OCS Study
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North Carolina Collaborative Archaeological Survey: Kitty Hawk Wind Energy Area

BOEM
Bureau of Ocean Energy Management

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

National Marine Sanctuaries
NOAA

U.S. Department of Commerce
National Oceanic and Atmospheric Administration

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DISCLAIMER

This study was funded by the United States (U.S.) Department of the Interior, Bureau of Ocean Energy Management (BOEM), through Interagency Agreement Number M15PG00003 with the National Oceanic and Atmospheric Administration (NOAA), Office of Marine Sanctuaries. This report has been technically reviewed by BOEM and NOAA and it has been approved for publication. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

REPORT AVAILABILITY

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ABOUT THE COVER

Target 24: An F-14 Tomcat fighter jet identified within the Kitty Hawk Wind Energy Area.

ACKNOWLEDGEMENTS

The North Carolina Collaborative Archaeology Survey represents the third in a series of successful research studies conducted by the Bureau of Ocean Energy Management (BOEM) and the National Oceanic and Atmospheric Administration's (NOAA) Monitor National Marine Sanctuary, along with other partners. These field studies are designed to survey and ground-truth potential archaeological sites to support environmentally-responsible renewable energy development on the Atlantic Outer Continental Shelf.

These studies follow a model – first tested and vetted offshore Massachusetts and reported in the *Collaborative Archaeological Investigations and Sound Source Verifications within the Massachusetts Wind Energy Area* (available at http://www.boem.gov/Collaborative-Archaeological-Investigations-and-Sound-Source-Verifications-Final/) – that relies upon Federal and state agencies, university partners, and others working together toward this common goal. Previous partnerships with NOAA under this framework include the *Virginia Collaborative Archaeological Survey* (available at http://www.boem.gov/VCAS-Report) and the *Maryland Collaborative Archaeological Survey* (available at https://www.boem.gov/MCAS-Report-Final-Public/).

Like its predecessor studies, the North Carolina Collaborative Archaeological Survey is the result of the concerted efforts of many individuals and organizations who brought to the project the necessary instruments, field equipment, dive operations support, and knowledge to ensure a safe, successful field season. Without committed individuals and their contributions, none of these studies would have been possible.

The authors wish especially to acknowledge John McCord of the University of North Carolina Coastal Studies Institute (CSI) for photography and boat operations/logistics; Eric Diadorrio and Jason Nunn of East Carolina University (ECU) for boat operations/logistics; Scott Sinclair of Cardinal Point Captains for ensuring operational safety and efficient vessel logistics; Steve Hall and David Wells of University of North Carolina Wilmington for vessel operations; Anne Wright of ECU for dive support; Dr. James Moore of BOEM for support during survey operations; E. Kimball Thompson of the U. S. Naval Safety Center for providing background information related to the F-14 site; and Paul Conigliaro and Michael Heinz for providing interpretation of the F-14 site and sharing their expertise on military aircraft.

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ACRONYMS AND ABBREVIATIONS

BOEM	Bureau of Ocean Energy Management
BUNO	Bureau Number
CMDR	Commander
CSI	Coastal Studies Institute
DOI	Department of the Interior
ECU	East Carolina University
ft	foot/feet
km	kilometer(s)
km^2	square kilometer(s)
kHz	kilohertz
kt	knot(s)
LCMD	Lieutenant Commander
m	meter(s)
m^2	square meter(s)
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NRHP	National Register of Historic Places
OCS	Outer Continental Shelf
RIO	Radar Intercept Officer
UNCW	University of North Carolina Wilmington
U.S.	United States
USCG	United States Coast Guard
USN	United States Navy
USS	United States Ship
WEA	Wind Energy Area

INTRODUCTION

With the passage of the Energy Policy Act of 2005, The Bureau of Ocean Energy Management (BOEM) acquired regulatory authority for renewable energy activities on the Outer Continental Shelf (OCS), including wind energy development. As part of this responsibility, BOEM conducts detailed environmental analyses of projects proposed for development. The potential direct, indirect, and cumulative impacts on the human, coastal and marine environments must be evaluated in order for BOEM to make environmentally sound decisions about managing renewable energy activities and developing mitigation measures to avoid or minimize impacts.

BOEM's overarching strategic goal is to achieve expeditious and orderly development of energy resources, while minimizing impacts on the environment. BOEM accomplishes this goal, in part, by developing and employing sound science and partnerships. As such, BOEM unites its need to gather baseline data with efforts to leverage partnerships with other Federal agencies, state agencies, universities, and tribal governments. Doing so creates efficiencies in BOEM's processes; reduces expenditures; builds relationships that will extend these efficiencies and cost reductions into the future; and provides needed data to inform sound decision-making in the present.

At the inception of this project in 2016, BOEM was considering issuing commercial wind energy leases offshore North Carolina within the Kitty Hawk Wind Energy Area (WEA). On March 16, 2017, BOEM announced the completion of the nation's seventh competitive lease sale for renewable wind energy in Federal waters within the Kitty Hawk WEA and subsequently executed a commercial lease with a wind energy developer. BOEM has a need for baseline archaeological data within wind energy planning and lease areas in order to make sound decisions about how to minimize impacts, to form post-construction comparisons during monitoring of environmental changes that might be discernable later, and to meet its responsibilities under Sections 106 and 110 of the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA). Identified geophysical targets (e.g., sidescan sonar contacts and magnetic anomalies) in these areas may prove to be archaeological resources that should be avoided, or they may prove *not* to be resources and therefore should not prevent development within a specific area of the seafloor. Archaeological identification and ground-truthing of these targets is necessary for informed, responsible decision-making and to assist BOEM in considering the effects of its undertakings subject to review under the NHPA and NEPA.

To meet these needs, BOEM invited the National Oceanic and Atmospheric Administration (NOAA) to collaborate via an Interagency Agreement to conduct a baseline archaeological survey near and within the Kitty Hawk WEA (Figures 1 and 2). NOAA provided scientific and technical advice and services, shared its resources, and assisted BOEM with conducting and analyzing the resulting data. This partnership afforded both BOEM and NOAA a unique opportunity to share equipment and expertise for mutual benefit. BOEM and NOAA jointly finalized a research design, collaboratively performed the survey and investigations, analyzed results, and produced this joint report.

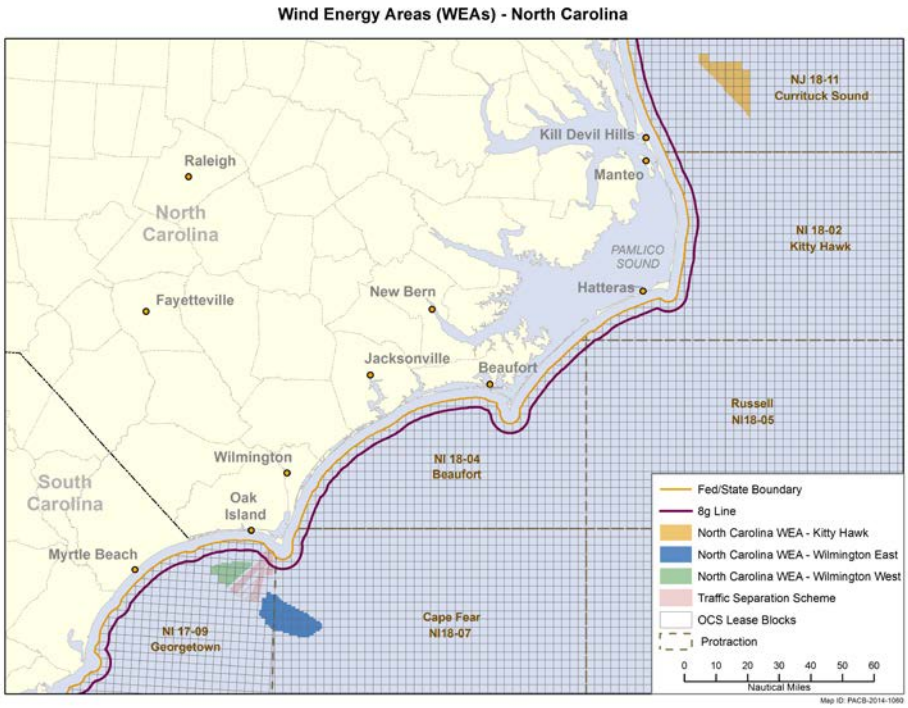


Figure 1. North Carolina Wind Energy Areas.

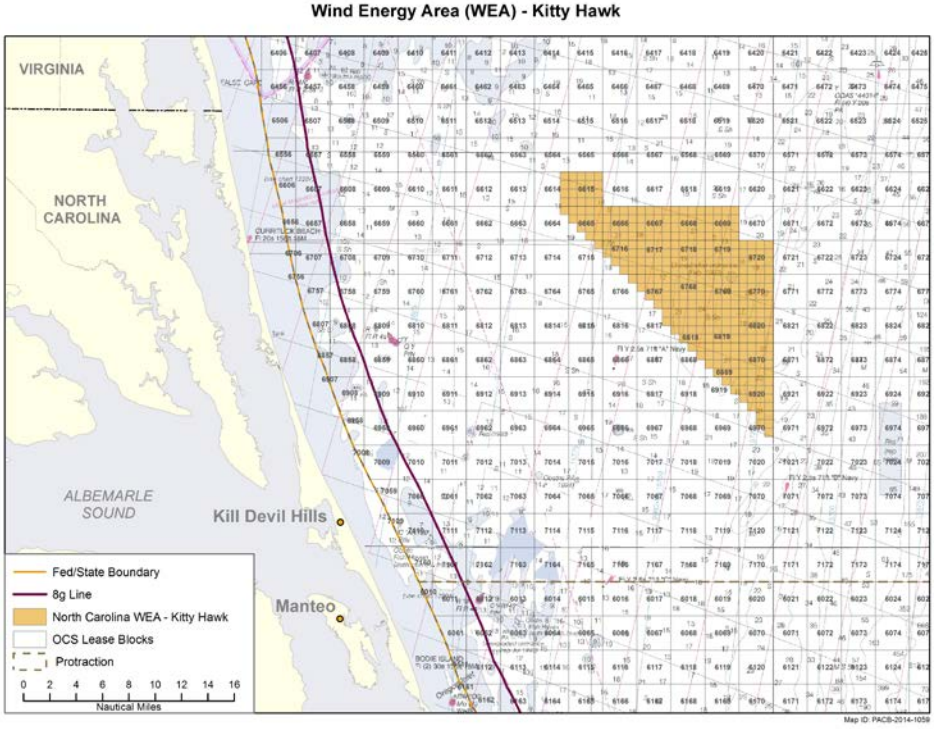


Figure 2. Kitty Hawk Wind Energy Area.

This report presents the results of baseline archaeological investigations of areas within and adjacent to the Kitty Hawk WEA. The Introduction presents the objectives of the study, the research design prepared to guide the study tasks, scope and limitations of the study, and personnel participating in the project. The Methods section outlines the techniques employed for the sidescan sonar survey and diver investigations. The Results section presents the outcome of the remote sensing survey and ground-truthing of selected targets. Finally, the Conclusions section provides a summary of the results, recommendations for each target and future considerations.

A single technical appendix was prepared to supplement this report. It contains sensitive information pertaining to the location of potential archaeological resources identified during this survey. In order to protect the locations of potential archaeological resources, the technical appendix is not included in the publically-available version of this report.

Objectives

The objective of the project was to obtain limited baseline archaeological data within and adjacent to the Kitty Hawk WEA to inform future decision-making. Project goals were achieved by conducting a reconnaissance-level sidescan sonar survey of portions of the WEA[1], followed by ground-truthing, via diver-based investigation, of selected targets of archaeological potential.

Research Design

The research design identified several tasks to achieve these objectives. Where possible, these included:

1. Perform reconnaissance-level, sidescan sonar survey of portions of the Kitty Hawk WEA;
2. If warranted, based on the results of the remote sensing data, conduct diver investigation of sidescan sonar targets that may represent archaeological remains;
3. Perform a rapid assessment, exterior survey of each target that is confirmed to be an archaeological resource;
4. As conditions allow, produce a cursory site map or photo-mosaic of each archaeological resource for interpretation and use in potential follow-up inquiry;
5. Conduct video and photographic surveys of confirmed archaeological resources;
6. Identify to what degree archaeological site preservation is influenced by environmental conditions, site formation processes, and anthropogenic impacts (e.g., determine whether the site has been subject to post-deposition looting or disturbance due to trawling or other activities);
7. Assess the historical significance and integrity of each confirmed archaeological resource;
8. Determine whether the archaeological resource warrants further investigation; and

[1] The reconnaissance-level side scan sonar survey performed as part of this archaeological investigation provided useful information for this study's specific purpose. However, it is insufficient to entirely replace the site characterization survey performed in support of a Site Assessment Plan or Construction and Operations Plan because the needed resolution of data for site characterization survey is of greater quality and a site characterization survey employs a suite of multiple instruments not utilized here.

9. If possible, determine if any confirmed archaeological resource possesses the characteristics of significance making it eligible for listing on the National Register of Historic Places (NRHP).

Scope and Limitations

This project was not designed to represent a comprehensive investigation, and therefore should only be viewed as a preliminary baseline assessment upon which future assessments can be founded. Furthermore, this investigation does not replace the need for site-specific archaeological identification survey to take place prior to future renewable energy development within the WEA. However, without baseline field data, it is difficult to ascertain the nature of potential archaeological resources that may be present and to broadly characterize seafloor and environmental conditions within an area.

As with any project, certain limitations are present that are taken into account in preparing the expedition. Fiscal constraints limited the amount of time and the availability of resources, which ultimately governed the duration of the project. As such, the sidescan sonar survey was designed as a low-resolution, reconnaissance-level survey to provide as much coverage of the WEA as possible within the available timeframe. It was also not anticipated that all sonar targets would be ground-truthed; therefore targets of archaeological potential were prioritized to ensure that the highest priority targets were investigated. Additionally, weather and sea state conditions offshore North Carolina varied greatly, and days of inactivity were anticipated and accounted for during the survey effort. During these weather days personnel processed the collected data sets. This particular survey was hampered at times due to unfavorable weather conditions delaying sidescan sonar operations; however, this did not ultimately prevent the planned, limited investigation of prioritized targets.

Additionally, working in the underwater environment poses certain limitations. High and variable currents were present offshore North Carolina, and visibility ranged from zero to more than 15 meters (m; 49.2 feet [ft]). These factors produced differing degrees of in-water efficiency from day-to-day. Furthermore, the depth of many of the sites, which ranged roughly from 36 to 45 m (118.1 to 147.6 ft), greatly limited accessibility and the amount of time spent on any particular site. Finally, target investigation was limited only to exterior observations of archaeological sites. The research team did not conduct any work that would impact or disturb a site in any way. This precluded establishing permanent baselines; recovering artifacts; or manipulating anything on-site.

Personnel and Roles

The following individuals participated in the investigation:

1. Brandi Carrier – BOEM: Archaeologist
2. Nick DeLong – Coastal Studies Institute (CSI)/East Carolina University (ECU): Data Technician
3. Eric Diadorio – ECU: Captain
4. Steve Hall – University of North Carolina Wilmington (UNCW): Captain

5. William Hoffman – BOEM: Co-Principal Investigator
6. Joseph Hoyt – NOAA: Co-Principal Investigator
7. John McCord – CSI: Photography
8. James Moore – BOEM: Archaeologist
9. Jason Nunn – CSI/ECU: Diving Safety and Logistics, Captain
10. Will Sassorossi – NOAA: Co-Principal Investigator
11. Scott Sinclair – Cardinal Point Captains: Captain
12. Dave Sybert – CSI: Photo and Video
13. David Wells – UNCW: Captain/Survey Support
14. Annie Wright – ECU: Archaeologist

METHODS

The project included both sidescan sonar survey and ground-truthing of selected targets of archaeological potential located within and adjacent to the Kitty Hawk WEA (Figure 2). Fieldwork consisted of at-sea operations from the CSI *West Cove III*, a 12.8-m (42-ft) Duffy research vessel and the UNCW R/V *Seahawk*, a 10.7-m (35-ft) research vessel (Figures 3 and 4). Both vessels provided platforms for sidescan sonar survey and diving operations.

Figure 3. CSI's *West Cove III*.

Figure 4. UNCW R/V *Seahawk.*

Sidescan Sonar Survey Methods

The preliminary reconnaissance-level survey took place from *West Cove III*. The survey utilized a Klein 5000 sidescan sonar operating at a frequency of 100 kilohertz (kHz). Survey line spacing was set for 100 m (328.1 ft) and oriented in a North/ South pattern over the Kitty Hawk WEA with the goal of achieving 100 percent, but not overlapping, sonar coverage of the seafloor (Figure 5). Sonar data were acquired using HYPACK 2016 and navigation information was input from a Trimble GPS unit mounted at the sonar tow point on the vessel's A-Frame. The Klein 5000 sidescan sonar was deployed from the tow point of the vessel's A-Frame using 0.40 inch armored cable, utilizing a lighter weight K-1 depressor wing to tow the sonar closer to the ocean floor. The sonar was towed at a speed that varied between 6.5 to 8.5 knots (kt).

Post-processing of the raw sidescan sonar data was required for target assessment and was conducted using HYPACK 2016. Assessment included review of the length, size of acoustic shadow, and reflectivity of selected sonar targets. Individual sidescan sonar transects were analyzed for sonar contacts. These contacts were then projected onto the mosaics where they were geo-rectified. Using the target feature, all contacts were measured for length, width, and height off of the seafloor. Images of individual sidescan sonar targets were generated during the post-processing. Both a designation and description of each target were also created. The final product was a database, which included the coordinates, dimensions, and a thumbnail sonar image of each individual target.

A subsequent phase of the sidescan sonar survey was conducted to refine target locations and acquire higher resolution imagery of selected targets identified during the reconnaissance-level survey. This survey was conducted from the R/V *Seahawk* and utilized a Klein 3000 sidescan sonar operating at a frequency of 500 kHz. A survey grid was established over each individual target location and lines were surveyed in a North/South orientation at a 30-m line spacing to re-locate and re-image the target at higher resolution. The Klein 3000 sidescan sonar was deployed from the tow point of the vessel's A-Frame using a Kevlar-armored cable and was towed at a speed between 3 to 4 kt.

Positioning information was input from a Trimble GPS unit mounted near the tow point of the vessel's A-Frame, and the survey lines were navigated using HYPACK 2016. Sonar data were acquired using Klein's SonarPro software. Targets were re-identified in real-time during the survey and were plotted on multiple and overlapping survey lines to refine the accuracy of the target positioning.

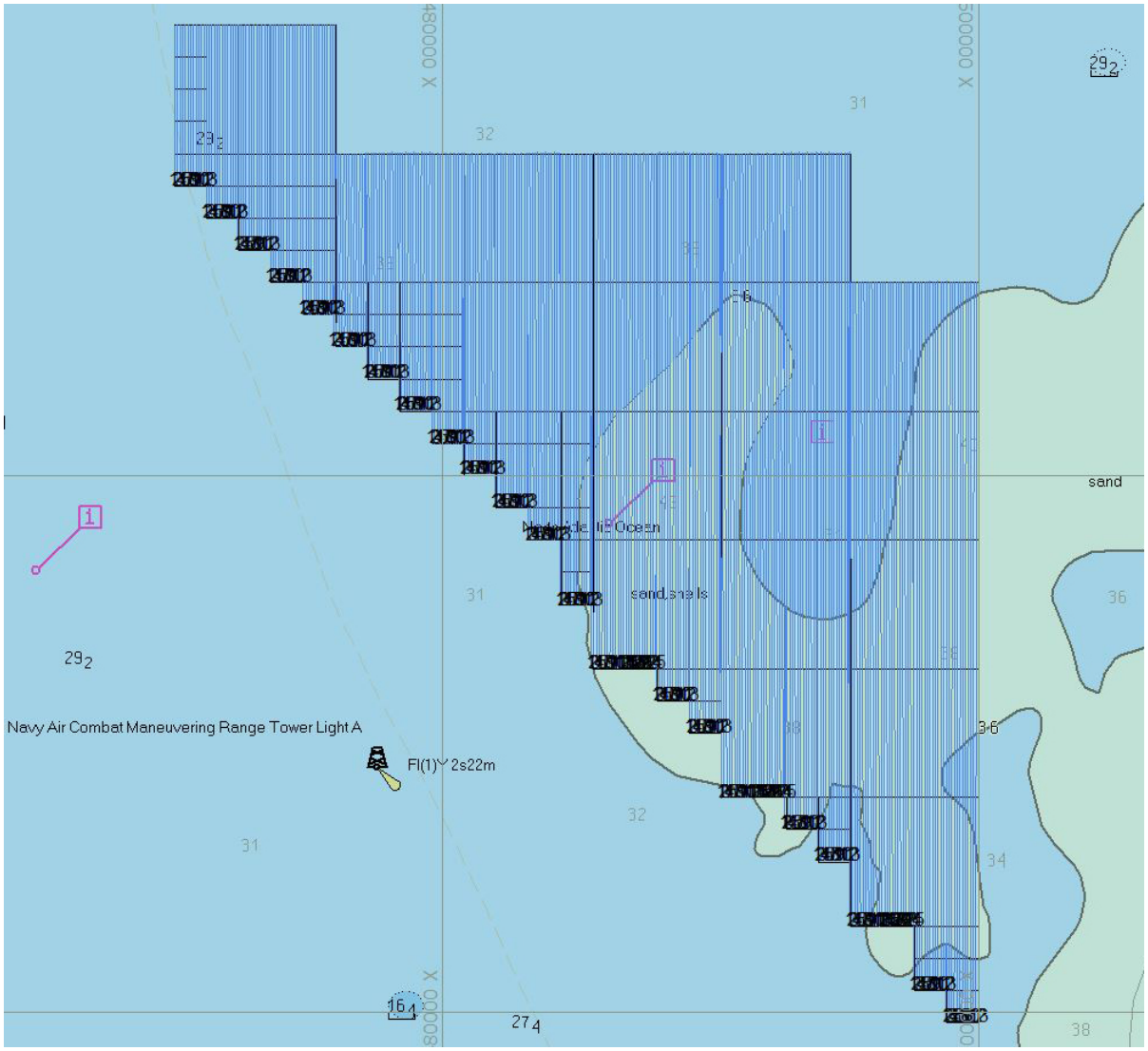


Figure 5. Planned reconnaissance survey lines within the Kitty Hawk WEA.

Diver Investigation Methods

The methodology for diver investigation consisted of the direct visual inspection of targets to ground-truth the sidescan sonar data and to determine if targets represent archaeological resources. Diving operations were conducted in a "live boat" mode. This method eliminated the need for and mitigated the possible impact of anchoring into an archaeological resource. If, upon inspection by scientific divers, a target was determined to not be archaeological (e.g., geological features, modern marine debris) no additional investigation was conducted. If, however, targets were confirmed as archaeological resources, the following protocols were employed to guide additional documentation and assessment. The protocols were designed to provide flexibility and adaptability based on the nature of the individual site under investigation.

In-Water Documentation Protocols

1. Documentation of the sites by observing and recording diagnostic features.
    a. Identify and record diagnostic structural features such as deck machinery, hatches, etc.
    b. Identify and record hull damage due to the sinking event, if evident.
    c. Identify and record hull damage caused to the sites post-sinking due to natural and/or man-made causes, if evident.
    d. Identify and record all exposed artifacts within the site's immediate vicinity.
    e. Identify, record, and determine the extent of hazardous material remaining on the site while maintaining all safety protocols.

2. As conditions allow: Create scaled photo-mosaics of the sites by generating plan and profile photo-mosaics and also supplement with hull measurements.
    a. Conduct plan view photo-mosaic survey.
    b. Conduct profile and oblique photo-mosaics surveys.
    c. Combine photo-mosaic data with the diver generated site plans.

3. Identify and document areas on the sites to monitor hull and structural degradation over time.
    a. Select features on the bow, amidships, and stern that would best illustrate hull and structural degradation over time.
    b. Document the extent of the features' degradation.
    c. Clearly identify the features on the site plans for future reference.
    d. Document the hull's list on the sea floor by calculating the degree of angle with a clinometer to determine the current pitch and roll of the hull.

4. Document artifacts, and any hazardous material, *in situ* showing their spatial relationships (vis-à-vis the rest of the shipwreck).
    a. Video, measure, and record exposed artifacts and hazardous material *in situ*, in addition to their relation to the rest of the site.
    b. Identify artifacts visible on the seafloor, if present.

Site Assessment Protocols

1. Identify the sites and make recommendations for future management.
    a. Identify a respective site's name and type.
    b. Assess if historical accounts coincide with archaeological interpretations.
    c. Assess whether additional fieldwork is needed.
    d. Consider eligibility for listing in the NRHP.
    e. Make suggestions for public interpretation.

2. Determine if remaining artifacts are visible and/or threatened.
    a. Identify artifacts of historical significance or unique type.
    b. Evaluate danger to artifacts if left undisturbed.

3. Determine if there are environmental hazards remaining at the sites and make recommendations for their possible removal or neutralization.
    a. Identify environmental hazards at the site and contact the appropriate government oversight agency, if warranted (e.g., United States Coast Guard [USCG])
    b. Identify ordnance at the site and contact the appropriate government oversight agency (e.g. U.S. Navy [USN], USCG).
    c. Make recommendations for the possible removal or neutralization of any environmental hazards that balances public safety with preserving the historical significance and integrity of the site.

4. Determine the site stability and integrity of each site and make recommendations for its long-term preservation.
    a. Assess site damage and determine if it was caused by the sinking event or post-sinking.
    b. Evaluate post-sinking hull damage/alterations and determine causes based on environmental and cultural considerations.
    c. Evaluate long-term hull integrity and make recommendations for site preservation.

RESULTS

Sidescan Sonar Survey

The reconnaissance-level sidescan sonar survey was completed between June 14 and September 30, 2016, encompassing 28 non-consecutive days of survey. The survey started furthest offshore in the eastern extent of the WEA and moved shoreward to provide as much survey coverage of as possible within the available timeframe. An area of approximately 173.2 square kilometers (km^2; 107.6 square miles [mi^2]) of the eastern portion of the WEA was surveyed. The Kitty Hawk WEA covers an area of approximately 307.8 km^2 (191.3 mi^2), resulting in completed survey coverage of approximately 56.3 percent of the WEA, as illustrated in Figure 6.

The survey revealed a generally flat, sandy seafloor with sand ridges oriented along a northeast to southwest axis across the WEA. A strong thermocline was encountered that reduced the

quality of the sonar data and likely inhibited identification of smaller objects on the seafloor. The scale of the sidescan sonar data was sufficient to yield 100 percent coverage of the seafloor, but not overlapping coverage; thus the area of the nadir and the outer boundaries of the data are not well resolved. Strong and unpredictable ocean currents also affected the position of the sidescan sonar towfish in the water, reducing the locational accuracy of identified targets. Initial diving operations revealed location inaccuracy of up to 100 m (328.1 ft) for some of the targets. This was caused, in part, by an incorrect layback setting input into HYPACK during the survey. To resolve this, the initial dataset was reprocessed with corrected towfish layback, and a subsequent survey operation was conducted June 26 and 27, 2017 to refine target locations and acquire higher resolution imagery. Diver investigations, described below, indicated that the final target locations determined from the subsequent survey are significantly more accurate and represent the location of the seafloor targets within approximately 5 m (16.4 ft).

A compilation of the 15 sonar contacts identified as a result of the survey is presented in Table 1. Reprocessing of the data and the subsequent higher resolution survey revealed that, in some cases, multiple targets from the initial survey were in fact the same target imaged on adjacent survey lines. These target names are combined in the sonar contact results table (e.g., Target 15/16). Additionally, during the higher resolution survey, some targets identified during the initial survey were determined to not be objects on the seafloor, but rather fish, other material in the water column, or data artifacts from thermocline interference. These targets were removed from the final sonar contact table; hence, the final target numbers are not sequential.

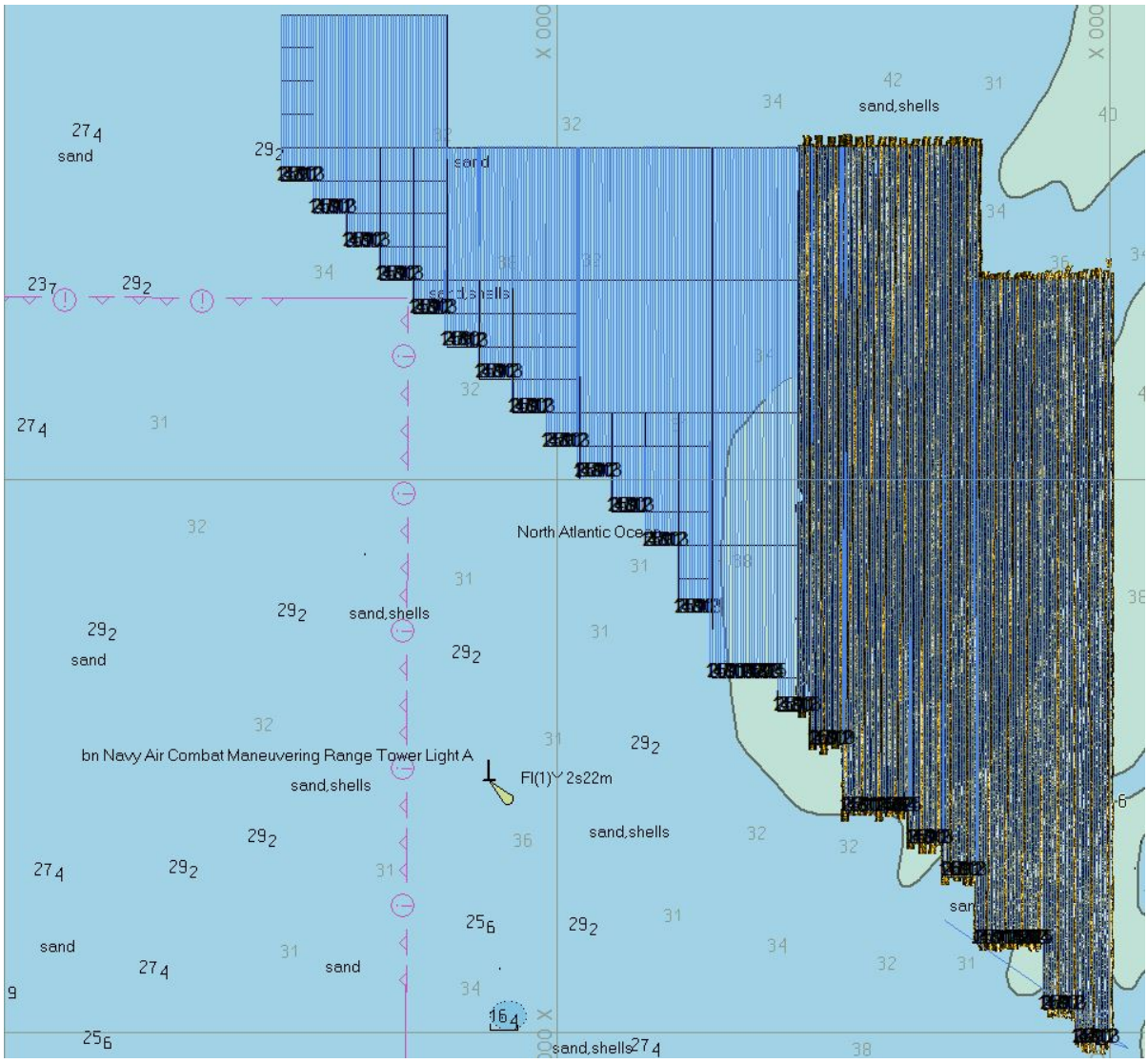
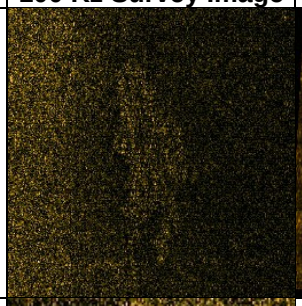
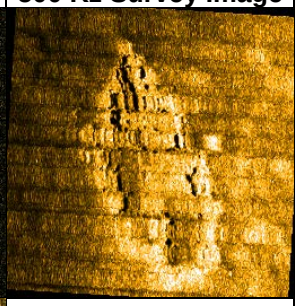
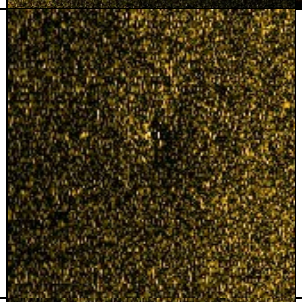
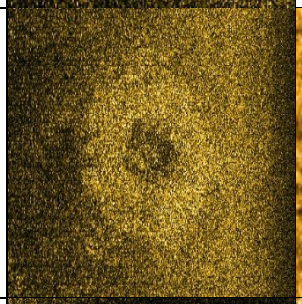
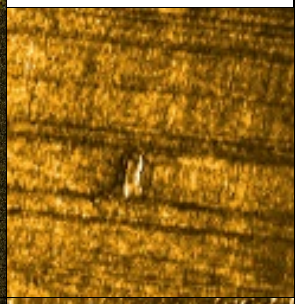
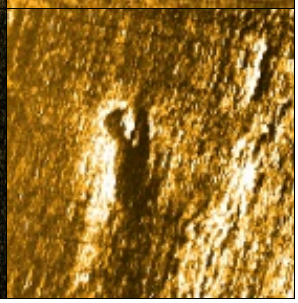
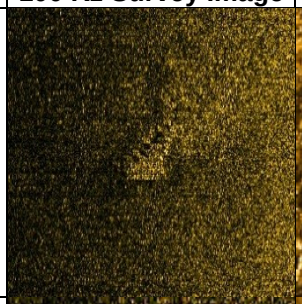
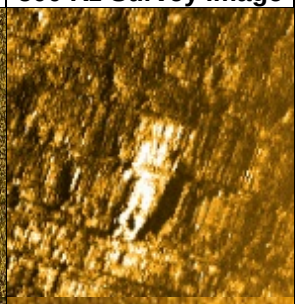
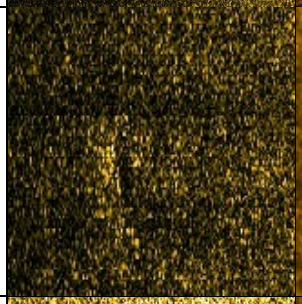
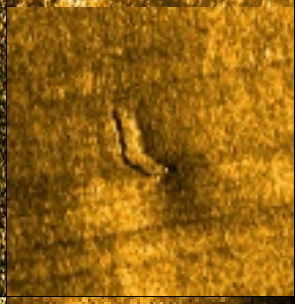
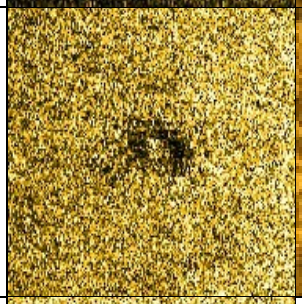
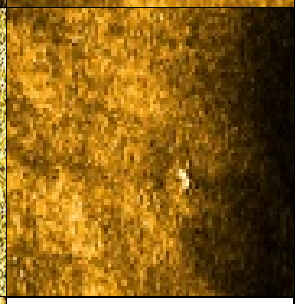
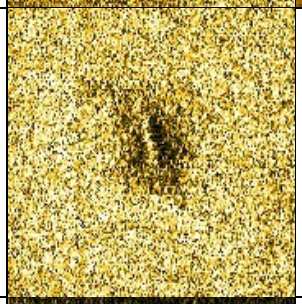
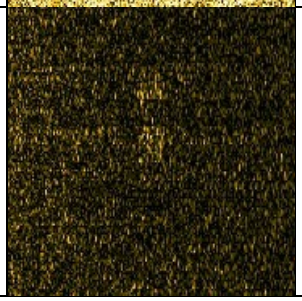
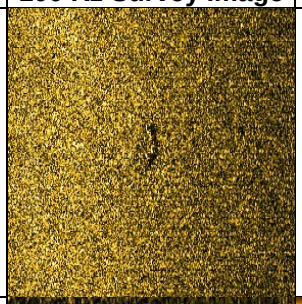
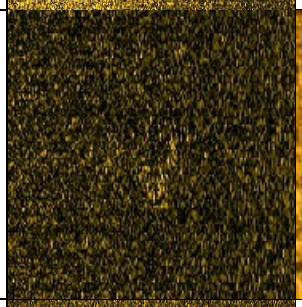
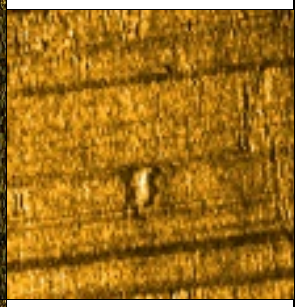
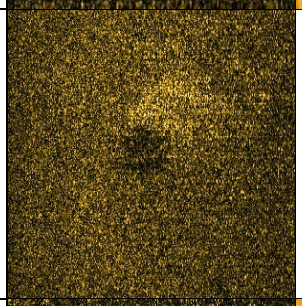
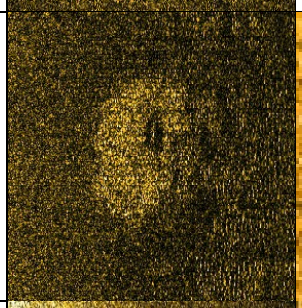
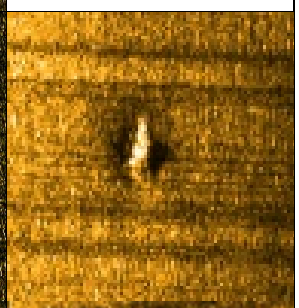
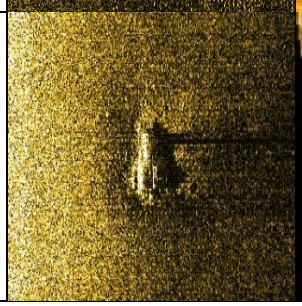
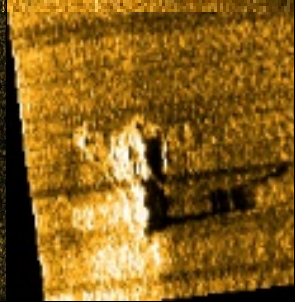


Figure 6. Reconnaisance sidescan sonar survey coverage within the Kitty Hawk WEA. Shaded portion represents the area surveyed.

Table 1. Sidescan sonar targets identified during the survey.

Target ID	Notes	100 Kz Survey Image	500 Kz Survey Image
2	Height: 0.2 m Length: 33.7 m Width: 11.3 m		
3	Height: 0.1 m Length: 2.6 m Width: 3.8 m		Not Resurveyed
6	Height: 0.1 m Length: 1.7 m Width: 4.1 m		No Target Acquired
8/9	Height: 1.5 m Length: 7.2 m Width: 7.1 m		
10	Height: 0.6 m Length: 4.8 m Width: 4.6 m		

Target ID	Notes	100 Kz Survey Image	500 Kz Survey Image
11	Height: 0.8 m Length: 11.6 m Width: 7.3 m		
13	Height: 0.1 m Length: 3.3 m Width: 2.2 m		
14	Height: 0.3 m Length: 3.0 m Width: 2.5 m		
15/16	Height: 1.0 m Length: 6.2 m Width: 1.3 m		No Target Acquired
17	Height: 0.4 m Length: 2.9 m Width: 1.8 m		No Target Acquired

Target ID	Notes	100 Kz Survey Image	500 Kz Survey Image
18	Height: 0.4 m Length: 6.2 m Width: 1.1 m		No Target Acquired
19/20	Height: 1.1 m Length: 5.5 m Width: 1.8 m		
21	Height: 1.4 m Length: 6.2 m Width: 7.3 m		Not Resurveyed
22/23	Height: 0.6 m Length: 4.4 m Width: 4.1 m		
24	Height: 0.1 m Length: 9.1 m Width: 8.6 m		

Diver Investigation

Priority for diver investigation was given to a known shipwreck adjacent to the Kitty Hawk WEA and targets identified during the sidescan sonar survey that indicated the presence of potential archaeological remains. Initial dive operations were conducted September 23 to 27, 2016, and subsequent dive operations took place June 28 and 29, 2017. The results of these investigations are detailed below.

Byron D. Benson

Prior to investigation of targets identified during sidescan sonar survey, a series of dives were completed September 23, 2016, on *Byron Benson*, a known wreck adjacent to the Kitty Hawk WEA. This allowed for evaluation of a site that had not been previously ground-truthed by archaeologists, in addition to providing a baseline understanding of dive conditions anticipated within the Kitty Hawk WEA.

Tanker *Byron D. Benson* began its service life in the small extension yard of the Oscar Daniels Company in Tampa, Florida (Figure 7). Based in Chicago, the Oscar Daniels Contractors and Engineers Company created this satellite yard mostly to fulfill contracts from the U.S. Shipping Board, starting in 1918. Tanker *Byron D. Benson*, ordered by Tidewater Oil Company, was the second-to-last ship the yard made before closing in 1922 (Shipbuildinghistory.com 2016). From these humble beginnings, the tanker would become one of the most gruesomely spectacular and iconic tanker losses along the North Carolina coast as the ship remained adrift for days, its burning cargo sending "…a great smoke cloud covering hundreds of square miles and casting a pall along the entire North Carolina coast" (Hickam 1989:123).

In April 1942, *Byron D. Benson* traveled north toward New Jersey on a cruise delivering crude oil from Texas. *Byron D. Benson* had been utilizing the recommended zig-zag pattern in an effort to evade German U-boats that had been operating along the East Coast since January of that year. As the vessel journeyed north, it was joined in a small convoy off the coast of North Carolina. The convoy group included another tanker, *Gulf of Mexico*, and two escorts, United States Ship (USS) *Hamilton* and His Majesty's Ship (HMS) *Norwich City*. On the night of April 5, 1942, the convoy slowly moved north while being stalked by U-*552*, captained by Erich Topp. U-*552* moved in to attack the convoy as it traveled past Kill Devil Hills and the Outer Banks of North Carolina. Moving to attack, U-*552* let loose a torpedo. The torpedo struck *Byron D. Benson* on the starboard side amidships and, almost immediately, the crude oil cargo began gushing from the opening; fire spread quickly (Blair 1996:539; Freeman 1987:212; Hickam 1989:121-299) (Figure 8).

Figure 7. Image of *Byron D. Benson* a few months prior to its sinking by U-*552* (Courtesy of the Mariners Museum Library).

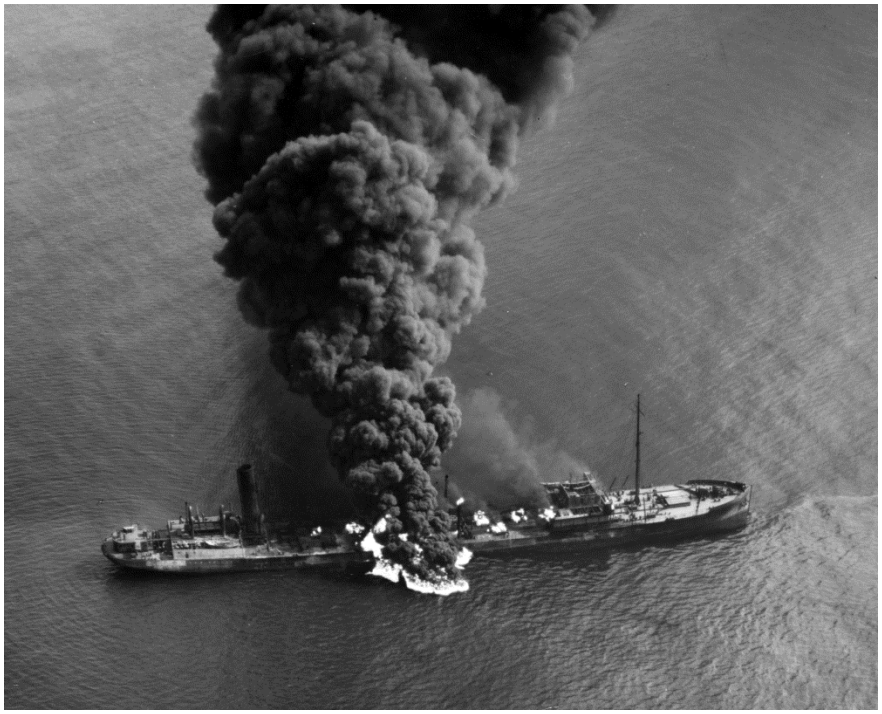


Figure 8. *Byron D. Benson* after being torpedoed by U-*552* (Courtesy of National Archives and Records Administration).

The crew of *Byron D. Benson* was ordered to abandon ship. During the attack the starboard side lifeboats were destroyed, leaving the remaining lifeboats beyond capacity as they filled with the surviving crewmembers. Amid panic to desert the burning vessel, the engines were never shut down, allowing *Byron D. Benson* to continue to make way at 6 kt while the crew attempted to escape. In spite of many difficulties, 27 of the 37 crewmembers aboard survived the attack. USS *Hamilton* rescued 25 men in a lifeboat, while one additional crewman was found clinging to the ship's emergency life raft and was subsequently rescued by a trawler. Another sailor was picked up by USS *Dione*, a USCG cutter. All of the survivors were taken to Norfolk, Virginia (Blair 1996:539; Freeman 1987:212; Hickam 1989:121-299).

The wreck of *Byron D. Benson* is broken amidships and rests in approximately 30.5 m (100 ft) of water. The vessel's remains were wire dragged by the USCG and/or USN in 1945 as a navigation hazard; however, the base of the hull and a debris field remain (Gentile 1993:42). During the 2011 Battle of the Atlantic field expedition, a high-resolution multibeam survey of the site was conducted (Figures 9 and 10). The resulting data from the multibeam survey provides a base-map of the site and precise positioning on which future surveys can be based. Some notable features are discernable, including the burned out midsection where the concentration of the fire could be seen from historic imagery (see Figure 8).

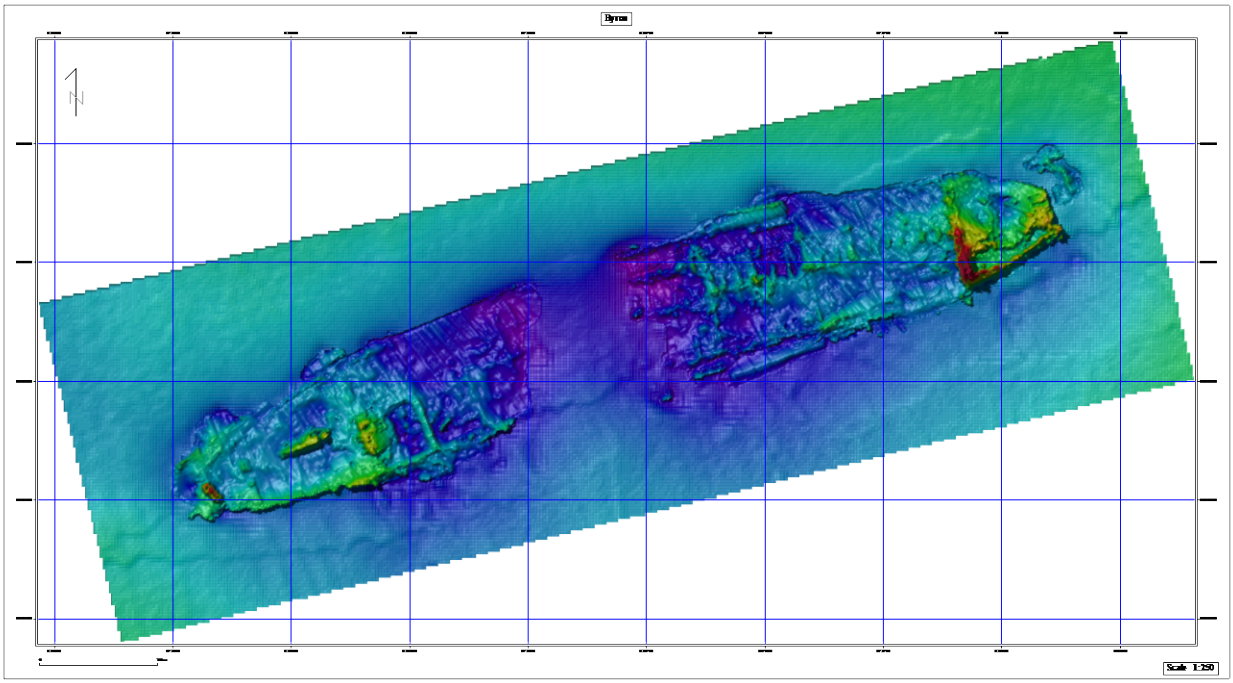


Figure 9. Reson 8125 scaled multibeam image of *Byron D. Benson* (Courtesy of Advanced Underwater Surveys Ltd.).

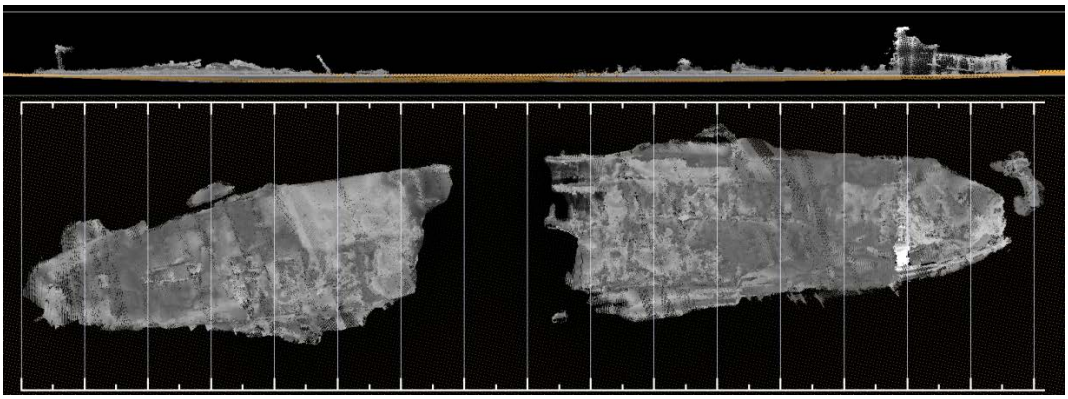


Figure 10. Plan and profile sonar visualization of the *Byron D. Benson* wreck site scaled in 10m grid (Courtesy of Advanced Underwater Surveys Ltd.).

Three dives were made on *Byron D. Benson* by NOAA, BOEM, and CSI divers. Divers were tasked with making observations regarding the condition of the wreck site, as well as documenting notable features imaged from the 2011 multibeam survey. Dive conditions were favorable, although visibility was limited to approximately 4.6 m (15 ft). Teams were able to navigate both the stern and bow sections of the vessel.

Diver observations were consistent with the 2011 multibeam data, in that much of the site was leveled with prominent relief at the stern and bow. Adjacent to the stern, the upright steering mechanism (Figure 11) was observed along with the engine and associated components (Figures 12 and 13). A debris field extends towards the bow (Figure 14), and a winch with entangled fishing gear (Figure 15) was observed.

Figure 11. Steering mechanism located at the stern of *Byron D. Benson*.

Figure 12. Engine of *Byron D. Benson*.

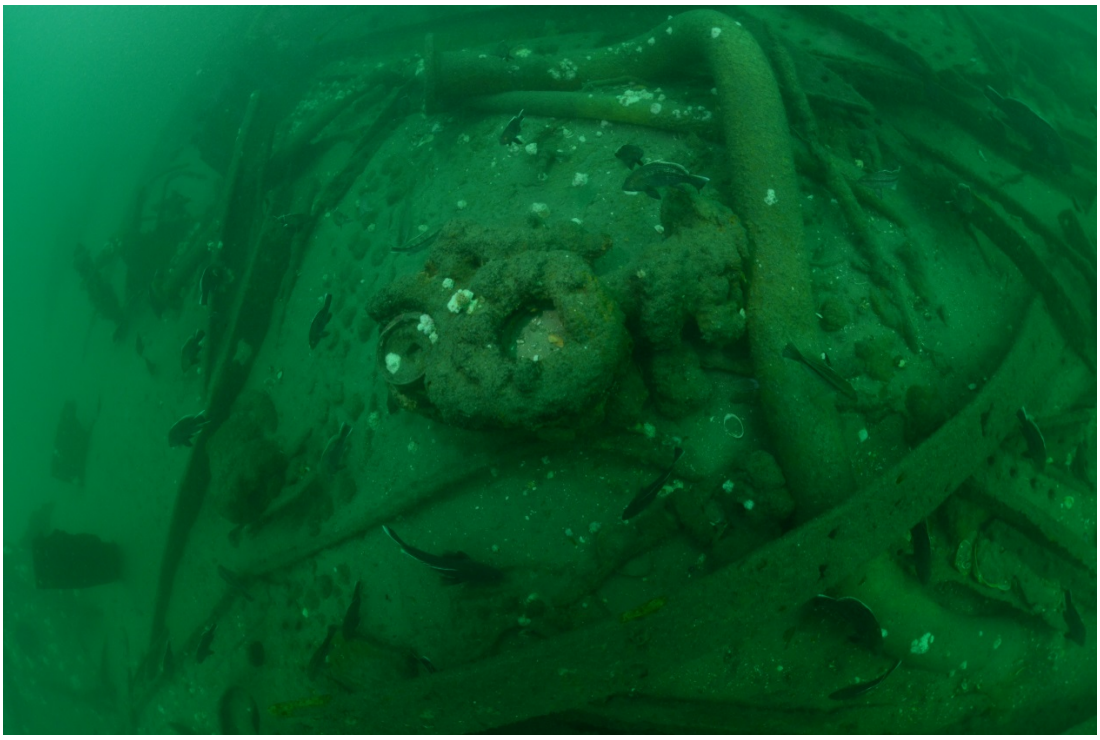


Figure 13. Piping and other machinery debris around the engine area of *Byron D. Benson*.

Figure 14. Winch covered in fishing gear on *Byron D. Benson.*

Target 24

Target 24 was identified as a high priority for diving operations based on its relative shape and size, which appeared indicative of a shipwreck, including two barrel-shaped features interpreted as possible boilers from a steam engine (Figure 15). The sonar target additionally included a long, thin shadow that measured over 20 m (65.6 ft), indicating an area of high relief extending off the sea floor. The target was investigated by divers on September 27, 2016. The depth of Target 24 is approximately 47.2 m (155 ft), deeper than the charted depth of 40.2 m (132 ft) on nautical charts at that location. This depth was beyond the limits of planned diving operations for the project; therefore, divers were not able to take direct measurements on the site and the photographic evidence and sonar imagery became the sole data sources from which to interpret the remains.

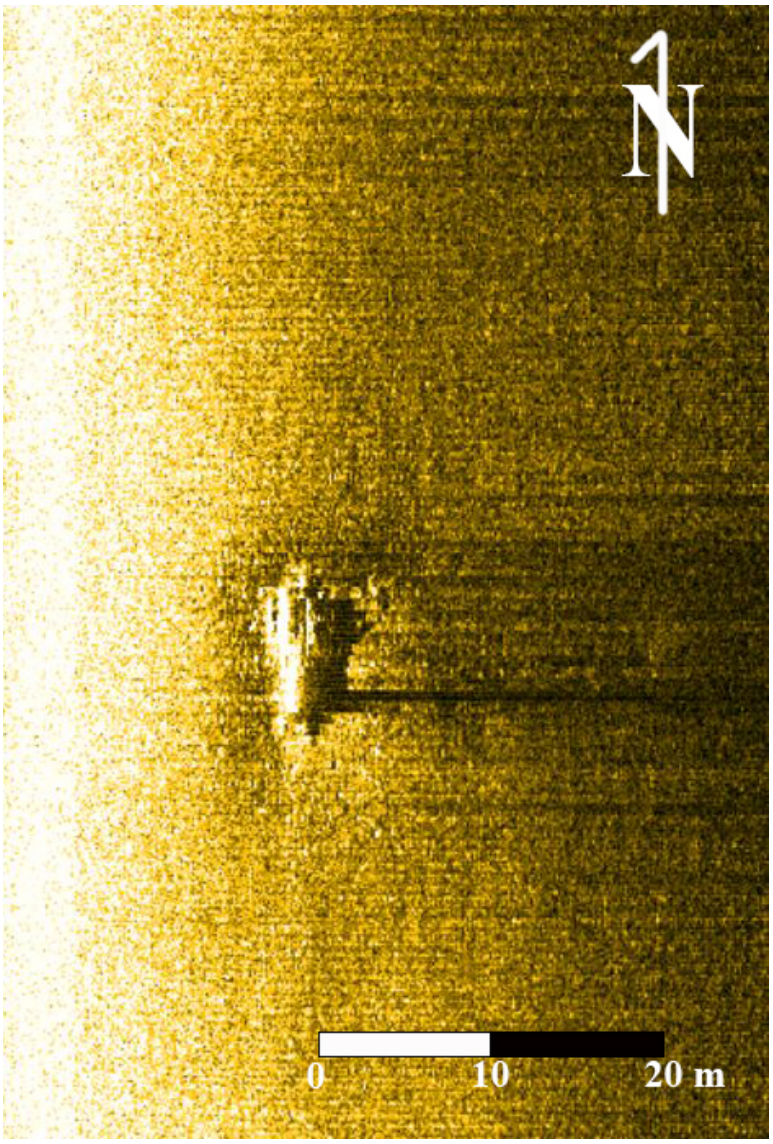


Figure 15. Target 24.

Upon investigation, divers observed a modern structure consisting of four, parallel cylindrical features approximately 15.3 m (50 ft) in length (Figures 16 and 17). Fishing nets, line and other gear were draped across the entirety of the site, in particular a tangle of line extending approximately 18.3 m (60 ft) from the sea bed into the water column. Also of note were the remains of clam shells scattered across the perimeter of the site. Following the dive, there was not an immediate consensus as to what the remains of Target 24 represented. Initial interpretations considered the remains to be fishing related, possibly a clamming dredge or other trawling gear, or to being potentially associated with military activities in the area related to Naval Station Norfolk. It was readily apparent, however, the large shadow that was displayed in the sidescan sonar image was the result of a long string of fishing net that was suspended in the water column due to numerous floatation devices entangled in the netting (Figures 18, 19, and 20).

Figure 16. Target 24 resting at a depth of approximately 47.2 m (155 ft).

Figure 17. View of Target 24 facing south.

Figure 18. Fishing net covering Target 24.

Figure 19. Fishing nets supported by floats extending off of Target 24.

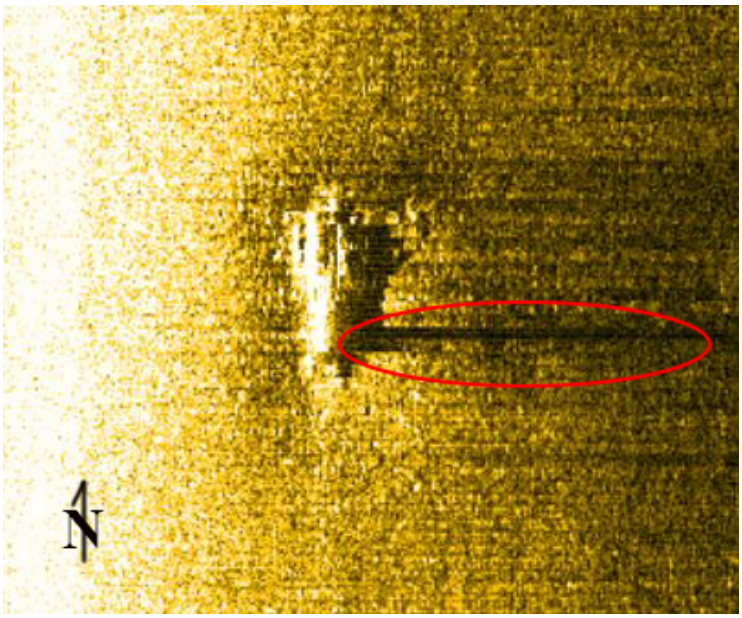


Figure 20. Fishing net visible in the side scan sonar image of Target 24.

In consideration that the site may be related to military activities from Naval Station Norfolk and out of concern that the site could include ordinance and/or human remains, images of the site were shared with the Department of Defense, Defense POW/MIA Accounting Agency, and USN offices including the Naval Air Systems Command and Naval History and Heritage Command. Based on analysis of the images, it was determined that the site may represent the remains of an F-14 fighter jet.

The F-14 "Tomcat" jet fighter (Figures 21 and 22) was a two-seater, supersonic, twin-engine, variable sweep wing, strike fighter manufactured by Grumman Aircraft Corporation. It first came into service in 1970 and was the primary strike fighter for the USN until the development of the F/A-18 "Super Hornet" that began replacing the F-14 in the early 2000s. Until that time, the F-14 was considered one of the most advanced fighter platforms ever built. Through its service life, it went through four modifications, the F-14 A, B, C, and D. The multiple tasks of navigation, target acquisition, electronic counter measures, and weapons employment were divided between the pilot and the radar intercept officer (RIO) (Navy.mil: 2003; 2006). The F-14 was officially retired from service in 2006.

The F-14 has an overall length of 19.1 m (62.8 ft), wingspans of 19.5 m (64 ft) spread, and of 11.6 m (38 ft) swept. As mentioned previously, the F-14 had a crew of two, with the pilot located forward and the RIO aft of the pilot. The F-14 was capable of reaching a max speed of Mach 2.34 (1,544 miles per hour) with a combat range of 1609.3 km (1000 mi). It was capable of carrying multiple configurations of missiles and bombs and was also equipped with a 20 millimeter Gatling gun (Navy.mil: 2003).

Additional review of the imagery by an F-14 technical expert confirmed the site as the remains of an F-14 aircraft and provided additional information regarding specific features of the wreckage (Personal Communication 2016). In particular, the site comprised the underside of an

F-14, including the engine inlets and mid-fuselage section, the portion of the aircraft that houses the wing center section and carry-through structure. The fuselage is constructed of an aluminum skin covering an aluminum and steel substructure. The primary wing box is reinforced with a milled-titanium support structure. The forward fuselage, cockpit, most of the aft fuselage, and the outer wing panels (i.e., the moveable portions of the wings) missing from the site. The AIM-54 Phoenix missile adapters are loaded on the forward fuselage; however, no missiles are present. This is a typical configuration for training flights where missile adapters would be mounted with no actual missiles loaded. There are no Phoenix missile adapters loaded on the aft store stations. There are no external fuel tanks mounted on the inlets, which is atypical as fuel tank mounting racks are usually installed. Figures 23 and 24 illustrate the features visible on the site in comparison to an intact example.

Figure 21. Air-to-air view of an F-14 Tomcat aircraft from Fighter Squadron 124 (VF-124). Wings are in the swept position. (Courtesy of National Archives).

Figure 22. Underside of an F-14 by Patrick Baker (RIO) of squadron VF-2 (Courtesy of Torsten Anft).

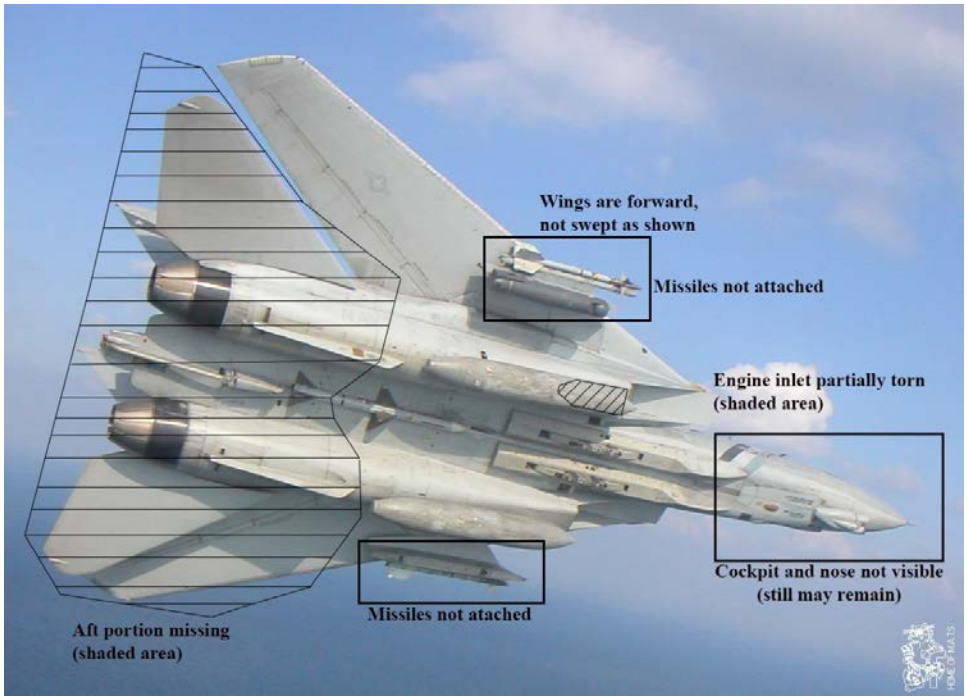


Figure 23. Identification of potential F-14 remains. (Image courtesy of Torsten Anft; interpretation courtesy of Paul Conigliaro and Michael Heinz).

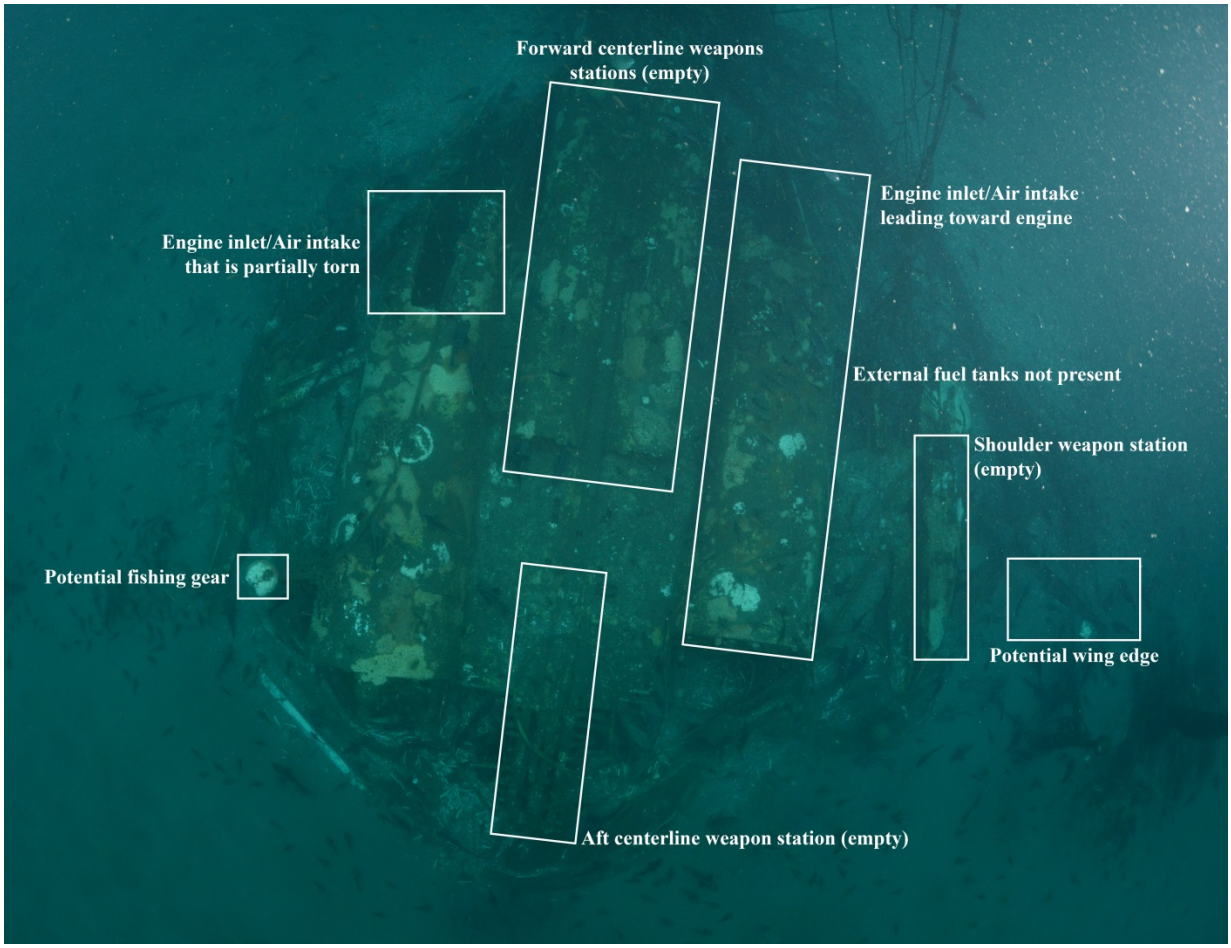


Figure 24. Potential features identified at Target 24. (Interpretation courtesy of Paul Conigliaro and Michael Heinz).

Based on review of the site imagery by an F-14 technical expert, it appears that the aft fuselage is missing, which would contain the unique Bureau Number (BUNO) indicating the individual aircraft and providing identification of the loss (Personal Communication 2016). Media sources have reported F-14 crashes within the region, including an incident that occurred in 1997 during a training exercise (CNN 1997; McMichael:1997; New York Times:1997). On October 2, 1997, two planes, based out of Oceana Naval Air Station at Virginia Beach, Virginia, and assigned to squadron VF-101, were on a training operation approximately 65 miles east of Elizabeth City, North Carolina, when one of the planes crashed. The pilot, Lieutenant Commander (LCDR) Logan A. Allen III, and the RIO, Commander (CMDR) Craig A Roll, both were able to eject from the aircraft, according to CMDR Roll. CMDR Roll was rescued by a USCG helicopter that evening. The pilot, LCDR Allen III, was never located during the search by both the USCG and USN and was presumed lost (CNN:1997; Daily Press:1997; New York Times:1997). The reason for the crash was never revealed; however, the location of the crashed F-14 corresponds with the location of Target 24.

The U.S. Naval Safety Center, Aviation Safety Programs conducted a review of their database and identified the site, based on the site depth and coordinates, as that of the VF-14, F-14A

(BUNO 160414) lost during a training exercise March 23, 1995 (Personal Communication 2017). Based on their records, the engines and aft stabilizer were salvaged following the incident. Both aircrew survived the incident.

Target 24 has also become a vibrant home for biological life. Hundreds of black sea bass were noted at the site, as well as the remains of a deceased sea turtle, likely caught and drowned in the fishing gear that litters the site. The fishing gear at Target 24 poses a threat to other marine life as well as a hazard to boating traffic.

Target 2

Target 2 was identified as a high priority for diving operations based on its shape and level of relief which appeared indicative of a shipwreck and debris scatter (Figure 25). The target was investigated by divers on June 28, 2017. Diver observation revealed the target to be an area of irregular seafloor, consisting of a raised bed of algal growth interspersed with shell hash extending over an area of approximately 30 m (99.9 ft) in length (Figure 26). As Target 2 was conclusively determined to not represent an archaeological resource, no additional dive operations were conducted. No further investigation is recommended at Target 2.

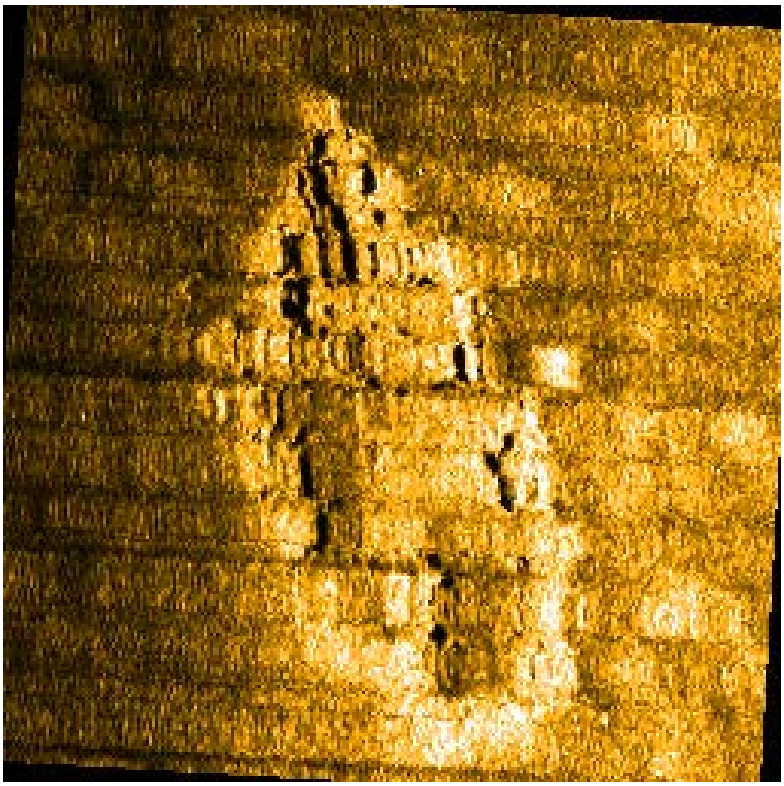


Figure 25. Target 2.

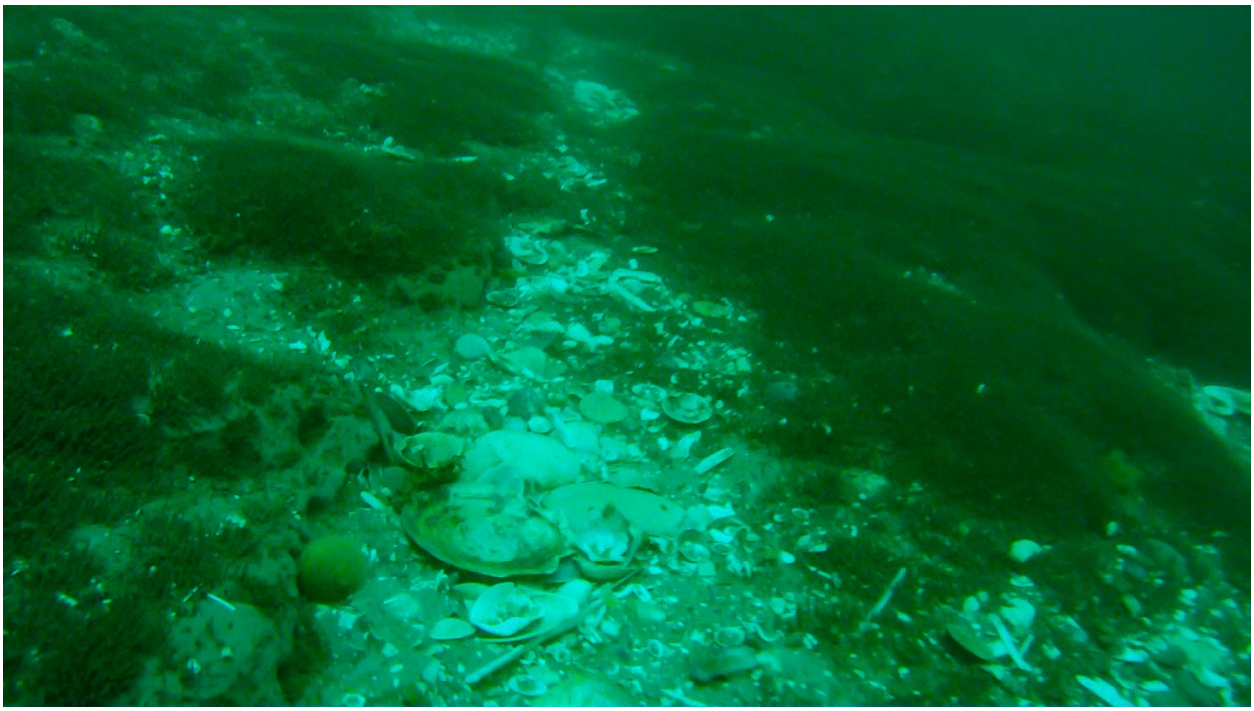


Figure 26. Irregular seafloor observed at the location of Target 2.

Target 11

Target 11 was identified as a moderate priority for diving operations as it appeared, based on the sonar data, as a discrete object on the seafloor. The target was investigated by divers on June 28, 2017. Diver observation revealed the target to be an area of irregular seafloor, consisting of a raised bed of algal growth interspersed with shell hash, similar to that observed at Target 2 (Figure 27). The irregular patch extended over an area of approximately 12 m (39.9 ft) in length. As Target 11 was conclusively determined to not represent an archaeological resource, no additional dive operations were conducted. No further investigation of Target 11 is recommended.

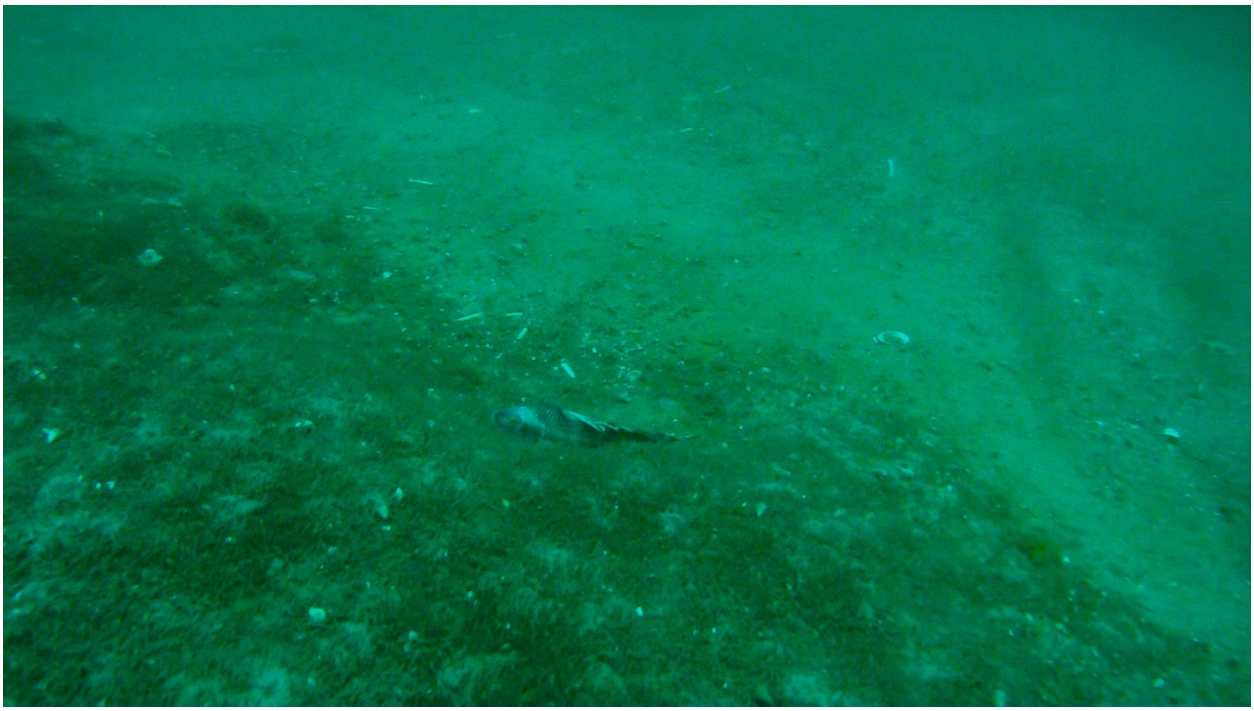


Figure 27. Irregular seafloor observed at the location of Target 11.

Target 19/20

Sonar Target 19/20 was identified as a moderate priority for diving operations as it appeared to indicate a discrete object on the seafloor that was representative of a number of linear targets of similar dimensions observed throughout the survey area (for example Targets 8/9, 15/16, 19/20 and 22/23). Areas within the Kitty Hawk WEA are designated as potential unexploded ordinance dumping site on the NOAA nautical charts and other sources document the disposal of chemical weapons and other munitions in the region post-World War II (Bearden 2007). Diver investigation was conducted on June 29, 2017 to determine the nature of this target and to observe if these features were related to dumping activities. Diver observation revealed the target to be fishing net covered in marine growth (Figure 28). No additional features were observed in the area. As Target 19/20 was conclusively determined to not represent an archaeological resource, no additional dive operations were conducted. No further investigation of Target 19/20 is recommended.

Figure 28. Fishing net observed at the location of Target 19/20.

Target 22/23

Sonar Target 22/23 was identified as a moderate priority for diving operations as it appeared to indicate a discrete object on the seafloor representative of a number of linear targets of similar dimensions, as discussed above under Target 19/20. Diver investigation was conducted on June 29, 2017. Diver observation revealed the target to be a length of fire hose (Figure 29). No additional features were observed in the area. As Target 22/23 was conclusively determined to not represent an archaeological resource, no additional dive operations were conducted. No further investigation of Target 22/23 is recommended.

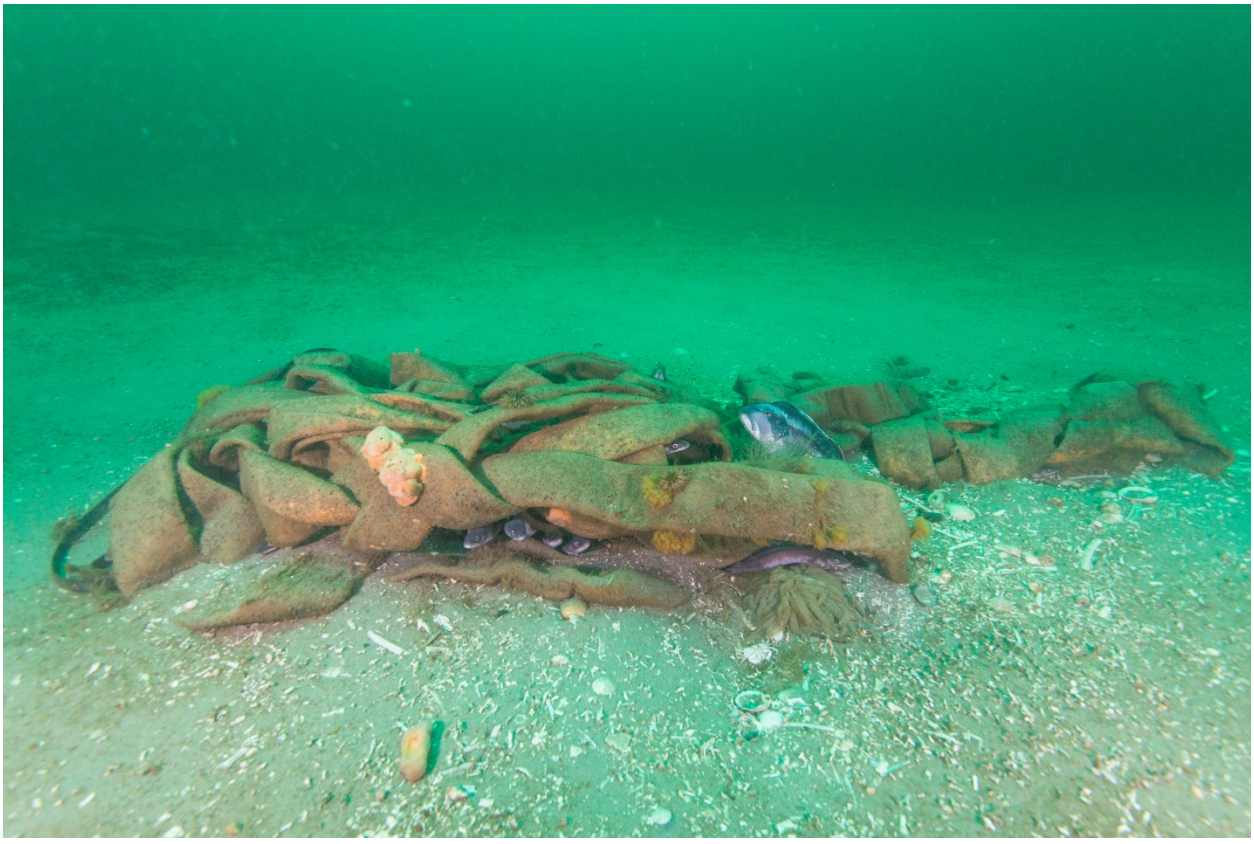


Figure 29. Fire hose observed at Target 22/23.

CONCLUSIONS AND RECOMMENDATIONS

The study completed a reconnaissance-level sidescan sonar survey of approximately 56 percent of the Kitty Hawk WEA, which identified 15 targets and ground-truthed, via diver investigation, six targets with archaeological potential. Recommendations for the six targets investigated are detailed in Table 2.

Table 2. Matrix of Targets Investigated and Recommendations

Target	Description	Recommendation
Byron D. Benson	141.7-m (465-ft) tanker sunk April 5, 1942 by the German submarine U-*552*.	Site is considered eligible for listing in the NRHP based on its association with the Battle of the Atlantic. Avoidance of this target is recommended by a distance of 100 m (328 ft) from the discernable extent of the site. Additional investigation is recommended to document and monitor the site.
Target 24	F-14 Tomcat Fighter jet.	Site may not be eligible for listing in the National Register based on it being less than 50 years in age. However, avoidance of the target as a seafloor hazard by a distance of 50 m (164 ft) and additional coordination with the Department of Defense regarding the target is recommended. Additional investigation is recommended to confirm site identity.
Target 2	Patch of irregular seafloor.	Not an archaeological resource; no further investigation is recommended.
Target 11	Patch of irregular seafloor.	Not an archaeological resource; no further investigation is recommended.
Target 19/20	Fishing net.	Not an archaeological resource; no further investigation is recommended.
Target 22/23	Fire hose.	Not an archaeological resource; no further investigation is recommended.

The methodological approach and collaborative nature maximized assessment time and allowed the survey team to collect extensive data to aid in the preliminary interpretation and evaluation of potential archaeological resources within the Kitty Hawk WEA.

Sites, such as *Byron D. Benson*, represent historic resources worthy of further investigation and condition monitoring. This site is associated with a historically significant event, the Battle of the Atlantic, and should be considered potentially eligible for the NRHP. Although outside of the Kitty Hawk WEA, avoidance of the remains of *Byron D. Benson* is recommended, should future renewable energy development activities be considered in the vicinity of the site.

As this was a preliminary investigation, only a general description of a sites' environment was conducted. Depending on future management strategies, it may be valuable to establish more concrete scientific descriptions of the environment and ecosystems present at each site. Water quality and characteristics at each site would aid in the study of corrosion potential and help researchers understand more accurately the various site formation processes acting on these sites. Additionally, subsequent efforts should be considered to monitor impacts of nearby renewable energy activities and associated scour, sediment transport, and sediment mobility on ongoing site formation processes.

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Department of the Interior (DOI)

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation’s trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

BOEM
Bureau of Ocean Energy Management

Bureau of Ocean Energy Management (BOEM)

The mission of the Bureau of Ocean Energy Management is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.

BOEM Environmental Studies Program

The mission of the Environmental Studies Program is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments. The proposal, selection, research, review, collaboration, production, and dissemination of each of BOEM’s Environmental Studies follows the DOI Code of Scientific and Scholarly Conduct, in support of a culture of scientific and professional integrity, as set out in the DOI Departmental Manual (305 DM 3).