

**North Carolina Outer Continental Shelf Sand Resource
Investigation**

Final Summary Report

BOEM Cooperative Agreement No. M14AC00009

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Introduction

North Carolina's coastal communities find themselves increasingly reliant on tourism-based models for their economic livelihoods. In accord, these communities are devising ever more innovative ways to sustainably exploit their natural and cultural resources, and for the State's eight ocean counties (Figure 1) it is the ocean beaches that take center stage. In eastern North Carolina, tourism revenues in large measure revolve around a series of Atlantic Ocean beaches that offer high recreational value, and a proven annual multi-billion dollar revenue potential. But, for their value and importance to the coastal and State's economy, these beaches are experiencing significant rates of erosion (Figure 2). The high erosion rates are driven by the region's underlying geology, but also recent changes in storm frequency and intensity. The impact that these storms can inflict on the beaches and adjacent areas can be considerable and permanent.

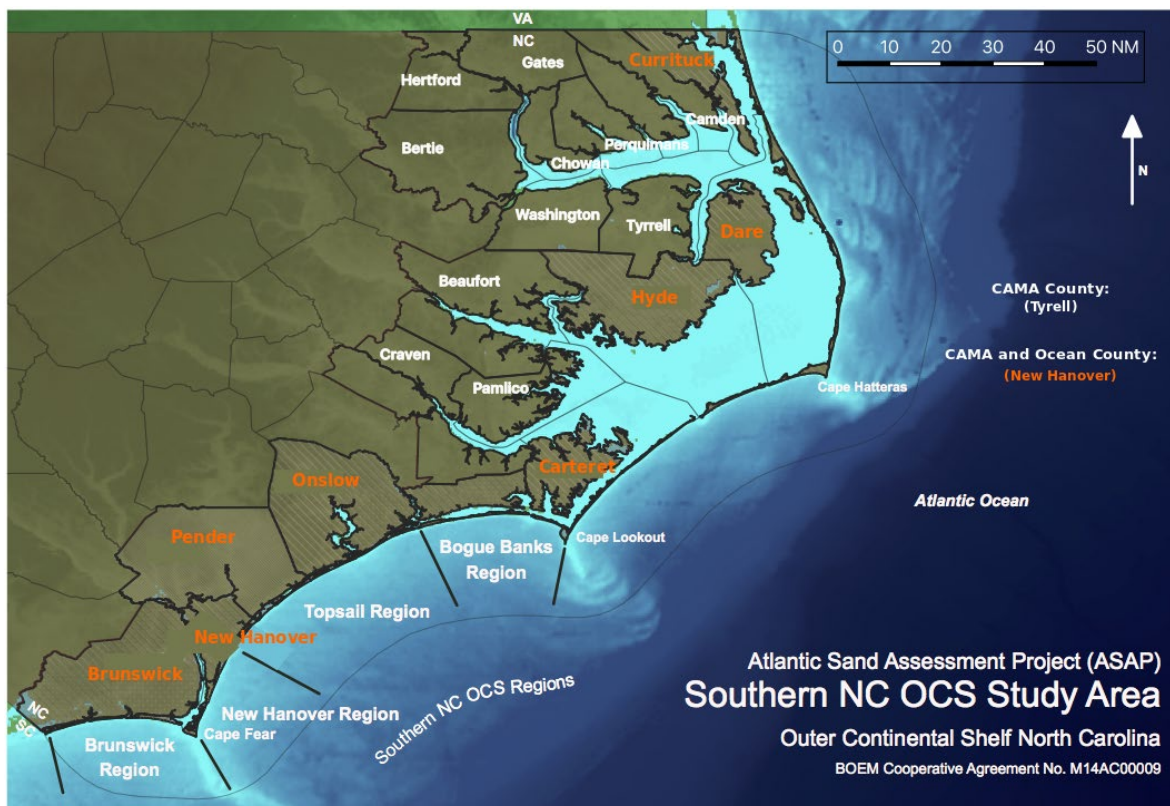


Figure 1: Eastern North Carolina showing coastal counties grouped as CAMA and CAMA plus Ocean designations, along with the location of the principal study area

Moreover, climate projections suggest that the stormy trend experienced over the past two decades can be expected to continue or perhaps worsen in the coming decades. For most North Carolina coastal communities, the only viable response to damages caused by these storms,

and/or proactive measures to ameliorate future damages, at least in the short term, is periodic beach restoration and renourishment.

Beach restoration, through sand renourishment (beach renourishment) is not a new idea in North Carolina. The Town of Wrightsville Beach near Wilmington carried out its, and the State of North Carolina's, first nourishment project almost 80 years ago (at this writing), in 1939. Since then, many other coastal counties and communities have pursued restoration projects of their own (Table 1). This trend is likely to grow in both number and frequency in the coming decades.

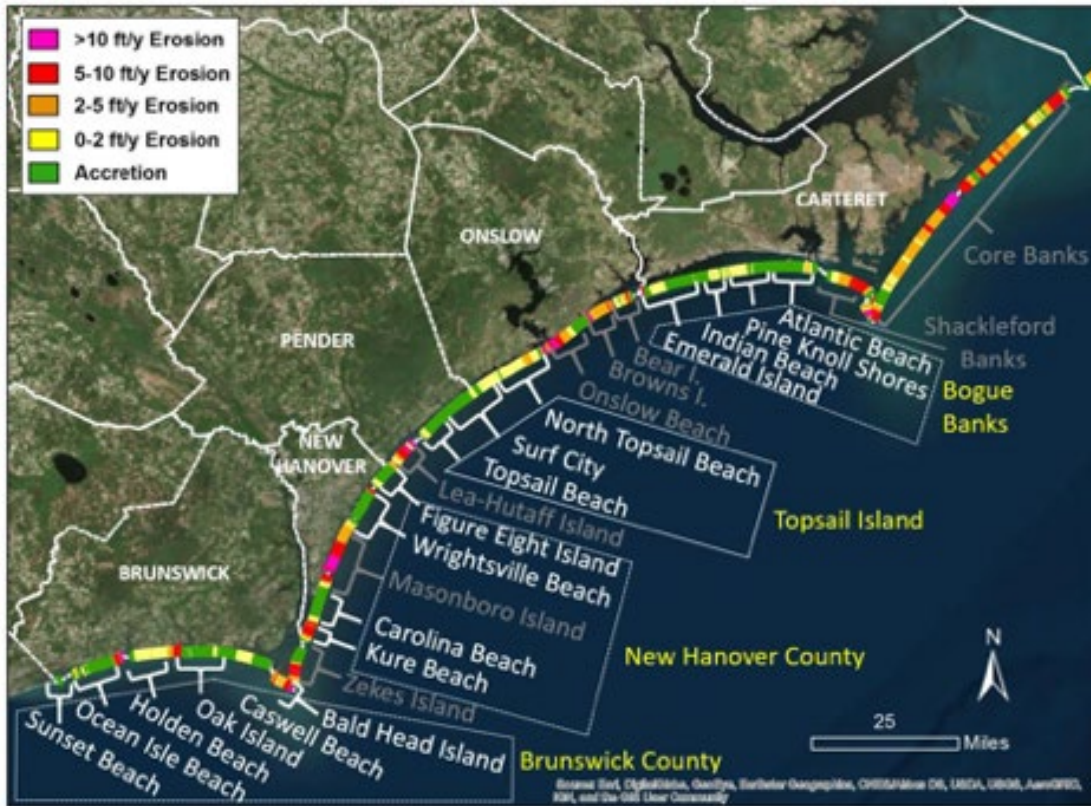


Figure 2: The four study area subregions: Bogue Banks, Topsail, New Hanover, and Brunswick with superimposed State of North Carolina determined shoreline erosion rates.

Beach renourishment can be technically complex and always expensive, but perhaps its most challenging aspect is the renourishment resource itself: beach quality sand. Finding sand of suitable composition and size, and in sufficient quantities is becoming more and more difficult. Resources have in the past, and continue to be drawn from navigation dredging projects, and nearshore mining in State-owned waters, but these are proving to be limited, especially along the coast south and west of Cape Lookout, where the geology suggests a patchy resource in generally short supply. The only recourse is to seek opportunity further offshore in federal waters (beyond 3 nm) for the much needed restoration sands. However, little is known of the resource potential in the federally-owned continental shelf south of Cape Lookout. It was a principal objective of this NC-BOEM Cooperative Investigation to further explore and expand our current

understanding of this portion of continental shelf off of North Carolina for viable sand resources that could be mined to meet community beach reconstruction needs. This study focused in the large area south of the Cape (Figure 1), a region where much less geological and geophysical research has been done, and where much less is known of the outer shelf geology. This document provides the reader with an overview of the reports, data, and other supporting materials resultant from this southeastern North Carolina Outer Continental Shelf sand resource investigation. This document provides a concise introduction to the overall beach and sand resources problem facing the state and that which inspired the investigations to address this problem. Further, this report can be used as a guide directing them to other more detailed resources included in the delivered package.

Table 1: Beach Nourishment Histories for North Carolina Coastal Communities.

Location	First Year of Record	Number of Times Nourished	Total Volume Nourished (cy)
Atlantic Beach/Fort Macon	1958	14	17,525,228
Bald Head Island	1991	12	11,186,190
Cape Hatteras	1966	3	1,812,000
Cape Lookout	2006	1	75,700
Carolina Beach	1955	36	19,803,048
Caswell Beach	2001	2	256,600
Emerald Isle	1984	19	4,571,214
Figure Eight Island	1977	26	6,113,852
Hatteras Island	1974	7	887,801
Holden Beach	1971	49	4,661,045
Indian Beach/Salter Path	2002	3	1,385,692
Kill Devil Hills	2004	1**	38,016
Kitty Hawk	2004	1**	143,000
Kure Beach	1998	6	5,964,932
Masonboro Island	1986	6	3,234,686
Nags Head	2001	3	4,800,000
Oak Island	1986	9	6,545,287
Ocean Isle Beach	1974	18	4,479,790
Ocracoke Island	1986	5	516,062
Onslow	1990	4	405,829
Pea Island	1990	20	9,673,228
Pine Knoll Shores	2002	6	2,969,185
Rodanthe	2014	1	1,618,083
Topsail Island	1982	20	5,394,479
Wrightsville Beach	1939	26	14,709,157

**Note that projects in Duck, Kitty Hawk, and Kill Devil Hills completed in 2018 are not included here.

NC-BOEM Data and Deliverable Products:

Walsh, J.P., Conery, I.W., Paris, P., Corbett, D.R., Mallinson, D., 2019. NC-BOEM Cooperative Agreement, Atlantic Sand Assessment Project (ASAP), Final Technical Report.

Synopsis: This report focuses strictly on the sand resources mapped along the North Carolina outer continental shelf south of Cape Lookout as part of the larger ASAP investigation. Maps displaying data collection sites and resource (sand body) estimates for each of the four subregions (Bogue Banks, Topsail, New Hanover, and Brunswick) are the centerpiece of the study.

Abstract: Tangible deliverables from the ASAP investigation conducted as a central part of this sand assessment project include spatial data products that locate and describe potential sand bodies, specifically identifying areas where subsurface material depths likely meet or exceed specified thresholds (i.e., > 5 ft and > 10 ft body thicknesses). This sand resources report provides a brief description of these data, along with representative maps which depict the location and approximate sand material quantities.

Field data collection associated with the ASAP included a series of shallow, sub bottom seismic (chirp) surveys, bathymetry, surface sediment samples, and 24 shallow (approximately 20 ft.) cores (Figure 2). The seismic data was manually interpreted to generate sediment thickness estimates along the survey lines using the commercial software application SonarWiz. The core data was sampled and analyzed using standard grain size analytical techniques. Fractions included bulk sand, silt, and clay components. When warranted, the sand component was further evaluated using mechanical sieves. This report focuses on and describes the former sediment thickness assessments. The latter core sediment analyses are described elsewhere in the Full Investigative Report (Project Deliverable: F).

The seismic interpretations attempted to locate shelf surface and subsurface sediments of relative recent (geologic) age that offered potential suitable sand resources for beach restoration projects in the state. Seismic reflectors were identified in software to locate the horizontal and vertical extents of unconsolidated Quaternary (QT and QC) and later Holocene (H) sedimentary near-bottom material units. The Quaternary designations QC and QT units distinguish channel-fill and non-channel sediments, respectively. Data is included here which provides the location of and volumetric extents for each of these units. In addition, in accord with the requirements as specified in Agreement M14AC00009, a composite thickness estimate that includes sediments from the H, QT, and QC unit layers is included, with depths defined in continuous units of meters and U.S. feet, along with depths grouped (binned) into 0 to 5 foot, 5 to 10 foot, and greater-than 10 foot thick divisions. These data are presented as a series of map graphics in the

Regions section of that report (see the accompanying ASAP Technical Report elsewhere in this archive). The raw data used to produce the maps is found GIS-ready in the accompanying [open-source format] geopackage.

Walsh, J.P., Conery, I.W., Paris, P., Corbett, D.R., Mallinson, D., 2019. Geological and geophysical data and information for the federally-managed outer continental shelf off North Carolina south of Cape Lookout.

Numerous data were collected and/or derived as part of this project. These data include:

- Geospatially referenced seismic survey track lines
- Geospatially referenced track line sample points with thickness and binned thickness attributes
- Vibracore sedimentological interpretations w/geochronology
- Sediment grain size analysis (wet and dry) results
- A master ESRI file-geodatabase containing a wealth of geospatially referenced data sets associated with the project

Walsh, J.P., Conery, I.W., Paris, P., Corbett, D.R., Mallinson, D., 2019. NC-BOEM Cooperative Agreement, Final Full Investigative Report.

Technical report and review of the state of knowledge, findings from the current research conducted as a part of this investigation, and priorities for future exploration and research.

Synopsis: This is the principal or core report for the study. The report first introduces the reader to the current beach erosion/restoration issue that impacts coastal North Carolina, providing some economic justification for the importance of and need for efforts to restore and maintain the state's often heavily-touristed ocean beaches. It then goes on to provide a discussion on the state of geologic and geophysical knowledge of the continental shelf area south of Cape Lookout south to the North Carolina - South Carolina border and our current assessment of the known sand resources. The core of the report, however, directs focus at a larger geographic scale study of a portion of the outer shelf between 5 and 8 nm offshore, where shallow seismic (chirp) subsurface structure was recorded along with a series of shallow cores, and surface sediment (grab) samples. Using the seismic data in concert with the core and surface samples for locational verification, sand bodies meeting prespecified project criteria (5-10 ft and > 10 ft interpreted bed thicknesses) were identified and mapped. These results are shown in brief in the overview report (Deliverable D). This report discusses the interpretations in greater detail. The final component of the report provides suggestions for where follow-up investigation(s) might best be directed in seeking out beach restoration/renourishment sands.

Abstract: Since 2000, 52 tropical cyclones (23 as hurricanes) have passed within 300 miles of the North Carolina coast (North Carolina Climate Office, 2019). Not all of these storms recorded heavy damage to the shoreline, but storms such as Isabel (2003), Irene (2011), Sandy (2012), Arthur (2014), Matthew (2016), Florence (2018), and Michael (2018) left behind impacts, including erosion to the State's ocean beaches. As a result of these and other storm events (e.g., nor'easters), many communities in NC are looking to beach nourishment as a way to protect their economically valuable beach-dune systems. However, there remains limited knowledge of offshore borrow areas for replenishment projects.

A review of the potential sand resource needs and borrow area knowledge was conducted in 2017 (NCDCM, 2017). The work described in this report builds on that effort, with a specific focus here on the offshore waters south of Cape Lookout where new data are available. Resources are anticipated to be limited, and demand will likely increase with sea-level rise and storm activity. This study examined new seismic data, shallow sediment cores, and sediment surface samples collected as part of the Atlantic Sand Assessment Project (ASAP). Much of the data analysis presented was conducted as part of doctoral research by Ian Conery at East Carolina University (Conery, 2019).

The principal objective of this project is to expand our knowledge of the replenishment resources that might potentially be available to NC coastal communities for future beach nourishment projects. The effort aimed to increase the inventory and database of information available in federal waters of the Outer Continental Shelf (OCS) offshore (3-8 nautical miles) of North Carolina. Specific goals of this report are three-fold: 1) to provide an overview of the need for sand resources and related data offshore of North Carolina, 2) to review and interpret the range of geological and geophysical information and data currently available and 3) to identify and prioritize future research needs in the OCS.

References:

- North Carolina Climate Office, 2019. North Carolina State University, Raleigh, NC.
- North Carolina Division of Coastal Management (NCDCM), 2017. North Carolina Coastal Sand Resource Availability Report.
- Conery, I.W., 2019. From Dunes to Shelf Deposits: A Multidisciplinary Investigation of Coastal Sand Management in North Carolina. Unpublished Ph.D. Thesis. East Carolina University, Greenville, NC. 164 p.

Walsh, J.P., Conery, I.W., Paris, P., Corbett, D.R., Mallinson, D., 2019. NC-BOEM Cooperative Agreement, Scientific Communication and Outreach efforts.

Peer and public communication, outreach, and engagement was a key component of this NC-BOEM Cooperative Agreement. The list below provides examples of project associated education and outreach:

- Conery, I. and Walsh, J, 2016. Beach Sand Needs, Offshore Data Availability and Resource Re-evaluation, Northeast NC. The American Shore and Beach Preservation Association (ASBPA) National Conference, October 2016. Long Branch, NJ.
- Walsh, J.P., 2016. Geological and Geophysical Data Offshore North Carolina for Sand Resources: Availability, Analysis and Needs. 2016 American Shore and Beach Preservation Association (ASBPA) in Long Branch, New Jersey.
- Conery, I., and Walsh, J. American Geophysical Union (AGU) Fall Meeting, December 2016. San Francisco, CA. Poster presentation and abstract: Offshore Sand Resource Needs, Data Availability and Revaluation, and Beach Nourishment Projects in North Carolina.
- Interview : The Virginia-Pilot 5/20/16; Types of sand become a tricky, vital part of storm protection in Outer Banks beach nourishment;
http://pilotonline.com/news/local/environment/beach-nourishment-projects-show-outer-banks-towns-have-different-kinds/article_961d04eb-2268-5ef9-8ef2-5e2b614ffc8.html
- Corbett, D. R., 2017. Water, Water Everywhere: North Carolina's Changing Coastline and Increased Vulnerability. UNC CSI Science on the Sound. Wanchese North Carolina.
- Corbett, D.R. Fall 2017. ECU Graduate Education. Coastal Geoscience field trip to OBX to study coastal processes and sand resource mapping. Coastal Studies Institute, Wanchese, NC.
- Corbett, D. R., 2017. Dynamics of the Coast from an OBX Perspective. Southern Shores Town Meeting - Nourishment Discussion. Southern Shores, North Carolina.
- Conery, I. 2019. Dissertation Defense and Public Seminar, April 2019, Coastal Studies Institute. Wanchese, NC. From Dunes to Shelf Deposits: A Multidisciplinary Investigation of Coastal Sand Management in NC

Walsh, J.P., Conery, I.W., Paris, P., Corbett, D.R., Mallinson, D., 2019. NC-BOEM Cooperative Agreement, Archive disks and delivery of project reports and data to BOEM.

Synopsis: The reports and data, along with other supporting materials used during and/or resulting from the conduct of this investigation have been bundled into a project archive for distribution and archival storage both at BOEM Headquarters in Sterling, Virginia, and at the Coastal Studies Institute (CSI) in Wanchese, North Carolina. Copies of the archive were presented to BOEM as directed in the initial agreement. The archive, in whole or in part, can be obtained from either source (BOEM or CSI) or downloaded from the USGS/BOEM data portal.