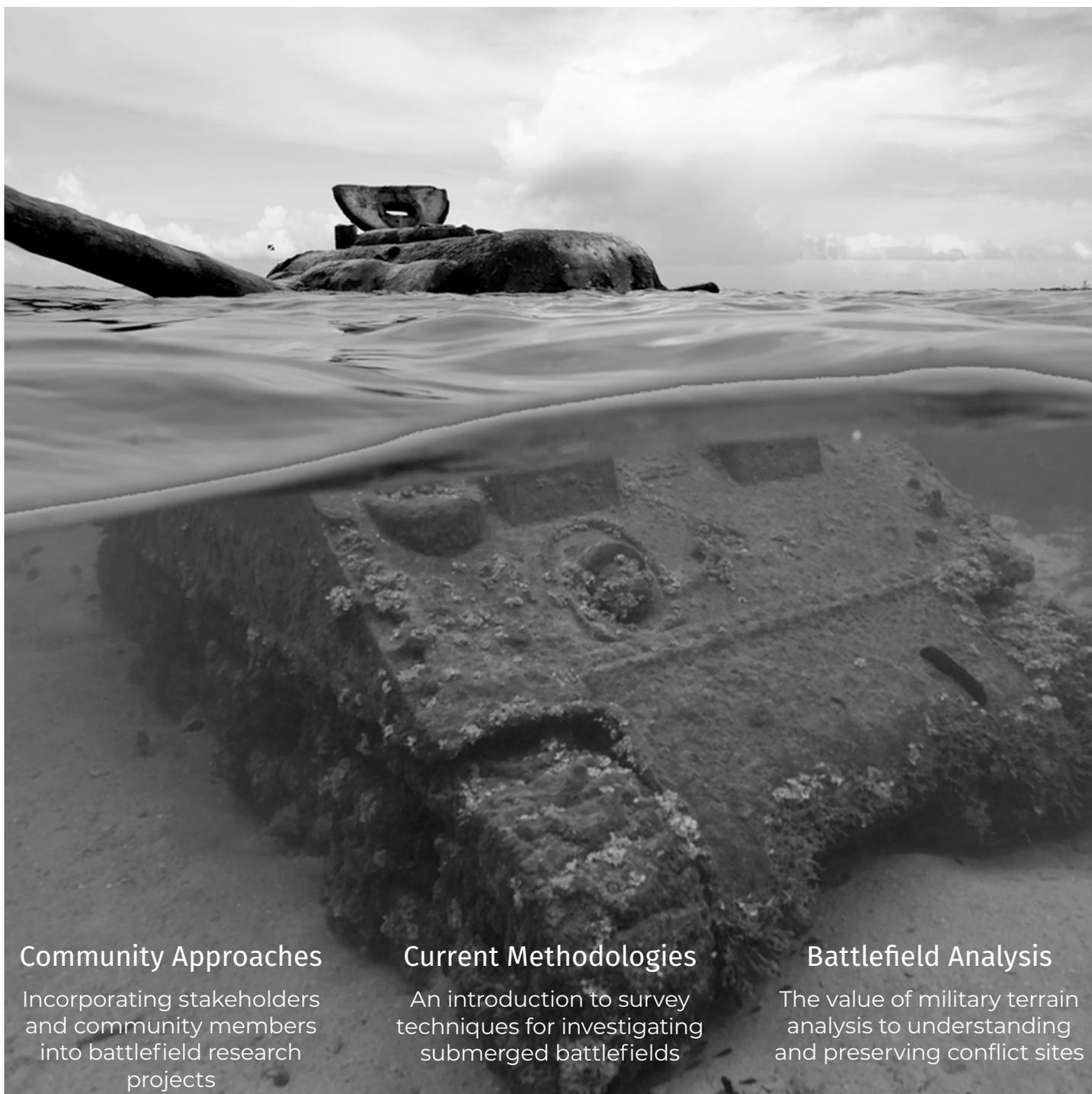


# SUBMERGED BATTLEFIELD SURVEY MANUAL



## Community Approaches

Incorporating stakeholders and community members into battlefield research projects

## Current Methodologies

An introduction to survey techniques for investigating submerged battlefields

## Battlefield Analysis

The value of military terrain analysis to understanding and preserving conflict sites

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Grant Agreement No. GA-2287-17-015  
American Battlefield Protection Program  
**Submerged Battlefield Survey Manual**  
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Ships of Exploration and Discovery Research, Inc.  
2020

This material is based upon work assisted by a grant from the Department of the Interior, National Park Service. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of the Interior.

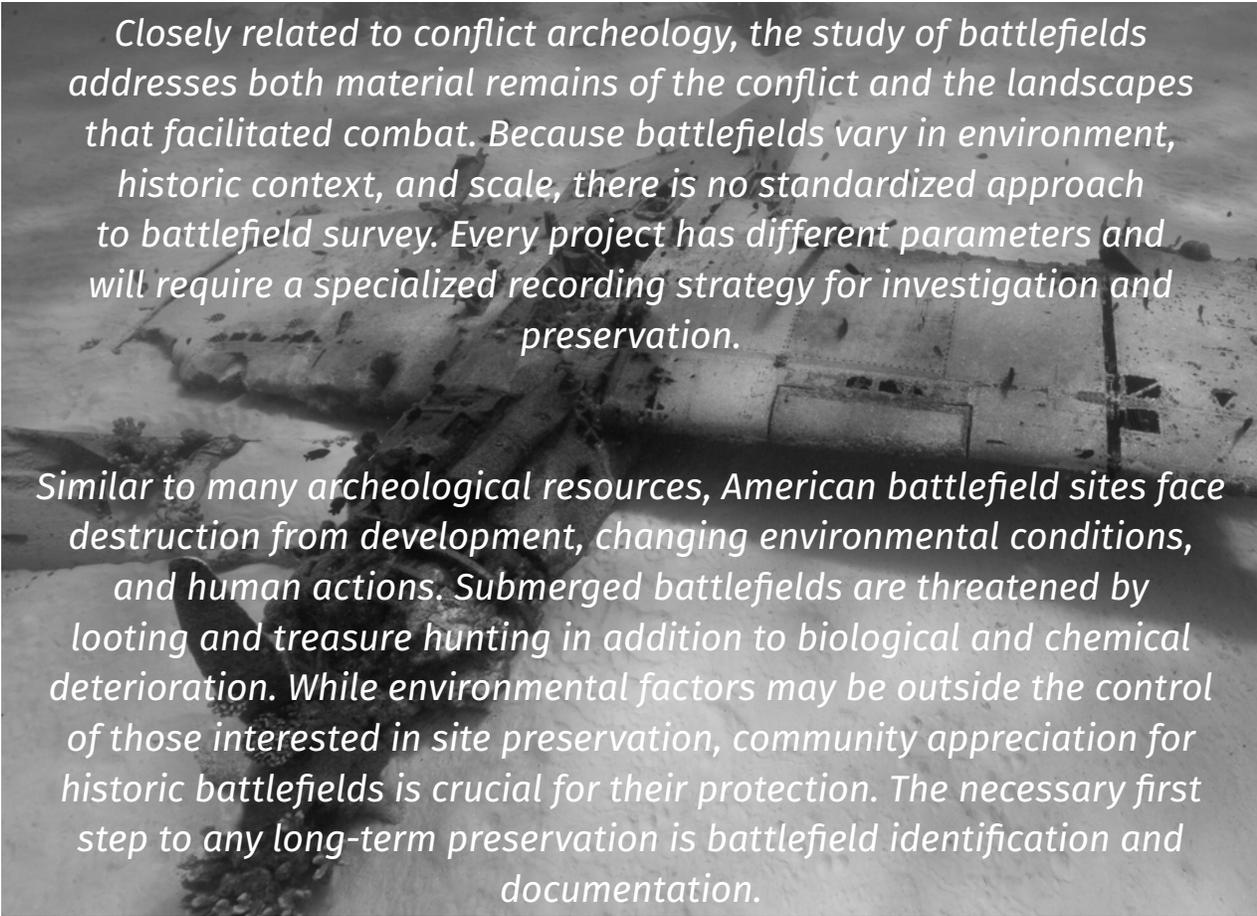
FRONT COVER: SHERMAN TANK, SAIPAN. IMAGE COURTESY OF SHIPS OF DISCOVERY  
INSET: (LEFT) WWII BATTLEFIELD OF KISKA, AK. IMAGE COURTESY OF PROJECT RECOVER; (RIGHT) WWII JAPANESE BOMBER. IMAGE  
COURTESY OF EAST CAROLINA UNIVERSITY

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## INTRODUCTION

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*The archeology of battlefields is a relatively recent area of study. Beginning in the 1980s, the subfield adapted terrestrial and submerged research methodologies to record and analyze historic battle sites.*



*Closely related to conflict archeology, the study of battlefields addresses both material remains of the conflict and the landscapes that facilitated combat. Because battlefields vary in environment, historic context, and scale, there is no standardized approach to battlefield survey. Every project has different parameters and will require a specialized recording strategy for investigation and preservation.*

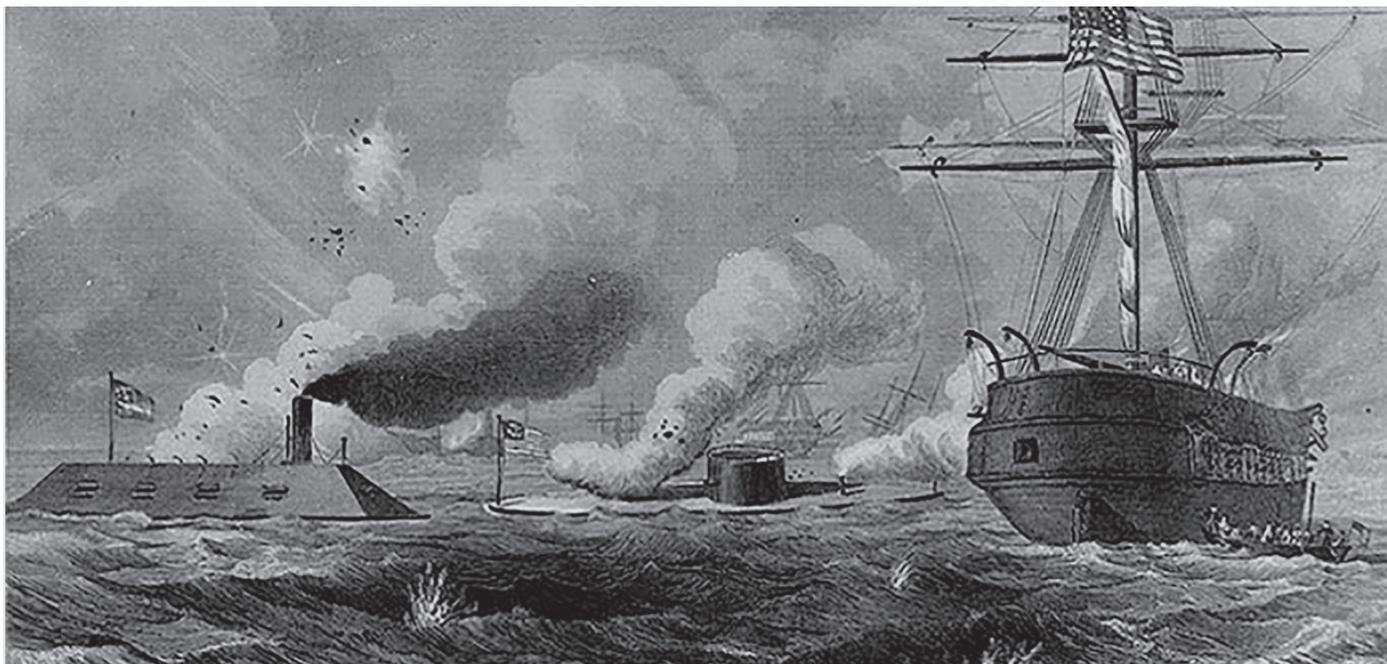
*Similar to many archeological resources, American battlefield sites face destruction from development, changing environmental conditions, and human actions. Submerged battlefields are threatened by looting and treasure hunting in addition to biological and chemical deterioration. While environmental factors may be outside the control of those interested in site preservation, community appreciation for historic battlefields is crucial for their protection. The necessary first step to any long-term preservation is battlefield identification and documentation.*

*The study of submerged battlefields is guided by current battlefield research methodologies, including analysis of historic documents, terrain, and artifacts. The major difference between terrestrial and submerged battlefield archeology is the environmental site context; working in submerged environments requires the use of different technologies to access sites and interpret terrain features. The aim of this manual is to present the steps necessary for identifying, recording, and preserving submerged battlefields and is designed for use by SHPOs, THPOs, and ABPP grantees.*

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## Research Potential of **SUBMERGED AMERICAN BATTLEFIELDS**

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ACTION BETWEEN *MERRIMAC* AND *MONITOR*, J. ROGERS 1862. IMAGE FROM NAVAL HISTORY AND HERITAGE COMMAND

### **Differing environments and military strategies create a signature on the seabed that requires a unique approach to how battlefields are studied and preserved.**

America's waterways are important features of our historic battlefields. They were used as transportation to battles and were the platforms on and in which battles occurred. From the Revolutionary War to World War II, battles took place on or around the Atlantic and Pacific Oceans, the Gulf of Mexico, and countless lakes, rivers, and estuaries.

The submerged portion of a battlefield can tell us as much about the battle as areas on land. This is why it is important to look at a battlefield holistically and consider the full landscape and seascape. It is easy to ignore what is underwater because it is out of sight and out of

mind, but researching and understanding portions of the battlefield that took place on the water, and might still be submerged, completes the story.

Some battles took place completely on water, such as the Battle of Lake Erie between the American and British Royal Navies, while others took place on and under the water, such as the engagement between USS *Housatonic* and submarine *HL Hunley*. Still others have both land and water components, such as the WWII amphibious invasion of the Pacific island of Saipan or the 1776 American retreat at Arnold's Bay on Lake Champlain in Vermont. These different environments and

associated military strategies and tactics create a signature on the seabed that requires a unique approach to how they are studied and preserved.

Depending on many environmental and cultural factors, submerged battlefields can range from nearly intact to highly disturbed. Additionally, communities might be very aware of their existence, having passed the history down through generations, or completely unaware. Even if a community is unaware, they still should be considered a stakeholder in the preservation of that battlefield and every effort should be made to engage them early in the process of documentation and in preservation strategies.

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## Community

# STEWARDSHIP AND STAKEHOLDERS

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The key to protecting battlefields is community. Community comes in many forms and involves multiple stakeholders. Potential stakeholders can include veterans and veteran families, non-combatant civilians and their ancestors, landowners, local governments, and tourists. Each stakeholder might relate to the battle differently. For example, descendants of soldiers may feel a sense of pride while non-combatant civilians, to whom the battle happened and disrupted their lives, may feel a sense of sadness and resentment. It is important to consider all stakeholders when attempting to identify, research, and interpret historic battlefields.

Engaging community and stakeholders can take the form of pre-planning public meetings with input at the beginning of a project, regular contact and updates, even involvement in the archeology and historical research. Stakeholders may act as reviewers of reports or publications. These steps provide communities the opportunity to develop a sense of stewardship and ownership, which is important in protecting battlefields long term.

Because submerged battlefields are underwater it is important to consider that they might not be accessible to those who do not have the personal capital or physical ability to dive. Finding ways to incorporate more than just divers in the study of submerged battlefields should be a key part of any project.

### **ABPP Submerged Battlefield Grants**

The National Park Service (NPS) American Battlefield Protection Program (ABPP) was created to assist individuals, groups, organizations, and governments with researching, evaluating, interpreting, and protecting historic American battlefields. Battlefield sites hold national significance and are preserved so that present and future generations can “better understand the connection between military conflicts and important social and political changes” (ABPP 2019). Since 1991, ABPP and partner organizations have surveyed more than 650 American battlefields covering 16 wars. Today, ABPP continues to allocate grants for the study and preservation of historic American battlefields, both submerged and terrestrial. The ABPP provided funding for the development of this manual because of the unique circumstances inherent in the study of submerged battlefields. For more information, visit [www.nps.gov/abpp](http://www.nps.gov/abpp).



ELDER ESCOLASTICA BORJA TUDELA CABRERA SHARING WWII MEMORIES. IMAGE COURTESY OF SHIPS OF DISCOVERY

**Community comes in many forms and involves multiple stakeholders**

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## SUBMERGED BATTLEFIELD SURVEY

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*An historic landscape approach can be used to interpret and record battlefields. Terrain features influenced military strategy and tactics, which in turn shaped the material record of the battle. While significant terrain features may no longer exist today, it is necessary to a) identify them in the historic record to determine historic significance, and b) ground truth the same features to determine modern cultural significance—assessing which features have been lost and which features remain.*

*Battlefield assessment and survey follows five steps—creation of a research design, preliminary battle research, definition of battlefield boundary and terrain features, fieldwork, and reporting. Each step is discussed with necessary modifications for submerged battlefields.*

### RESEARCH DESIGN

Written research designs are a necessity before any archeological fieldwork can take place. A research design outlines project significance, aims, methods, equipment, and the necessary steps to meet project goals. While the research design addresses historical background and relevant methodologies for fieldwork and reporting, it also indicates that the researcher is aware of all local and Federal guidelines for archeological investigations that may be applicable to the project. Finally, it identifies the relevant stakeholders and necessary steps for community engagement. The research design is used in any subsequent permitting processes and becomes a necessary first step in planning a successful battlefield project.

### HISTORICAL BACKGROUND

Historical research is critical to any battlefield evaluation. While the archeological record contains physical remnants of the battle, historical sources can provide valuable contextual clues about the significance of battlefield remains. Prior to any in-field work, researchers should begin by compiling battle accounts, including both primary and secondary sources. It is recommended that researchers begin by collecting the secondary sources created after the initial event. These materials can provide an overview of major events and place battles within their larger social, political, and economic contexts. Furthermore, these sources use primary documents and may have suggestions for

accessing eyewitness accounts and records.

Materials that are contemporary to the battle are considered primary sources, as are those published later by eyewitnesses. These primary documents can include anything from personal journal entries and oral histories to official military records, photographs, and films. The scope of primary sources will vary depending on the author's role in the battle and the intended audience. Diaries of sailors, for example, may solely reflect their experience on the frontlines, while paperwork filed by their superior officers discusses large scale operations. Both these accounts are valuable to understanding the progression of battle but will vary in degree of detail, terminology, and tone. When evaluating any

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This “fog of war” brought on by adrenaline, fear, or even confusion, can blur or distort details in the historic record.

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primary source, it is important for the researcher to be aware of any possible biases, shortcomings, and the author’s intent.

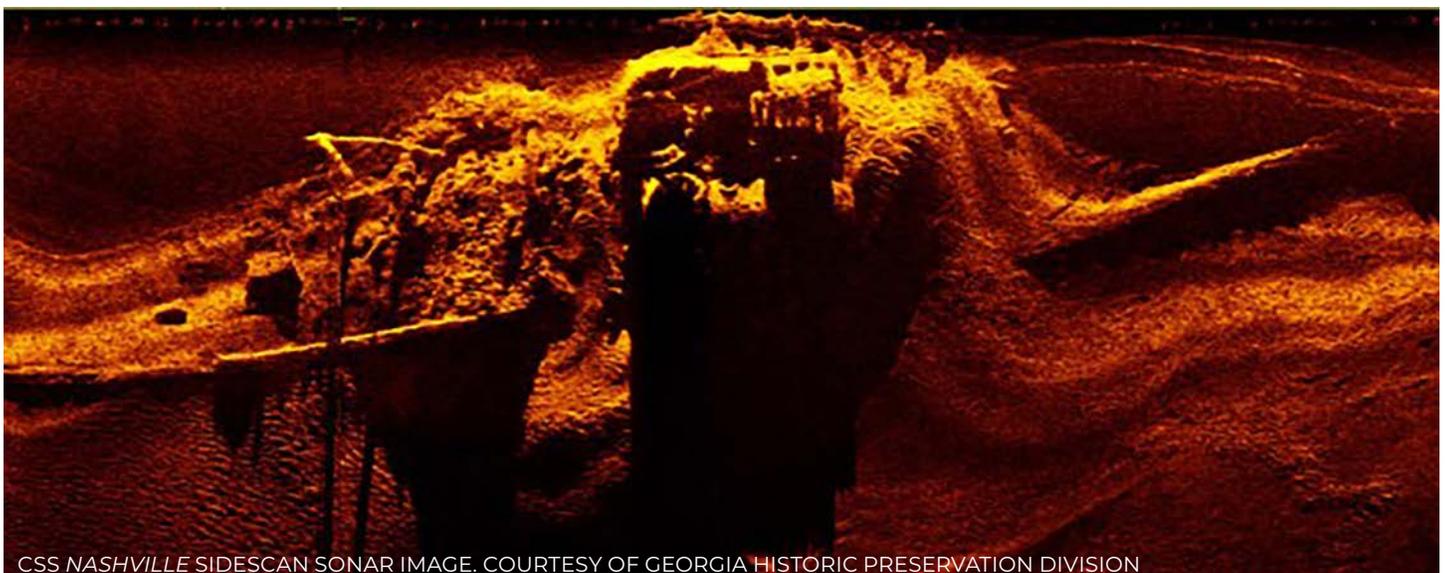
One caveat to working with historic records is that they can be riddled with inaccuracies and conflicting statements. Combat participants often only experienced their immediate surroundings, and so may share secondhand information in written statements that contradict other sources. Furthermore, battle participants were subjected to human emotions during the conflict, which can muddle accounts recorded after the fact. This “fog of war” brought on by adrenaline, fear, or even confusion, can blur or distort details in the historic record. For that reason, researchers should carefully evaluate written histories and note discrepancies and possible sources of error.

#### JURISDICTION

Submerged battlefields and associated artifacts fall under various jurisdictions based on geographic location and resources investigated. While there are some general considerations listed below, it is important to research all relevant governing bodies and associated legislation to secure proper permitting and permission for investigation.

General Jurisdictional Considerations: Inland lakes, rivers, and coastal waters (extending 3 miles offshore or 6 leagues for Texas, Florida, and Puerto Rico’s coastlines bordering the Gulf of Mexico) fall under state jurisdiction and require SHPO/THPO consultation. Bottomlands extending from 3 to 200 miles offshore fall under Federal jurisdiction as do any submerged lands protected by Federal entities. These are subject to national legislation along with navigable waterways under the jurisdiction of the U.S. Army Corps of Engineers.

The Sunken Military Craft Act (SMCA) of 2004 preserves and protects from unauthorized disturbance all sunken military craft that are owned by the U.S. government, as well as foreign sunken military craft that lie within U.S. waters. If any submerged resources are identified, or likely to be identified as military craft, the U.S. Department of the Navy should be contacted for the proper archeological permitting. For more information, visit: <https://www.history.navy.mil/research/underwater-archaeology/policy-and-resource-management/sunken-military-craft-act.html>.



CSS NASHVILLE SIDESCAN SONAR IMAGE. COURTESY OF GEORGIA HISTORIC PRESERVATION DIVISION



Table 1. KOCO A Terrain Features and Parameters

<b>Attribute</b>	<b>Definition</b>	<b>Naval Parameters (Babits et al. 2011)</b>	<b>Aerial Parameters (Roth and McKinnon 2018)</b>	<b>Examples</b>
<b>Key Terrain</b>	Ground that must be controlled to accomplish the mission.	Navigable waterways offer access to terrestrial targets. Areas of land or buildings which sit above the water greatly enhance visibility.	Enemy-held areas, forces, and infrastructure are target areas. Landing zones, drop zones, and refueling are key terrain for aerial combat.	High ground with good observation and clear fields of fire, transportation choke point, junction, landing/loading and refueling area, navigable waterway, the weather gauge.
<b>Observation and Fields of Fire (FF)</b>	The ability to see friendly and enemy forces. FF are areas that weapons cover/can fire on efficiently.	Coastal defenses, ships, and vessels on the water are high-visibility structures. Vessel armament defines field of fire but will fluctuate with wind, tides, channel obstructions, topographic obstructions, and enemy defenses.	Areas of engagement and surveillance are larger. Aircraft and ground forces need large clearings for visibility. Maximum firing range of artillery and anti-aircraft defenses.	High ground, sloping ground, entrenched positions, ship superstructure, observation towers, radar, some terrestrial coastal defenses.
<b>Cover and Concealment</b>	Protection from enemy fire, observation, and surveillance.	Defenders have foreknowledge of navigable waters and create defenses to protect/obstruct waterways. Vessels provide cover to their occupants.	Cloud cover and time of day impact visibility as well as enemy surveillance equipment. Topography and vegetation limits aerial visibility.	Ditches, buildings, walls, forests, ravines, reverse slopes, radar, cloud cover, mist, fog, night, vessels.
<b>Obstacles</b>	Natural or human-made landscape features that prevent, impede, or divert movement.	Set and temporally variable obstacles such as weather exist. Water is an obstacle itself to terrestrial forces.	Weather/time of day limits visibility. Flight ceiling and fuel consumption limits maneuverability, as does anti-aircraft defenses and combat patrols.	Swamps, rivers, bridges, entrenchments, reefs, earthworks, sandbars, navigable channels, fog, anti-aircraft artillery, defensive aircraft.
<b>Avenues of Approach and Withdrawal</b>	Relatively unobstructed ground route that leads to and/or away from an objective or key terrain and does not come under enemy fire.	Navigable channels act as avenues of approach, however tides and wind may stall withdrawal along same route.	Direct approach from staging area for fixed wing aircraft is limited by terrestrial terrain features, fuel load, and flight ceiling.	Roads, paths, creek beds, navigable channels, air channels, valleys and low altitude areas.



FIGURE 1. KOCCA TERRAIN ANALYSIS OF THE 1944 LANDING ON PELELIU, PALAU. IMAGE COURTESY OF SHIPS OF DISCOVERY

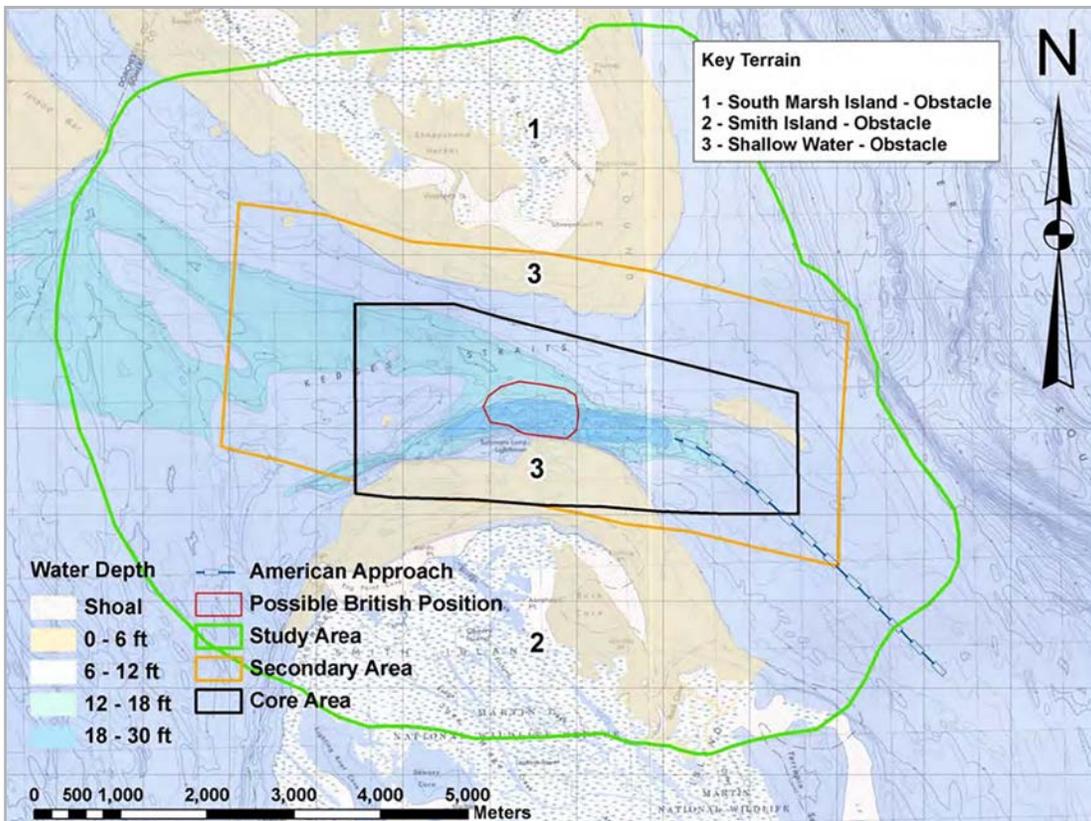


FIGURE 2. METT-TC ANALYSIS OF THE BATTLE OF KEDGES STRAIT (1782). IMAGE COURTESY OF LAWRENCE E. BABITS, NEW SOUTH ASSOCIATES

When paired with historic documents, terrain analysis provides the context for many archeological features that remain today.

In 2018, Ships of Discovery conducted an archeological survey of the reef and landing beaches associated with the 1944 Battle of Peleliu. KOCO A military terrain analysis was used to interpret cultural resources and terrain features encountered during the amphibious assault (Figure 1). When paired with oral accounts of the battle, the terrain analysis provided context for the many archeological resources that remain on the landing beaches today.

Similar to other terrain analyses, KOCO A has limitations and may not be the best choice for submerged battlefield recording. Because there is no consideration for temporal components with KOCO A, other approaches, discussed below, may yield different results.

M E T T - T C

METT-TC analysis

is used to organize and plan tactical operations, and has been further adapted for archeological study (Babits et al. 2011). Still inclusive of KOCO A terrain analysis, METT-TC addresses five additional components—the acronym stands for Mission, Enemy, Terrain, Troops available, Time available, and Civilian considerations.

Mission and Enemy account for the plan of action and the opposition forces, respectively. Analysis of these factors includes examining overarching goals, initial objectives, and motivations in the chain of command for both the friendly and opposing forces. Analysis of the Enemy further includes an understanding of known tactics, equipment available, and size of the opposing force. Terrain under METT-TC involves the KOCO A analysis.

Troops available is only applied to analysis of friendly

forces because Enemy covers size of opposing parties. Babits et al. (2011) note that Troops available emphasizes combat power over human power; analysis is undertaken to look at the training and history of individual units in the battle to understand how they were effectively or ineffectively used.

Analysis of Time available addresses the time needed to carry out the mission, including time needed to rehearse, refuel, and even rest. When dealing with aerial and naval operations, temporal considerations also include tidal changes and weather patterns that may be encountered.

Finally, Civilian considerations addresses the interactions between armed forces and civilian populations. These interactions may include detainment, joint operations, evacuation, collateral damage, and/or humanitarian relief.

**The 1782 Battle of Kedges Strait was the result of increasing tensions between a British Loyalist flotilla and American colonists. Fought in Chesapeake Bay, the engagement lasted approximately 25 minutes, ending with the retreat of American vessels. Working under an ABPP grant, New South Associates were able to determine likely vessel locations using a METT-TC analysis of historic battle accounts (Figure 2). Terrain features, such as channel location and depth, had a significant impact on time and troop availability (including vessel limitations), which in turn impacted the outcome. Finally, the data generated through analysis were used to predict the potential location and archeological signature of material culture associated with the engagement.**

## **PRINCIPLES OF WAR**

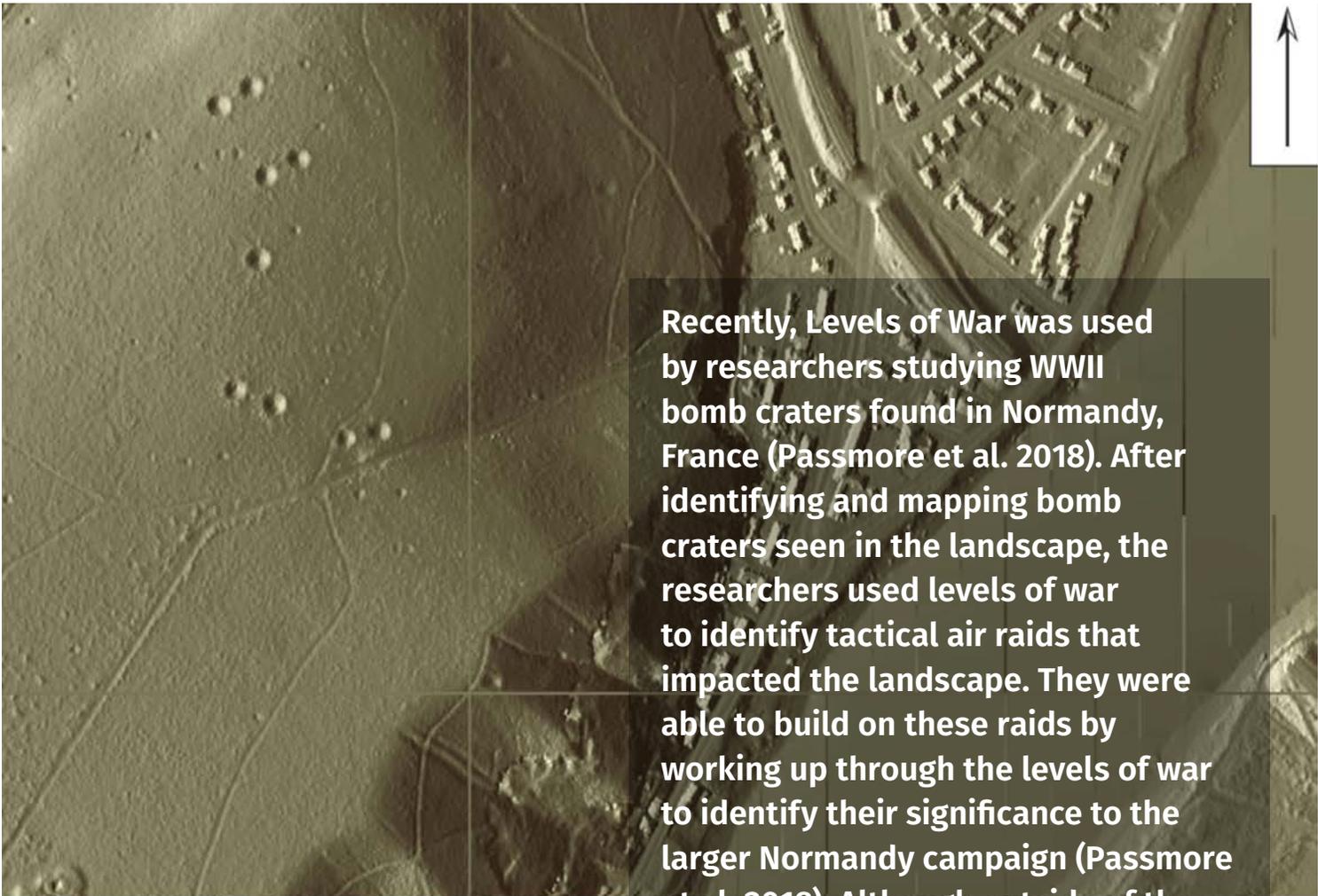
**Principles of War is an analytical framework designed to enhance understanding of past battle engagements. While it aids in understanding the choices made by military leaders and units, it does not directly address terrain and terrain features. It is a recommended secondary analysis and is not further discussed here (Babits et al. 2011:10-12).**

## **LEVELS OF WAR**

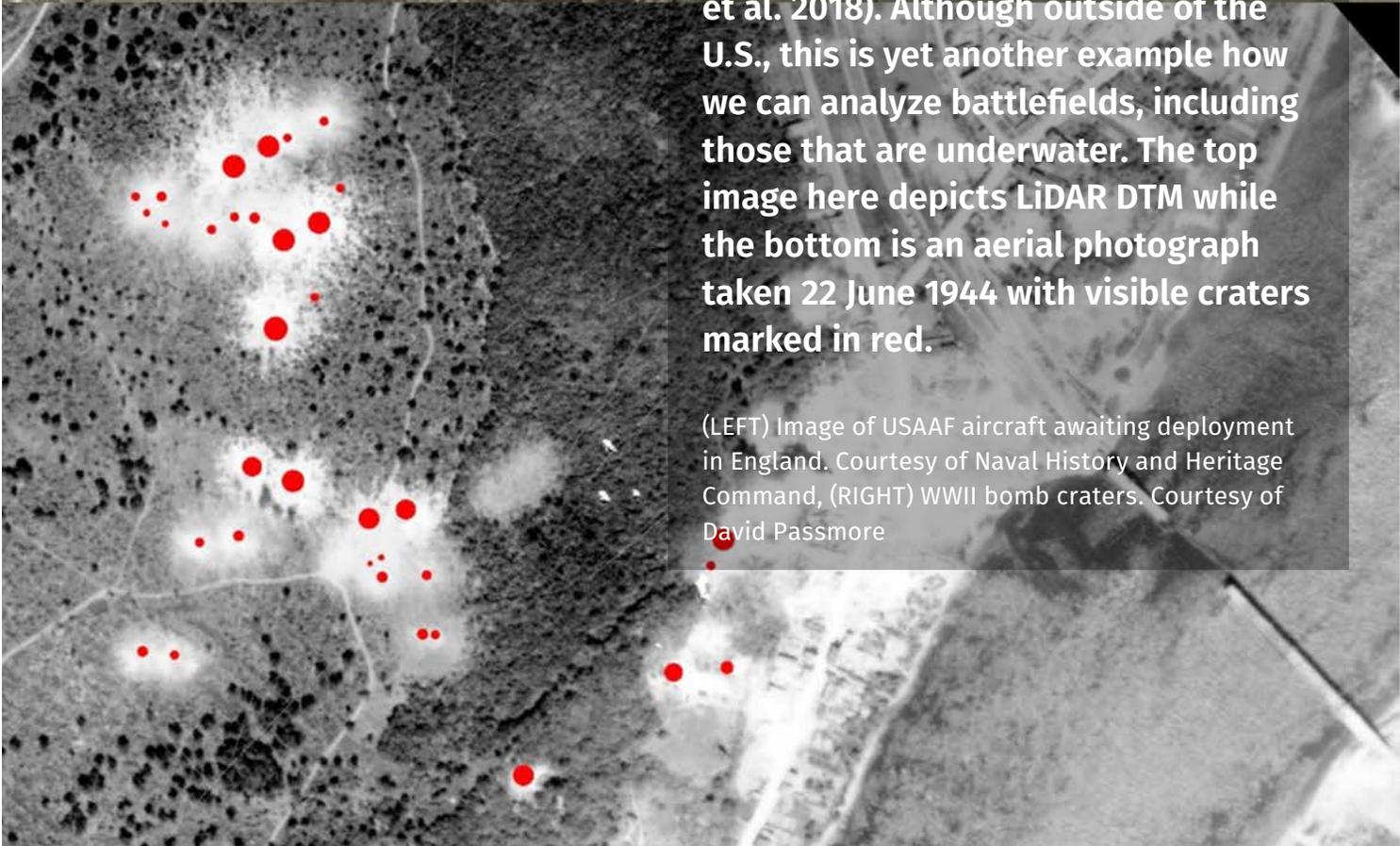
**Another military analytical tool, Levels of War, was used to understand military engagements from the perspectives of policymakers, military leaders, and those on the ground. There are three levels of war that are commonly analyzed: the strategic, the operational, and the tactical (U.S. Army 1982:2-3).**

**Levels of War begins with a broad analysis of overarching strategy and national policy at the strategic level (i.e. the goals of the war or campaign). This includes devoting resources to the military goals and ensuring those at the operational level are supported. The operational level addresses the necessary military strategy and major operations needed to plan and execute campaigns. These sustained operations are designed with a specific area and timeframe in mind. Finally, the tactical level of war addresses actions on the battlefield.**





Recently, Levels of War was used by researchers studying WWII bomb craters found in Normandy, France (Passmore et al. 2018). After identifying and mapping bomb craters seen in the landscape, the researchers used levels of war to identify tactical air raids that impacted the landscape. They were able to build on these raids by working up through the levels of war to identify their significance to the larger Normandy campaign (Passmore et al. 2018). Although outside of the U.S., this is yet another example how we can analyze battlefields, including those that are underwater. The top image here depicts LiDAR DTM while the bottom is an aerial photograph taken 22 June 1944 with visible craters marked in red.



(LEFT) Image of USAAF aircraft awaiting deployment in England. Courtesy of Naval History and Heritage Command, (RIGHT) WWII bomb craters. Courtesy of David Passmore

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## Submerged ARCHEOLOGICAL FIELDWORK

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Submerged archeological fieldwork varies in methodological approach but often requires a combination of diver and remote geophysical survey. The efficacy of any survey depends on the size of the search area, size of the targets, and the submerged environment. Remote sensing surveys can cover large areas and be used to identify submerged terrain features and artifacts, such as wrecks and vessel debris. They are ineffective, however, in detecting small artifacts such as ordnance. Furthermore, specialized experience and equipment can be cost-prohibitive. In contrast, diver surveys can be conducted at lower cost and used effectively to cover small search areas. Two technical manuals that are useful for understanding underwater archeology fieldwork are Bowen's (2011) *Underwater Archaeology: The NAS Guide to Principles and Practice* or Green's (2009) *Maritime Archaeology: A Technical Handbook*. They can be consulted for the appropriate survey design and methods.

### SIDESCAN SONAR

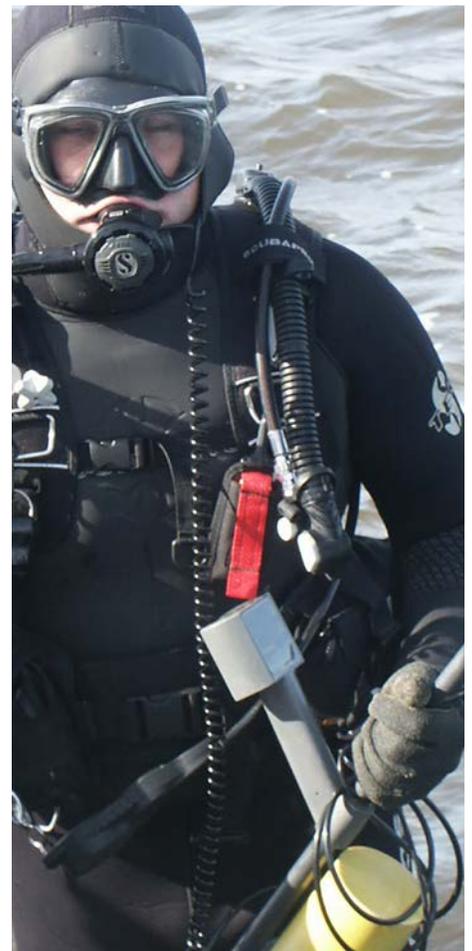
Sidescan sonar survey is a form of remote sensing that uses sound waves to map bottom topography. Often towed beside or behind a vessel, the sonar unit (referred to as a "towfish") emits pings into the water. The time it takes

for these sounds to hit the bottom and bounce back to the unit is directly related to water depth and submerged landscape features. As the data is collected, it forms a map of the bottom that emphasizes any structure with noticeable relief. The caveat to any sonar data is that it still requires a visual survey (either remote or diver conducted) to confirm findings and requires post-processing.

Sidescan sonar is effective in surveying large areas and can be paired with other remote sensing instruments. When surveying Charleston Harbor from 2009-2012, the South Carolina Institute of Anthropology and Archaeology (SCIAA) paired sidescan sonar with magnetometer to investigate submerged American Civil War material. Harbor defenses such as torpedoes, obstructions, and forts were all located by remote sensing in search areas created from the historic record (Figure 3). While some of these resources were documented on historic maps, remote sensing enhanced diver survey by helping staff anticipate size and location of finds (Spirek 2012:94).

There are several caveats to working with sidescan sonar instruments. As the survey vessel is looking for obstructions, researchers should take precautions to keep the towfish well above any potential targets. This is

especially important when surveying in shallow water. Because the sonar emissions document seabed relief, there are also limitations to what can be seen in the data. While surveying a coral reef for WWII amphibious landing craft, for instance, researchers were unable to differentiate between coral encrusted vehicles and naturally occurring reef structure because both had similar sonar profiles (Figure 4) (Carrell 2018). For that reason, the sonar data needed to be paired with magnetometer survey (discussed below) for accurate results.

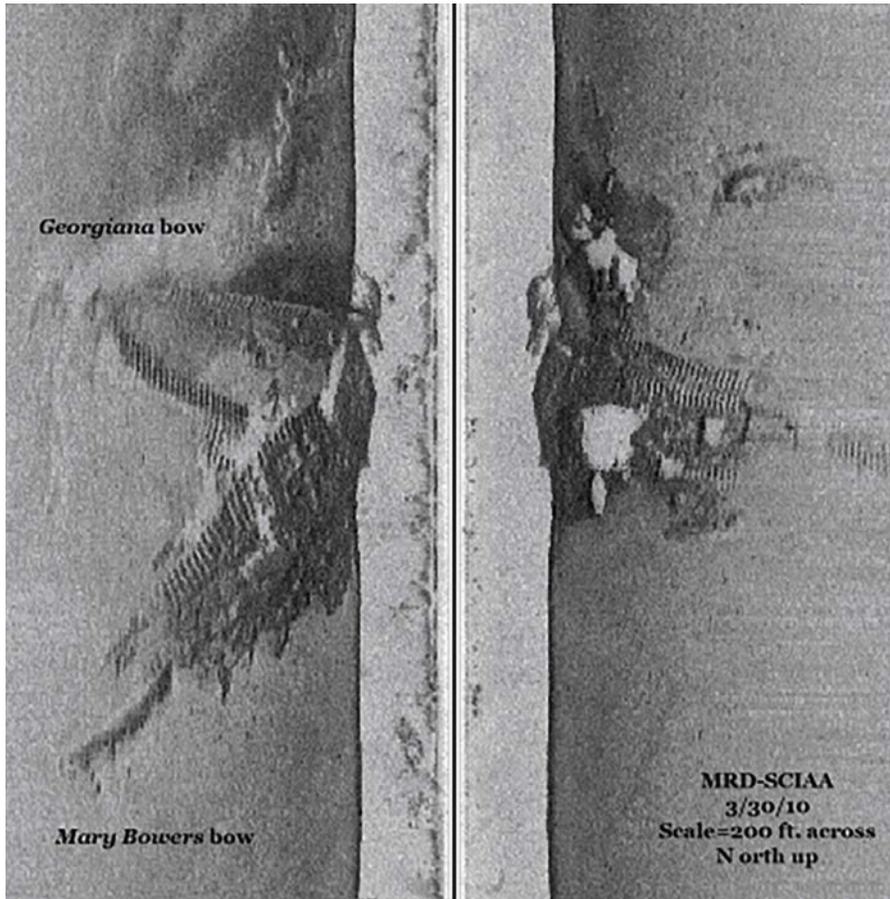


DIVER. IMAGE COURTESY OF GEORGIA HISTORIC PRESERVATION DIVISION

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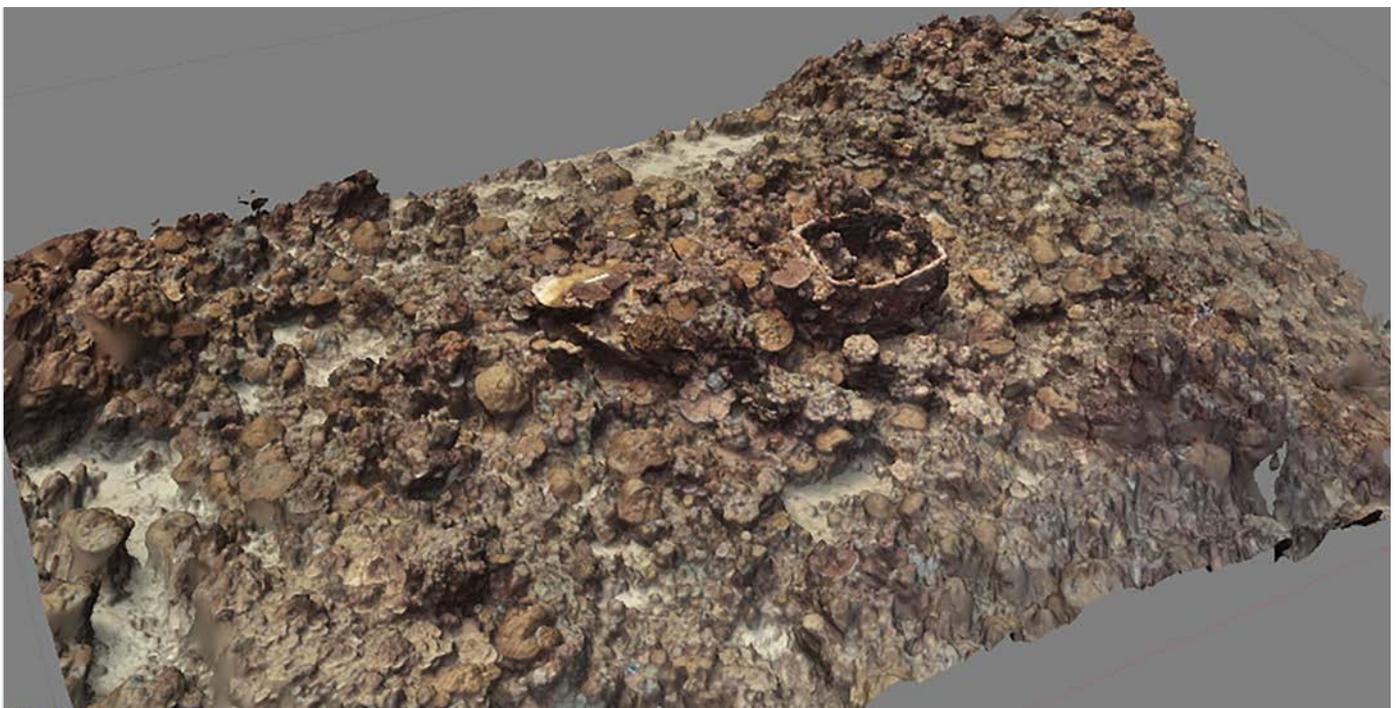
Remote sensing can stand alone for documenting resources or can enhance diver survey by anticipating size and location of finds.

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**Figure 3.** To the left is a sonogram of two Civil War blockade runners, *Georgiana* and *Mary Bowers*, wrecked off Charleston Harbor. Image courtesy of the South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Columbia.

**Figure 4.** Below is a photogrammetry model of a submerged WWII amphibious vehicle encrusted with coral. Image courtesy of Ships of Discovery.



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## Lowtech and Hightech TECHNOLOGY

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### ADVANCES IN TECHNOLOGY

**Geophysical instruments such as sub-bottom profilers, Ground Penetrating Radar (GPR), and Electrical Resistivity Tomography (ERT) are gaining popularity for surveying archeological sites. Each of these instruments surveys below ground level to determine composition of sediment and presence of sub-surface features. While these methodologies are often secondary to other remote sensing instruments, they can be used in the delineation of submerged and terrestrial archeological sites.**

### MAGNETOMETER

Towed magnetometers measure disturbances in the earth's magnetic field created by anomalies with high ferrous (i.e. iron) metal content. While magnetometers typically register metal artifacts, other objects or natural formations will appear as anomalies if they contain ferrous materials. The magnetic signature of an object is related to ferrous content. As such, magnetometers can detect buried or concreted artifacts such as those embedded within a coral reef.

When collecting magnetometer data, the information is typically displayed as a graph with associated numerical values. This output needs further processing to identify an anomaly's geographic location and size. Additionally, the magnetometer towfish requires a specific setup, because the boat can create interference in the data set. There are archeologists who specialize in this type of technology who assist with the planning and implementation of surveys.

Careful planning and assessment of the historical record and survey area should be undertaken before any remote sensing is conducted. For instance, harbor survey has a high potential for unassociated magnetic anomalies such as anchors, aids to navigation, and refuse. An understanding of survey aims and end product can greatly enhance how a magnetometer is used and can impact efficacy of survey resources.

In the above mentioned SCIAA survey of Charleston Harbor, for example, magnetometer survey aided in identifying large submerged shot concentrations. These aided researchers in gauging the accuracy of Union

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An understanding of survey aims and end products can greatly enhance how magnetometer is used and can impact efficacy of survey resources.

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and Confederate battle accounts (Spirek 2012:108-110). A similar survey of submerged Revolutionary War battlefields conducted by the Maryland Maritime Archaeology Program (MMAAP), however, found that the magnetometer was ineffective in delineating small concentrations of shot as the anomalies were indistinguishable from submerged crab traps and metal refuse. Instead, magnetometer was used to identify larger anomalies such as the shipwrecks and sunken blockades from the battle (MMAAP 2013:159).

## ROV

**Remotely Operated Vehicles (ROVs) can be used for a variety of tasks including photography, videography, small object retrieval, 3-D modeling, and visual survey even in low visibility. Operated from the surface via tether, ROVs are often equipped with image and acoustic sensors such as laser scanners, hydrophones, and cameras. These vehicles can perform some of the same tasks as divers but are not limited by depth and dive time. While large vessels are required to operate ROVs at extreme depths, some small scale units can be used off smaller platforms at depths up to 300 meters (975 feet).**

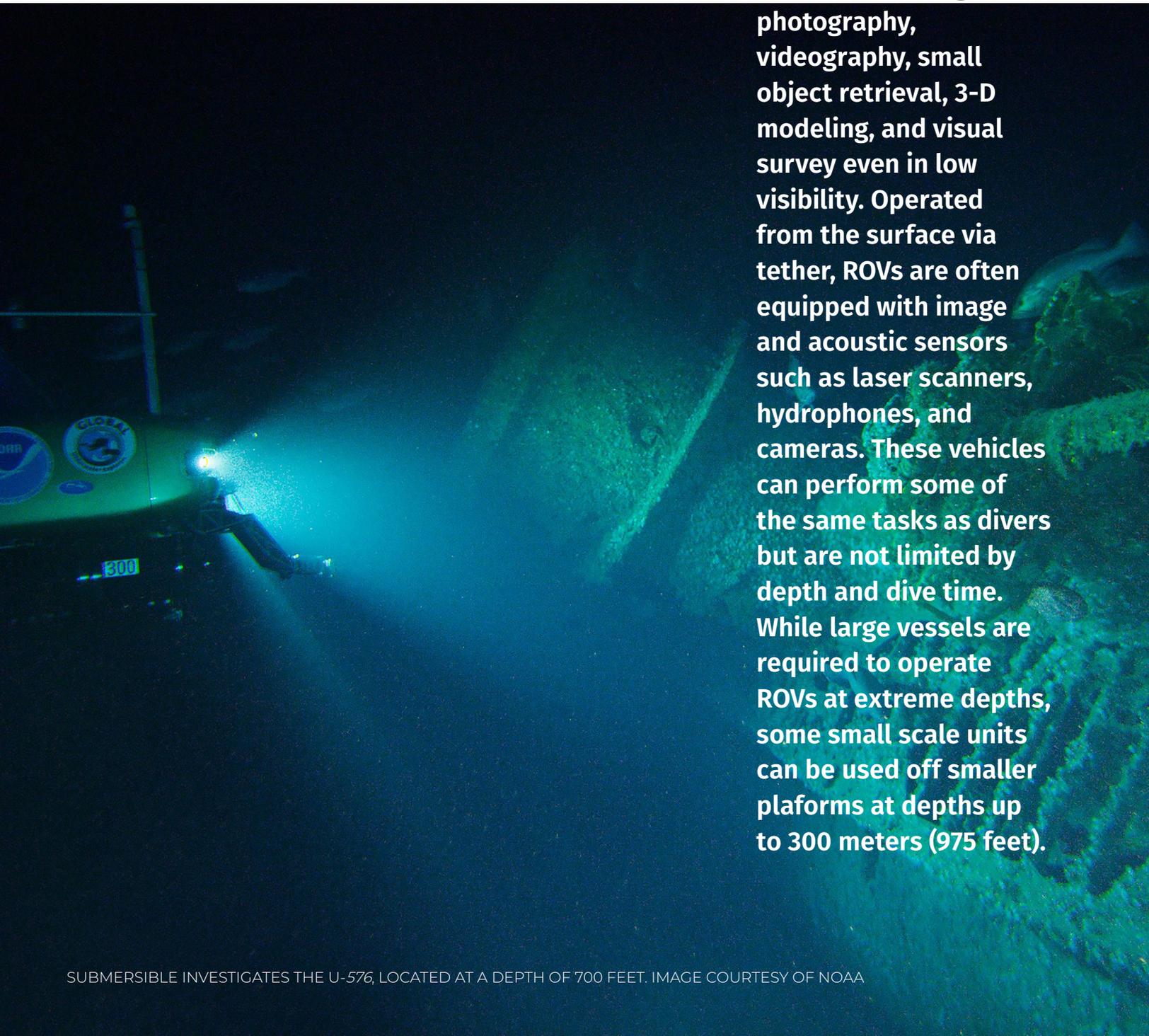




FIGURE 5. AUV INVESTIGATING THE WWII BATTLEFIELD AT KISKA, AK. IMAGE COURTESY OF PROJECT RECOVER

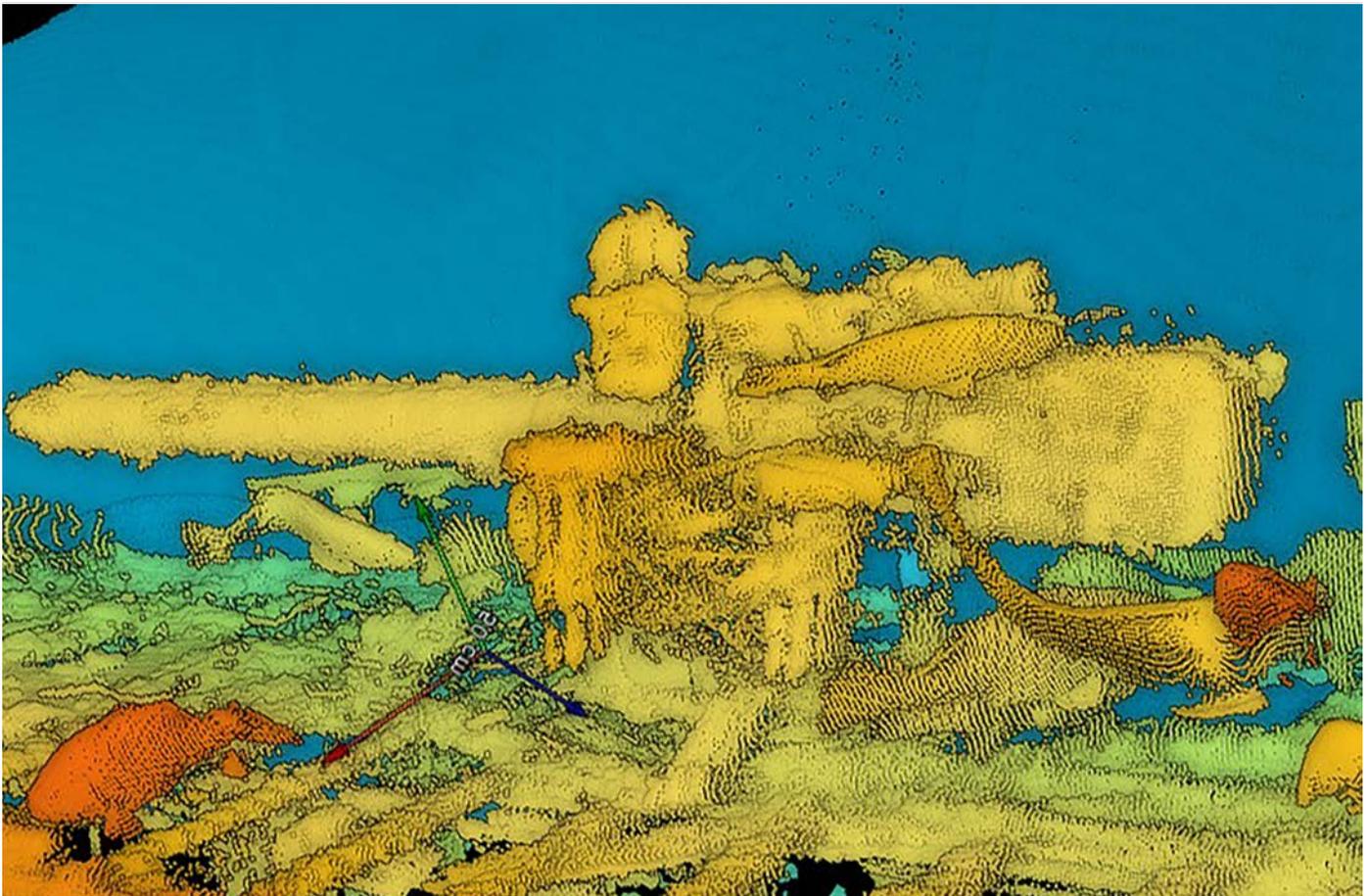


FIGURE 6. LASER SCAN OF THE 88MM DECK GUN ON BOARD U-576. IMAGE COURTESY OF NOAA, 2DROBOTICS/SONARDYNE

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## Remote sensing technologies are gaining popularity in field survey because they offer the opportunity to explore sites that were once out of reach.

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### A U V

Autonomous Underwater Vehicles (AUVs) are gaining in popularity for use in submerged archeology. These systems operate without tethers or controls and can host a suite of technologies, including remote sensing units and cameras. Use is restricted to battery life and operation requires pre-programming a search area into the system.

Researchers operating under a NOAA Ocean Explorer grant used four AUVs to investigate a WWII battlefield at Kiska, Alaska (Gallimore 2018). The mission, which involved searching for 10 lost American aircraft and part of the hull from the American destroyer USS *Abner Read*, covered an expanse of approximately 30 square kilometers. To prioritize sonar targets and ROV work, the AUVs were used in a preliminary survey, which generated areas of further interest (Figure 5).

### S U B M E R S I B L E

Like AUVs, submersibles can contain a number of technologies in addition to their human occupants including audio/visual recorders, remote sensing equipment, and robotic arms and add-ons. While they are limited in mobility (compared to divers), they can reach much greater depths and can conduct longer dives.

During the summer of 2016, archeologists from Monitor National Marine Sanctuary used a submersible outfitted with laser scanning technology to investigate a sunken WWII battlefield (Howes 2016). The sites, a German submarine U-576 and Nicaraguan freighter SS *Bluefields*, are only separated by approximately 200 yards, but sit in over 700 feet of water. To record their structures, each vessel was laser scanned, creating a three-dimensional model showing site integrity (Figure 6). Given the extreme water depths, the scans are the first step in creating baseline documentation necessary for understanding deterioration and digital preservation of this submerged battlefield.

### L A S E R S C A N N I N G & L I D A R

Light Detection And Ranging (LiDAR) involves using waterborne and airborne laser scanning to map terrain features, including cultural materials. The scanners emit light in the form of lasers that hits bottom features and bounce back. As these data are collected, a bathymetric or digital elevations model of the landscape is formed. Regarding terrestrial application, if the emitted light can bypass foliage and hit the underlying terrain, it can be used to extrapolate ground surface and features. This is

only possible with moderate vegetation, however.

All LiDAR requires clear waters to operate. Airborne LiDAR can be used to map shallow water depths but is inefficient past 30 meters (100 feet).

### D R O N E

Drones are being utilized more frequently, and as the platforms develop to load different equipment, they become more useful to archeologists. Drones can be utilized on battlefield sites to capture aerial photographs that can then be used to create photogrammetric models of the landscape and seascape. Drones now are able to carry magnetometers making it easier to reach sites that boats cannot simply survey.

Naval History and Heritage Command (NHHC) Underwater Archaeology Branch conducted an aerial magnetometry survey in search for Joshua Barney's flotilla. The war of 1812 flotilla was pursued up the Patuxent River by the British. The flagship *Scorpion* is believed to have been located by archeologists, but the project was surveying for the remainder of the flotilla.

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## Pedestrian and diver surveys are an ideal way to incorporate local community members and stakeholders into battlefield research projects.

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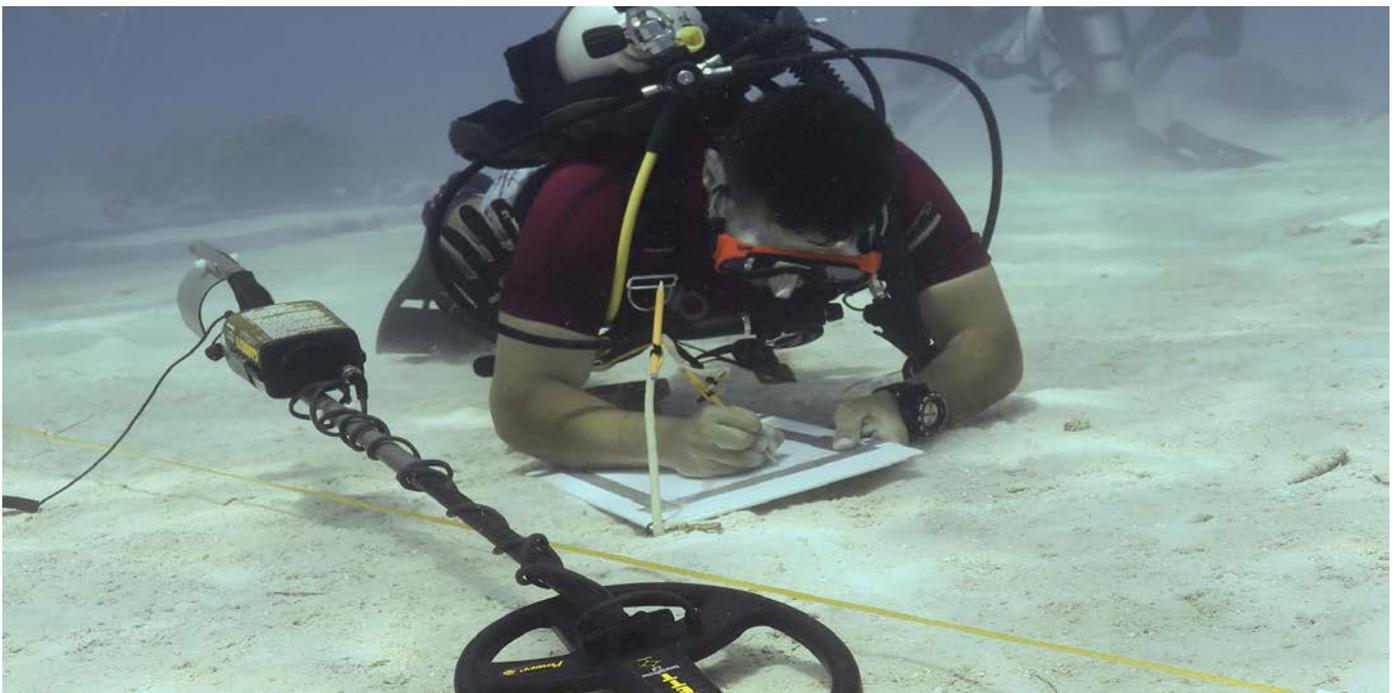
### VISUAL SURVEY

Visual survey techniques include pedestrian, snorkel, diver, and tow board surveys are dependent on environmental limitations and personnel training. Whichever method is used, it should be carried out in a systematic manner to ensure that the survey area is covered. Systematic survey methods include various types of grid patterns as well as circle searches, often used in low-visibility diving environments. The visual survey should also be accompanied by some form of recording mechanism that allows for the location and details of finds to be documented.

### METAL DETECTION

Handheld metal detectors are supplemental tools that can greatly aid in identifying materials while in the field. Unlike magnetometers, metal detectors create their own magnetic field. When in the presence of metals (both ferrous and non-ferrous), the decay of the magnetic field slows, resulting in a positive “hit.” While training and familiarity with the detector is necessary for successful results, metal detectors are less costly than other forms of remote sensing equipment. For the most accurate results, any metal detecting survey should be conducted in a systematic fashion that can be repeated in the future.

Diver survey using metal detecting was the primary methodology used by the Lake Champlain Maritime Museum (LCMM) to systematically survey bottomlands associated with the Battle of Valcour Island (Cohn et al. 2003:25). Recreational volunteer divers worked with trained archeologists to conduct metal detecting transects of the survey area. Any positive metal detecting hits were recorded, along with visible artifacts, to create an extended site plan of the battlefield and delineate site extents.



DIVER RECORDING A MAGNETIC ANOMALY. IMAGE COURTESY OF EAST CAROLINA UNIVERSITY

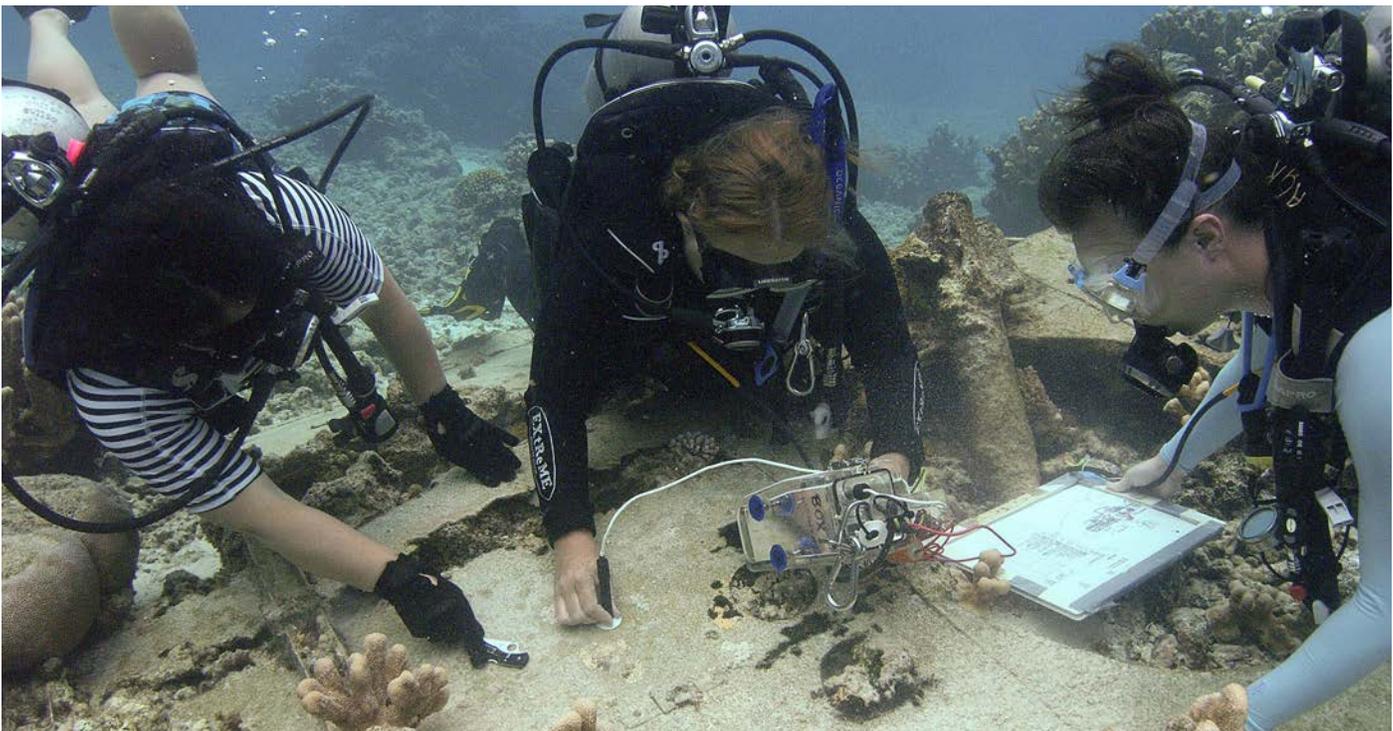
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Visual survey techniques include pedestrian, snorkel, diver, and tow board surveys are dependent on environmental limitations and personnel.

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U.S. SPECIAL FORCES VETERAN VOLUNTEERING TO CONDUCT A CIRCLE SEARCH. IMAGE COURTESY OF EAST CAROLINA UNIVERSITY



DIVERS CONDUCTING IN SITU CORROSION SURVEYS ON WWII AIRCRAFT IN SAIPAN. IMAGE COURTESY OF WESTERN AUSTRALIA MARITIME MUSEUM

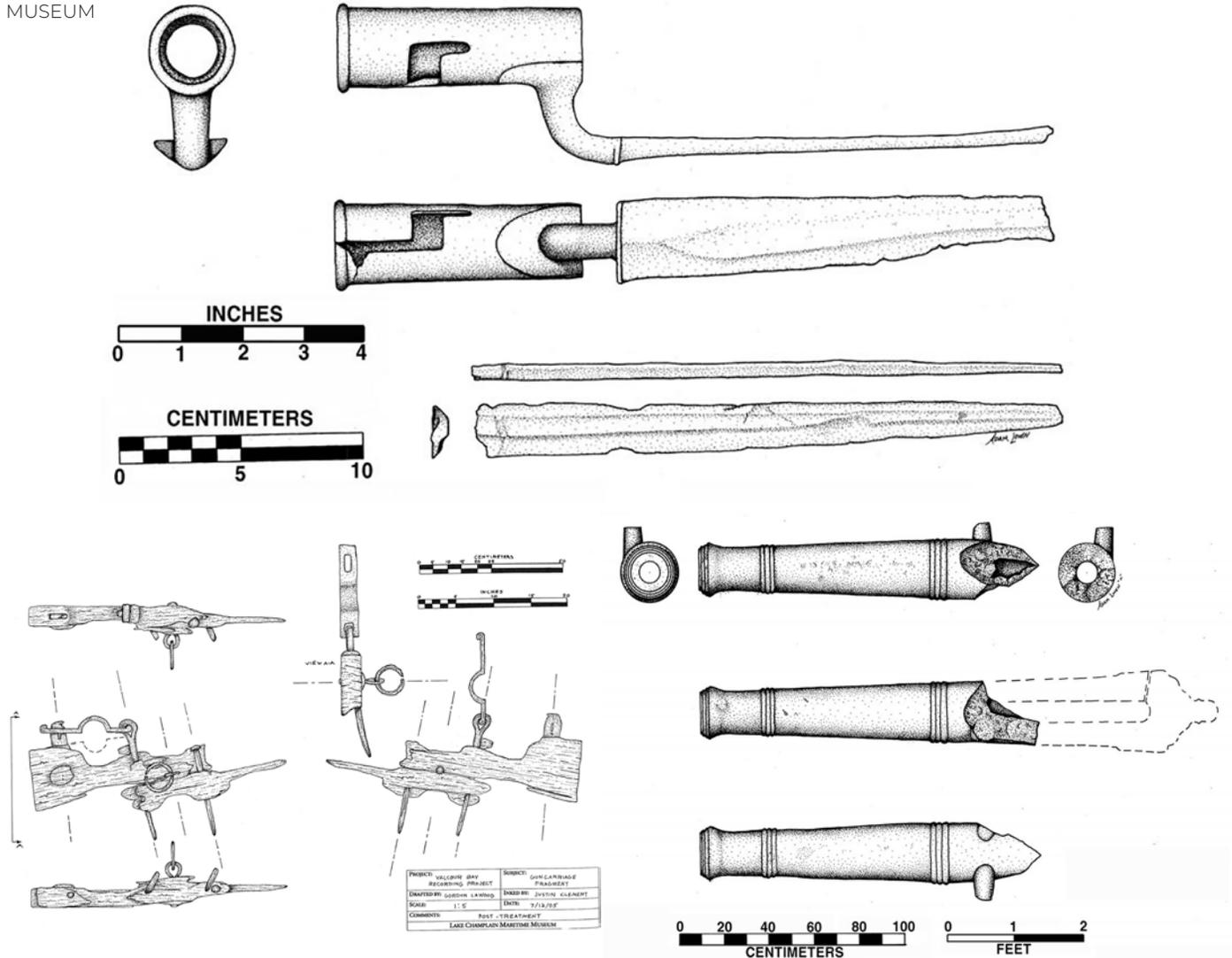
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## Recording Features and **RECORD KEEPING**

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FIGURE 7. SURVEY DRONE FITTED WITH MAGNETOMETER. IMAGE COURTESY OF NAVAL HISTORY AND HERITAGE COMMAND



# All projects face different requirements

for documenting submerged archeological features depending on overarching aims and goals. Regardless of a project's scale, it is important to document all activities that occurred on site. Field journals are traditionally kept by all members of an archeological project; these serve to document daily activities, areas surveyed, problems encountered, and present a brief overview of findings. Daily logs and journals are usually further accompanied by images and/or site, feature, and artifact drawings.

Because battlefield projects address defining features with set geographic coordinates, a record of associated geographic locations should be kept for every feature surveyed in the field. This record should also include associated metadata, such as the geographic coordinate system, projection, and instrument accuracy.

Pre-made recording forms, also known as pro-formas, can greatly enhance organization and record keeping. Prior to any fieldwork, it is useful to develop forms such as photograph and video logs, dive or snorkel logs, metal detecting logs, GPS logs, and defining feature recording sheets. Various examples of these forms exist and can easily be tailored to individual projects.

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## Final PRODUCTS

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In all likelihood, the study of a battlefield was undertaken because it was deemed significant to a stakeholder or group of stakeholders. While not all interested parties will be involved in site research or visitation, it is important to disseminate results of the study in a timely manner to ensure inclusivity. Furthermore, it may also encourage interest in site history, which leads to further involvement in site protection, outreach, or education.

A variety of public outreach and information sharing options are recommended to reach a wider audience than formal reporting can achieve. Social media publications, radio advertisements and interviews, public meetings, newspaper articles, websites or blogs, archeological site reports, and conference presentations all reach different populations and can be a means of inviting different stakeholder groups into ongoing research.

### SITE INTEGRITY

All final reports should address site threats and integrity. Threats can be further differentiated into two categories: immediate threats and long-term threats. Ongoing development and/or landscape changes that

threaten the submerged battlefield are considered immediate threats. For example, installation of a pier or bridge over a historic submerged battlefield could have immediate negative consequences for submerged resources. Unfortunately, looting and illicit removal of resources is another threat frequently associated with submerged sites. These threats should be addressed with their potential impact on battlefield resources.

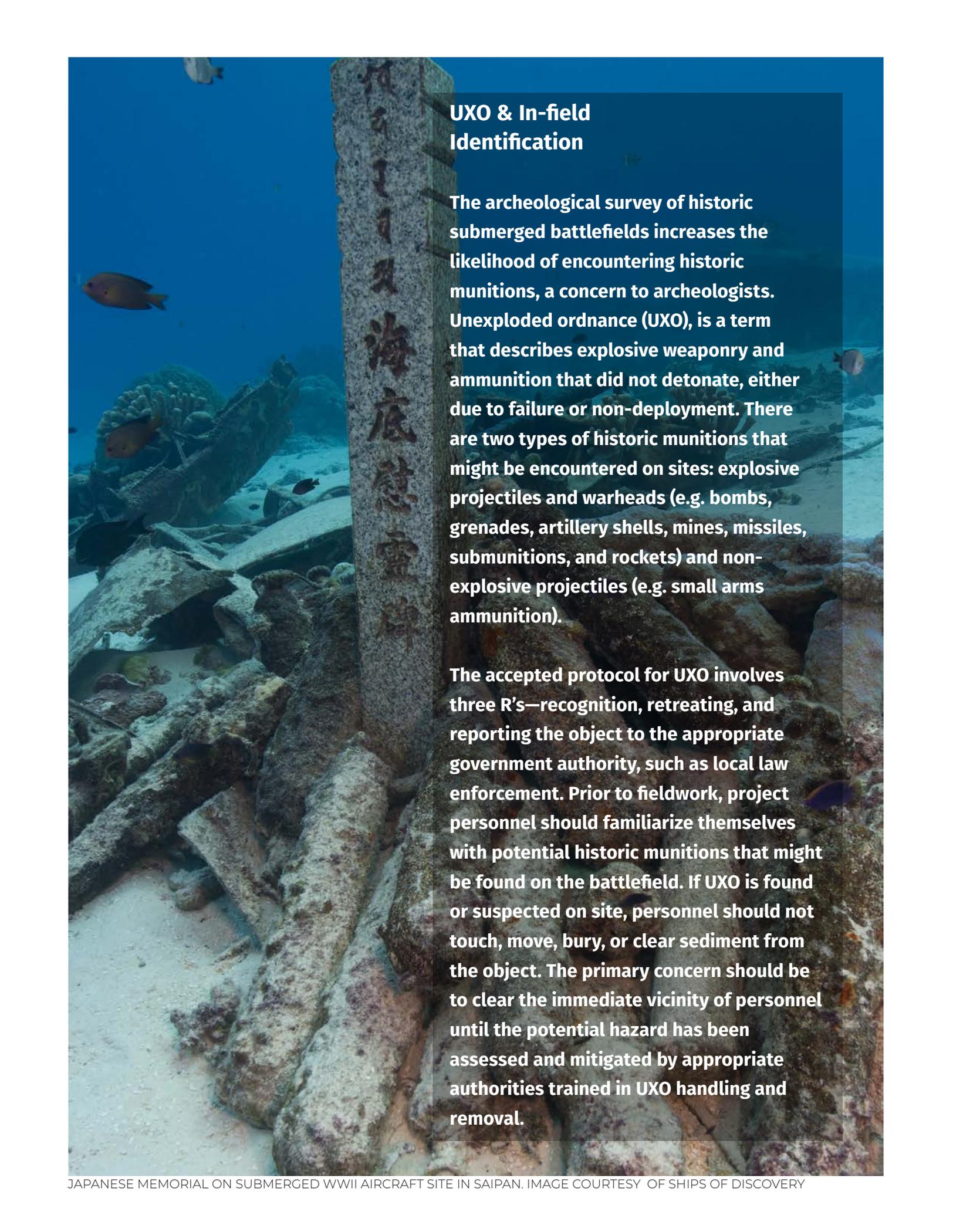
Long-term threats are those that, while not immediate, will eventually impact a battlefield's resources and interpretation. Environment, future development, and prolonged human activity can all be factors that contribute to loss of battlefield integrity. Of these, erosion and deterioration from the aquatic environment are threats that many submerged resources face.

Any data or research generated during a project has the potential to become the best record of a battlefield's resources if site integrity is lost. Data and metadata should be recorded in a way that accounts for long-term preservation and accessibility. Federal institutions maintain data standards that are highly recommended for researchers

generating geographic data. For more information on GIS data, visit [https://www.nps.gov/crgis/crgis\\_standards.htm](https://www.nps.gov/crgis/crgis_standards.htm).

Repositories are institutions designed to store data over the long-term. If possible, researchers should budget for long-term data storage in an appropriate repository and should plan to maintain duplicate copies of data.

Unfortunately, one of the realities of studying submerged battlefields are encounters with relic hunters. As artifacts and sites of combat are used to interpret submerged battlefields, the removal or destruction of these resources negatively impacts battlefield integrity. As a researcher, it is important to protect site integrity by working with local agencies to determine the level of detailed information shared with the public. Often this means a redaction of geographic coordinates in publicly released reports to protect site integrity until a management plan is in place. Other reasons to redact data from reports may be for safety (e.g. large quantities of UXO on site), confidentiality (if aspects of site history remain classified), or sensitivity (e.g. human remains were located that correlate to a known loss).

An underwater photograph showing a large, vertical concrete pillar with Japanese characters carved into it. The pillar is surrounded by various pieces of wreckage, including what appears to be the fuselage of an aircraft. The water is clear and blue, with several small fish swimming around. The scene is set on a sandy seabed.

## UXO & In-field Identification

The archeological survey of historic submerged battlefields increases the likelihood of encountering historic munitions, a concern to archeologists. Unexploded ordnance (UXO), is a term that describes explosive weaponry and ammunition that did not detonate, either due to failure or non-deployment. There are two types of historic munitions that might be encountered on sites: explosive projectiles and warheads (e.g. bombs, grenades, artillery shells, mines, missiles, submunitions, and rockets) and non-explosive projectiles (e.g. small arms ammunition).

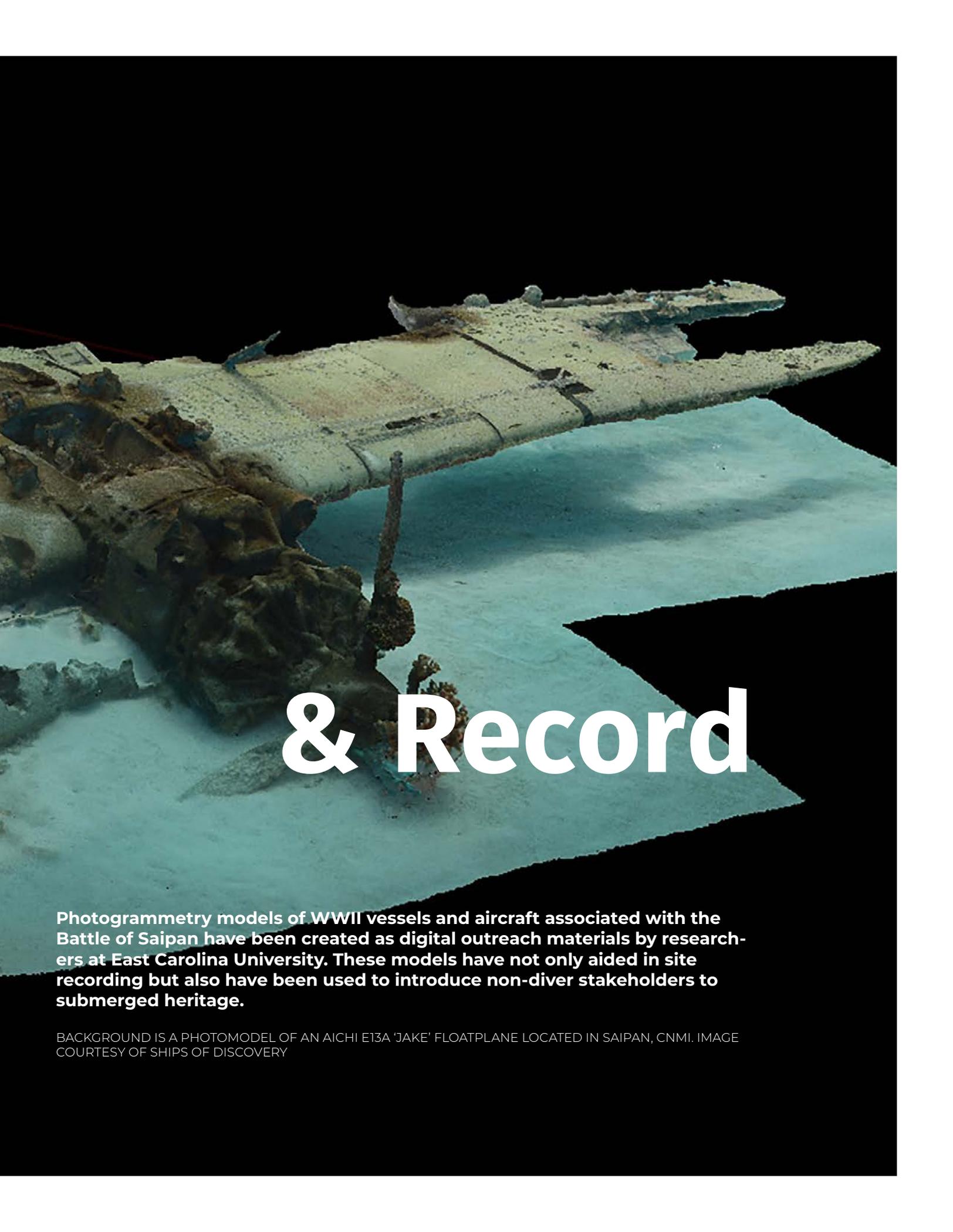
The accepted protocol for UXO involves three R's—recognition, retreating, and reporting the object to the appropriate government authority, such as local law enforcement. Prior to fieldwork, project personnel should familiarize themselves with potential historic munitions that might be found on the battlefield. If UXO is found or suspected on site, personnel should not touch, move, bury, or clear sediment from the object. The primary concern should be to clear the immediate vicinity of personnel until the potential hazard has been assessed and mitigated by appropriate authorities trained in UXO handling and removal.



# Document

## PHOTOGRAMMETRY

Photogrammetry is the process of recording 3D objects using 2D images. Software programs then use images to extract measurements of 3D objects and create digital models. Over the past decade, photogrammetry has revolutionized archeology as it allows for rapid site recording via photography. After the images are taken (often over the course of a single site visit), the model can be built and used to create site plans and take scaled measurements. The models can also be shared online or even printed in 3D as outreach materials.



# & Record

**Photogrammetry models of WWII vessels and aircraft associated with the Battle of Saipan have been created as digital outreach materials by researchers at East Carolina University. These models have not only aided in site recording but also have been used to introduce non-diver stakeholders to submerged heritage.**

BACKGROUND IS A PHOTOMODEL OF AN AICHI E13A 'JAKE' FLOATPLANE LOCATED IN SAIPAN, CNMI. IMAGE COURTESY OF SHIPS OF DISCOVERY



LEFT: DIVERS INVESTIGATING SUBMERGED AMPHIBIOUS VEHICLE. IMAGE COURTESY OF SHIPS OF DISCOVERY. RIGHT: SURVEY TARGETS ON A HISTORICAL CHART. IMAGE COURTESY OF GEORGIA HISTORIC PRESERVATION DIVISION

## CONCLUSION

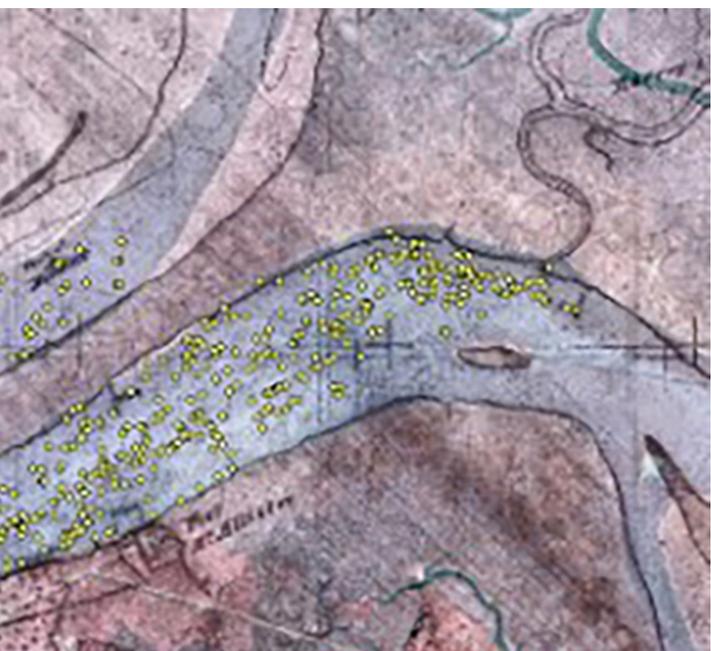
Submerged battlefield archeology involves the systematic study of battles that took place on, near, or under water. This manual was designed to offer insight into current submerged battlefield research by addressing the field methodologies, battlefield analysis approaches, and technological innovations that are currently shaping battlefield archeology research.

While the parameters for every survey will differ (based on environmental constraints, resources available, and overarching research aims), the end goals of battlefield research, outreach, protection, and preservation unite submerged battlefield projects.

The study of submerged American battlefields offers researchers, community members, and stakeholders opportunities to understand and interact with events that define our nation's history. Ongoing submerged battlefield research will strengthen our shared understanding of the role waterways played in past conflicts. Furthermore, continued battlefield studies will aid in the preservation of sites that honor the sacrifices and bravery of those involved.

## HUMAN REMAINS

The potential to find human remains on a submerged battlefield is in some instances better than on land due to the preservation that an anaerobic environment can provide. There are Federal and State laws that apply to the discovery of human remains on archeological sites. There is also a Federal agency, the Defense POW/MIA Accounting Agency (DPAA), whose mission it is to account for lost service personnel. Typically, the first point of contact is local law enforcement and the SHPO. Should one find human remains, it is important to report them immediately and be respectful.



## GLOSSARY

**Battlefield Archeology:** the study of military technologies, features, and conflicts through material evidence.

**Battlefield Boundary:** the historical and archeological area in which the battle took place.

**Conflict Archeology:** the study of technological, social, and cultural tensions between people through material evidence.

**Core area:** the area where the most significant fighting took place.

**DPAA:** The Defense POW/MIA Accounting Agency is the Federal agency responsible for providing the fullest possible accounting for our missing personnel to their families and the nation.

**GPS:** Global Positioning System.

**KOCSA:** Stands for Key terrain, Observation and fields of fire, Cover and conceal-

ment, Obstacles, and Avenues of Approach and Withdrawal. A military terrain analysis used to understand physical space associated with conflict.

**Levels of War:** A military strategic analysis that examines engagements from the tactical, operational, and strategic levels.

**METT-TC:** A military analysis used to examine operations that addresses the Mission, Enemy, Terrain, Troops available, Time, and Civilian considerations.

**NHHC:** The Naval History and Heritage Command is an Echelon II command responsible for the preservation, analysis, and dissemination of U.S. Naval history and heritage located at the historic Washington Naval Yard.

**PotNR:** Potential National Register boundary. This is the area of the battlefield which retains historic integrity. The PotNR may have been identified in a previous study or it may require further delineation.

**Principles of War:** Guidelines used by the U.S. armed forces to prepare for a military engagement.

**Remote Sensing:** Non-intrusive methodologies used to gather geophysical data.

**SHPO:** State Historic Preservation Office(r).

**Sunken Military Craft Act:** Legislation enacted in 2004 which protects all U.S. sunken military craft from unauthorized disturbance. Foreign sunken military craft located in U.S. waters are also protected. Implemented and enforced by NHHC.

**THPO:** Tribal Historic Preservation Office(r).

**Towfish:** The survey instrument towed behind a vessel to collect data. The instrument can be outfitted with various sensors such as a magnetometer or sidescan sonar.

**UXO:** Unexploded ordnance or historic munitions which have not detonated.

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## SUBMERGED BATTLEFIELD-RELATED ORGANIZATIONS

### AMERICAN BATTLEFIELD PROTECTION PROGRAM

The American Battlefield Protection Program (ABPP) promotes the preservation of significant historic battlefields associated with wars on American soil. The goals of the program are 1) to protect battlefields and sites associated with armed conflicts that influenced the course of our history, 2) to encourage and assist all Americans in planning for the preservation, management, and interpretation of these sites, and 3) to raise awareness of the importance of preserving battlefields and related sites for future generations. The ABPP focuses primarily on land use, cultural resource and site management planning, and public education.

### DEFENSE POW/MIA ACCOUNTING AGENCY

The Defense POW/MIA Accounting Agency's mission is to provide the fullest possible accounting for our missing personnel from past conflicts to their families and the nation. Within this mission, they search for missing personnel from World War II (WWII), the Korean War, the Vietnam War, the Cold War, the Gulf Wars, and other recent conflicts.

### NAVAL HISTORY AND HERITAGE COMMAND

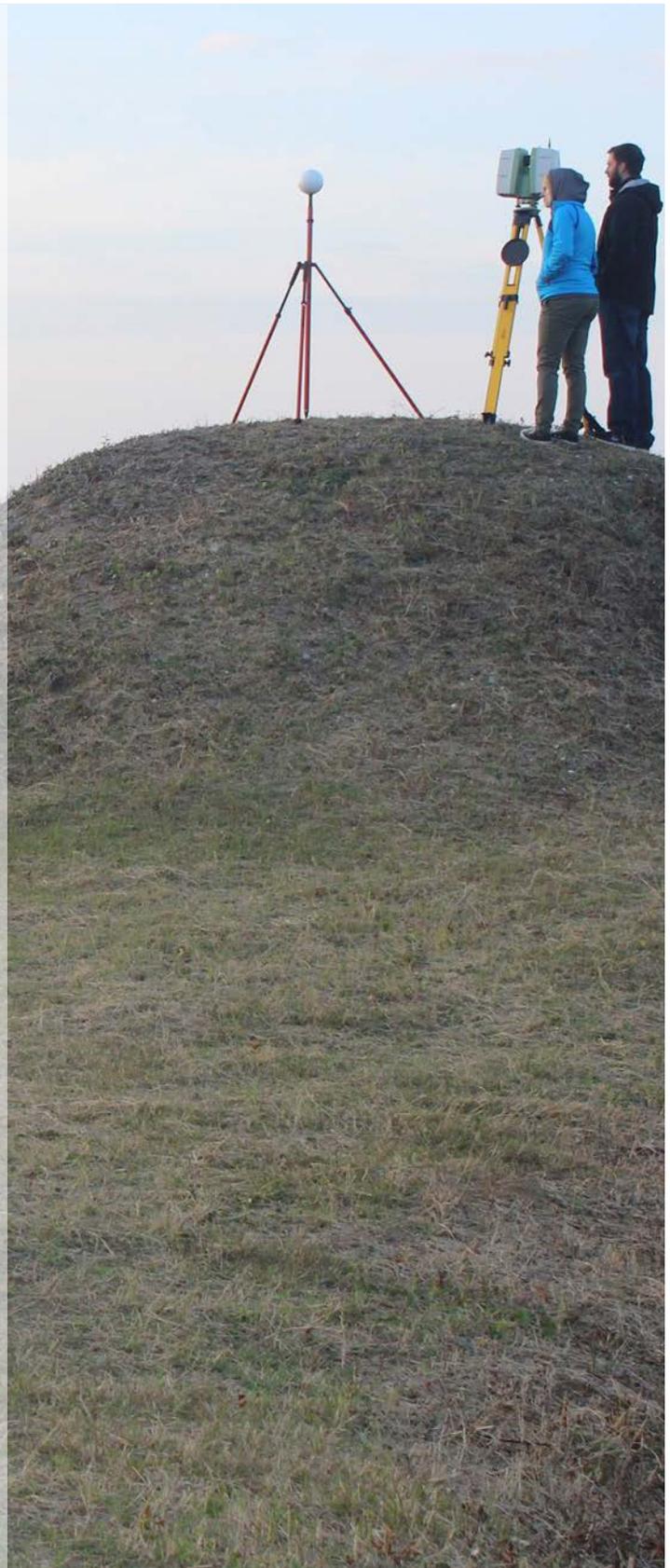
The Naval History and Heritage Command (NHHC), headed by the Director of Naval History, is an Echelon II command headquartered on the Washington Navy Yard, D.C. Its vision is to serve our nation, by using the power of history and heritage to enhance the warfighting capability of the U.S. Navy. Its mission is to preserve and present an accurate history of the U.S. Navy.

### STATE HISTORIC PRESERVATION OFFICE(R)

A State Historic Preservation Officer is the appointed official in each of the 59 states, territories and the District of Columbia who is responsible for the management and protection of historical and archeological resources. The SHPO Federal mandate is set forth in the National Historic Preservation Act of 1966.

### TRIBAL HISTORIC PRESERVATION OFFICE(R)

Tribal Historic Preservation Officers are officially designated by a federally-recognized Indian tribe to direct a program approved by the National Park Service. THPOs assume some or all of the functions of State Historic Preservation Officers on Tribal lands. This program was made possible by the National Historic Preservation Act of 1966.



SURVEY OF FORT FISHER, THE CIVIL WAR'S LARGEST AMPHIBIOUS BATTLE. IMAGE COURTESY OF EAST CAROLINA UNIVERSITY



Grant Agreement No. GA-2287-17-015  
American Battlefield Protection Program  
**Submerged Battlefield Survey Manual**  
Jennifer F. McKinnon, Madeline Roth, Toni L. Carrell  
Ships of Exploration and Discovery Research, Inc.  
2020

This material is based upon work assisted by a grant from the Department of the Interior, National Park Service. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of the Interior.