GIS Coverage Delineating Areas for Future Geophysical and Geological Surveys to Fill Existing Data Gaps

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DISCLAIMER

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List of Abbreviations and Acronyms

ASAP	Atlantic Sand Assessment Project
BOEM	Bureau of Ocean Energy Management
CMECS	Coastal and Marine Ecological Classification Standard
NJGWS	New Jersey Geological and Water Survey
nm	Nautical Miles
OCS	Outer Continental Shelf
USACE	Unites States Army Corps of Engineers
XRF	X-Ray Fluorescence

1 Introduction

As part of Cooperative Agreement M22AC00002, the New Jersey Geological & Water Survey (NJGWS) were tasked with conducting a data gap analysis in Federal waters off the coast of New Jersey. The objective of this report is to identify data gaps and offer recommendations for future work specific to –

- Geophysical data
- Geologic data
- Geologic framework
- Mineral resources
- Sand resource areas

Filling geophysical data gaps is essential for developing accurate geologic maps and improving sand resource assessments, which are critical for coastal resilience and beach nourishment planning. Many existing datasets are outdated, low resolution, or limited in spatial coverage, which limits their utility in new research. The integration of cores is a requirement to ground truth seismic data interpretations and to enhance the reliability of reconnaissance-level geological assessments, particularly in complex depositional settings. The report emphasizes the need to collect data farther offshore to identify and evaluate potential sand resources for beach nourishment projects, highlighting the importance of accurate marine seismic data along with additional geophysical methods such as multibeam bathymetry, sidescan sonar, and magnetometer surveys.

NJGWS focuses on reconnaissance-level geophysical and geological exploration with the goal of gaining a better understanding of the shallow geologic framework and ultimately identifying potential resource areas to be further investigated. This work informs U.S. Army Corps of Engineers (USACE) and the Bureau of Ocean Energy Management (BOEM) decision making for sand resource management, enhancing the efficiency to conduct design-level surveys. This report outlines current NJGWS data gaps within the scope of our existing capabilities, while referencing relevant work performed by other agencies.

2 Geophysical Data

The NJGWS has a continued interest in advancing knowledge about the marine seafloor and shallow subsurface using geophysical exploration. Marine sediments and geologic formations exposed at the seabed are subject to dynamic transformations over time, driven by currents, tides, and dredging activities. These factors continually shape the composition and arrangement of the seafloor, influencing marine habitats, availability of resources, and placement of infrastructure. As a result, a comprehensive understanding of the seafloor requires ongoing study and data collection. Seismic data optimizes the planning and execution of beach nourishment endeavors, where reconnaissance-level surveys inform core placement and follow on investigations such as design-level work. For example, seismic profiles delineate the geometry and thickness of sand shoals which allow targeted coring to provide ground truthing and lithologic correlation with seismic facies.

Seismic data is one part of an integrated geophysics toolkit that can be utilized to locate suitable sand resources beach nourishment. Advancements in high-resolution acquisition technologies, processing, and methodologies offer higher resolution, greater accuracy, and improved data quality. Techniques such as chirp seismic, multibeam bathymetry, sidescan sonar, and magnetometer, when used together with geological samples, complement one another enhancing our ability to characterize the seabed and shallow subsurface with more accuracy and confidence. These techniques can help us to distinguish subtle variations in sediment properties, identify previously hidden geological structures, and delineate subsurface features that might have been undetected or poorly resolved with older technologies or in instances when only one data type was available. The integration of real-time data telemetry, global positioning systems (GPS), and advanced source control mechanisms has significantly enhanced data accuracy, resulting in more reliable interpretations of subsurface characteristics.

Traditionally, NJGWS acquisition surveys are organized based on the project requirements for USACE, therefore making it infeasible to prioritize specific areas at this time. Prior to 2019, NJGWS focused on collecting out to 8 nm. Since then, NJGWS shifted its focus on extending data collection up to 10 nm to ensure comprehensive spatial coverage (Figure 1). Prioritizing the 0–10 nm corridor captures the zone most commonly used for borrow area sites due to production economics (shorter hopper cycles/pipeline distances), permitting and construction constraints.

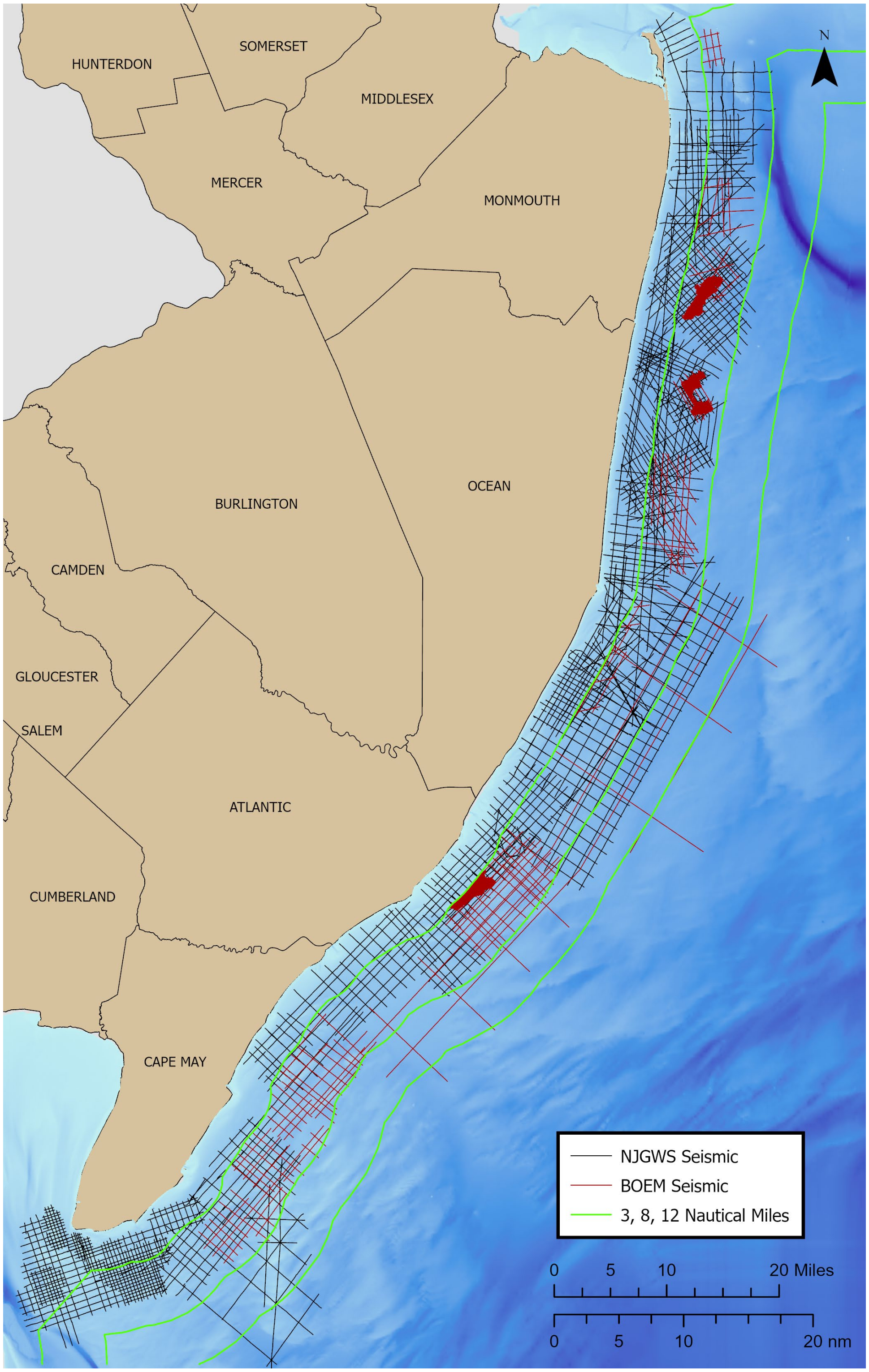

Figure 1. NJGWS and BOEM offshore seismic data track lines
This map shows existing geophysical survey track lines collected by NJGWS and BOEM offshore New Jersey, highlighting spatial data gaps within the 0-10 nautical mile corridor that require future seismic data collection to support comprehensive geological mapping and sand resource assessment.

Given the critical nature of seismic data in informing offshore geologic mapping and identifying potential sand sources for long-term coastal resilience planning, it is vital to consider the potential benefits of renewing and updating our data repository. Historically, NJGWS has collected seismic using a single plate boomer as a sound source. This was done as it is an economical and simple system to use and gets sufficient penetration and resolution for reconnaissance data. The majority of the NJGWS seismic data is over 10 years old (Table 1) and datasets may be outdated due to changes from dredging activities, advancements in seismic data acquisition and processing technology, and seafloor dynamics. NJGWS should aim to recollect some of this old or poor data while simultaneously using other methods as mentioned above. Reports from the NJGWS and USACE may reference historical project areas (Figure 2) where offshore data collection has occurred and are therefore provided for reference purposes. Outdated geophysical data could contain limitations such as reduced resolution, insufficient penetration depth, and limitations in capturing subsurface details. These shortcomings can lead to incomplete or low-confidence interpretations and conclusions in exploration and analysis efforts. Recollecting older marine seismic data may also offer insights into the changing nature of marine environments and the geological and anthropogenic processes that shape them.

Table 1. Project areas and years of seismic data collection

Year Data Collected	Area Offshore New Jersey
1996	Area I
1997	Area C, Area E, Area F, Area G
2000	Area C, Area F, Area H
2001	Area H, Area I, Area J
2003	Area K
2005	Area L
2007	Area K, Area L, Area M
2010	Area E
2013	Area E, Area F
2016	Area C, Area D, Area E, Area F
2017	Area E, Area F, Area J, Area H
2019	Area C, Area D

Note: Historical project areas offshore New Jersey where geophysical data has been collected. Refer to Figure 2 for area locations. Some seismic data may be located beyond the boundaries of historic areas and are categorized based on the nearest region.

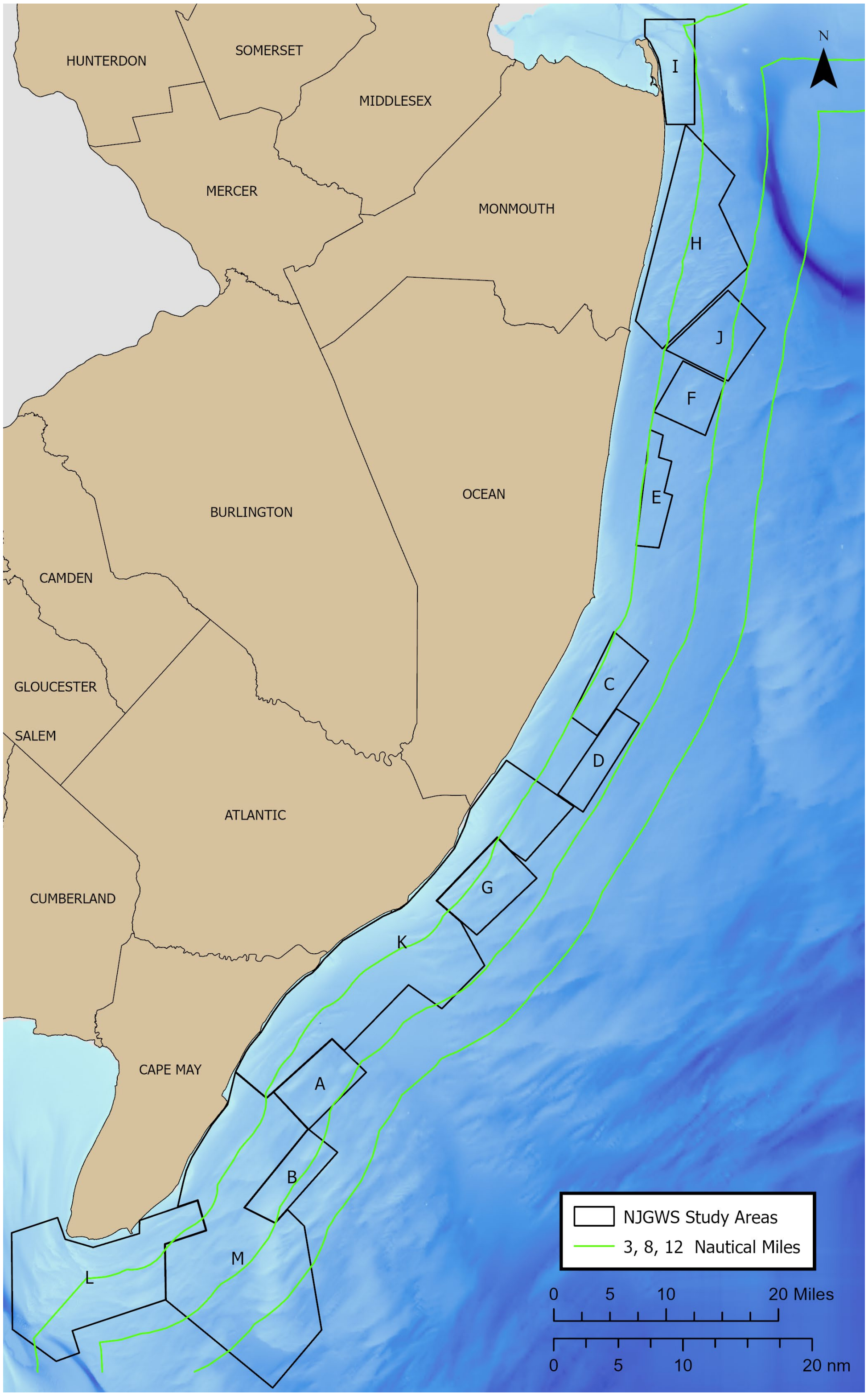

Figure 2. Map of historical project areas
Historical project areas designated by NJGWS for geophysical and geological data collection (see Table 1).

In anticipation of future needs for beach replenishment initiatives, it is prudent to collect marine seismic data further offshore, particularly within water depths of up to 90 feet (Figure 3). This depth threshold aligns with the operational limitations of most U.S.-flagged sand dredges, which are integral to the extraction and transport of sand for large beach nourishment projects. Considering the increasing demand for sand resources located on the outer continental shelf (OCS), the prevalence of large, offshore wind energy leases, and other competing uses (e.g., fisheries, submerged cable networks, etc.), it is logical that sand resource exploration and inventorying efforts expand to include all portions of the OCS that are technically feasible (within 90-foot isobath), and doing so offshore of New Jersey would include most areas of the seabed out to approximately 18nm offshore. By conducting marine seismic surveys in these depths, we aim to locate and characterize potentially viable sand deposits in areas that were previously avoided in the past due to economic, environmental, and logistical constraints.

Looking further ahead, advancements in dredging technology may allow the potential to extract sand from water depths of up to 120 feet. Additionally, BOEM, in partnership with contractors, is focusing on collecting data in the Mid-Atlantic OCS up to 24nm offshore. By conducting comprehensive seismic surveys encompassing areas further offshore and at greater depths, we can proactively identify and evaluate sand deposits that may become economically and technically feasible in the future. This proactive approach not only augments the pool of available replenishment sand resources but also contributes to a more comprehensive understanding of the shallow geologic framework.

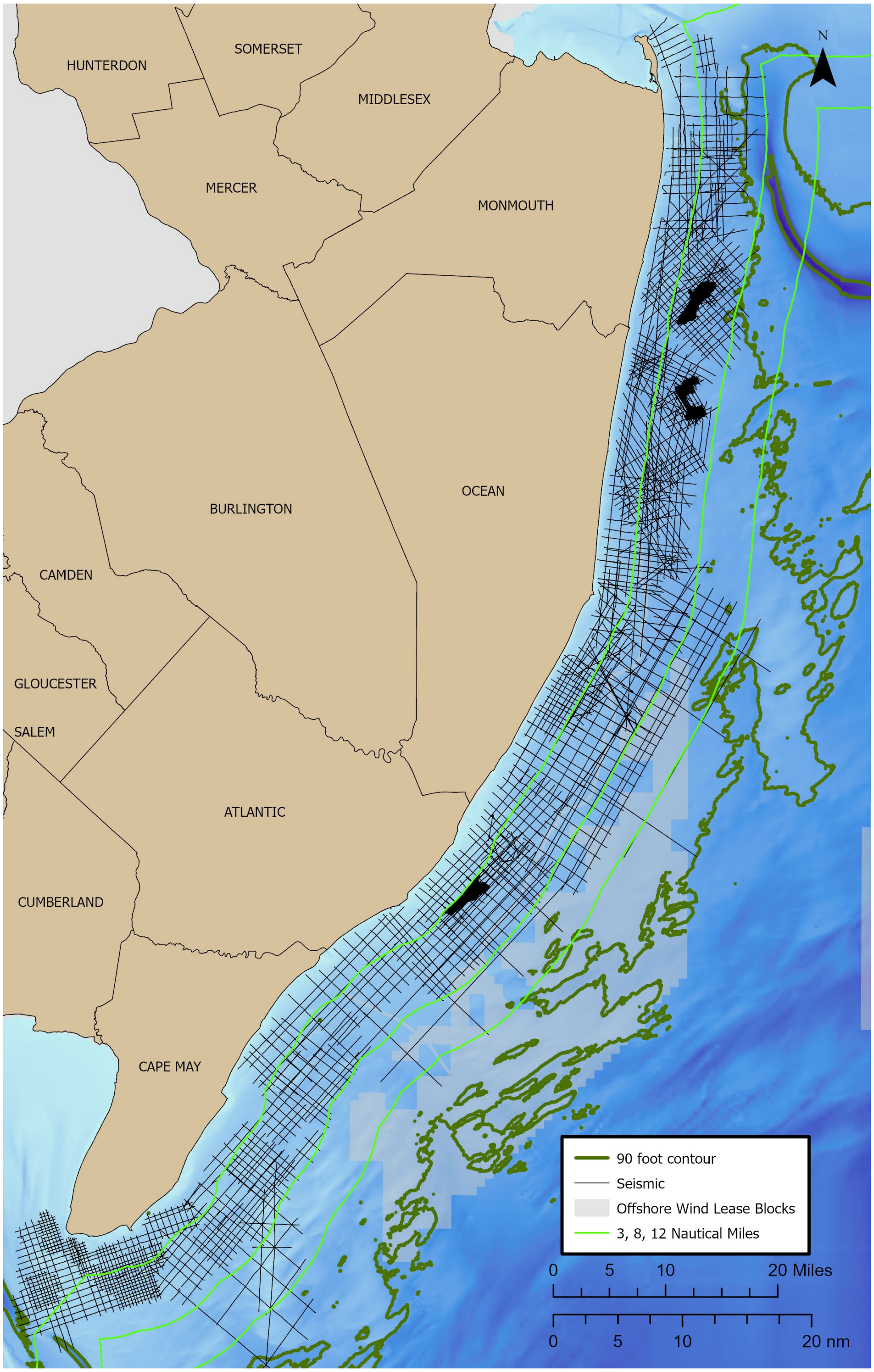

Figure 3. Map illustrating the 90-foot water depth contour
Ninety-foot water depth contour, which reaches a maximum of 18nm offshore at the farthest point. This water depth corresponds to the typical operational limit of U.S.-flagged sand dredges and has been largely unexplored for sand resource potential.

3 Geologic Data

Ground truthing marine seismic data with cores is essential to enhance the accuracy and reliability of geologic interpretations, ensuring a more robust foundation for subsequent analyses and decision making. Cores provide direct sediment samples that validate interpretations of seismic facies, offer high-resolution details, and serve as calibration points for seismic profiles. To date, NJGWS has collected over 300 cores since 1994 (Table 2, Figure 4). As NJGWS, in collaboration with BOEM and USACE, continues to collect seismic data in identified priority areas, it will be necessary to obtain cores to validate seismic interpretations. However, prospective core locations cannot be identified until thorough processing and review of the collected seismic data is completed. Thus, a detailed map with prospective core locations cannot be provided at this time.

In ongoing support of working with the Bureau of Ocean Energy Management (BOEM), NJGWS collected seismic data offshore Long Beach Island in summer 2019 and collected 30 cores in spring 2025, which was identified in a previous data gap report (NJGWS, 2018). NJGWS provided technical assistance to BOEM by supplying locations and preliminary geologic data from these cores. This information aided BOEM's planning and decision-making efforts for their most recent geophysical data acquisition (completed May 2025) offshore of Atlantic and Ocean Counties, New Jersey. This collaborative approach to data collection demonstrates our commitment to maintaining an accurate and up-to-date knowledge base and maintaining a working relationship with BOEM to further empower our decision-making processes and improve the effectiveness of our operations.

In addition to collecting cores to supplement geophysical acquisition, NJGWS recommends the collection of seafloor surface grab samples in support of Coastal and Marine Ecological Classification Standard (CMECS) mapping efforts. These samples will help characterize seafloor substrate and physical habitat types, providing essential information for ecological classification, habitat mapping, and resource management.

Table 2. Project areas and core collection years

Year Data Collected	Area Offshore New Jersey	Total Number of Cores
1994	Area A, Area B, Area K, Area M	21
1997	Area C, Area D, Area E, Area F, Area G	20
2000	Area C, Area H	20
2001	Area H	20
2002	Area F, Area H, Area J	21
2003	Area G, Area K	20
2004	Area G, Area K	20
2005	Area L	30
2008	Area A, Area B, Area H, Area L, Area M	30
2011	Area C, Area D, Area E, Area K	33
2014	Area E, Area F	30
2018	Area E, Area F, Area M	30
2025	Area C, Area D, Area K	30

Note: Refer to Figure 1 for historic project area locations. Some cores may be located beyond the boundaries of historic areas and are categorized based on the nearest region.

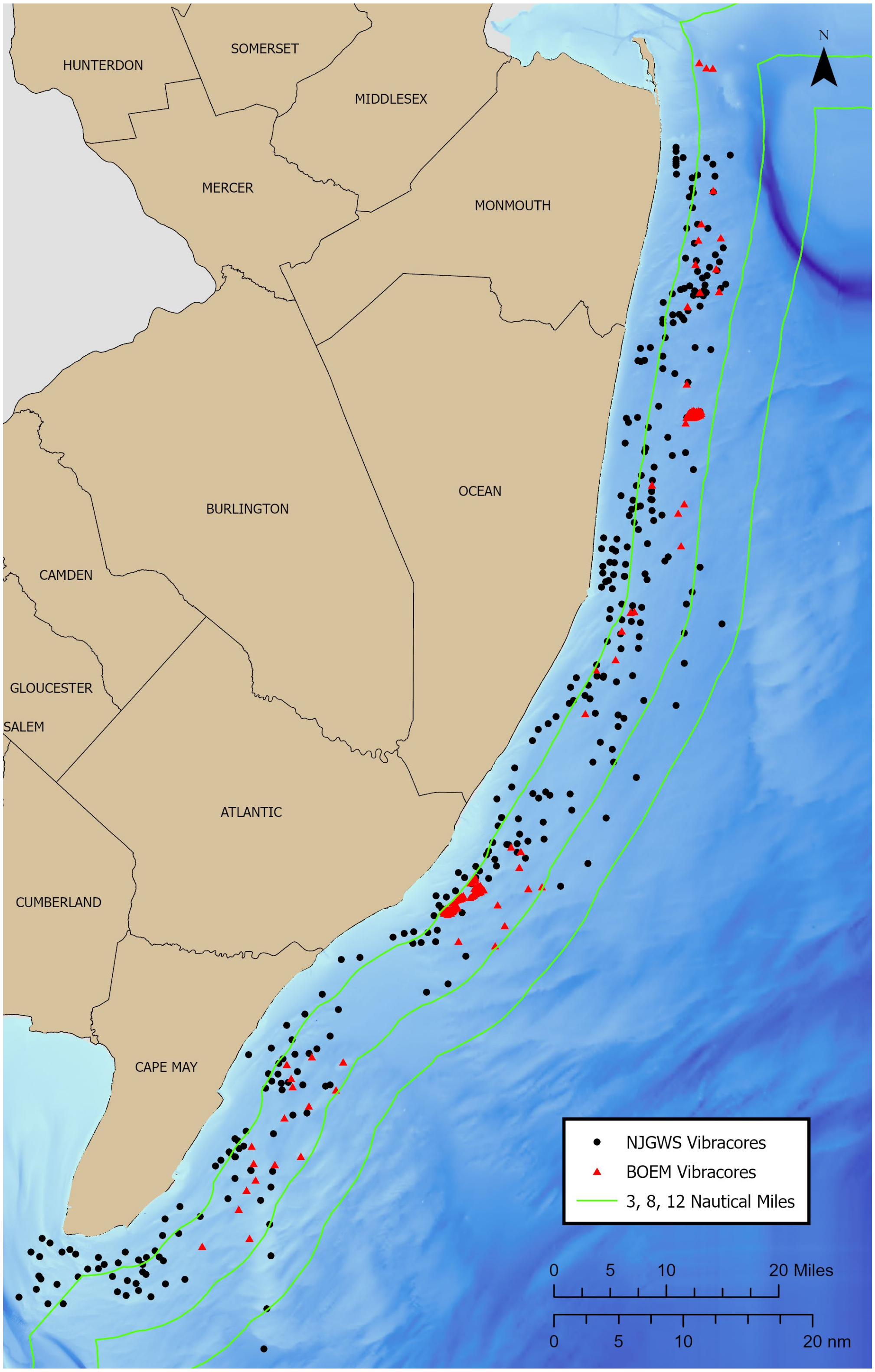

Figure 4. Core locations offshore New Jersey
Locations of offshore sediment cores collected by the NJGWS and BOEM.

4 Geologic Framework

Understanding the geologic framework offshore New Jersey will assist in identifying the location and extent of potential sand resources. By analyzing these geological formations and sedimentary structures, geologists can pinpoint areas with resources potentially suitable for economic opportunities such as commercial aggregate or heavy mineral sands associated with certain critical minerals. In addition, geologic maps are important for managing and developing regulations, proper planning for multiple uses and conflicts that may arise between stakeholders such as offshore wind development, commercial and sport fishing entities, government agencies, and environmental groups. Accurate geologic maps enable better planning and management of resources.

4.1 Offshore Geologic Maps

The NJGWS started analyzing and interpreting geologic and geophysical data in the 1990s to map offshore geology. To date, one report (Waldner and Hall, 1991) and one geologic map (Uptegrove et al., 2012) pertaining to New Jersey's offshore geology has been published. There are several offshore geologic framework publications in the process for offshore New Jersey, south of Barnegat Inlet (Figure 5):

- Cape May Map Area - Southern Cape May County
- Townsend-Absecon Map Area - Townsend Inlet to Absecon Inlet
- Brigantine Map Area - Southern Long Beach Island to Absecon Inlet

Additional contributions have been published by NJGWS staff in peer-reviewed scientific journals and conference proceedings (Uptegrove et al., 2015; Uptegrove et al., 1999). It is recommended the NJGWS prioritize comprehensive geologic mapping of offshore regions of New Jersey to support government agencies, stakeholders, and the public, facilitating informed decision-making and planning efforts. A recent study led by the Association of American State Geologists (AASG) found that the value of geologic maps is up to ten times greater than the cost of their production (Berg and Faulds, 2025).

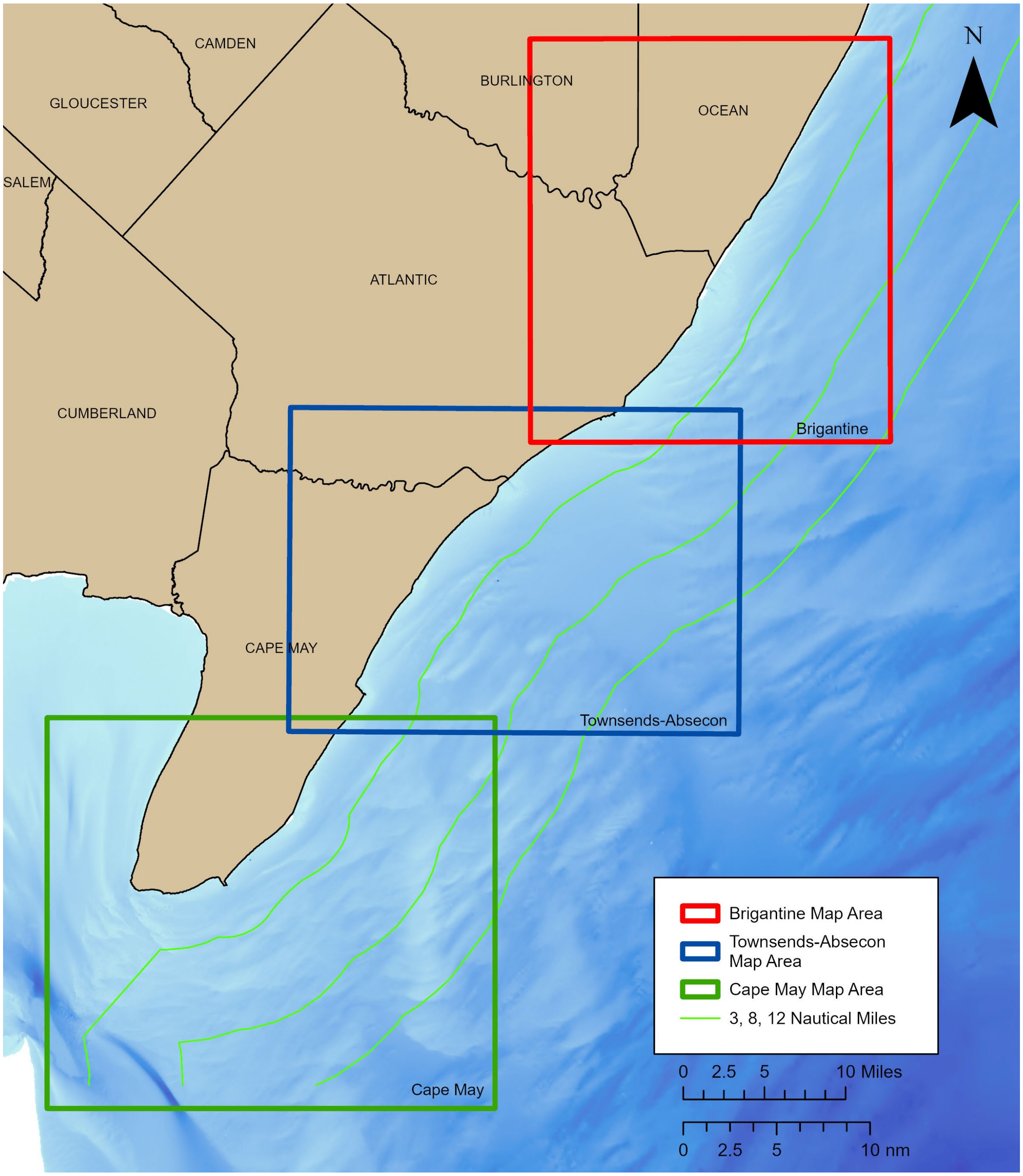

Figure 5. NJGWS offshore geologic maps in publication
Approximate areas for three NJGWS offshore geologic framework maps in the publication process.

Offshore New Jersey may contain marine heavy mineral sands with the potential for economic opportunities to extract these minerals during sand renourishment projects (Nelson et al., 2024). By mapping the offshore geologic framework, we can better predict and locate these mineral resources. With increasing demand, advances in marine exploration and analysis techniques, it is important to identify these resources to effectively manage them and prevent waste by factoring them into long-term ocean use planning. The NJGWS has one published study pertaining to heavy minerals from cores offshore Absecon Island to Barnegat Inlet (Uptegrove et al., 1991). However, this study focuses on cores collected by USACE. NJGWS currently retains approximately 325 cores (Figure 4), it is recommended to analyze all cores using mineral analysis techniques such as x-ray fluorescence (XRF). Economically viable minerals have been found onshore in New Jersey which may indicate similar deposits can be found offshore (Markewicz et al., 1958; Markewicz, 1969). It is recommended to review historical maps and reports to identify the geologic formations these minerals are found and how they relate to offshore geology.

4.2 Coastal and Marine Ecological Classification Standard (CMECS)

The NJGWS recommends the development of CMECS maps to provide a standardized classification framework of the coastal and marine environments. These maps will supplement offshore geologic maps, offering additional information about the physical characteristics of the seafloor. CMECS are valuable in various applications, including benthic habitat (e.g., seafloor substrate, geoforms, etc.) mapping, environmental impact assessments, energy development and resource management. By understanding the spatial distribution of ecological and physical characteristics of the seafloor, the maps will support BOEM's mission to manage the development of the OCS and use of its resources.

5 Sand Resources

Since the inception of the offshore program, the NJGWS has worked with BOEM and USACE to identify potential sand resources up to 8 nautical miles offshore (Figure 6). These potential sites have been addressed and shared by formal and informal channels. To date, only one significant sand resource map has been published for offshore Monmouth County as part of the BOEM cooperative agreement M14AC00002 (Castelli et al, 2015).

As part of BOEM cooperative agreement M14AC00002, two sand resource maps for northern Ocean County and northern Atlantic County were created (Kuhn, 2016; Diaz, 2018). Five new potential sand resources were identified from Manasquan Inlet to Barnegat Inlet (Figure 5), in addition to the USACE borrow areas in this region. Additional cores were recommended to further delineate and characterize these potential resources. Northern Atlantic County was also assessed to identify and characterize potential sand resources, where three main shoals were identified, overlapping with a USACE borrow area. Other potential features were identified on the seismic data but lacked supporting core data.

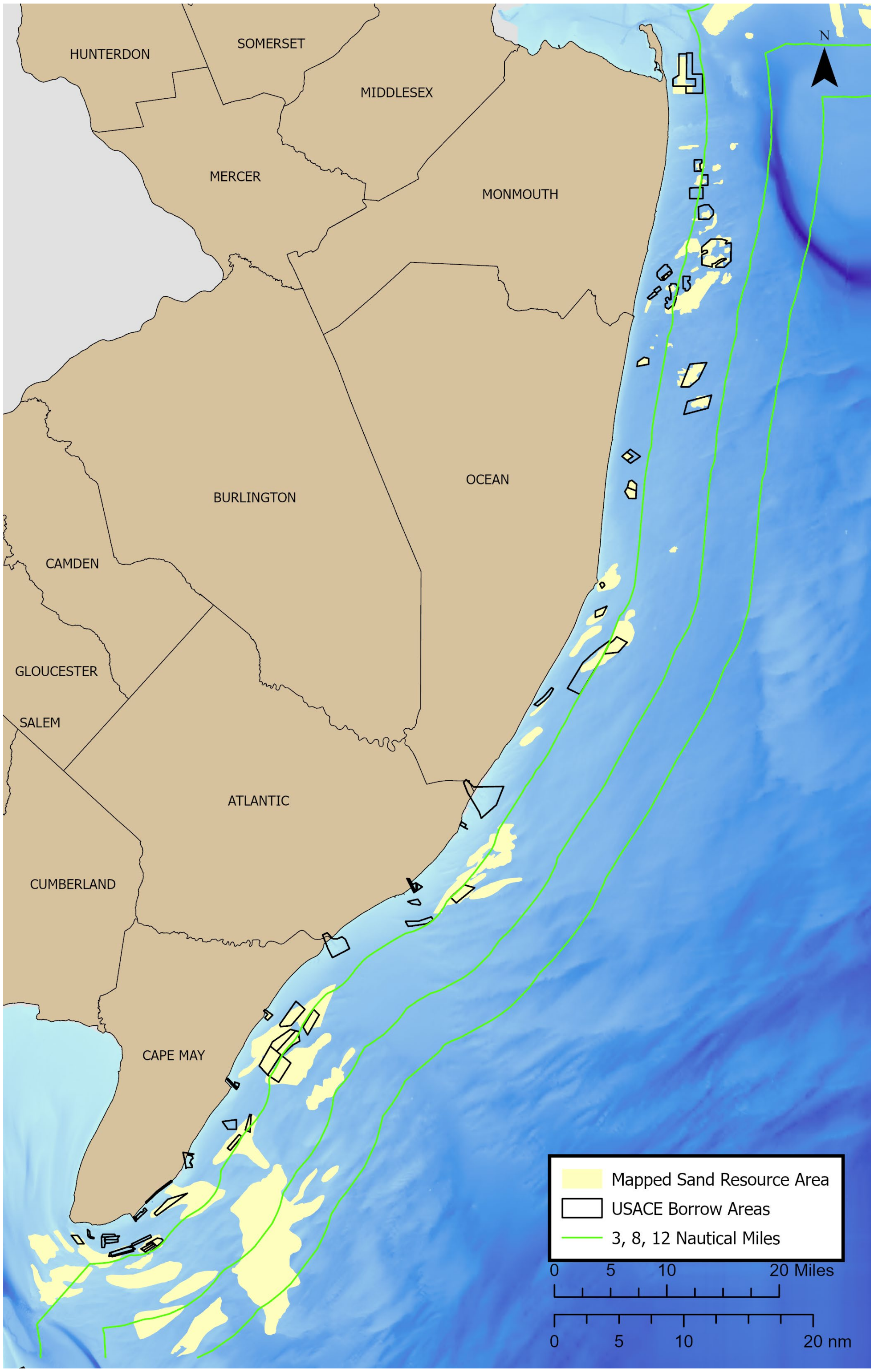

Figure 6. Mapped sand resource areas and USACE borrow areas offshore New Jersey
Map showing mapped sand resource areas and USACE borrow areas offshore New Jersey.

6 Summary

This report identifies and evaluates offshore New Jersey data gaps related to several key areas - geophysical data, geological data, offshore geologic framework maps, sand resource areas and offshore mineral resources. Historically, NJGWS has relied on boomer seismic sources, which are effective for reconnaissance level mapping of sand resources, but newer technologies may allow for better depth and resolution to accompany our current datasets. Future geophysical data acquisition surveys should integrate additional technologies to enhance data accuracy and confidence, subject to the availability of time and funding. Extending data collection beyond 8 miles, to at least 10 nm and in some cases to the 90-foot isobath, is important to characterize shallow geologic framework to identify sand resources and is essential for effective resource management amidst long-term challenges and competing uses such as energy development.

Government agencies and stakeholders have data from various offshore projects (e.g. offshore wind) that will be valuable for addressing data gaps. Consolidating datasets from these agencies and stakeholders will help NJGWS focus efforts and avoid duplication, becoming more effective resource managers and better support these other agencies. Moving forward, NJGWS should prioritize recollecting outdated seismic data, integrating new technologies, expanding CMECS surface sampling, and analyzing existing vibracores for heavy mineral content. These efforts will strengthen offshore geologic understanding, optimize sand resource management, and improve support for BOEM, USACE, and other stakeholders.

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