers in the master grid are from the maritime theme; thus, the overall pattern between the master grid and the maritime theme grid (Figure 10) is similar.

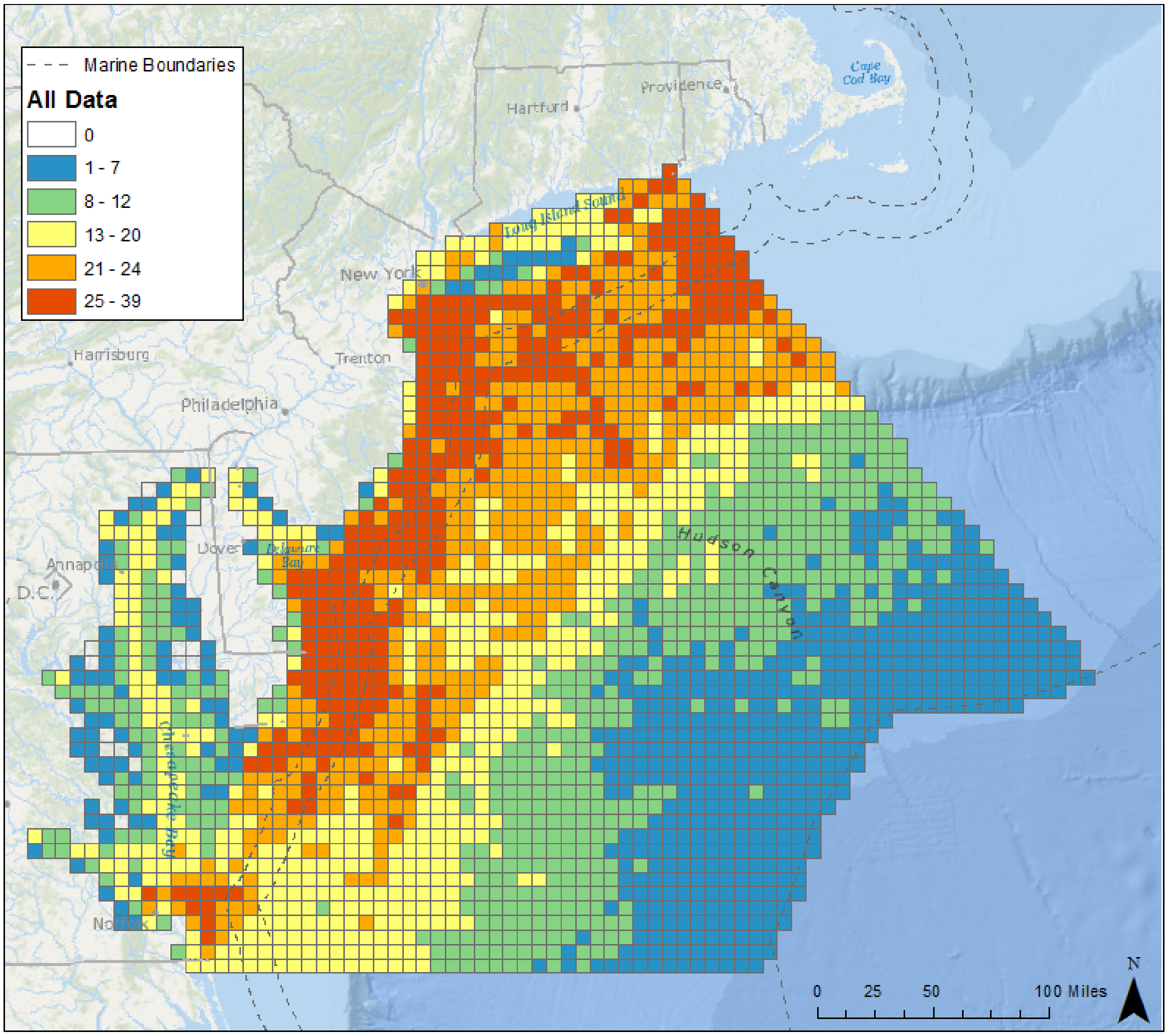


Figure 9. HUDS All Data Presence Grid (i.e., "master" grid) colored via quantile bins. Values represent the number of human use data layers contained in a grid cell. For a list of all layers see Table 3.

Figure 10 through Figure 14 depict the results for each of the five theme grids. The maritime theme grid contains the largest number of data layers (21), the highest concentrations of which are distributed in nearshore areas such as the Port of New York/New Jersey, Delaware Bay, and Chesapeake Bay. This pattern is largely due to the concentration of AIS vessel traffic layers and nearshore regulatory and physical infrastructure layers (e.g., anchorage areas, aids to navigation) in these areas. The fishing theme grid included a total of 15 layers, with higher concentrations near the coast and in areas on the continental shelf. There are very little or no data present in certain areas, such as Delaware Bay and the mid-to-upper reaches of the Chesapeake Bay; this reflects the offshore, commercial character of the available data and is due to missing data more than true absence of fishing in these areas. The recreation theme contains nine layers, all of which are the results of participatory surveys or mapping efforts. There is a very high concentration of recreational data presence along the coast throughout the region. Although caution should be exercised in drawing inferences from the small sample sizes in these surveys, this pattern nonetheless highlights that humans recreate along the coast far more than in offshore areas. The energy theme contains the fewest number of layers (4), which are scattered in near to mid-shore areas (representing wind energy lease blocks) and coastal areas (representing existing power facilities). Finally, the security theme included a total of 15 layers mostly comprised of Navy Operational Areas, which occupied large areas both offshore and nearshore. Most security layers designated very large regulatory areas; however, a couple represented unexploded ordnance and military installation locations.

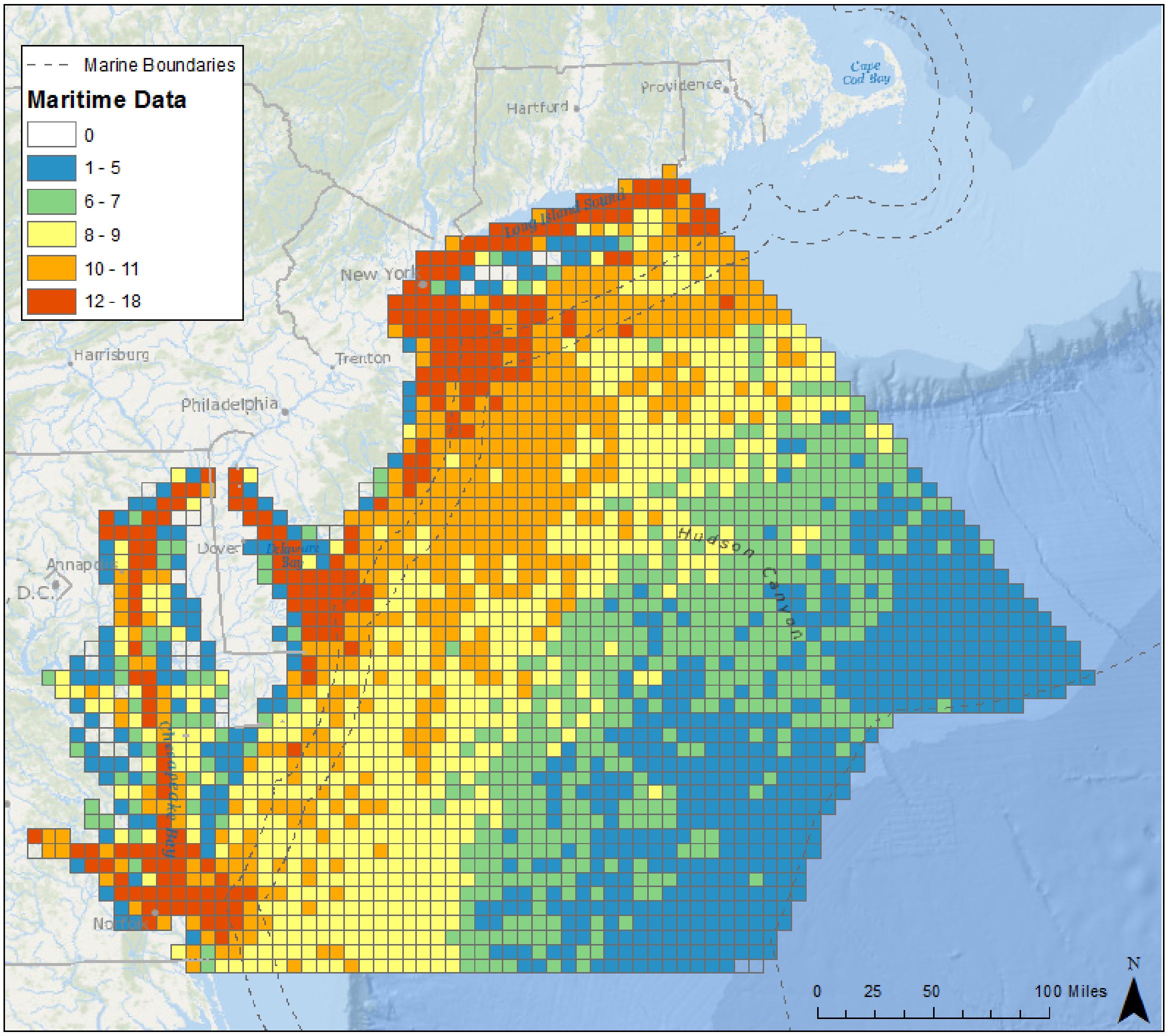


Figure 10. HUDS Maritime Theme Grid with data presence displayed in quantile bins. Values represent the number of maritime data layers contained in a grid cell. Layers in this theme include: Aids to Navigation, Anchorage Grounds, Maintained Channels, Federal OCS Sand/Gravel Borrow Lease Areas, Wrecks & Obstructions, Submarine Cables, Routing Measures, Pilot Boarding Areas, N. Atlantic Right Whale SMAs, Port Facilities, Ocean Disposal Sites, Offshore Discharge Locations, and AIS Vessel Density 2013 (Cargo, Fishing, Military, Passenger, Pleasure, Tug/Tow, Tanker, All Others, Not Available).

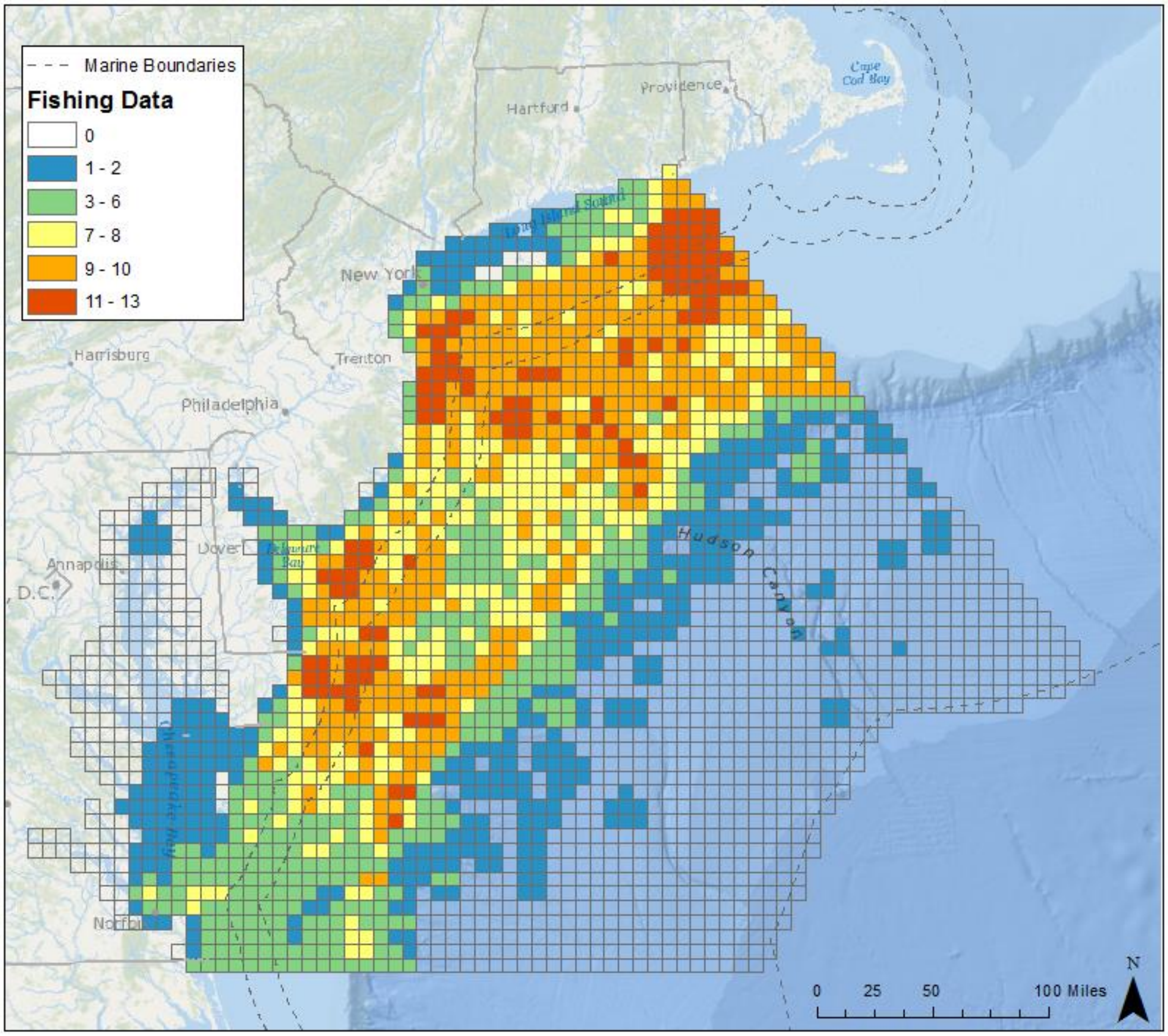


Figure 11. HUDS Fishing Theme Grid with data presence displayed in quantile bins. Values represent the number of fishing data layers contained in a grid cell. Layers in this theme include: VMS (herring, monkfish, multispecies, scallop, surfclam/ocean quahog); CAS (dredge, gillnet, groundfish > 65ft, groundfish <65ft, lobster, longline, pots/traps, seine, shrimp); and Artificial Reefs.

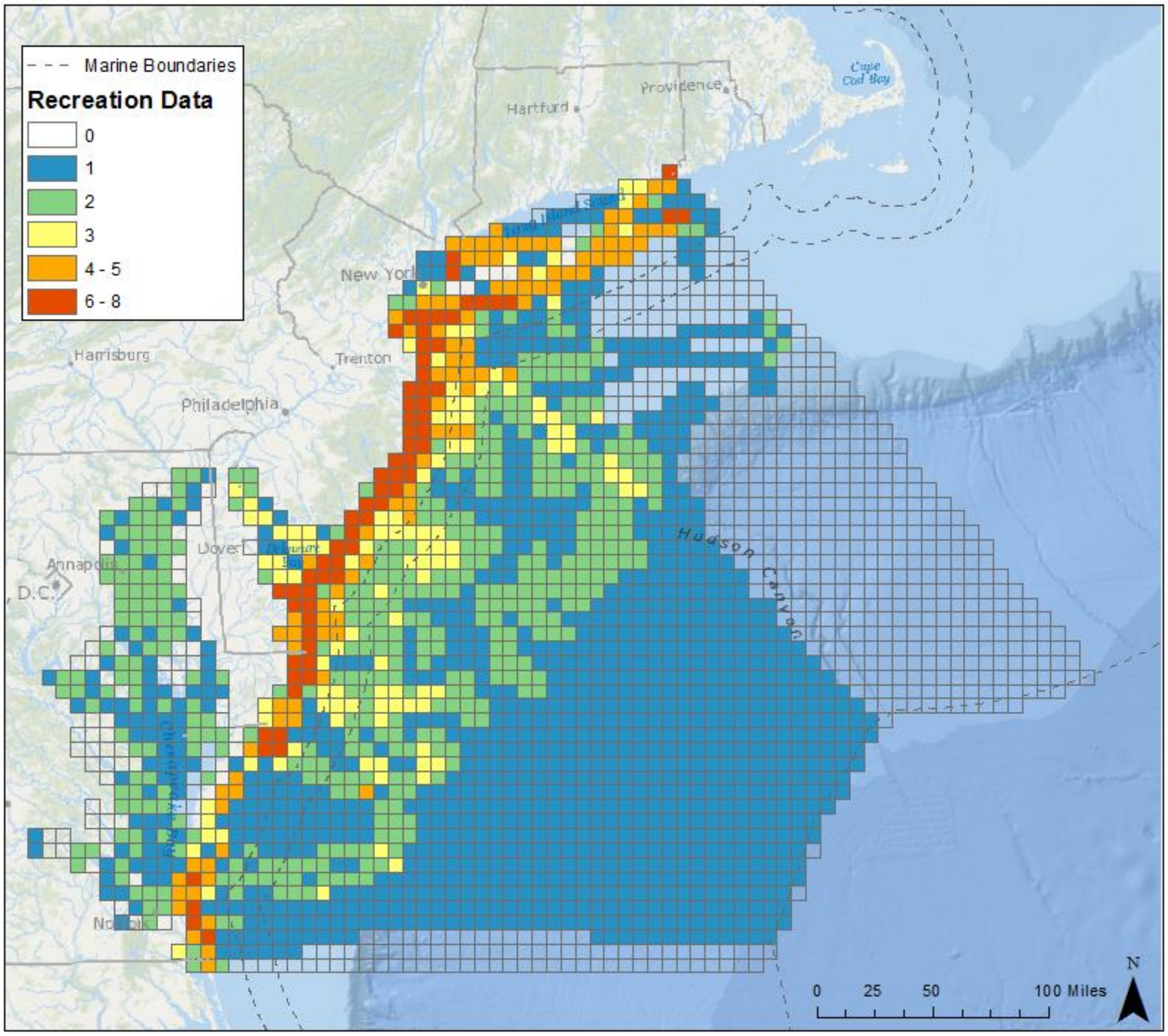


Figure 12. HUDS Recreation Theme Grid with data presence displayed in quantile bins. Values represent the number of recreation data layers contained in a grid cell. Layers in this theme include: Recreational Boater Activities, Recreational Boater Routes; Coastal Use Surveys (Surface Water Activities, Shore Based Activities, Underwater Activities, Wildlife/Sight Seeing Activities); PGIS (NJ Sport fishing, VA to NJ, NY Recreational Uses).

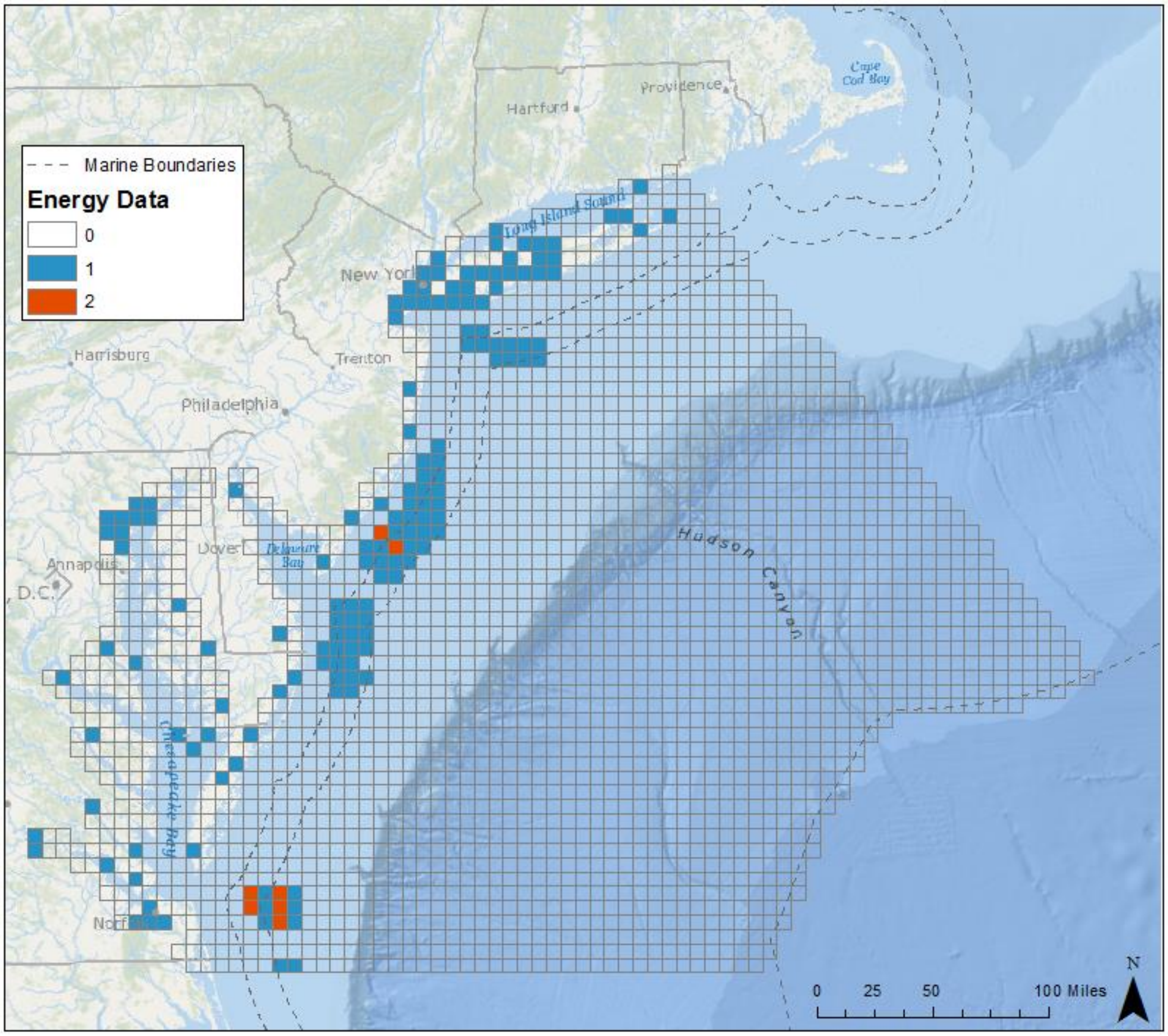


Figure 13. HUDS Energy Theme Grid with data presence displayed in quantile bins. Values represent the number of energy data layers contained in a grid cell. Layers in this theme include: BOEM Wind Energy Areas, BOEM Wind Planning Areas, Virginia Wind Energy Areas, and Coastal Energy Facilities.

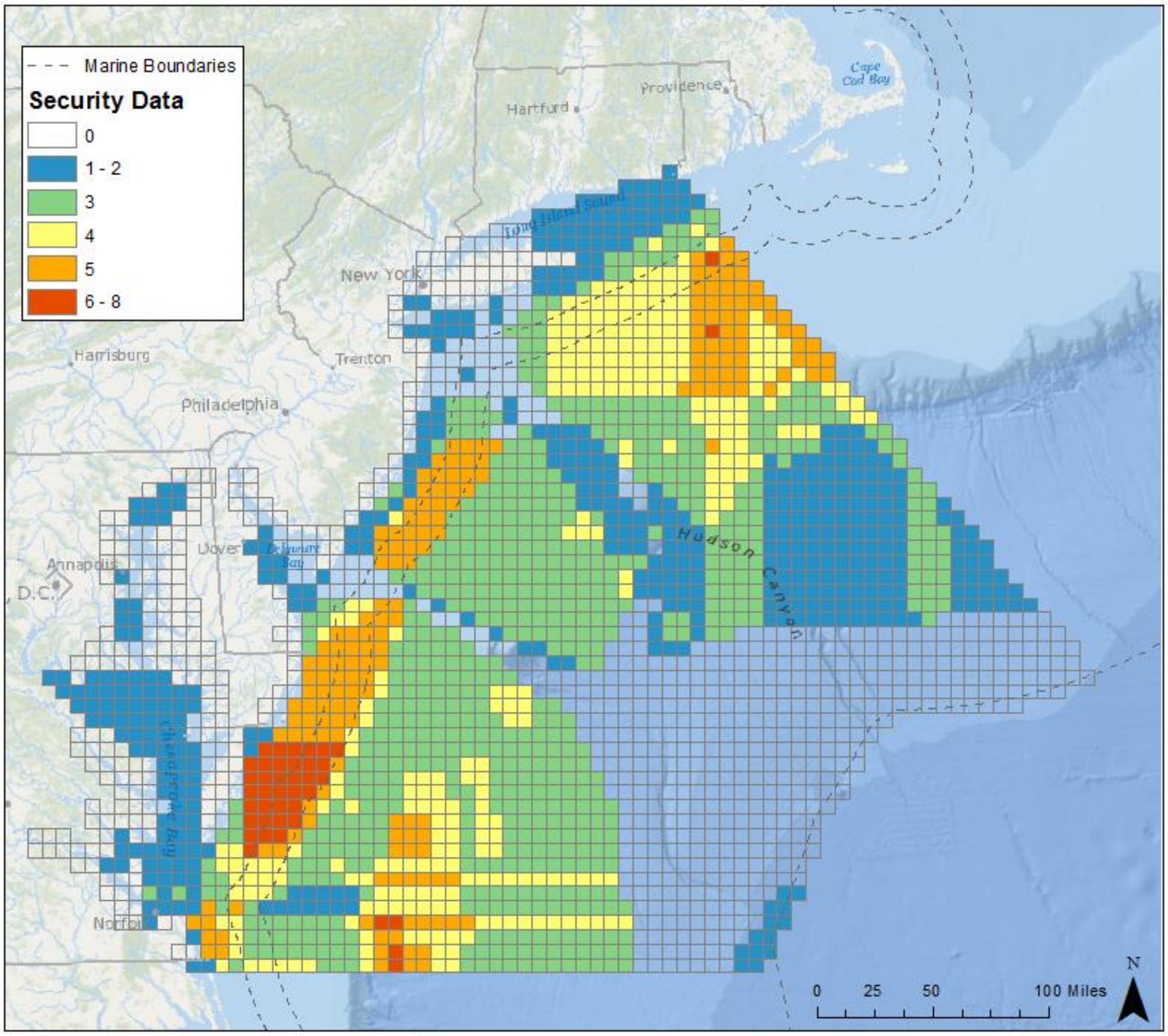


Figure 14. HUDS Security Theme Grid with data presence displayed in quantile bins. Values represent the number of energy data layers contained in a grid cell. Layers in this theme include: Danger Zones & Restricted Areas, Unexploded Ordnances, and 13 Navy Operational Areas.

Additional HUDS grids depicting the spatial distribution of uses based on their activity or infrastructure designation are presented in Figure 15 through Figure 18. Activity-type uses cover much of the region, with the highest concentration in continental shelf waters extending from south of Delaware Bay toward New York and along Long Island. These concentrations of activity layers are likely due to vessel traffic and fishing data from the AIS, VMS, and CAS layers. Infrastructure uses are concentrated closer to shore as opposed to offshore. The highest areas of infrastructure presence include waters surrounding the Port of New York/New Jersey, Cape May, NJ, and Norfolk, VA. The physical infrastructure grid has a similar concentration pattern to the parent infrastructure grid, albeit with slightly lower concentrations of data along the coast. The regulatory infrastructure use grid is highly influenced by the Navy Operational Areas, however some higher data presence occurs in near-coastal waters due to the presence of layers such as anchorages, danger zones, and ocean disposal sites.

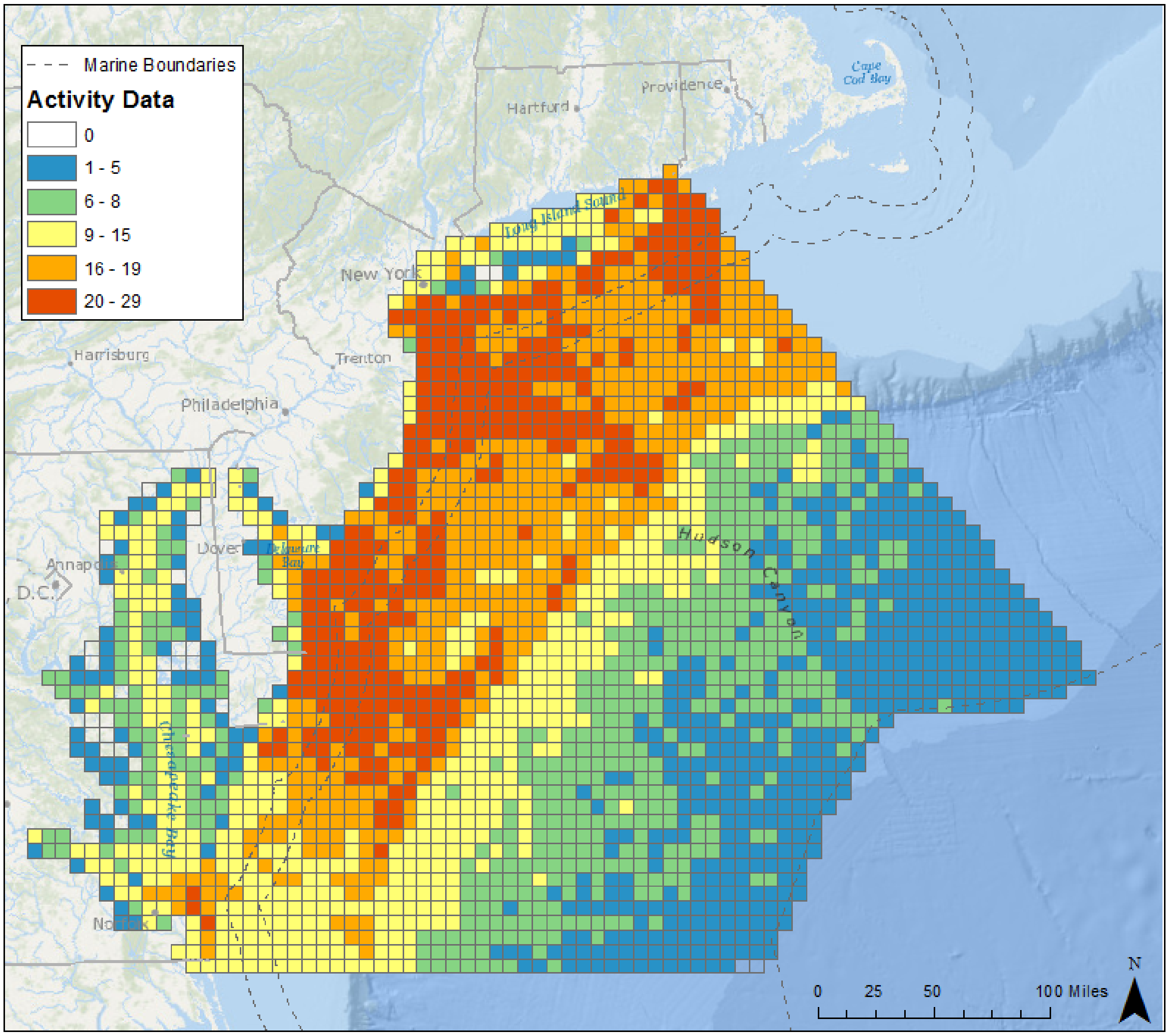


Figure 15. HUDS Grid for Uses Designated as Activities with data presence displayed in quantile bins. Values represent the number of activity data layers contained in a grid cell. Layers in this theme include: VMS (herring, monkfish, multispecies, scallop, surfclam/ocean quahog); CAS (dredge, gillnet, groundfish > 65ft, groundfish <65ft, lobster, longline, pots/traps, seine, shrimp); AIS Vessel Density 2013 (Cargo, Fishing, Military, Passenger, Pleasure, Tug/Tow, Tanker, All Others, Not Available), Recreational Boater Activities, Recreational Boater Routes; Coastal Use Surveys (Surface Water Activities, Shore Based Activities, Underwater Activities, Wildlife/Sight Seeing Activities); and PGIS data (NJ Sport fishing, VA to NJ, NY Recreational Uses).

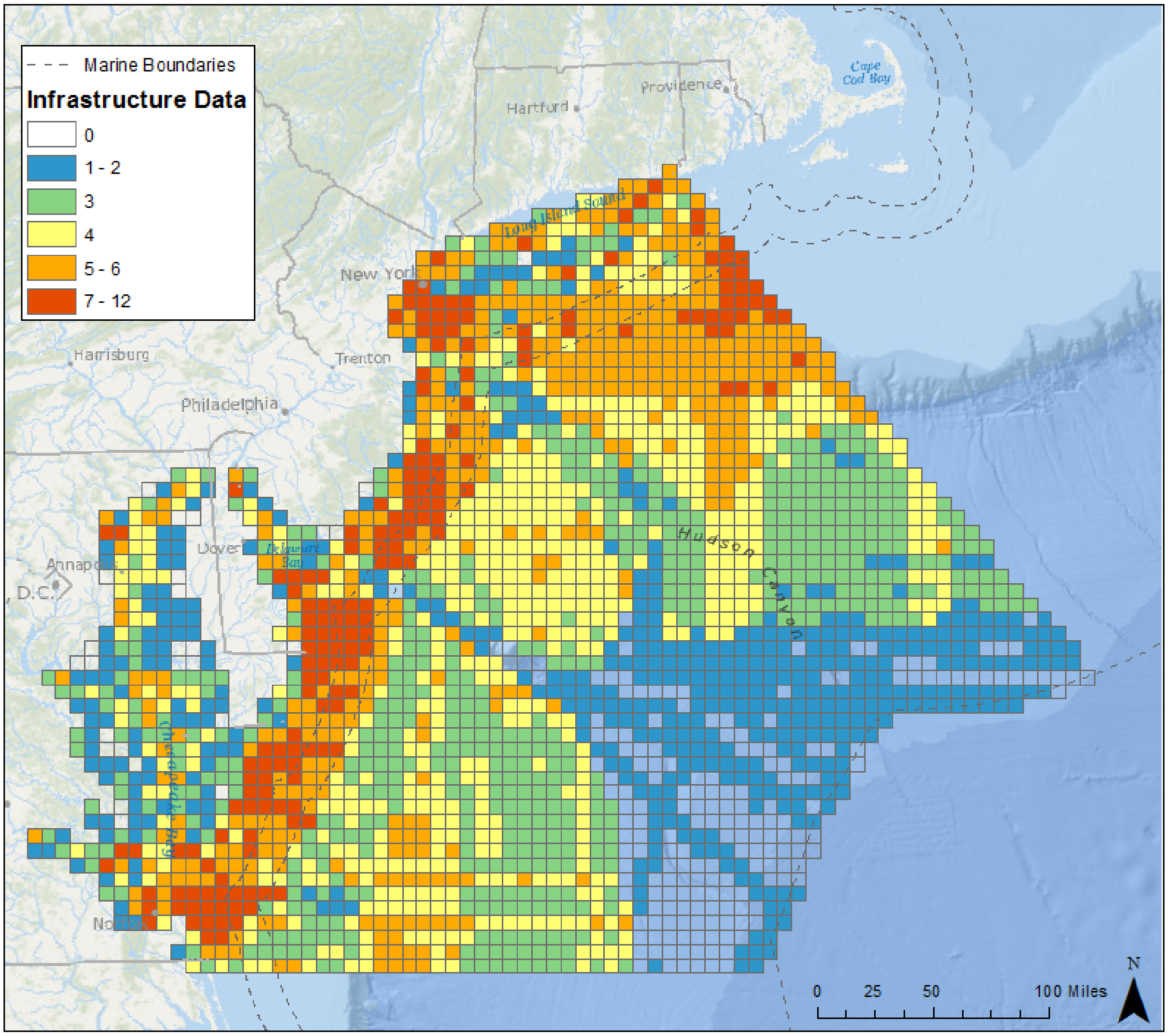


Figure 16. HUDS Grid for Uses Designated as Infrastructure with data presence displayed in quantile bins. Values represent the number of infrastructure data layers contained in a grid cell. Layers in this theme include: Artificial Reefs, Aids to Navigation, Anchorage Grounds, Maintained Channels, Federal OCS Sand/Gravel Borrow Lease Areas, Wrecks & Obstructions, Submarine Cables, Routing Measures, Pilot Boarding Areas, N. Atlantic Right Whale SMAs, Port Facilities, Ocean Disposal Sites, Offshore Discharge Locations, BOEM Wind Energy Areas, BOEM Wind Planning Areas, Virginia Wind Energy Areas, Coastal Energy Facilities, Danger Zones & Restricted Areas, Unexploded Ordnances, and 13 Navy Operational Areas.

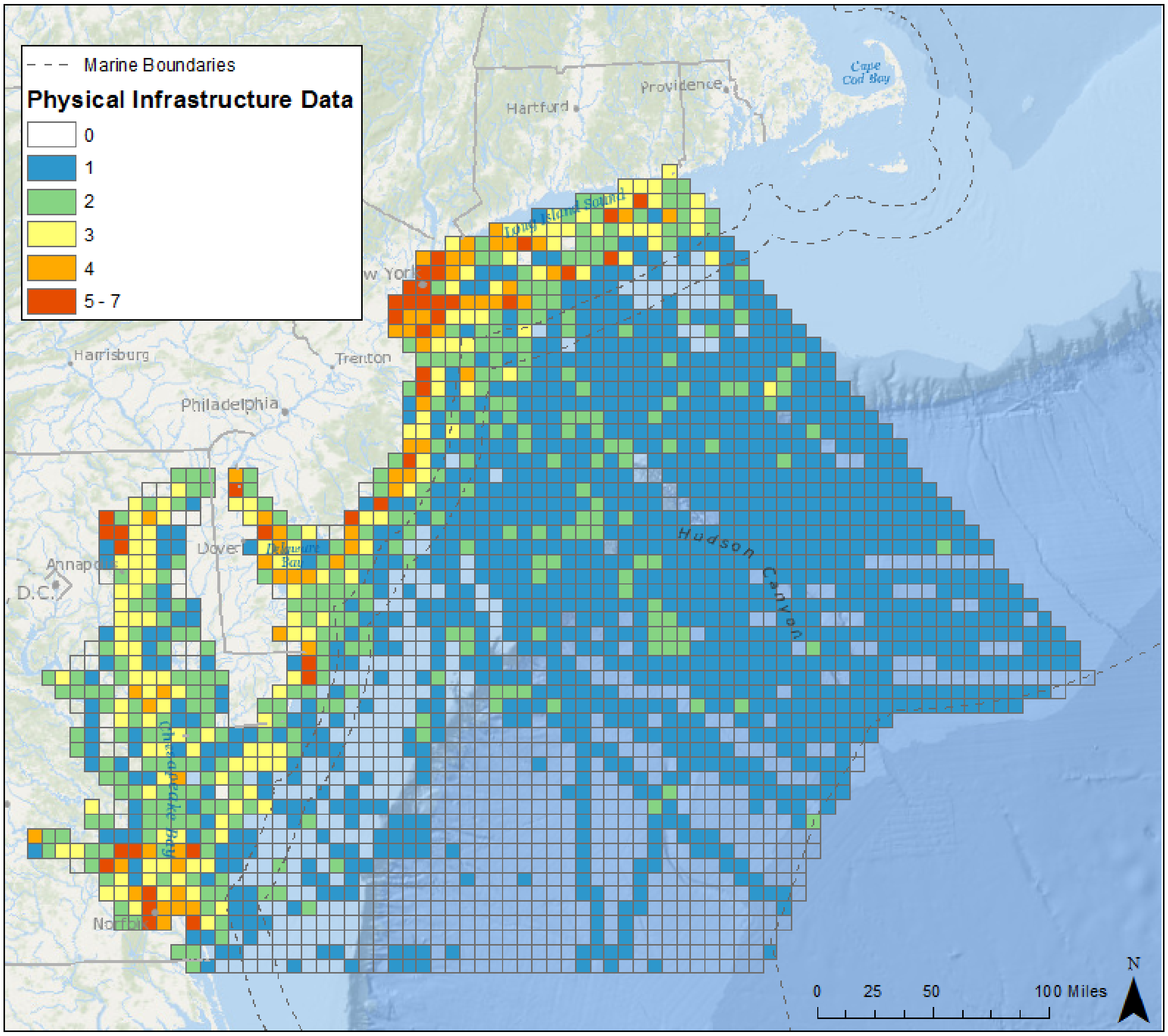


Figure 17. HUDS Grid for Uses Designated as Physical Infrastructure with data presence displayed in quantile bins. Values represent the number of physical infrastructure data layers contained in a grid cell. Layers in this theme include: Artificial Reefs, Aids to Navigation, Maintained Channels, Wrecks & Obstructions, Submarine Cables, Port Facilities, Offshore Discharge Locations, Coastal Energy Facilities, and Unexploded Ordnances.

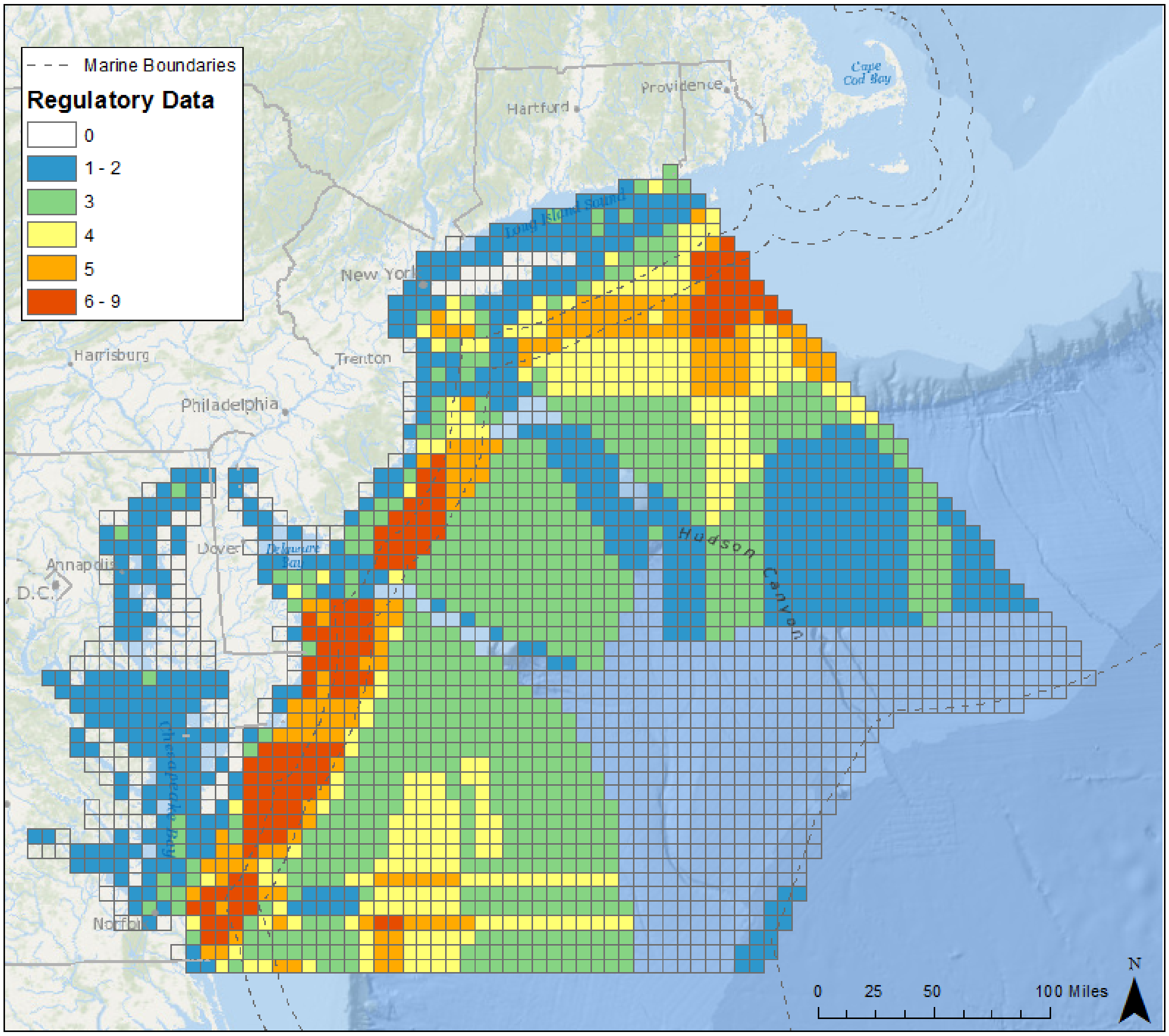


Figure 18. HUDS Grid for Uses Designated as Regulatory Infrastructure with data presence displayed in quantile bins. Values represent the number of regulatory data layers contained in a grid cell. Layers in this theme include: Anchorage Grounds, Federal OCS Sand/Gravel Borrow Lease Areas, Routing Measures, Pilot Boarding Areas, N. Atlantic Right Whale SMAs, Ocean Disposal Sites, BOEM Wind Energy Areas, BOEM Wind Planning Areas, Virginia Wind Energy Areas, Danger Zones & Restricted Areas, and 13 Navy Operational Areas.

3.4.2 Use Intensity

The use intensity results provided a more nuanced approach to mapping human use activity beyond a simple count of layers. Applying this method was most suitable for themes with data that fit the following criteria:

- The underlying source data contained an activity-based metric and was structured in raster (i.e., density-based) format and are believed to be representative of actual level of use or;
- The underlying source data contained an infrastructure-based metric but the assumption of relatively consistent use throughout the infrastructure footprint appeared valid.

Thus, the Maritime and Fishing themes had the best use intensity results. This is addressed in more detail in Section 1.

Figure 19 and Figure 20 compare data presence and use intensity for the Maritime and Fishing themes. The Maritime use intensity map reveals highly trafficked areas within shipping lanes and at port entrances, in contrast to the Maritime data presence map. It also highlights cells with some infrastructure data, such as submarine cables.

The Fishing use intensity map portrays some similar trends to the Fishing data presence map at a general level, however, the use intensity map shows a more concentrated picture of fishing activity, with highly fished regions off the coast of Long Island and in the New York/New Jersey Bight. Highly fished regions also extend south beyond Cape May, NJ, with some additional high activity areas at the mouth of the Chesapeake Bay.

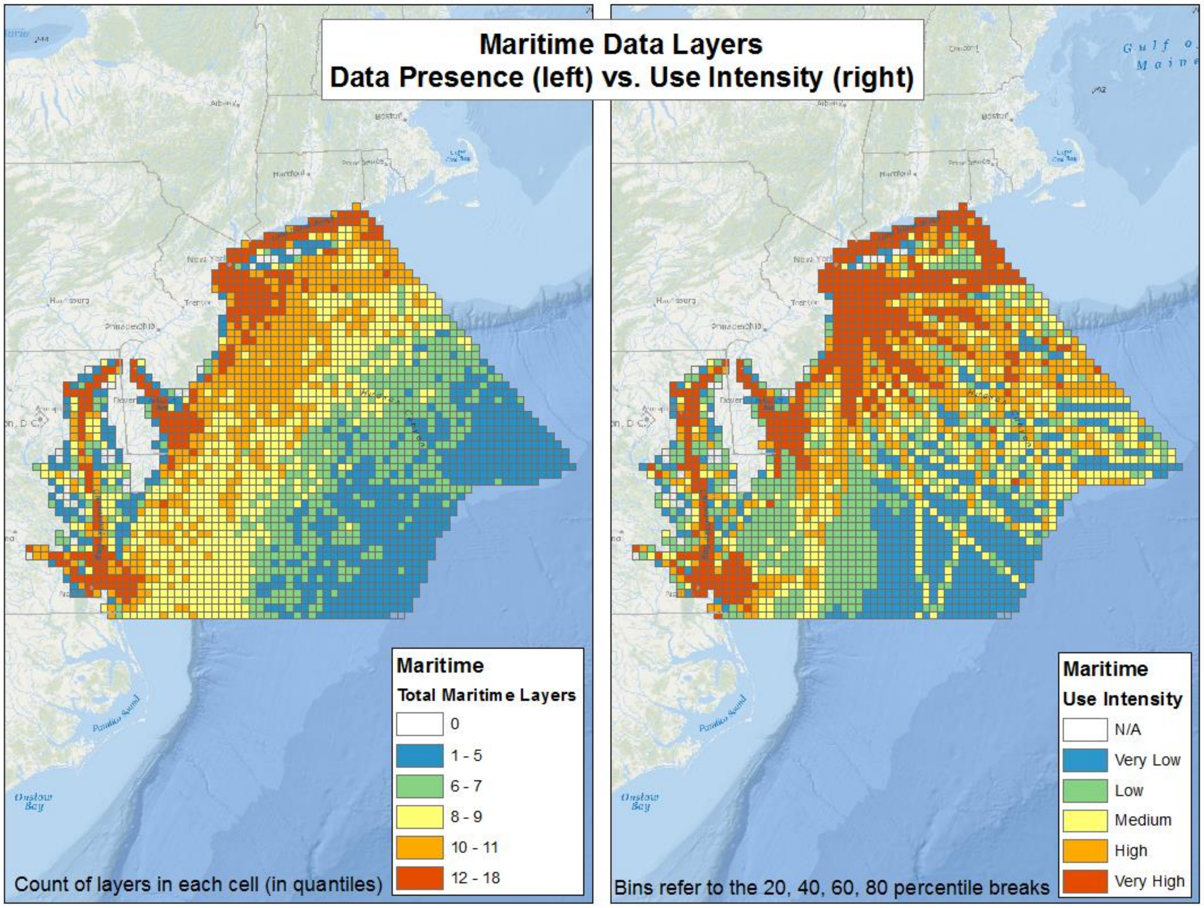


Figure 19. Comparison of Maritime Data Presence and Use Intensity heat maps in quantile bins. Data Presence values represent the number of layers while Use Intensity values indicate amount of human use. Layers in this theme include: Aids to Navigation, Anchorage Grounds, Maintained Channels, Federal OCS Sand/Gravel Borrow Lease Areas, Wrecks & Obstructions, Submarine Cables, Routing Measures, Pilot Boarding Areas, N. Atlantic Right Whale SMAs, Port Facilities, Ocean Disposal Sites, Offshore Discharge Locations; AIS Vessel Density 2013 (Cargo, Fishing, Military, Passenger, Pleasure, Tug/Tow, Tanker, All Others, Not Available).

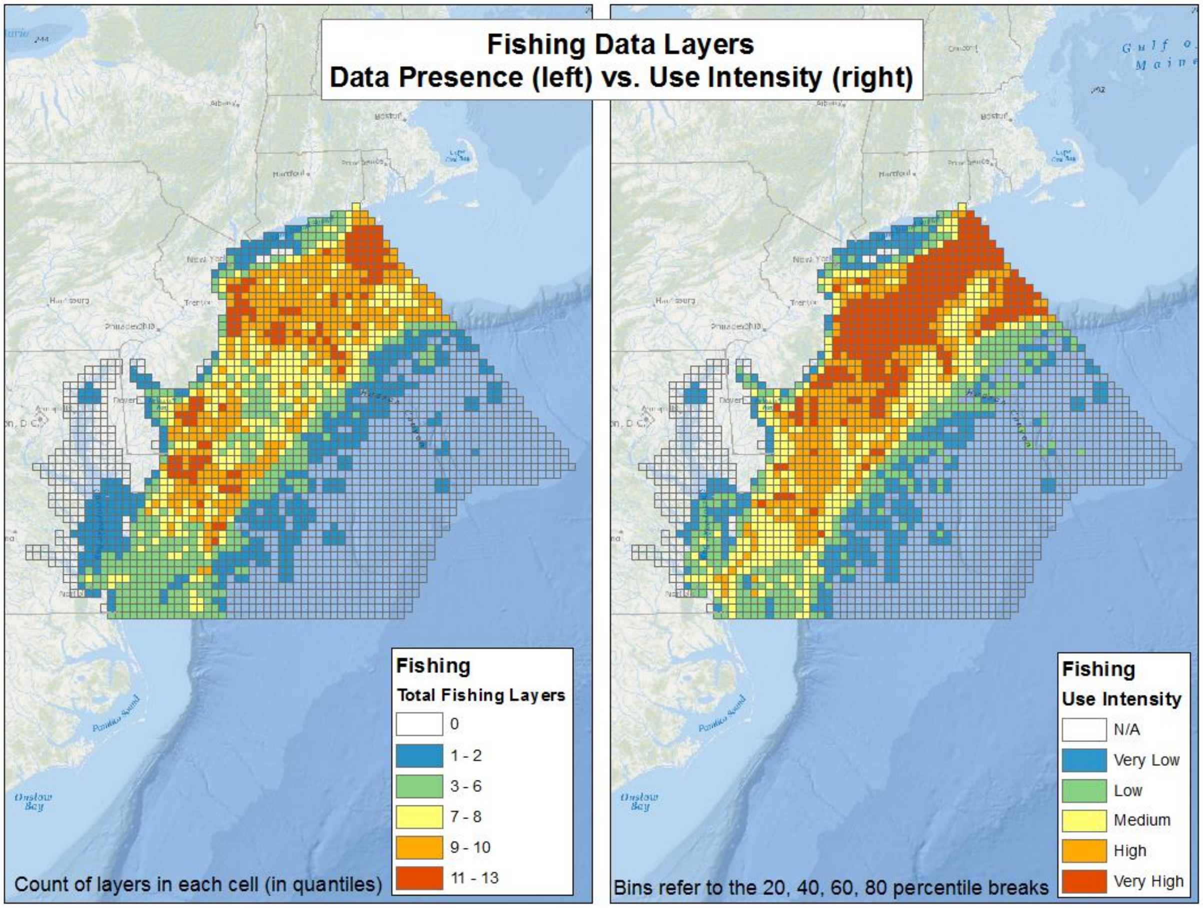


Figure 20. Comparison of Fishing Data Presence and Use Intensity heat maps in quantile bins. Data Presence values represent the number of layers while Use Intensity values indicate amount of human use. Layers in this theme include: VMS (herring, monkfish, multispecies, scallop, surfclam/ocean quahog); CAS (dredge, gillnet, groundfish > 65ft, groundfish <65ft, lobster, longline, pots/traps, seine, shrimp); and Artificial Reefs.

4 Discussion and Conclusions

4.1 HUDS Grids Limitations and Interpretation

It is important for HUDS grid users to fully understand the limitations and caveats of the products so that interpretation and resultant decision making can be presented in a transparent manner. As noted in earlier sections, each individual human use dataset had its own set of gaps, biases, and concerns relating to completeness, positional accuracy, temporal resolution, etc. Therefore, all of these limitations were interwoven into the final synthesized grid products. In addition, new caveats arose as a result of the gridding process. For example, aggregating uses into 10 km by 10 km grid cells does not necessarily mean that these uses overlap spatially. In other words, points representing unexploded ordinance at the bottom of the sea floor, lines representing surface vessel traffic, and polygons representing ocean disposal sites might all be present within a given grid cell but never “touch” in reality. Similarly, uses might overlap in space or be present in the same grid cell, but not overlap in time. For instance, much of the commercial fishing traffic and recreational uses are seasonally dependent, and these seasonal use patterns may not be apparent when aggregated at the theme level (or higher).

Additionally, St.Martin and Hall-Arber (2008) caution that GIS-based systems for environmental decision making are necessarily limited by the available data. For example, human uses that are more heavily regulated (e.g., commercial shipping and fishing) tend to have more data available whereas recreational uses rarely have reporting requirements and are typically less represented (ERG, 2010). Illegal uses (e.g., certain kinds of dumping, out-of-season fishing) are rarely represented at all. Thus, the patterns in the total HUDS grid tended to reflect these regulated, commercial uses. The theme grids helped somewhat mitigate this bias, however.

4.1.1 Grid

The choice of grid resolution entailed a compromise between sample size, spatial precision, and utility for planning purposes. As an example, if the entire study area were a single cell, this cell would have a very high sample size and a very stable estimate for the number/extent of features in it. However, the large size would be almost useless for planning purposes. On the other hand, very small cells would have much higher spatial precision and allow for fine-scale decision-making, but result in high sensitivity to shifts in data or grid location. It would also be tedious to click through many small cells in order to characterize a larger area of interest. Thus, in consultation with MARCO, The Team decided on an intermediate grid resolution (10 km by 10 km) that attempts to balance the need for sufficient samples within each cell with appropriate spatial precision for planning purposes. Different grid dimensions and resolutions (e.g., 5 km by 5 km, 10 km by 10 km) would have yielded somewhat different results, although the overall pattern would have remained similar. Once grid resolution was finalized, the Team aligned the HUDS grids with MDAT marine mammal products (also at 10 km by 10 km resolution) to allow for consistency with biological data from that project.

4.1.2 Temporal Coverage

Another important limitation to consider of the HUDS grids is that they are based on data that describe the contemporary and recent state of human use. As the patterns of use change, authorities in the region recognize the importance of updating existing data and developing mechanisms for regular data collection. Users should be aware of these changing patterns and strive to incorporate the latest information in planning decisions. For example, the OAP identifies ocean aquaculture as an Objective of the Sustainable Ocean Uses Goal, but there is no ocean aquaculture activity (and hence no data) yet in Mid-A waters.

4.1.3 Data Presence

The data presence metric indicates data availability for data within the region only. If data for a given layer occur outside the region, they are not accounted for.

Although the number of data layers present in a given cell is potentially related to human use intensity (i.e., the more data in an area, the more use), the user should interpret this metric with caution for several reasons. Each source dataset has an assigned “Completeness” score (see Section 2.2.2 and Appendix B), and presence for data with a score of “Incomplete,” “Partially complete,” or “Near Complete” may not reflect true use levels. In some cases, lack of information in a given location may indicate true absence, but in other cases it may only indicate missing data or a data gap. These “false absences” are more likely to occur with activity as opposed to infrastructure data. Again, users are encouraged to consult the dataset-specific factsheets (Appendix B) for information on collection methods, completeness (e.g., sampling effort and survey extent), timeliness, and other important details. Furthermore, for the Data Presence HUDS grids, uses were not assessed or weighted with respect to the impact they produce on the environment, nor were differing uses scaled to a common unit of magnitude. The maps are best thought of as static snapshots of data availability. However, the user can gain a qualitative sense of use from the data embedded within each grid cell on use type (e.g., attributes including descriptive information, data presence totals, and calculated statistics). Furthermore, in some cases these statistics directly indicate use amount. For example, raster-based vessel traffic and fishing data contain densities which clearly communicate a magnitude per unit area for high to low values across the dataset, and this range of magnitudes is captured in the percentile classifications.

4.1.3.1 Fishing

The VMS and CAS data share certain traits and caveats. The raw data for both come from NMFS and represent fishing activity that follows the Rule of Three. This rule, required for public display of these data, effectively masks out individually-identifiable fishing locations; densities are only provided where three or more raw data points occurred within a given location. Both products were reviewed and vetted by fishing stakeholders within their region (VMS in the Northeast and CAS in the Mid-Atlantic).

While the VMS and CAS data share or even duplicate certain aspects of one another, they also differ in important (and sometimes complementary) ways. The VMS data represent the density of records from 2011-2014 for five fishery products (herring, multispecies, monkfish, scallop, and surfclam/ocean quahog) for select federally-permitted commercial fishing vessels. In contrast, CAS data represent density of the number of fisher days from 2011-2013 based on Vessel Trip Report (VTR) data for federally-permitted commercial and party/charter fishing vessels and summarize data by gear type (dredge, gillnet, groundfish (vessels <65 ft), groundfish (vessels > 65 ft), lobster, longline, pots and traps, seine, and shrimp). This fishery (VMS) vs. gear type (CAS) discrepancy prevents direct comparisons of these datasets. Furthermore, CAS fisher days are calculated from the number of crew aboard and hours spent at a site to show the labor hours for a given trip, whereas VMS fishing activity, or effort, is simply based on the number of reported vessel positions. The positional accuracy of VMS is higher because vessel locations are transmitted by satellite signal, whereas CAS data are based on manually-entered locations by fishers. However, only a subset of fishing vessels are required to carry VMS, while all fishing vessels must fill out VTRs. In addition, the VMS resolution is finer than CAS due to a smaller grid size and smaller search radius for the density smoothing function. Thus, the VMS grids have higher spatial accuracy but lower completeness than the CAS grids.

Despite these differences, comparing certain VMS and CAS products highlights some striking similarities in spatial pattern, for example between scallop (VMS) and dredge (CAS), and between multispecies (VMS) and groundfish (CAS). Lastly, some uses and user groups are duplicated when combining both layers into the Fishing theme, however, this duplication emphasizes important areas captured by both datasets.

4.1.3.2 Vessel Traffic

Like the VMS and CAS datasets, the AIS datasets have a unique suite of caveats. AIS grids show the density of vessel tracklines from 2013 summarized by nine vessel type categories (cargo, tug-tow, tanker, passenger, pleasure, fishing, military, all others, and not available) based on codes within the raw AIS signals. For example, “tug-tow” includes five individual codes which are grouped together. The “all others” category includes AIS codes not included in other categories (i.e., pilot vessels, law enforcement), while "not available" includes vessels which do not have an interpretable code recorded in the raw data. The original codes are entered manually by vessel operators and may not reflect the most accurate vessel status or purpose.

The data were reviewed by shipping stakeholders at a number of port meetings in the northeast region hosted by Northeast Regional Ocean Council (NROC). Stakeholders reiterated that AIS is intended as a navigational aid for the benefit of mariners but is not required for all vessels, and that not everyone will outfit their ships with it, turn it on, maintain the equipment, change codes while in transit, or even enter the correct code to begin with. All of these factors could bias the data. However, stakeholders reviewed the various codes and generally agreed that aggregating them in the manner employed by NROC (and the Team) was appropriate.

Because the nine AIS layers account for a high proportion of all layers within the Maritime theme, they have a strong influence on patterns in this theme and highlight densely trafficked zones. Combining these nine layers into one cumulative layer would have mitigated this bias, but retaining the individual layers makes it possible to identify trends within vessel traffic patterns if desired. Furthermore, shipping is an important ocean use with many different stakeholders, and perhaps warrants a relatively strong signal in the Maritime theme product.

It is worth noting that one AIS layer is dedicated to fishing. The Team queried fishing records in the raw AIS trackline data and counted roughly 100 vessels engaged in fishing throughout and beyond the Mid-A region in 2013. It is not immediately evident how the fishing AIS data should be regarded in comparison to the VMS or CAS data. Conducting a thorough assessment of fishing vessels that report locations using AIS, VMS, or VTR is beyond the scope of the HUDS effort, however, it is important to bear in mind while viewing the HUDS products.

Finally, users should be aware that some AIS layers (specifically "pleasure" and "passenger") in the Maritime theme may represent recreational activity. However, analyzing these layers in tandem with the Recreation theme grid is challenging given the limited temporal and spatial coverage of the recreational surveys and the vastly different collection methods between the AIS and recreation data.

4.1.4 Use Intensity

The use intensity maps bear some special guidance. The limitations outlined for data presence apply here as well, along with some additions. These maps reflect use intensity in that the relative magnitude of the original data values is preserved, as opposed to these values being reduced to 1 (present) or 0 (absent). For example, within the tanker layer, a cell with high tanker shipping density received a higher scaled intensity value than a cell with lower tanker shipping density. Similarly, within the danger zones layer, a cell that was only 10% covered by a danger zone received a lower scaled intensity value than one that was 70% covered. In these examples, the assumption is that amount of vessel traffic and amount of area covered by danger zone are linearly related to use intensity. Furthermore, scaling data from 0 to 1 by dividing all grid cell values by the maximum cell value assumes that zero is the minimum value for each dataset. In other words, the divisor in the scaling calculation is the range of the data, and we have assumed that the lower end of the range is zero. Because much of the data gathered for this project is incomplete, the validity of this assumption is unknown in many cases. However, this assumption is conservative in that, if the true minimum value were greater than zero, the output of the scaling calculation would be (slightly) biased upward.

Definitions of high, medium, low, etc., are based on classifying the scaled values into percentile bins (specifically the 20^{th}, 40^{th}, 60^{th}, and 80^{th} percentiles). This allocates cells roughly equally across the five bins and assumes that, for example, data in the $80\text{-}100^{th}$ percentile range represents very high intensity. These generic categories were developed for consistent terminology across multiple datasets, but it is important to remember that they are relative within each individual layer (e.g., what value constitutes "high" for gillnet fishing is different from the value that constitutes "high" for tug-tow shipping). Furthermore, some datasets had duplications of the same value in multiple percentile bins due to a compressed data distribution. This is especially true for some large Navy Operational Areas where most grid cells had 100% coverage (100 sq. km.), therefore the scaled value of "1" was duplicated across multiple percentile ranges (e.g., for both the 60^{th} and 80^{th} percentile). Finally, while binning data in this fashion helps interpret broad trends in the data, it does mask subtle variations in the pattern since a scaled use intensity value at the lower and higher end of the percentile range are treated the same (i.e., the 61^{st} and 79^{th} percentile are both included in the $60\text{-}80^{th}$ range).

For cumulative use intensity, density-based activity data and infrastructure-based data with clear, compact "footprints" that implied relatively even, consistent use (e.g., maintained channels, anchorage grounds) were considered to provide appropriate results. It became more difficult to interpret meaningful distributions of use intensity for themes which contained large polygons of potentially uneven usage (e.g., security zones, recreational PGIS drawings). For example, the raster (i.e., density-based) data inherently contained intensity values (e.g., ship trackline density, fisher days) within the raster cells and had wide spatial coverage, whereas the Security theme was comprised of numerous large and overlapping jurisdictions that resulted in a large quantity of grid cells with "Very High" or "High" classifications that reflected regulatory decisions over use intensity.

Similarly, while the Recreation theme contained activity layers, the source data were obtained through different collection methods that did not reflect the same systematic, wide-ranging approach as the Maritime and Fishing data. Specifically, the PGIS data were collected to discern areal coverage and not intensity of use. While the Recreational Boater and Coastal Use surveys included count of user records for various activity types (e.g., diving, kayaking, swimming), they were geographically restricted to nearshore areas and did not report activity as robustly as, for example, AIS vessel traffic.

Therefore, only the Maritime and Fishing use intensity maps exhibited high interpretability and sufficient “added value” beyond their simpler data presence versions. In the Maritime use intensity grid, the shipping lanes and precautionary areas exhibit a stronger signal than in the data presence grid. This is due to both high density values within the nine AIS layers for those regions and Routing Measure areas that cover large portions of those same grid cells. There is a striking difference in offshore grid cells that contain submarine cables; these are subdued in the data presence map but very apparent in the Maritime use intensity map.

In the Fishing theme, high data presence is restricted to isolated grid cells throughout the region, whereas high use intensity spans a broad region within the New York/New Jersey Bight, off the coast of Long Island, and in some canyons. This is due to the overlap of CAS and VMS data and the high density values that occur at locations within these grid cells. The use intensity map also identifies cells near the mouth of the Chesapeake Bay as having relatively high use intensity compared to the data presence grid, in part due to scallop, multispecies, and monkfish VMS data. However, in the middle and upper reaches of the Chesapeake Bay, there is an obvious lack of data presence and use intensity since the fishing data included in this theme are primarily from commercial sources. This bias toward offshore, commercial datasets persists throughout most of the HUDS products.

4.2 Conclusions

The data presence maps paint a clear picture of data availability in the Mid-A and reveal data collection biases and gaps that are important to recognize for ocean planning. This project represents the first time such data have been synthesized in a comprehensive manner, and indicates much about what we do and do not know about ocean use. It is a step toward a quantitative, as opposed to anecdotal, understanding of human use in the Mid-A, but far from complete.

It is not surprising that high data presence occurs near coastal areas and decreases away from shore. Three areas of high use emerge consistently from the All Data Presence and most theme-based maps, namely shipping lanes, ports, and coastal areas. At a broad level, these patterns point toward recreational activity along the coast, vessel traffic within shipping lanes and near ports, and fishing activity within certain grounds on the continental shelf. At a finer level, however, it is possible to pick out a more nuanced view of data presence and human use intensity through these maps. For example, shipping occurs in almost every corner of the Mid-Atlantic, and different shipping industries exhibit different spatial patterns of use. Furthermore, while much of the fishing activity occurs out on the shelf, it is still important in coastal areas for coastal communities and ports that rely economically on fishing.

When all layers are combined together, some core areas with known human use activity are not represented fully, namely the Chesapeake Bay, Delaware Bay, and Long Island Sound. However, these regions are given their due in some theme grids, namely the Maritime and Infrastructure grids, which depict high levels of vessel traffic and medium to high presence of features such as aids to navigation and regulatory areas. These theme-level patterns are not strong enough to appear in the All Data Presence map, however.

Datasets analyzed for the HUDS project were as current as possible, including some recently-released datasets such as the VMS, CAS, AIS data which shed new light on human uses in the Mid-A. Nonetheless, there is some key, missing information that could improve this analysis, including:

- Fishing data in coastal waters, e.g., Chesapeake Bay
- More comprehensive data on recreational uses, including similar PGIS workshops for fishing locations in state waters for Maryland, Delaware, and Virginia
- Data on sand/gravel borrow areas within state waters
- More accurate data on the locations of unexploded ordinance
- Data on cultural and tribal uses
- Spatially-explicit data which reflect the market value of ocean uses

Some of these datasets (e.g., tribal uses) are in development, and others are not (e.g., unexploded ordinances). As more datasets become available, MARCO will be able to update the HUDS grids with basic information on data presence/absence, in consultation with The Team.

By design, the HUDS grids share the same resolution, alignment, and extent as many of the MDAT biological products, allowing for side-by-side interpretation of these two efforts. With additional funding a beneficial next step for development of the HUDS products includes mapping out areas of known data gaps (data layer by data layer). These areas could be accounted for, or represented in the cumulative synthesis products. Therefore, areas that may be currently misrepresented as having “no activity”, which are more likely to be data gaps (e.g., the survey just didn’t cover that area), would be depicted. Finally, depending on availability of funding, future improvements to the portal-based HUDS interface include a customized, wide-form attribute table suitable for printing and PDF export, and the ability to concurrently view attribute data from multiple cells at once.

5 References

Ban, N. and J. Alder. 2008. How wild is the ocean? Assessing the intensity of anthropogenic marine activities in British Columbia, Canada. Aquatic Conserv: Mar. Freshw. Ecosyst. 18: 55–85 (2008). DOI: 10.1002/aqc.816. Report: http://onlinelibrary.wiley.com/doi/10.1002/aqc.816/epdf.

Bureau of Ocean Energy Management (BOEM). 2015. "BOEM advances Atlantic coastal preparedness and resilience with identification of new offshore sand resources." 2p. Available http://www.boem.gov/Marine-Minerals-Program-offshore-sand-resources/. Accessed 30 November 2015.

Bureau of Ocean Energy Management (BOEM). 2015a. "2017-2022 Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program." 299p. Available http://www.boem.gov/2017-2022-DPP/. Accessed 30 November 2015.

Bureau of Ocean Energy Management (BOEM). 2015b. "Marine Minerals Program." 2p. Available http://www.boem.gov/MMP-General-Fact-Sheet/. Accessed 8 January 2016.

Bureau of Ocean Energy Management (BOEM). 2014. "Atlantic OCS Proposed Geological and Geophysical Activities. Mid-Atlantic and South Atlantic Planning Areas. Final Programmatic Environmental Impact Statement. Volume I." BOEM 2014-001. 788 p.

Bureau of Ocean Energy Management (BOEM). n.d. "State Activities." Available http://www.boem.gov/Renewable-Energy-State-Activities/. Accessed 23 November 2015.

Bureau of Ocean Energy Management (BOEM). n.d.(a) "New Jersey Activities." Available http://www.boem.gov/New-Jersey/. Accessed 27 November 2015.

Dahl R, Ehler C, and Douvere F. 2009. Marine spatial planning, a step-by-step approach toward ecosystem-based management. Paris, France: UNESCO. IOC Manual and Guides No 53, ICAM Dossier No 6.

Eastern Research Group (ERG), 2010. "A Review and Summary of Human Use Mapping in the Marine and Coastal Zone." Conducted for NOAA Coastal Services Center, Charleston, SC. 46 pp.

Environmental Law Institute (ELI). 2015. "U.S. Army Corps of Engineers Regulation of Offshore Aquaculture." 34p. Available http://eli-ocean.org/wp-content/blogs.dir/3/files/U.S.-Army-Corps-Regulation-of-Offshore-Aquaculture.pdf. Accessed 30 November 2015.

ESS Group, Inc. "NROC White Paper: Overview of the Energy Sector in the Northeastern United States." 2013. 18p. Available http://neoceanplanning.org/wp-content/uploads/2013/12/Energy-White-Paper1.pdf. Accessed 30 November 2015.

Federal Energy Regulatory Commission (FERC). 2014. "Environmental Assessment for the Cove Point Liquefaction Project." 242p. Available http://www.ferc.gov/industries/gas/enviro/eis/2014/05-15-14-ea/ea.pdf. Accessed 30 November 2015.

Federal Register. 2011. "Permits for Structures or Work in or Affecting Navigable Waters of the United States." 33 CFR 322. Available https://www.gpo.gov/fdsys/pkg/CFR-2011-title33-vol3/pdf/CFR-2011-title33-vol3-part322.pdf.

Field, P. and K. Longley-Wood. 2015. "Northeast Regional Ocean Planning White Paper Update: Overview of the Maritime Commerce Sector in the Northeastern United States." 15 p.

Halpern, B. S., Kappel, C. V., Selkoe, K. A., Micheli, F., Ebert, C. M., Kontgis, C., Crain, C. M., Martone, R. G., Shearer, C. and Teck, S. J. (2009), Mapping cumulative human impacts to California Current marine ecosystems. Conservation Letters, 2: 138–148. doi: 10.1111/j.1755-263X.2009.00058.x. data: https://www.nceas.ucsb.edu/globalmarine/ca_current_data.

Halpern, B. S., S. Walbridge, K.A. Selkoe, C.V. Kappel, F. Micheli, C. D'Agrosa, J.F. Bruno, K. S. Casey, C. Ebert, H. E. Fox, R. Fujita, D. Heinemann, H. Lenihan, E. M. P. Madin, M. T. Perry, E. R. Selig, M. Spalding, R. Steneck, and R. Watson. A Global Map of Human Impact on Marine Ecosystems. Science 15 February 2008: 319 (5865), 948-952. [DOI:10.1126/science.1149345]. data: https://www.nceas.ucsb.edu/globalmarine2008/impacts.

International Maritime Organization (IMO). 2015. "AIS transponders." Available http://www.imo.org/en/OurWork/Safety/Navigation/Pages/AIS.aspx. Accessed 30 November 2015.

Kappel, Halpern, and Napoli. (2012, January). Mapping Cumulative Impacts of Human Activities on Marine Ecosystems (03.NCEAS.12). Boston: SeaPlan. Report: http://www.seaplan.org/wp-content/uploads/mapping_cumulative_indicators-nceas-12.pdf.

Kite-Powell, H. 2013. "NROC White Paper: Overview of the Maritime Commerce Sector in the Northeastern United States." 15 p.

Kittinger et al. 2014. A practical approach for putting people in ecosystem-based ocean planning. Frontiers in Ecology and Environment. 12(8):448-456

Koehn et al. 2013. Progress and promise in spatial human dimensions research for ecosystem-based ocean planning. Marine Planning. 42:31-38.

Link, J.S., R. Griffiss, R., and S. Busch (Editors). 2015. "NOAA Fisheries Climate Science Strategy." Dept. of Commerce, NOAA Technical Memorandum NMFS-F/SPO-155. 70p.

Marine Cadastre. 2015. MarineCadastre.gov. National Oceanic and Atmospheric Administration Office for Coastal Management and Bureau of Ocean Energy Management. http://marinecadastre.gov/. Accessed 21 December 2015)

Mid-Atlantic Regional Council on the Ocean (MARCO). 2014. "Summary of MARCO Submarine Cable Industry Sector-Specific Meeting." 5 p.

Mid-Atlantic Regional Council on the Ocean (MARCO). 2014a. "Summary of MARCO Tug and Barge Sector-Specific Meeting." 5 p.

Mid-Atlantic Regional Planning Body (Mid-A RPB). 2015. "A Brief Overview of the Mid-Atlantic Ocean: Characteristics, Trends, and Challenges." 35 p. Available http://www.boem.gov/Mid-Atlantic-ROA-summary-white-paper/. Accessed 23 November 2015.

Mid-Atlantic Regional Planning Body (Mid-A RPB). 2015a. "Mid-Atlantic Regional Planning Body – Roster of Members and Alternates." 4p. Available http://www.boem.gov/Mid-Atlantic-RPB-Roster/. Accessed 8 January 2016.

Mid-Atlantic Regional Planning Body (Mid-A RPB). 2014. "Mid-Atlantic Regional Ocean Planning Framework." 9p. Available http://www.boem.gov/Mid-Atlantic-Regional-Ocean-Planning-Framework/. Accessed 30 November 2015.

National Ocean Economics Program (NOEP). 2014. "State of the U.S. Ocean and Coastal Economies." 84 p. Available http://www.oceaneconomics.org/download/. Accessed 23 November 2015.

National Oceanic and Atmospheric Administration (NOAA). "Overfished Stocks (37) – as of December 31, 2014." Available http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/archive/2014/fourth/mapoverfishedstockscy_q4_2014.pdf. Accessed 23 November 2015.

National Oceanic and Atmospheric Administration. 2010. The California Ocean Uses Atlas Project. National Marine Protected Areas Center, Office of Ocean and Coastal Resource Management. Available at http://marineprotectedareas.noaa.gov/pdf/helpful-resources/factsheet_atlasmar10.pdf. Accessed 4 December 2015. Data: http://marineprotectedareas.noaa.gov/dataanalysis/atlas_ca/.

National Oceanic and Atmospheric Administration Greater Atlantic Regional Fisheries Office (NOAA GARFO). n.d. "Atlantic Herring." Available http://www.greateratlantic.fisheries.noaa.gov/sustainable/species/atlherring/. Accessed 30 November 2015.

National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA NMFS). 2008. Economic Analysis for the Final Environmental Impact Statement of the North Atlantic Right Whale Ship Strike Reduction Strategy. Prepared by Nathan Associates, Inc., Arlington, VA. 179 pp.

National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA NMFS). n.d. "Annual Commercial Landing Statistics." Available http://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index. Accessed 7 January 2016.

National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA NMFS). n.d. (a). Vessel Reporting. Available http://www.greateratlantic.fisheries.noaa.gov/aps/evtr/ Accessed 30 November 2015.

National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA NMFS). n.d. (b). Vessel Monitoring System Program. Available http://www.nmfs.noaa.gov/ole/about/our_programs/vessel_monitoring.htm Accessed 30 November 2015.

Nye, J.A., J.S. Link, J.A. Hare and W.J. Overholtz. 2009. Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf. Mar Ecol Prog Ser 393:111-129

Shumchenia, E. and Taylor, P. MARCO Regional Ocean Assessment (ROA). http://roa.midatlanticocean.org/.

Surfrider Foundation, Point 97, The Nature Conservancy, and Monmouth University's Urban Coast Institute. 2014. "U.S. Mid Atlantic Coastal and Ocean Recreation Study." 91p Available http://surfridercdn.surfrider.org/images/uploads/publications/MidAtlanticCoastalandOceanRecreationStudyReport.pdf. Accessed 12 December 2015

St. Martin, K. and M. Hall-Arber. 2008. The missing layer: Geo-technologies, communities, and implications for marine spatial planning, Marine Policy, Volume 32, Issue 5, September 2008, Pages 779-786, ISSN 0308-597X, http://dx.doi.org/10.1016/j.marpol.2008.03.015.

Turner, L. and Miner, M. 2015. "Marine Minerals Geospatial and Information System (MMPGIS) Project." Available http://gulfofmexicoalliance.org/documents/fed-working-group/presentations/mmpgis_projectupdate_goma.pdf. Accessed 30 November 2015.

United States Coast Guard (USCG). 2014. Automatic Identification System Overview. Available http://www.navcen.uscg.gov/?pageName=AISmain. Accessed 30 November 2015.

United States Department of the Navy (USDON). 2013. “Atlantic Fleet Training and Testing Final Environmental Impact Statement / Overseas Environmental Impact Statement. Volume 1.” 590p.

Appendix A: Human Use Spatial Data Inventory

This appendix contains the list of human use GIS data layers included in the HUDS grids. The individual root GIS data layers are available on the data portal under each of the themes. Table 7 lists the layer's name which includes the dataset collection that the layer is a part of, the theme that layer was categorized into, the data type (infrastructure verses activity), and the descriptive information and statistics calculated that was included in the attribute tables of the theme HUDS grids (maritime, fishing, energy, recreation, and security).

Table 7. Listing of all 64 data layers included in the HUDS grids. The theme and data character that each layer was categorized into is indicated. The descriptive information that was pulled for each data layer is summarized as well as the statistics calculated. Dataset acronyms: Communities at Sea (CAS), Vessel Monitoring System (VMS), Automated Identification System (AIS), and Participatory GIS (PGIS).

Layer Name	Theme	Data Character	Descriptive Information	Statistics
Artificial Reefs	Fishing	Infrastructure - Physical	Name of artificial reef	Area
CAS - Dredge	Fishing	Activity	Percentile range for density of fisher days	Area
CAS - Groundfish 65+	Fishing	Activity	Percentile range for density of fisher days (days fished from VTR data)	Area
CAS - Groundfish 65-	Fishing	Activity	Percentile range for density of fisher days	Area
CAS - Gillnet	Fishing	Activity	Percentile range for density of fisher days	Area
CAS - Lobster	Fishing	Activity	Percentile range for density of fisher days	Area
CAS - Longline	Fishing	Activity	Percentile range for density of fisher days	Area
CAS - PotsTraps	Fishing	Activity	Percentile range for density of fisher days	Area

Layer Name	Theme	Data Character	Descriptive Information	Statistics
CAS - Seine	Fishing	Activity	Percentile range for density of fisher days	Area
CAS - Shrimp	Fishing	Activity	Percentile range for density of fisher days	Area
VMS - Multispecies 2011-2014	Fishing	Activity	Percentile range for density of VMS records	Area
VMS - Monkfish 2011-2014	Fishing	Activity	Percentile range for density of VMS records	Area
VMS - Herring 2011-2014	Fishing	Activity	Percentile range for density of VMS records	Area
VMS - Scallop 2011-2014	Fishing	Activity	Percentile range for density of VMS records	Area
VMS - Surfclam / Ocean Quahog 2012-2014	Fishing	Activity	Percentile range for density of VMS records	Area
AIS Data 2013 - Tug-Tow	Maritime	Activity	Percentile range of trackline density	Area
AIS Data 2013 - Tanker	Maritime	Activity	Percentile range of trackline density	Area
AIS Data 2013 - Cargo	Maritime	Activity	Percentile range of trackline density	Area
AIS Data 2013 - Passenger	Maritime	Activity	Percentile range of trackline density	Area
AIS Data 2013 -All others	Maritime	Activity	Percentile range of trackline density	Area
AIS Data 2013 -Not available	Maritime	Activity	Percentile range of trackline density	Area
AIS Data 2013 - Fishing	Maritime	Activity	Percentile range of trackline density	Area
AIS Data 2013 - Military	Maritime	Activity	Percentile range of	Area

Layer Name	Theme	Data Character	Descriptive Information	Statistics
			trackline density	
AIS Data 2013 - Pleasure	Maritime	Activity	Percentile range of trackline density	Area
Port Facilities (Points)	Maritime	Infrastructure - Physical	Commodity code and description	Count of features
Routing Measures	Maritime	Infrastructure - Regulatory	Classification of area	Area
Anchorage Grounds	Maritime	Infrastructure - Regulatory	Name of location	Area
Maintained Channels	Maritime	Infrastructure - Physical	Minimum depth range of channel	Area
Ocean Disposal Sites	Maritime	Infrastructure - Physical	Name of disposal site	Area
Offshore Discharge Locations	Maritime	Infrastructure - Physical	Discharge flow rate range	Count of features
Aids to Navigation	Maritime	Infrastructure - Physical	n/a	Count of features
North Atlantic Right Whale Seasonal Management Areas	Maritime	Infrastructure - Regulatory	Restricted area type	Area
Pilot Boarding Areas	Maritime	Infrastructure - Regulatory	Name of pilot boarding area	Area
Federal OCS Sand and Gravel Borrow (Lease Areas)	Maritime	Infrastructure - Regulatory	Project identification and fiscal year	Area
Shipwreck and Obstructions Locations	Maritime	Infrastructure - Physical	n/a	Count of features
Submarine Cables	Maritime	Infrastructure - Physical	Description of cable type	Length
Coastal Recreation Survey - Shore-based Activities	Recreation	Activity	Recreational activity types	Count of activities

Layer Name	Theme	Data Character	Descriptive Information	Statistics
Coastal Recreation Survey - Surface Water Activities	Recreation	Activity	Recreational activity types	Count of activities
Coastal Recreation Survey - Underwater Activities	Recreation	Activity	Recreational activity types	Count of activities
Coastal Recreation Survey - Wildlife and Sightseeing Activities	Recreation	Activity	Recreational activity types	Count of activities
Recreational Boating Survey - Boater Activities	Recreation	Activity	Recreational activity types	Count of activities
Recreational Boating Survey - Boater Routes	Recreation	Activity	n/a	Length
PGIS Regional (VA-NJ) - All activity	Recreation	Activity	Number of dominant surveyed uses	Count of total surveyed uses
PGIS NY	Recreation	Activity	General use description	Area
PGIS NJ - Sportfishing	Recreation	Activity	Target fishing species	Area
BOEM Active Renewable Energy Lease Areas	Energy	Infrastructure - Regulatory	Name of area and protraction number	Area
BOEM Wind Planning Areas	Energy	Infrastructure - Regulatory	Name of area and protraction number	Area
Virginia Research Lease Areas	Energy	Infrastructure - Regulatory	Name of area and protraction number	Area
Coastal Energy Facilities	Energy	Infrastructure - Physical	Type of energy facility and power capacity	Count of features
Danger Zones & Restricted Areas	Security	Infrastructure - Regulatory	Boundary Type and Agency of Use	Area
Unexploded Ordnances	Security	Infrastructure - Physical	Description of UXO type and Source Date	Area
Atlantic City Airspace Corridor	Security	Infrastructure - Regulatory	n/a	Area

Layer Name	Theme	Data Character	Descriptive Information	Statistics
Military Installation Location	Security	Infrastructure - Physical	Name of facility	Count of locations
Military Range Complex	Security	Infrastructure - Regulatory	Name of military range complex	Area
Mine Warfare Area	Security	Infrastructure - Regulatory	n/a	Area
Naval Undersea Warfare Center	Security	Infrastructure - Regulatory	n/a	Area
OPAREA Boundary	Security	Infrastructure - Regulatory	Name of OPAREA	Area
Ship Shock Trial Area	Security	Infrastructure - Regulatory	n/a	Area
Sink Exercise	Security	Infrastructure - Regulatory	n/a	Area
Submarine Transit Lanes	Security	Infrastructure - Regulatory	n/a	Area
VACAPES Airspace Corridors	Security	Infrastructure - Regulatory	n/a	Area
VACAPES Restricted Areas	Security	Infrastructure - Regulatory	n/a	Area
Wallops Test Track	Security	Infrastructure - Regulatory	n/a	Area
Warning Areas	Security	Infrastructure - Regulatory	Name of warning area	Area

Appendix B: Human Use Dataset Fact Sheets

The following appendix consists of fact sheets that contain information common across the geographic extent of each human use dataset. This table is intended to complement the "Identify" tool and pop-up summary when using the HUDS grids on the data portal. Short descriptions of each attribute listed in each fact sheet are provided below.

Definitions and Fact Sheet Template

Dataset Attributes – Title of Dataset

Theme – This is simply a designation of the theme of the dataset: Fishing, Recreation, Energy, or Maritime

Description – A brief description of each dataset is given here for reference.

Character – The data generally fall into two categories: infrastructure and activity. Infrastructure datasets are those that either represent physical stuff in the water (e.g., submarine cables) or regulatory boundaries, which affect the way people use that ocean space. Activity datasets actually show or measure use of ocean space (e.g., AIS based shipping density).

Source of Data – The agency, organization, or people who supplied the data or from whom the data were collected.

Lead Agency – The primary agency responsible for managing or undertaking either the activity or infrastructure represented by the data.

Data Point of Contact – The person (and contact information) identified as the primary point of contact in the metadata.

Spatial Data Type – An indication of the geographic form of the data, which may include point, line, polygon, or raster grid.

Stakeholder Involvement – A description of how stakeholders were involved in the creation of the dataset. The values and a short description of each is below:

- Direct generation – Stakeholders with authority in their group created the data and have provided it (e.g., NASCA Submarine Cables)
- Facilitated generation – Stakeholders contributed their knowledge through a participatory process to build the dataset (e.g., PGIS recreation data)
- Reviewed – Data were independently generated; however review was completed by stakeholders to inform the independent source on the reliability of the data (e.g., Communities at Sea)
- Defined by Authority – Typically regulatory infrastructure data, data here represent information defined and provided by regulatory authorities (e.g., BOEM Wind Planning Areas).

- Compiled from Agency Sources – These are datasets most commonly created by agencies drawing from multiple, possibly disparate, sources of information. Often, the sources of the data are internal to the agency or from other government entities (e.g., shipwreck locations, offshore discharge flow data, coastal energy facilities).

Spatial Extent – A description of the area the data cover.

Time Range / Currency – A description of the time period the data cover and how recent they are.

Vertical Impact – For activity datasets: a description of where the activity occurs in the water column. For infrastructure datasets this describes where in the water column: the infrastructure is located, the construction of the infrastructure affected, and / or use invited by the infrastructure occurs.

Completeness – A qualitative evaluation of how complete a dataset is. This evaluation considers how the data were collected and the inherent limitations of the data. The values this attribute takes on are described below:

- Complete – The data represent a complete census, no omissions have been made. The source data are authoritative and exact, at least at the scale of the grid cells.
- Near Complete – Only a handful of omissions or questionable records exist, which do not affect the representativeness and utility of the overall pattern.
- Partially Complete – Gaps and/or uncertainties exist which may affect the representativeness and/or utility of these data.
- Incomplete – Substantial gaps and/or uncertainties exist and the data should be used with considerable caution for planning purposes.

Completeness Comments and Caveats – The justification for assigning the completeness value given to the dataset.

Metadata Link – Follow this link to find the associated metadata for the data.

Dataset Attributes – Artificial Reefs

Theme – Fishing

Description – These data represent the locations of artificial reefs in the Mid-Atlantic.

Character – Physical Infrastructure

Source of Data – Mid-Atlantic States

Lead Agency – NOAA - National Marine Fisheries Service

Agency Point of Contact – None provided

Data Point of Contact – Chris Bruce [TNC] - cbruce@tnc.org

Spatial Data Type – Polygons

Stakeholder Involvement – Compiled from Agency Sources

Spatial Extent – Entire Mid-Atlantic planning area

Time Range / Currency – Snapshot as of July 2010

Vertical Impact – Bottom extending into the water column

Completeness – Near Complete

Completeness Comments and Caveats – Derived from various, authoritative state sources. However, the metadata states that "no representation is made as to the currency, accuracy or completeness of the data set or of the data sources on which it is based."

Metadata Link

Dataset Attributes – Communities at Sea (CAS)

Theme – Fishing

Description – These data represent fishing activity and were derived from federal Vessel Trip Reports (VTRs) and vetted with fishermen throughout the Mid-Atlantic. The data measure effort using 'fisherman days,' which is calculated using trip length and number of crew. Data are broken down into groups by gear type.

Character – Activity

Source of Data – NOAA - National Marine Fisheries Service

Lead Agency – NOAA - National Marine Fisheries Service

Agency Point of Contact – None provided

Data Point of Contact – Metadata in development

Spatial Data Type – Raster grid

Stakeholder Involvement – Reviewed

Spatial Extent – Mid-Atlantic and Northeastern waters

Time Range / Currency – 2011-2014

Vertical Impact – Depending on gear type, impacts the surface, water column, and/or seafloor

Completeness – Partially Complete

Completeness Comments and Caveats – Based on VTR and permit data. Most federally permitted vessels are required to complete a VTR. Quality of data depends on accuracy of the report, filled out by the operator. Logistics of reporting and hardcopy submission process may introduce errors. A VTR for a given trip may be missing, requiring estimates instead. Does not capture fishing in state waters under state permits. CAS data was validated and, where necessary, corrected in partnership with local commercial fishers. Some low-data areas excluded to protect confidentiality.

Metadata Link – Under development

Dataset Attributes – VMS Fishing

Theme – Fishing

Description – These data represent fishing vessel activity and were derived from Vessel Monitoring System data from 2011-2014. Data are broken down by target species or species group based on Northeast Fisheries Management Plans for herring, multispecies, monkfish, scallop, and surfclam/ocean quahog. Data were vetted with fishermen in the Northeast to confirm their accuracy.

Character – Activity

Source of Data – NOAA - National Marine Fisheries Service; Northeast Regional Ocean Council

Lead Agency – NOAA - National Marine Fisheries Service

Agency Point of Contact – None provided

Data Point of Contact – Rachel Shmookler [RPS ASA] - Rachel.Shmookler@rpsgroup.com

Spatial Data Type – Raster grid

Stakeholder Involvement – Reviewed

Spatial Extent – Mid-Atlantic and Northeastern waters

Time Range / Currency – 2011-2014

Vertical Impact – Impacts the surface, water column, and seafloor

Completeness – Partially Complete

Completeness Comments and Caveats –
Automatic system with good positional accuracy. Required for a subset of commercial fishing vessels. On occasion, equipment may malfunction. Some low-data areas excluded to protect confidentiality. Surfclam\Ocean quahog time span is from 2012-2014.

Metadata Link

Dataset Attributes – Maritime Shipping and Commerce (AIS 2013)

Theme – Maritime

Description – From the metadata: "This dataset represents the density of vessel traffic in 2013 for the contiguous United States offshore waters from vessels with AIS transponders in 100 meter grid cells. The dataset is best interpreted using a high to low density scale and does not represent actual vessel counts." There are nine raster grids based on AIS code groupings for cargo, tug and tow, tanker, pleasure, passenger, military, fishing, all others, and not available. The all others category contains vessels not included in the prior groupings (e.g., pilot vessels, law enforcement), the not available category includes vessels which did not report an informative code.

Character – Activity

Source of Data – United States Coast Guard, NOAA Office for Coastal Management

Lead Agency – United States Coast Guard

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov; Doug Simpson, USCG, cgd5waterways@uscg.mil

Data Point of Contact – MarineCadastre.gov Data Steward, NOAA Office of Coastal Management, coastal.info@noaa.gov TBD

Spatial Data Type – Raster grid

Stakeholder Involvement – Reviewed

Spatial Extent – Mid-Atlantic and Northeastern waters

Time Range / Currency – 2013

Vertical Impact – Primarily on the surface and shallow water column, if vessels are conducting specialized marine operations, their impact may extend further into the water column and potentially to the bottom. Anchored vessels impact the seafloor and to a minor extent through the water column.

Completeness – Near Complete

Completeness Comments and Caveats – Automatic system with good positional accuracy. Requirements for carriage vary with vessel tonnage, length, and destination. On occasion, equipment may malfunction or be affected by weather, time of day, atmosphere, which reduces reception range. Some blind spots exist. Vessel operator enters in codes for vessel type/status and is prone to user error or may not be updated if conditions change.
Metadata Link

Dataset Attributes – Port Facilities (Points)

Theme – Maritime

Description – Port facility locations in the Mid-Atlantic in the vicinity of four major ports.

Character – Physical Infrastructure

Source of Data – United States Army Corps of Engineers

Lead Agency – United States Coast Guard

Agency Point of Contact – None provided

Data Point of Contact – Chris Bruce [TNC] - cbruce@tnc.org

Spatial Data Type – Points

Stakeholder Involvement – Compiled from Agency Sources

Spatial Extent – The vicinity of four primary ports in the Mid-Atlantic: NY/NJ, Philadelphia, Baltimore, and Virginia

Time Range / Currency – Dataset created in August 2013. Currency of data it was derived from (USACE) is unknown

Vertical Impact – Port facilities have impacts throughout the water column and on the seabed

Completeness – Partially Complete

Completeness Comments and Caveats – Based on US Army Corps of Engineers data. Only facilities relevant to four major Mid-Atlantic ports (Virginia, Baltimore, Philadelphia, and New York/New Jersey) were included. Facilities serving primarily fishing or recreational craft are excluded. Dataset uses point representations, whereas in reality facilities are polygons.

Metadata Link

Dataset Attributes – Routing Measures

Theme – Maritime

Description – Boundaries of regulated areas that control shipping traffic including Shipping Safety Fairways, Traffic Separation Zones, Traffic Lanes, Precautionary Areas, and Mandatory Ship Reporting Zones for the Protection of Right Whales.

Character – Regulatory Infrastructure

Source of Data – United States Coast Guard

Lead Agency – United States Coast Guard

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov; Doug Simpson, USCG, cgd5waterways@uscg.mil

Data Point of Contact – MarineCadastre.gov Data Steward [NOAA OCM] - coastal.info@noaa.gov

Spatial Data Type – Polygons

Stakeholder Involvement – Defined by Authority

Spatial Extent – All US waters

Time Range / Currency – Snapshot as of August 2010

Vertical Impact – Invites shipping and maritime transit that impacts the surface and upper water column

Completeness – Complete

Completeness Comments and Caveats – Based on NOAA Office of the Coast survey, which is the authoritative source

Metadata Link

Dataset Attributes – Anchorage Grounds

Theme – Maritime

Description – From the metadata, "An anchorage area is a place where boats and ships can safely drop anchor. These areas are created in navigable waterways when ships and vessels require them for safe and responsible navigation. A variety of designations refer to types of anchorage areas or restrictions, or even to alerts of potential dangers within an anchorage area."

Character – Regulatory Infrastructure

Source of Data – National Oceanic and Atmospheric Administration

Lead Agency – United States Coast Guard

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov; Doug Simpson, USCG, cgd5waterways@uscg.mil

Data Point of Contact – MarineCadastre.gov Data Steward [NOAA OCM] - coastal.info@noaa.gov

Spatial Data Type – Polygons

Stakeholder Involvement – Defined by Authority

Spatial Extent – All US waters

Time Range / Currency – Snapshot as of May 2015

Vertical Impact – Primarily on the surface and shallow water column, while vessels are anchored impacts will be on the seafloor and to a minor extent through the water column

Completeness – Complete

Completeness Comments and Caveats – Based on NOAA Nautical Charts, which are updated regularly and the definitive data source for navigation

Metadata Link

Dataset Attributes – Maintained Channels

Theme – Maritime

Description – Data represent channels that are maintained to a depth necessary to allow specific types of ship traffic.

Character – Physical Infrastructure

Source of Data – National Oceanic and Atmospheric Administration

Lead Agency – United States Army Corps of Engineers

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov

Data Point of Contact – MarineCadastre.gov Data Steward [NOAA OCM] - coastal.info@noaa.gov

Spatial Data Type – Polygons

Stakeholder Involvement – Defined by Authority

Spatial Extent – Mid-Atlantic and Northeastern waters

Time Range / Currency – Reported data are current through 2012. USACE survey dates vary from 1949 to 2012

Vertical Impact – Digging and maintaining channels has direct impacts are to the seafloor and through the water column and on the surface. The presence of the channels invites maritime traffic in those areas

Completeness – Complete

Completeness Comments and Caveats – Based on NOAA Nautical Charts, which are updated regularly and the definitive data source for navigation

Metadata Link

Dataset Attributes – Ocean Disposal Sites

Theme – Maritime

Description – From the metadata, "In 1972, Congress enacted the Marine Protection, Research, and Sanctuaries Act (MPRSA, also known as the Ocean Dumping Act) to prohibit the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment. Virtually all material ocean dumped today is dredged material (sediments) removed from the bottom of waterbodies in order to maintain navigation channels and berthing areas. Other materials that are currently ocean disposed include fish wastes, human remains, and vessels. Ocean dumping cannot occur unless a permit is issued under the MPRSA. In the case of dredged material, the decision to issue a permit is made by the U.S. Army Corps of Engineers, using EPA's environmental criteria and subject to EPA's concurrence. For all other materials, EPA is the permitting agency. EPA is also responsible for designating recommended ocean dumping sites for all types of materials."

Character – Regulatory Infrastructure

Source of Data – United States Department of Defense

Lead Agency – United States Army Corps of Engineers

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov

Data Point of Contact – MarineCadastre.gov Data Steward [NOAA OCM] - coastal.info@noaa.gov

Spatial Data Type – Polygons

Stakeholder Involvement – Defined by Authority

Spatial Extent – All US waters

Time Range / Currency – Current as of February 2015

Vertical Impact – Impacts vary by waste type - dredged sediments will ultimately settle on the bottom but will impact the water column and may be carried into adjacent areas. Other disposal activities may also impact adjacent areas and may impact the seafloor as well. During dumping activities surface waters are impacted by vessel traffic.

Completeness – Complete

Completeness Comments and Caveats – Designated areas have a legal basis. Dataset source is authoritative and assumed to be free of errors.

Metadata Link

Dataset Attributes – Offshore Discharge Locations

Theme – Maritime

Description – From the metadata, "This GIS shapefile represents offshore discharge flow point locations which were extracted from state and federal sources. Each point is attributed with data source information and discharge flow values in MGD (million gallons per day), which were obtained from Environmental Protection Agency (EPA) web resources, and are dated 1995-2010. Please note some point locations did not have available flow data at the time of data compilation for this shapefile."

Character – Physical Infrastructure

Source of Data – Environmental Protection Agency

Lead Agency – Environmental Protection Agency

Agency Point of Contact – None provided

Data Point of Contact – Don Evans [EPA] - don@epamail.epa.gov

Spatial Data Type – Points

Stakeholder Involvement – Compiled from Agency Sources

Spatial Extent – Mid-Atlantic

Time Range / Currency – Data cover 1995-2010

Vertical Impact – Depending on currents and the qualities of the outflow, impacts range from the surface to seafloor.

Completeness – Partially Complete

Completeness Comments and Caveats – Geographic extent limited to NY, NJ, DE, MD, VA. Some sites did not have flow data available at time of compilation. The data will change based on further knowledge of the activities at each site. Flow data obtained from Environmental Protection Agency (EPA) web resources, and are dated 1995-2010. Only offshore locations are included; inland source facilities were excluded.

Metadata Link

Dataset Attributes – Aids to Navigation

Theme – Maritime

Description – From the metadata, "Structures intended to assist a navigator to determine position or safe course, or to warn of dangers or obstructions to navigation. This dataset includes lights, signals, buoys, day beacons, and other aids to navigation."

Character – Physical Infrastructure

Source of Data – United States Coast Guard

Lead Agency – United States Coast Guard

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov; Doug Simpson, USCG, cgd5waterways@uscg.mil

Data Point of Contact – MarineCadastre.gov Data Steward, NOAA Office of Coastal Management, coastal.info@noaa.gov

Spatial Data Type – Point

Stakeholder Involvement – Defined by Authority

Spatial Extent – All US waters.

Time Range / Currency – Snapshot as of April 17, 2015.

Vertical Impact – On the surface with attachment to the bottom that is either dynamic (e.g., chain) or fixed.

Completeness – Complete

Completeness Comments and Caveats – Based on information from the US Coast Guard, which is assumed to be complete and authoritative.

Metadata Link

Dataset Attributes – North Atlantic Right Whale Seasonal Management Areas

Theme – Maritime

Description – From the metadata, "These data represent Seasonal Mangagement Area locations where regulations implement speed restrictions in shipping areas at certain times of the year along the coast of the U.S. Atlantic seaboard. The purpose of the regulations is to reduce the likelihood of deaths and serious injuries to endangered North Atlantic right whales that result from collisions with ships as designated by 73 FR 60173, October 10, 2008, Rules and Regulations."

Character – Regulatory Infrastructure

Source of Data – NOAA: National Marine Fisheries Service

Lead Agency – NOAA: National Marine Fisheries Service

Agency Point of Contact – None provided

Data Point of Contact – GIS Coordinator [NOAA NMFS] - nmfs.ser.gis.coordinator@noaa.gov

Spatial Data Type – Polygons

Stakeholder Involvement – Defined by Authority

Spatial Extent – Mid-Atlantic and Northeastern waters

Time Range / Currency – Established in December 2008, the sunset clause on regulated areas was removed in 2013

Vertical Impact – Primarily on the surface, requiring vessels equal to or greater than 65ft in length to maintain speeds 10kts or less.

Completeness – Complete

Completeness Comments and Caveats – Designated areas have a legal basis. Areas are near-perfectly captured by the polygons, with only minor variations in shoreline location affecting their position.

Metadata Link

Dataset Attributes – Pilot Boarding Areas

Theme – Maritime

Description – From the metadata, "Pilot boarding areas are locations at sea where pilots familiar with local waters board incoming vessels to navigate their passage to a destination port. Pilotage is compulsory for foreign vessels and U.S. vessels under register in foreign trade with specific draft characteristics."

Character – Regulatory Infrastructure

Source of Data – NOAA Office for Coastal Management (OCM)

Lead Agency – NOAA Office for Coastal Management (OCM)

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov

Data Point of Contact – MarineCadastre.gov Data Steward [NOAA OCM] - coastal.info@noaa.gov

Spatial Data Type – Polygons

Stakeholder Involvement – Defined by Authority

Spatial Extent – All US waters

Time Range / Currency – Dataset created in December 2014

Vertical Impact – Vessel traffic occurs on the surface and in the upper water column and may impact the bottom and entire water column if vessels drop anchor

Completeness – Near Complete

Completeness Comments and Caveats – Based on data from the Coast Pilot and NOAA ENC Charts. Non-compulsory areas not included. Based on coordinates (preferred) or bearings and distances where coordinates were unavailable. Questionable areas were verified with pilots if contact information was available.

Metadata Link

Dataset Attributes – Federal OCS Sand and Gravel Borrow (Lease Areas)

Theme – Maritime

Description – From the metadata, "The polygons define areas where entities that have entered into a Negotiated Non-Competitive Lease or Memorandum of Agreement with BOEM can dredge sand, gravel or shell resources from the OCS. Section 8 (k) of the OCS Lands Act (OCSLA), as amended by Public Law 103-426 (enacted in 1994), provides BOEM the authority to negotiate an agreement for the use of OCS sand, gravel, and shell resources for use in: (1) a project for shore protection, beach restoration, or coastal restoration under taken by a Federal, State, or local government agency; or (2) for use in a construction project funded in whole or in part by, or authorized by, the Federal government."

Character – Regulatory Infrastructure

Source of Data – Bureau of Ocean Energy Management

Lead Agency – Bureau of Ocean Energy Management

Agency Point of Contact – Lora Turner, Lora.Turner@boem.gov

Data Point of Contact – Oceanographer [BOEM MMP] - marineminerals@boem.gov

Spatial Data Type – Polygon

Stakeholder Involvement – Defined by Authority

Spatial Extent – From Texas to mid-New Jersey along the Atlantic coast

Time Range / Currency – All past and present leases as of January 1, 2015

Vertical Impact – Sand and gravel extraction operations have significant effects on the seafloor (the lasting duration of which varies) and have effects on the surface and throughout the water column during extraction operations

Completeness – Complete

Completeness Comments and Caveats – Polygons have legal definition. This dataset is a collection of previous and current authorized lease areas under BOEM's purview. The intent is to update the dataset when leases are added or renewed. Does not include non-federal borrow areas.

Metadata Link

Dataset Attributes – Shipwreck and Obstructions Locations

Theme – Maritime

Description – From the metadata, "The Automated Wreck and Obstruction Information System (AWOIS) is an automated file that contains information on wrecks and obstructions, and other significant charted features in coastal waters of the United States subject to NOS Hydrographic Surveys. Items in this file are individually catalogued and are accompanied by historic and descriptive information gathered from field observations and Government and private publications."

Character – Physical Infrastructure

Source of Data – National Oceanic and Atmospheric Administration

Lead Agency – National Oceanic and Atmospheric Administration

Agency Point of Contact – None provided

Data Point of Contact – Kyle Ward [NOAA OCS] - HSD.Inquiries@noaa.gov

Spatial Data Type – Point

Stakeholder Involvement – Compiled from Agency Sources

Spatial Extent – All US waters

Time Range / Currency – Covers historic wrecks and contemporary wrecks up to mid-2009

Vertical Impact – Shipwrecks exist on the seafloor and into the water column. Where the water is shallow, wrecks may be close or at the surface

Completeness – Incomplete

Completeness Comments and Caveats – The most accurate points occur near shore. It is likely offshore locations are underrepresented as they are less likely to be known or reported. Additionally, these data do not include all shipwrecks, but focus on wrecks that pose a navigational hazard.

Metadata Link

Dataset Attributes – Submarine Cables (Including some NASCA Data)

Theme – Maritime

Description – From the metadata, "These data depict the occurrence of submarine cables in and around U.S. navigable waters... Source geometry and attributes were derived from 2010 NOAA Electronic Navigation Charts and 2009 NOAA Raster Nautical Charts." Additional cables were manually digitized forsome missing North American Submarine Cable Association cable locations using online.web material from MarineCadastre.Gov.

Character – Physical Infrastructure

Source of Data – National Oceanic and Atmospheric Administration

Lead Agency – United States Army Corps of Engineers

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov

Data Point of Contact – ENC GIS Technical [NOAA OCS] - james.hawks@noaa.gov; MarineCadastre.gov Data Steward [NOAA OCM] - coastal.info@noaa.gov

Spatial Data Type – Polyline

Stakeholder Involvement – Compiled from Agency Sources; Direct Generation

Spatial Extent – All US waters

Time Range / Currency – Snapshot as of March 2013

Vertical Impact – Submarine cables impact the seafloor.

Completeness – Partially Complete

Completeness Comments and Caveats – Data were compiled from both NOAA charts and the NASCA submarine cable layer. The NASCA dataset does not contain information on non-member cables, and it unknown if the NOAA chart data contains this information or not.

Metadata Link – By source

- NOAA ENC and RNCs
- NASCA

Dataset Attributes – Coastal Recreational Survey

Theme – Recreation

Description – Coastal Recreational Survey information covers activity in the Mid-Atlantic from mid-2012 through 2013. These data were collected through an online, opt-in survey and included 16 different non-consumptive recreational activity types with 50 or more responses regionally. The survey did not gather information about fishing or other consumptive activities.

Character – Activity

Source of Data – Recreational users via stakeholder engagement

Lead Agency – N/A

Agency Point of Contact – None provided

Data Point of Contact – Cheryl Chen, Point 97, cheryl@pointninseven.com

Spatial Data Type – Polygon grid

Stakeholder Involvement – Facilitated Generation

Spatial Extent – Mid-Atlantic coast and ocean

Time Range / Currency – Data represent activities from mid-2012 to the end of 2013.

Vertical Impact – By recreation type:

- Shore-based Activities - Entire water column and seabed in areas very close to the shore.
- Surface Water Activities - Entire water column and seabed in areas very close to the shore
- Underwater Activities – Entire water column
- Wildlife and Sightseeing Activities – Surface for activities performed on a vessel and likely no impact for activities performed on land

Completeness – Incomplete

Completeness Comments and Caveats – In an online survey running from July 1, 2013 to December 31, 2013, 1,436 respondents marked where they recreated in the Mid-Atlantic over the past 12 months. The opt-in survey did not result in a random sample and may not be representative of the study population (e.g., all Mid-Atlantic recreational users).

Metadata Link – By activity type:

- Shore-based Activities
- Surface Water Activities
- Underwater Activities

- Wildlife and Sightseeing Activities

Dataset Attributes – Recreational Boating Survey

Theme – Recreation

Description – These data were collected through an opt-in online survey from June to December 2013. They describe both specific activities undertaken during recreational boating, including fishing, as well as the routes that recreational boaters reported to have taken.

Character – Activity

Source of Data – Recreational boaters via stakeholder engagement

Lead Agency – N/A

Agency Point of Contact – None provided

Data Point of Contact – Cheryl Chen [Point 97] - cheryl@pointnineseven.com

Spatial Data Type – Point

Stakeholder Involvement – Facilitated Generation

Spatial Extent – The mid-Atlantic coastline, with most responses occurring along the New Jersey shore and in the Chesapeake Bay. There are very few responses in NY. There are some responses in offshore waters.

Time Range / Currency – Data were collected from June to December of 2013 - the time period of the described activities in the survey are unknown

Vertical Impact – The impact depends on the associated activity. All activities impact the surface waters, while some, like fishing, impact the water column as well

Completeness – Incomplete

Completeness Comments and Caveats – From the metadata: "Please note this data set should not be construed as representative of private boater activity as a whole. Due to the limited number of survey respondents, the data represents only a portion of actual offshore private boating activities."

Metadata Link

Dataset Attributes – PGIS Recreation

Theme – Recreation

Description – These data were collected through a series of meetings held along the Mid-Atlantic coast. During these meetings, stakeholders identified areas on a map that were important to them for various recreational activities. In the states of Virginia, Maryland, Delaware, and New Jersey, stakeholders identified the general footprint of each use and the dominant area for each use. Additionally in New Jersey, stakeholders identified areas important specifically to recreational fishing and the target species for each of those areas. In New York, stakeholders identified important recreational areas but did not differentiate between dominant use areas and footprints.

Character – Activity

Source of Data – Recreational users via stakeholder engagement

Lead Agency – State Coastal Zone Management Programs

Agency Point of Contact – None provided

Data Point of Contact – Metadata in development

Spatial Data Type – Polygon

Stakeholder Involvement – Facilitated Generation

Spatial Extent – By region/activity:

- Regional (VA-NJ): Coast and waters from Virginia through New Jersey
- NJ Sportfishing: Waters off of New Jersey
- NY Activities: Waters and coast of New York

Time Range / Currency – Data were collected during 2012

Vertical Impact – By region/activity:

- Regional (VA-NJ): Activities have different impacts depending on the type but can impact the surface, water column, and seafloor
- NJ Sportfishing: Impacts occur at the surface, in the water column, and on the bottom if anchoring
- NY Activities: Activities have different impacts depending on the type but can impact the surface, water column, and seafloor

Completeness – Incomplete

Completeness Comments and Caveats – Awaiting documentation, but assumed to be limited response rate and survey effort relative to the total population of interest. PGIS accuracy is limited to the scale at which features where digitized. Polygon boundaries may not perfectly capture "fuzzy"/seasonal use areas.

Metadata Link – Under development

Dataset Attributes – BOEM Active Renewable Energy Lease Areas

Theme – Energy

Description – Polygons represent areas that have been leased by BOEM for renewable energy development on the Outer Continental Shelf (>3nm from shore).

Character – Regulatory Infrastructure

Source of Data – Bureau of Ocean Energy Management

Lead Agency – Bureau of Ocean Energy Management

Agency Point of Contact – Stephen Creed [BOEM] - stephen.creed@boem.gov

Data Point of Contact – Stephen Creed [BOEM] - stephen.creed@boem.gov

Spatial Data Type – Polygon

Stakeholder Involvement – Defined by Authority

Spatial Extent – Entire East Coast

Time Range / Currency – Snapshot as of September 9, 2013

Vertical Impact – Invites development of wind energy infrastructure, the process of which impacts the surface, water column, and seafloor. Once constructed, wind facilities continue to impact the surface, water column, and seafloor.

Completeness – Complete

Completeness Comments and Caveats – Information is exact/perfectly known, source is authoritative.

Metadata Link

Dataset Attributes – BOEM Wind Planning Areas

Theme – Energy

Description – These data represent areas of interest for wind energy development in federal waters (beyond 3nm from shore). As BOEM leases areas for development, they migrate to the Active Renewable Energy Lease Areas dataset.

Character – Regulatory Infrastructure

Source of Data – Bureau of Ocean Energy Management

Lead Agency – Bureau of Ocean Energy Management

Agency Point of Contact – Stephen Creed [BOEM] - stephen.creed@boem.gov

Data Point of Contact – Stephen Creed [BOEM] - stephen.creed@boem.gov

Spatial Data Type – Polygon

Stakeholder Involvement – Defined by Authority

Spatial Extent – Entire East Coast

Time Range / Currency – Snapshot as of 2015

Vertical Impact – Invites development of wind energy infrastructure, the process of which impacts the surface, water column, and seafloor. Once constructed, wind facilities continue to impact the surface, water column, and seafloor.

Completeness – Complete

Completeness Comments and Caveats – Information is exact/perfectly known, source is authoritative.

Metadata Link

Dataset Attributes – Virginia Research Lease Areas

Theme – Energy

Description – These data represent areas where the Virginia Offshore Wind Technology Advancement Project is taking place.

Character – Regulatory Infrastructure

Source of Data – Dominion Power

Lead Agency – Bureau of Ocean Energy Management

Agency Point of Contact – Stephen Creed [BOEM] - stephen.creed@boem.gov

Data Point of Contact – Stephen Creed [BOEM] - stephen.creed@boem.gov

Spatial Data Type – Polygon

Stakeholder Involvement – Defined by Authority

Spatial Extent – Offshore Virginia

Time Range / Currency – Snapshot as of November 7, 2014

Vertical Impact – Invites development of wind energy infrastructure, the process of which impacts the surface, water column, and seafloor. Once constructed, wind facilities continue to impact the surface, water column, and seafloor.

Completeness – Complete

Completeness Comments and Caveats – Information is exact/perfectly known, source is authoritative.

Metadata Link

Dataset Attributes – Coastal Energy Facilities

Theme – Energy

Description – From the metadata, "This data product depicts the locations of facilities that generate electricity. Only facilities adjacent to the coast and Great Lakes are identified. Contained within the database are records that define the fuel source and other characteristics of the facility that may benefit ocean planners."

Character – Physical Infrastructure

Source of Data – Environmental Protection Agency

Lead Agency – Environmental Protection Agency

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov

Data Point of Contact – MarineCadastre.gov Data Steward [NOAA OCM] - coastal.info@noaa.gov

Spatial Data Type – Point

Stakeholder Involvement – Compiled from Agency Sources

Spatial Extent – Ocean and inland coasts of the Mid-Atlantic from Virginia to NY including both coasts of Long Island Sound

Time Range / Currency – Underlying EPA data published in 2010, processed by NOAA in 2014

Vertical Impact – Onshore

Completeness – Near Complete

Completeness Comments and Caveats – From the metadata: "eGRID is based on available plant-specific data for all U.S. electricity generating plants that provide power to the electric grid and report data to the U.S. government" and "eGRID is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States." Note that only facilities adjacent to the coast and Great Lakes are identified.

Metadata Link

Dataset Attributes – Danger Zones & Restricted Areas

Theme – Security

Description – From the metadata, "The CFR [Code of Federal Regulations] defines a Danger Zone as, 'A defined water area (or areas) used for target practice, bombing, rocket firing or other especially hazardous operations, normally for the armed forces. The danger zones may be closed to the public on a full-time or intermittent basis, as stated in the regulations.' The CFR defines a Restricted Area as, 'A defined water area for the purpose of prohibiting or limiting public access to the area. Restricted areas generally provide security for Government property and/or protection to the public from the risks of damage or injury arising from the Government's use of that area.'"

Character – Regulatory Infrastructure

Source of Data – United States Department of Defense, United States Navy

Lead Agency – United States Coast Guard

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov

Data Point of Contact – MarineCadastre.gov Data Steward [NOAA OCM] - coastal.info@noaa.gov

Spatial Data Type – Polygon

Stakeholder Involvement – Defined by Authority

Spatial Extent – All US waters

Time Range / Currency – Snapshot as of July 2012

Vertical Impact – Impact depends on use of zone - some have little ongoing impact (e.g., areas with unexploded ordnances), others including test sites or training grounds may have impacts on the surface, throughout the water column, and on the seafloor

Completeness – Complete

Completeness Comments and Caveats – Based on NOAA Raster Navigational Charts (RNCs), which are updated regularly and a definitive data source for navigation in U.S. coastal and marine waters. Locations of Danger Zones and Restricted Areas are outlined by the Code of Federal Regulations (CFR).

Metadata Link

Dataset Attributes – Unexploded Ordinances

Theme – Security

Description – From the metadata, "Unexploded ordnance (or UXOs/UXBs, sometimes identified as UO) are explosive weapons (bombs, bullets, shells, grenades, land mines, naval mines, etc.) that did not explode when they were employed and still pose a risk of detonation, potentially many decades after they were used or discarded."

Character – Physical Infrastructure

Source of Data – National Atmospheric and Oceanic Administration, Bureau of Ocean Energy Management

Lead Agency – United States Department of Defense

Agency Point of Contact – Dave Stein, NOAA, dave.stein@noaa.gov

Data Point of Contact – MarineCadastre.gov Data Steward [NOAA OCM] - coastal.info@noaa.gov

Spatial Data Type – Polygon

Stakeholder Involvement – Compiled from Agency Sources

Spatial Extent – All US waters

Time Range / Currency – Covers known ordinance until February 2014

Vertical Impact – Impacts are primarily on the seafloor

Completeness – Incomplete

Completeness Comments and Caveats – This is NOT a complete collection of unexploded ordnances on the seafloor, nor are the locations considered to be exact. The presence and locations of the unexploded ordnance have been derived from graphical representations recorded on NOAA Raster Navigation Charts (RNCs). These data are intended for coastal and ocean planning.

Metadata Link

Dataset Attributes – Navy Operational Areas Layers

Theme – Security

Description

- Atlantic City Airspace Corridor: Air Traffic Control Assigned Airspace for the Atlantic City Airspace Corridor.
- Military Installations: Military installations located on land adjacent to the offshore Range Complexes. These installations may use the waters and air space of the range complexes for training or testing activities as well as other nearby range complexes.
- Military Range Complexes: A range complex is a designated set of specifically bounded geographic areas and encompasses a water component (above and below the surface), airspace, and may encompass a land component where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occur.
- Mine Warfare Areas: A location where mine warfare training can be conducted which is not considered a Military Range and can be scheduled by military training units.
- OPAREAs: Ocean area defined by geographic coordinates with defined sea surface and subsurface training areas and associated special use airspace, and includes danger zones and restricted areas.
- Ship Shock Trial Area: A location where ship shock trials can be conducted which is not considered a Military Range and can be scheduled by military training units.
- SINKEX Box: An area where sinking exercise of a seaborne target, usually a deactivated ship, can be conducted.
- Submarine Transit Lanes: An area where submarines may navigate underwater. Includes transit corridors designated for submarine travel.
- Testing Range Boundary: The Naval Undersea Warfare Center Division Newport (NUWCDIVNPT) Testing Range consists of waters within Narragansett Bay, nearshore waters of Rhode Island Sound, Block Island Sound, and coastal waters of New York, Connecticut, and Massachusetts. The Testing Range located near NUWCDIVNPT is an area used for research, development, test, and evaluation of Undersea Warfare systems, and, as necessary, to support other Navy and DoD operations.
- VACAPES Airspace Corridors: Not available at this time.
- VACAPES Restricted Areas: A restricted area is a type of Special Use Airspace.
- Wallops Test Track: Part of the Wallops Flight Facility.
- Warning Areas: Warning areas are a type of special use airspace commonly found in range complexes. A warning area is an area of defined dimensions which serves to warn non-participating aircraft of potential danger in a particular area.

Character – Regulatory Infrastructure

Source of Data – United States Department of Defense

Lead Agency – United States Department of the Navy

Agency Point of Contact – None provided

Data Point of Contact –Metadata in development

Spatial Data Type – Polygon

Stakeholder Involvement – Defined by Authority

Spatial Extent – Mid-Atlantic and Northeastern waters

Time Range / Currency – Delivered mid-December 2015

Vertical Impact – Impacts depend on operations conducted and may include impacts at all levels of the water column and the seafloor.

Completeness – Complete

Completeness Comments and Caveats – Data provided by authoritative source.

Metadata Link – Under Development

Appendix C: HUDS Grids User Guidance

Basic Navigation and Attribute Description

Viewing and Navigating the Grids

All HUDS grids are contained within the existing structure of the MARCO Portal (http://portal.midatlanticocean.org/portal). To view them, users should navigate to the *Marine Planner* section of the website and click on the *Data* tab in the *Data Layers* window (i.e., the "table of contents"). Then, expand the Human Use Data Summary grouping to see the HUDS grids. Click the check box to the right of the grid of interest to display it in the map window, and click the "i" button to the left of the grid of interest to view metadata and download the dataset. Click and drag the map to move it and use the zoom buttons or mouse scroll wheel to zoom in and out. Click on a grid cell to view the attribute information associated with it in a new pop-up (attribute) table.

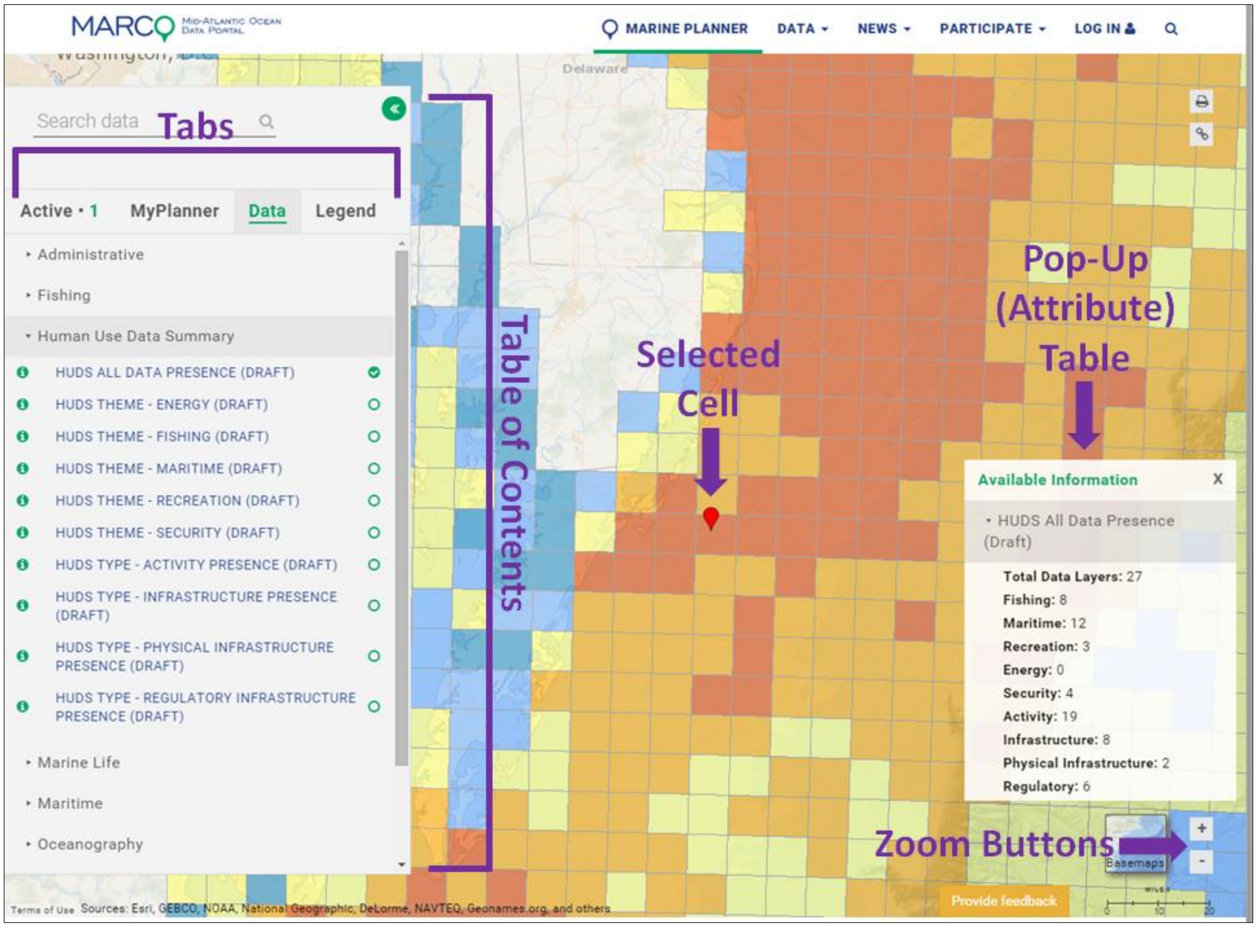


Figure 21. Overview of HUDS grid navigation.

Users can view the legend under the *Legend* tab and adjust layer transparency and drawing order (if multiple layers are turned on) under the *Active* tab. The cartography for all HUDS grids consists of 5 color classes ranging from blue (lowest) to red (highest). Values within the classes refer to the total count of layers present in a given grid cell or the classified use intensity, depending on whether the selected HUDS grid is a data presence or use intensity grid. The class break values are based on percentiles (<20th, 20-40th, 40-60th, 60th-80th, >80th), thus, in most cases each class contains a roughly equal number of grid cells. However, this is not true in the case of the energy theme, recreation theme, security theme, and infrastructure sub-types (physical and regulatory) due to the small range of possible counts in these layers.

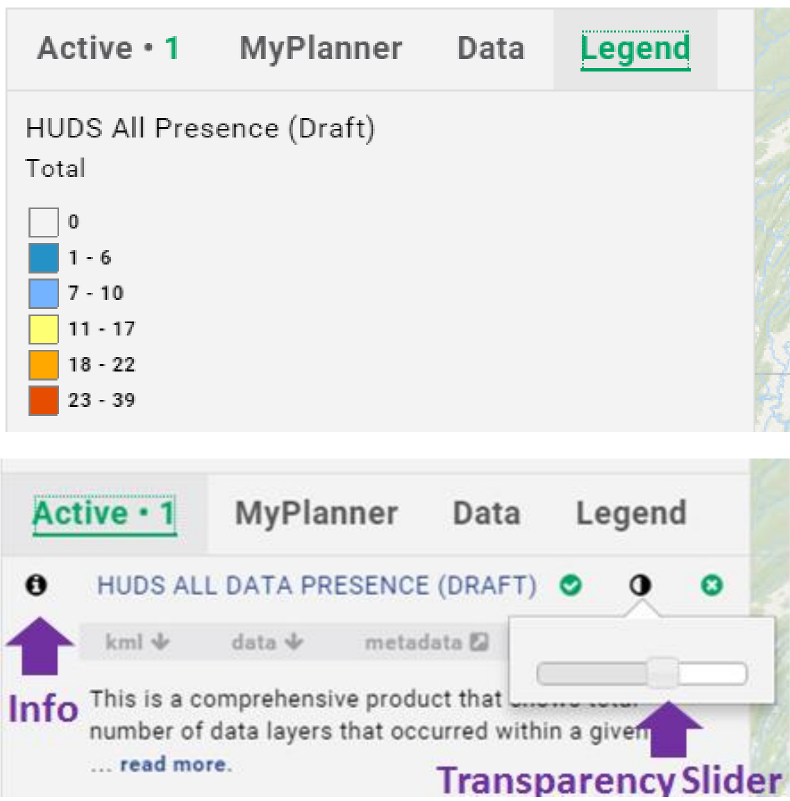


Figure 22. Legend (top) and transparency and info tools (bottom).

Attributes for Master, Theme, and Type Data Presence Grids

The sort of attribute information contained in a given grid cell depends on whether it is part of a master, theme, or type grid. Attributes for cells in the *master* grid (i.e., all data presence) include a total count of all layers present and a total count of layers grouped by various themes (e.g., fishing) and types (e.g., infrastructure). Attributes for cells in a *theme* grid (i.e., energy, fishing, maritime, recreation, security) contain a total count of layers within that theme plus additional, descriptive text and statistical information from these root layers (e.g., listing of recreational activities, amount of AIS traffic by vessel type, names of lease areas). Similarly, attributes for cells in a *type* grid (i.e., activities, all infrastructure, physical infrastructure only, regulatory infrastructure only) contain the same sort of total count and descriptive, root information within each type.

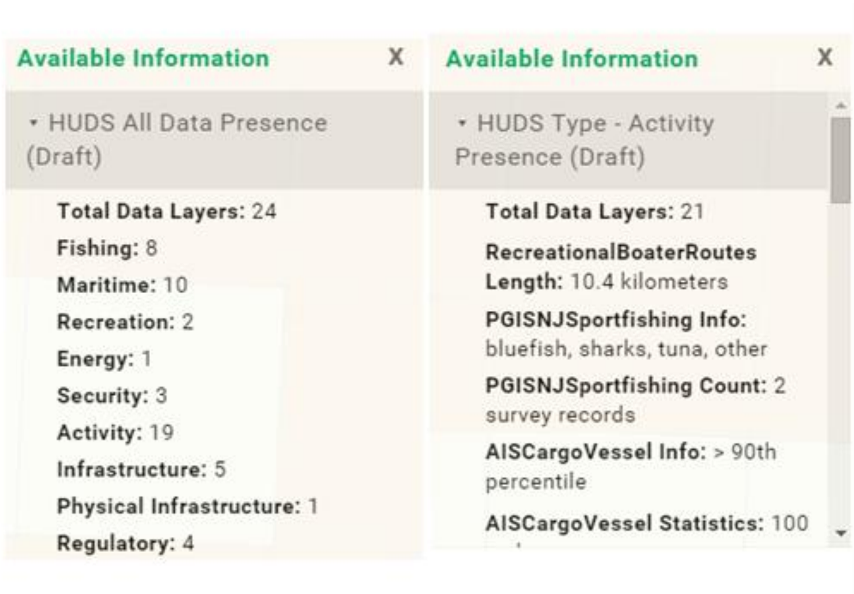


Figure 23. Master grid attributes (left) and theme/type grid attributes (right).

Attributes for Use Intensity Grids

There are two special theme grids (Maritime Use Intensity and Fishing Use Intensity) with a slightly different set of attributes from the rest. Like other grids, attributes for cells within these grids contain total layer counts and descriptive information from root data layers. However, they also contain a scaled intensity value for each root data layer, reflecting the relative amount of that particular activity, and a total intensity value, reflecting the relative amount of all activities within that theme. The attributes also contain categorized versions of these values (e.g., "Low"). For details on how these intensity metrics were calculated, please refer to Section 3.3.4.

Example Case Studies

Exploring High Concentrations of Data

In this scenario, a user may be interested in exploring why a certain area of the master grid (i.e., all data presence) appears red (indicating high concentrations of available data). Such a location occurs near Staten Island, New York. First, the user would click on the cell of interest, generating the following pop-up (attribute) window:

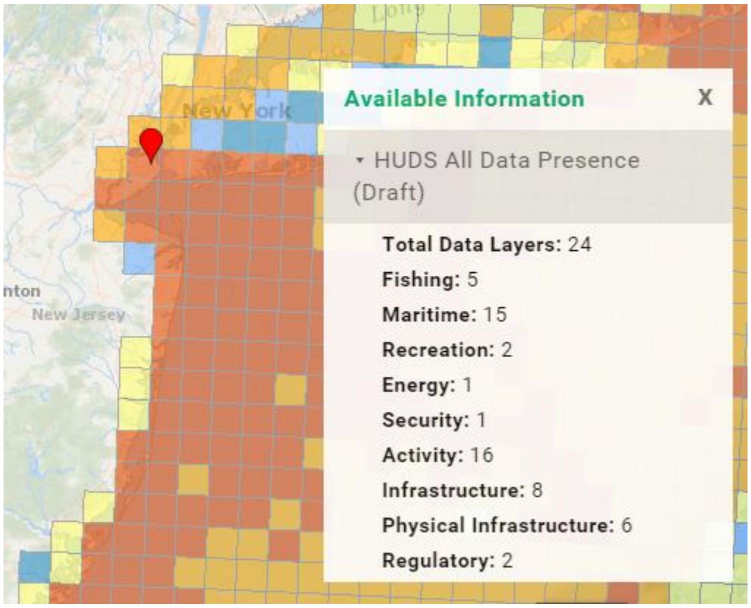


Figure 24. Master grid attributes for a cell of interest.

This window indicates that 15 out of the 24 data layers present are maritime in nature. The user could then turn on the maritime theme grid and query this same cell for more detailed information on these maritime uses:

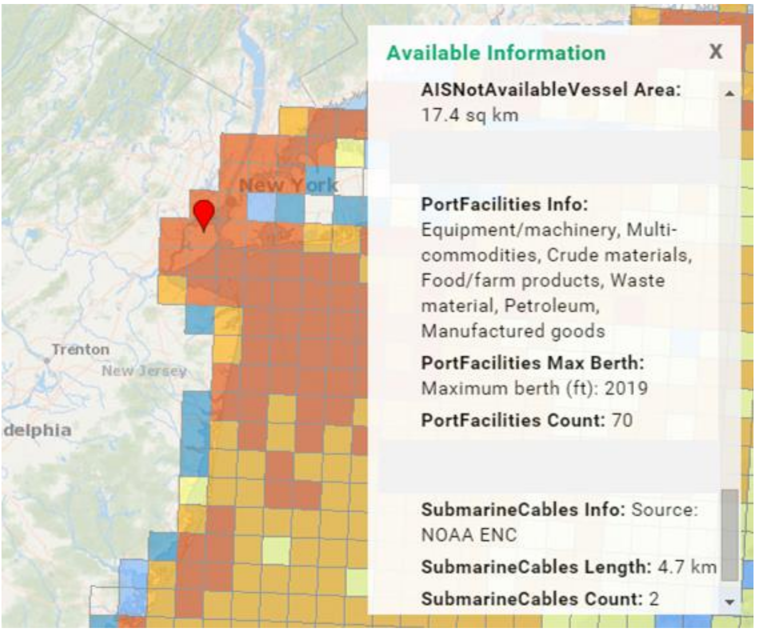


Figure 25. Maritime theme grid attributes for a cell of interest.

Scrolling through the attributes for the maritime theme grid reveals that 8 anchorage grounds, 41 maintained channels, 47 wrecks and obstructions, 70 port facilities, 2 submarine cables, and high amounts of cargo, passenger, tanker, tug tow, military and fishing traffic all occupy this grid cell. If the user was particularly interested in wrecks and obstructions, for example, he or she could then view this "root" data layer on the portal, located in the "Maritime" theme grouping of data layers in the portal table of contents:

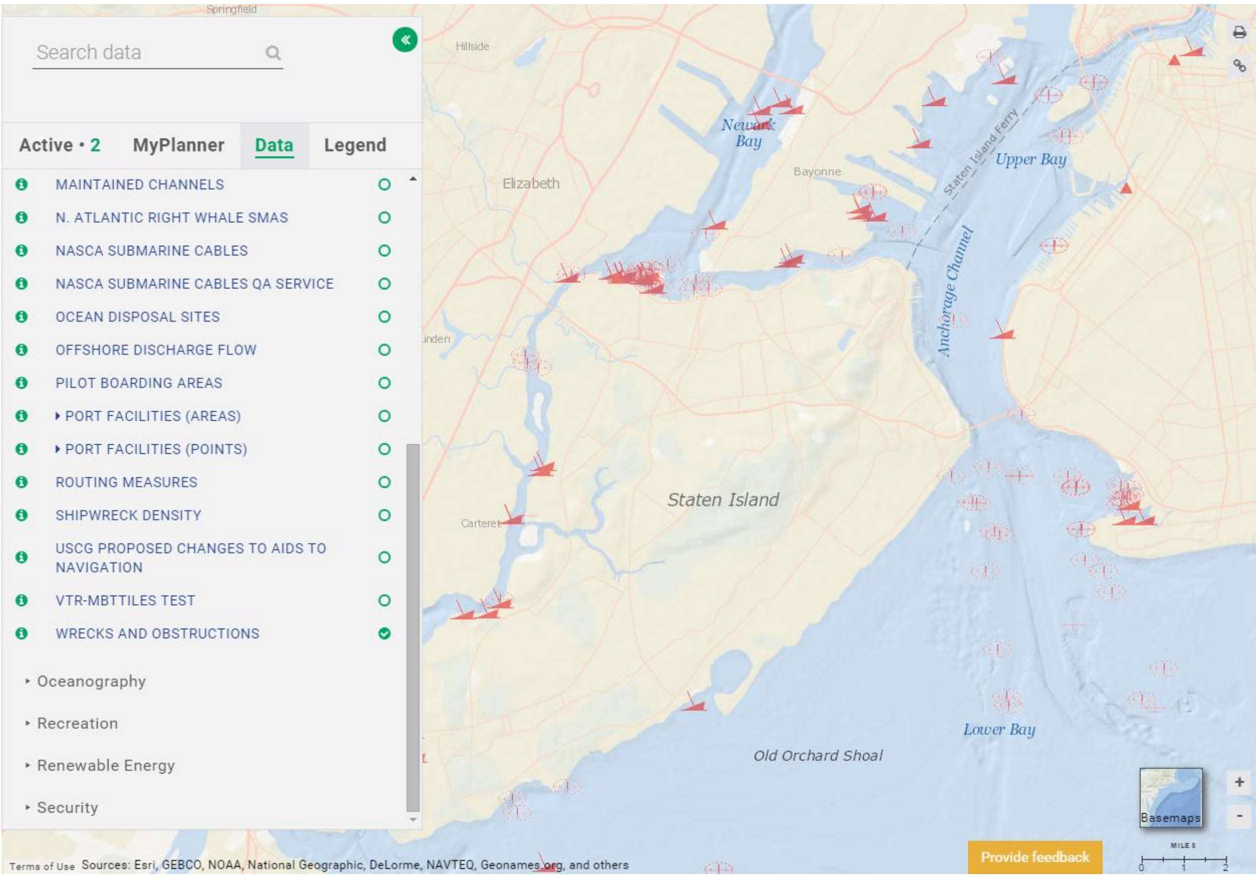


Figure 26. Wrecks and obstructions "root" data layer.

Identifying Shipping within a Wind Energy Area

In this scenario, a user may be interested in identifying the amount of vessel traffic within an Active Renewable Energy Lease Area, perhaps in order to anticipate possible compatibility concerns. First, the user would turn on the BOEM Active Renewable Energy Lease Areas and zoom to the area of interest (in this case, New Jersey GSOE-I LLC). Then, the user would turn on the HUDS maritime theme grid, and perhaps place it below the lease areas in the Table of Contents to allow for clearer display. Finally, the user would query the HUDS maritime theme grid cell that contains the lease area of interest:

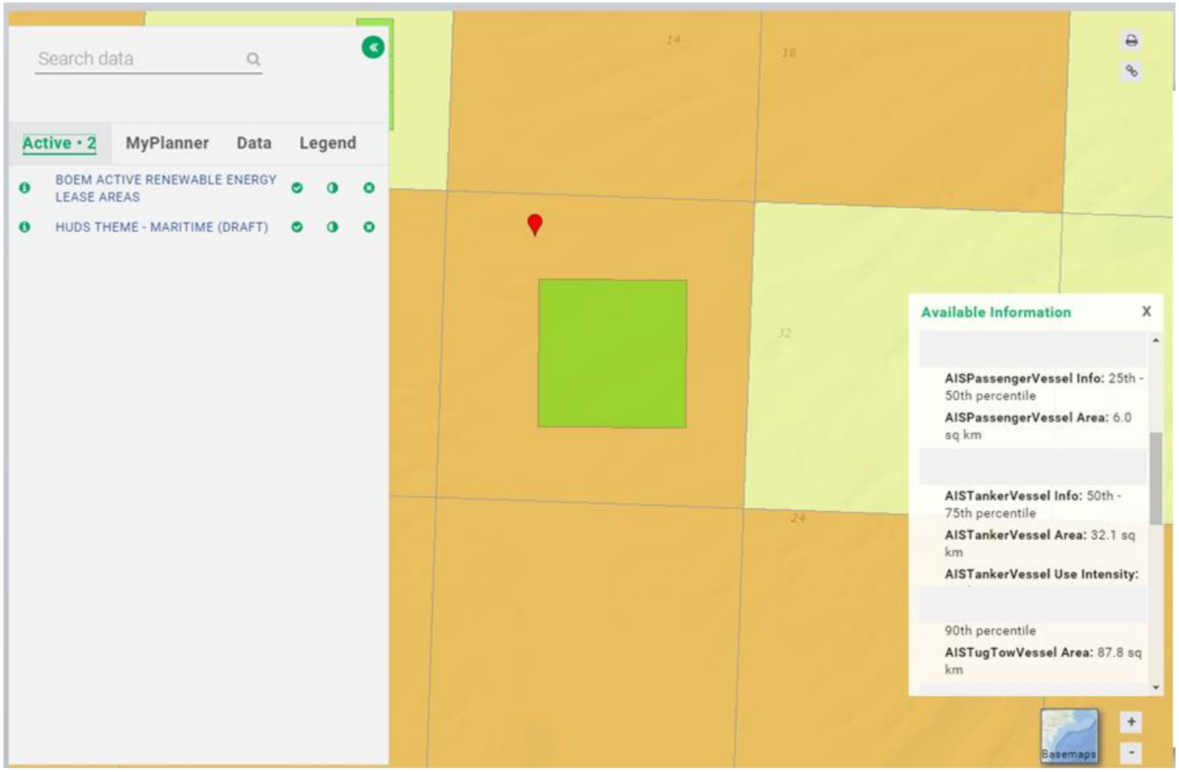


Figure 27. Overlap of a wind energy area with maritime use data.

Scrolling through the attributes for the maritime theme grid reveals that cargo vessel traffic, passenger vessel traffic, and military vessel traffic are somewhat low (25th-50th percentile) whereas tanker, pleasure, and fishing vessel traffic are higher (75th-90th percentile).