Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration

Exploring Shipwrecks in Wisconsin Shipwreck Coast National Marine Sanctuary

Lesson Specifications

Age

8-12

Timeframe

One 45-minute classroom session
One 90-minute pool mission

Materials

Lesson:
- Computer w/ internet
- Projector
- Legos or similar
- Internet-enabled device with 3D scanning app

Scuba:
- All required scuba gear
- Assorted weights
- Compass
- UW Camera
- Dive slate and pencil
- Ruler

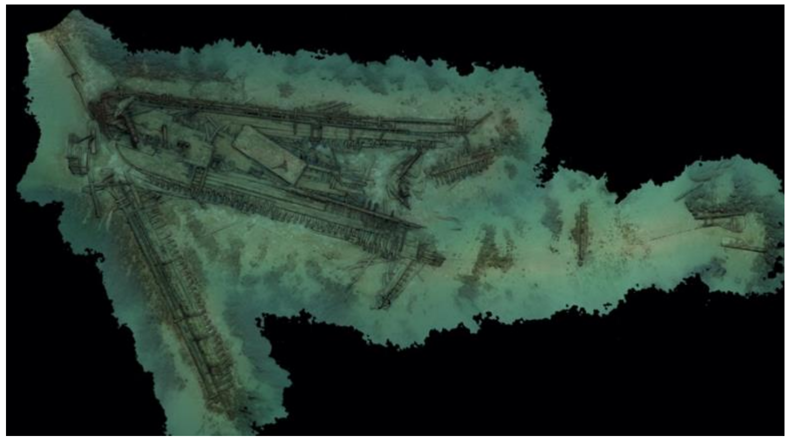
Key Words

model, shipwreck, maritime heritage, photogrammetry, simulation, observation

Standards

PADI, SSI, NAUI, Ocean Literacy Principles 6 & 7

The steam paddle boat, *Sheboygan* sank in 1914. Photo: NOAA.



A photomosaic of the shipwreck *Mahoning* that sank in 1864. Photo: NOAA

Activity Summary

This lesson introduces students to Wisconsin Shipwreck Coast National Marine Sanctuary and the important maritime heritage resources it protects. Students simulate using photogrammetry to make a model of a shipwreck. Students practice buoyancy control, awareness of their environment and buddy, and air management while drawing a wreck site plan on a dive slate. Students take compass bearings to indicate artifact locations and take measurements and images of simulated artifacts.

Learning Objectives

Students will be able to:

- Explain the importance of Wisconsin Shipwreck Coast National Marine Sanctuary, by using examples.
- Explain, by using examples, the tools and methods used to explore shipwrecks.
- Practice buoyancy control, environment and buddy awareness, and gas management while simulating making a wreck site plan and simulating the use of photogrammetry.

Essential Questions

1. What are national marine sanctuaries and why are they important?
2. What important resources are protected by Wisconsin Shipwreck Coast National Marine Sanctuary?
3. What tools and methods are used to explore shipwrecks?

National Marine Sanctuary Diver Performance Requirements

At the surface, students will:

- Streamline gear prior to entry.
- Perform a comprehensive buddy check.
- Review necessary hand signals.
- Establish an air management plan.
- Perform a weight check and adjust weighting as necessary.

Underwater, students will:

- Demonstrate proper descent techniques and awareness of the environment.
- Demonstrate proper buddy awareness and air management.
- Demonstrate appropriate use of hand signals.
- Demonstrate appropriate buoyancy control.
- Demonstrate the ability to use a dive slate, ruler, and compass to make a dive plan of a simulated wreck site.
- Demonstrate the ability to use a camera to take images of simulated artifacts.

A map of national marine sanctuaries and marine national monuments in the United States and its territories.

Background Information

Wisconsin Shipwreck Coast National Marine Sanctuary

NOAA's Office of National Marine Sanctuaries serves as the trustee for a network of underwater areas encompassing more than 620,000 square miles of marine and Great Lakes waters. The network includes a system of national marine sanctuaries and Papahānaumokuākea and Rose Atoll marine national monuments. Few places on the planet can compete with the diversity of the National Marine Sanctuary System, which protects America's most iconic natural and cultural marine resources. The system works with diverse partners, treaty holders, and stakeholders to promote responsible, sustainable ocean uses that ensure the health of our most valued ocean places. Healthy aquatic ecosystems, whether fresh, brackish, or marine, are the basis for thriving recreation, tourism, and commercial activities that drive coastal economies.

The National Marine Sanctuary System includes a strong commitment to maritime heritage, the study of human interactions with the ocean and coastal lands and waters. Maritime heritage seeks to preserve valuable historical, cultural, and archaeological resources above and below the waves, including not only physical resources such as shipwrecks and archaeological sites, but also intangible resources such as cultural practices and traditions. The study of maritime heritage enriches our understanding of how exploration, trade, and the transportation of goods and people affected our country's development and continues to influence the character and economies of coastal communities. The study and preservation of maritime heritage is a large part of the research conducted at Wisconsin Shipwreck Coast National Marine Sanctuary.

The study of maritime heritage resources may include photo-documentation (shown in the image above) and site plans. Photo: NOAA

Designated in 2021, Wisconsin Shipwreck Coast National Marine Sanctuary provides stewardship for our nation's maritime heritage in Lake Michigan. Co-managed by NOAA and the state of Wisconsin, the sanctuary expands on the state's 30-year management of these historic sites, bringing new opportunities for research, resource protection, and education. In partnership with local communities, the sanctuary provides a national stage for promoting recreation and heritage tourism. Wisconsin Shipwreck Coast National Marine Sanctuary is only the second sanctuary to be designated in the Great Lakes region. The sanctuary is located in Lake Michigan, the second largest of the five Great Lakes.

Top: Map showing Wisconsin Shipwreck Coast National Marine Sanctuary in Lake Michigan, Thunder Bay National Marine Sanctuary in Lake Huron, and the proposed Lake Ontario National Marine Sanctuary in Lake Ontario.

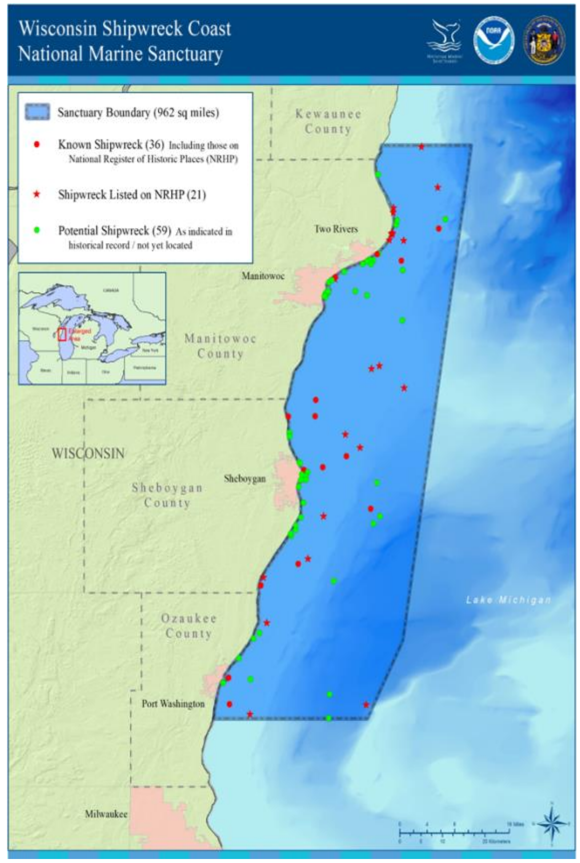
Bottom: The five Great Lakes Credit: NOAA

The Great Lakes system, often referred to as an "inland sea," includes lakes Superior, Michigan, Huron, Erie, and Ontario, as well as a number of rivers and tributaries that connect the lakes to each other and, via the St. Lawrence River, to the Atlantic Ocean. Together, they hold about 90% of the surface freshwater in North America and approximately 20% of the world's surface freshwater supply. Wisconsin

Shipwreck Coast National Marine Sanctuary protects 962mi^2 of Lake Michigan waters and the shorelines of the historic port towns of Two Rivers, Manitowoc, Sheboygan, and Port Washington, Wisconsin.

The sanctuary protects 36 historic shipwreck sites, representing vessels that played a central role in building the nation between 1830 and 1930. Twenty-seven of these wrecks are listed on the National Register of Historic Places and research suggests that another 60 plus shipwrecks may yet to be discovered. Some wrecks are visible from the surface by paddlers and snorkelers, while others lie much deeper and are only accessible by trained divers and/or other exploration technology.

Tens of millions of people depend on the Great Lakes, including Lake Michigan, for drinking water. Additionally, the Great Lakes provide water for much of the agricultural production and industrial processes of both the United States and Canada. Spanning more than 750 miles from west to east, and bordering eight U.S. states and two Canadian provinces, the Great Lakes provide means of transportation and power generation, many recreational opportunities, and habitat for over 3500 species. Commercial and sport fishing, agriculture, recreation, tourism, manufacturing, and shipping are all important to the region. These activities create millions of jobs and provide many goods, like whitefish and timber, and services, like water filtration and flood control. Wisconsin Shipwreck Coast National Marine Sanctuary plays an important role in conserving the many important resources of the Great Lakes region.



Map of Wisconsin's mid Lake Michigan shoreline showing the sanctuary boundaries, which encompasses 962 square miles and includes 36 known shipwreck sites. Credit: NOAA

Nearshore fish seining for larval whitefish survey. Muskegon, Lake Michigan. Credit: NOAA Great Lakes Environmental Research Laboratory

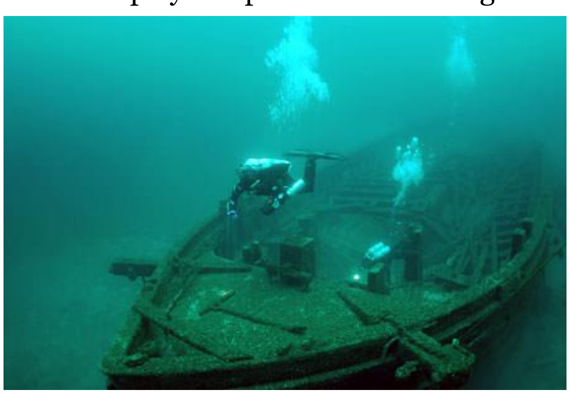
Shipwrecks in Wisconsin Shipwreck Coast National Marine Sanctuary

In the mid-19th century, the inland waterways of the Great Lakes became busy highways for trade in goods, such as wheat, corn, lumber, coal, and iron ore, and provided transportation for millions of people moving west. Fleets of ships served industries around the lakes and helped grow port cities, such as Cleveland, Detroit, and Chicago. The shipping industry also shaped the character of smaller industrial centers fueled by Great Lakes trade such as those on the shores of Wisconsin Shipwreck Coast National Marine Sanctuary.

A scuba diver explores *Walter B. Allen*, a two-masted schooner within Wisconsin Shipwreck Coast National Marine Sanctuary. Canallers like the *Allen* were unique to the Great Lakes and were constructed to fit perfectly through the Welland Canal Locks that connects Lakes Erie and Ontario. Photo: Tamara Thomsen/Wisconsin Historical Society

The Great Lakes are among the most treacherous waters in the world. Powerful storms are common, especially in late fall, and often form quickly giving little warning. As the shipping industry expanded in the 19th century, loss of vessels, cargo, and crew became very real factors affecting the industry and the people who relied upon it. In 1871, there were 591 maritime accidents—one for every four boats on the Great Lakes. Maritime historians estimate that there are upwards of 6,000 shipwrecks, most awaiting discovery, in the Great Lakes. The cold, freshwater of the Great Lakes preserves the structural integrity of vessels sunk hundreds of years ago, making it possible to observe details of the vessels structure and cargo, and in some cases, even the personal items brought on board by the crew. Unlike their saltwater counterparts, freshwater shipwrecks have not experienced the same deterioration from shipworms (a saltwater clam) burrowing through their wooden hulls. As saltwater speeds metal deterioration, iron and steel vessels also maintain their structural details much longer in freshwater. The quality of the shipwrecks found throughout the Great Lakes make them a top destination for many wreck divers and shipwreck explorers interested in experiencing each vessel.

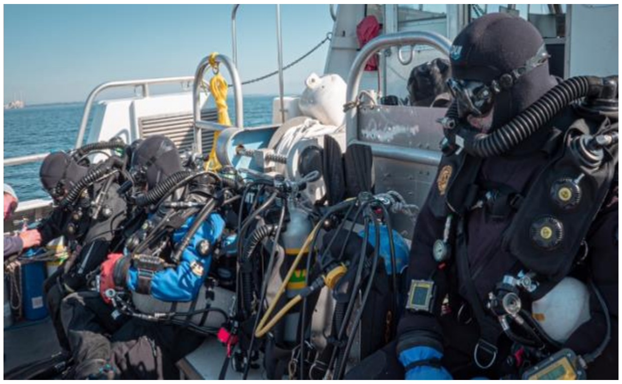
Shipwrecks in Wisconsin Shipwreck Coast National Marine Sanctuary represent a diversity of vessels that played a pivotal role in the growth of the United States. From pre-Civil War sailing ships to modern bulk-freighters, these vessels transported America's business and industry to population centers on the East Coast and supported western expansion. The collection of shipwrecks within Wisconsin Shipwreck Coast National Marine Sanctuary is considered a national treasure because, in addition to the shipwrecks themselves, many of their cargo remain largely intact. One example is the three-masted schooner *Rouse Simmons,* also known as the Christmas Tree Ship. It was built in 1868 and sank along with its captain and crew in 1912 as it carried Christmas trees destined for port in Chicago.



Bound for Chicago with a hold full of Christmas trees, the *Rouse Simmons* was lost with all hands in a November gale in 1912. Some tree remnants can be observed within the wreck. Photo: Wisconsin Historical Society

Fifteen of the sanctuary's wrecks are almost completely intact and three have standing masts, a rarity among sunken wrecks. The sanctuary includes Wisconsin's two oldest known shipwrecks, including the schooner *Home*. *Home* was a trade ship that carried grain, lumber, and general merchandise between Lake Erie and the upper Great Lakes. The *Home*'s captain, James Nugent, was a known abolitionist and collaborator on the Underground Railroad. While difficult to confirm, *Home* was likely used in some capacity, but never caught with fugitive slaves aboard.

Historic sites like the wrecks in Wisconsin Shipwreck Coast National Marine Sanctuary create exceptional scuba diving opportunities. Due to their depth, some of the wrecks in the sanctuary require technical diving. Technical diving includes all diving methods that exceed the limits imposed on depth and/or bottom time for recreational scuba diving. Technical diving involves the use of special gas mixtures for breathing. The type of gas mixture used is determined by the specific dive plan. Technical divers may work in the range of 170 feet to 350 feet, sometimes even deeper. Technical diving almost always requires one or more mandatory decompression stops, during which the diver might change breathing gas mixes. Decompression stops are necessary to allow gasses that have accumulated in the diver's tissues to be released in a slow and controlled manner.

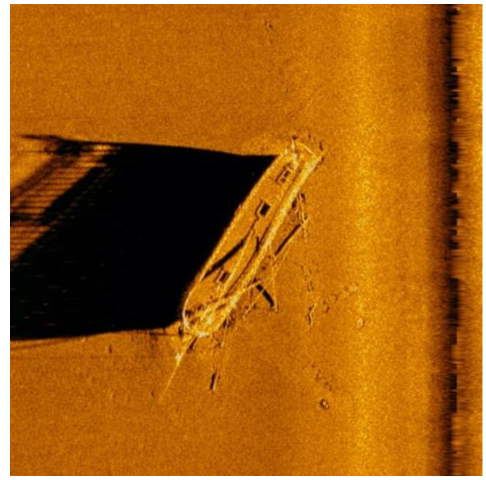


Known as tech divers, these divers are able to attain deeper depths and longer dive times through the use of additional equipment and substantial training. Photo: NOAA

Many of the sanctuary's wrecks are within the depth limits of recreational scuba diving (less than 130 feet). Some wrecks, like two near Two Rivers, provide opportunities for snorkelers. However, the water in Lake Michigan is often cold. A 7mm wetsuit is generally sufficient protection for most divers during the main diving season (May through October), although some divers prefer to use a dry suit, especially when diving deeper wrecks. During the colder months, a dry suit is required. Divers should use a regulator that is designed to be used in temperatures below 50°F. Free flows can occur on any regulator, but this is a common problem with equipment not designed for the cold conditions found in Lake Michigan. Carrying a redundant air source is recommended. Visibility can vary dramatically from day to day. At times visibility can exceed 100 feet, but generally visibility is about 35 to 40 feet. Currents may be present, and conditions can change quite quickly. Divers should be sure to check with the National Weather Service before going out. Most dive operators that conduct dives on sanctuary wrecks require divers to hold both their Advanced Open Water and Deep Diver Specialty certifications.

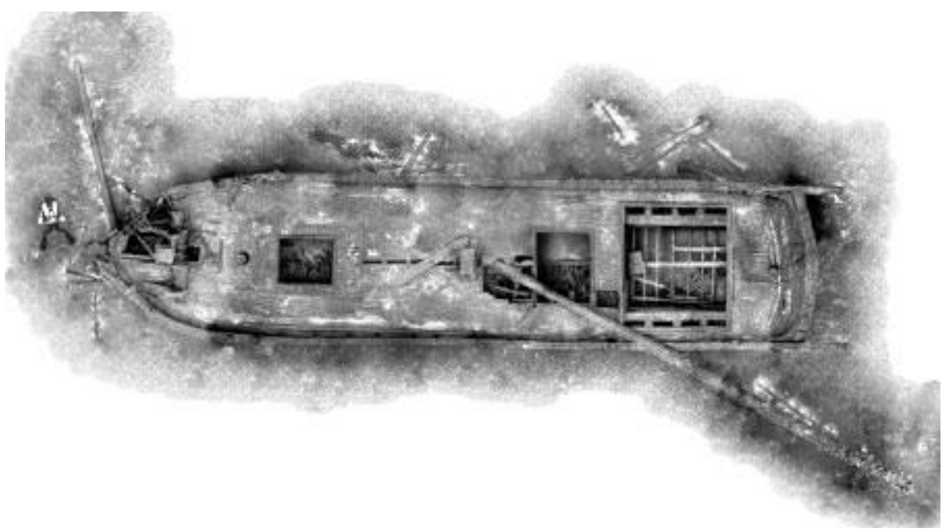
A diver uses laser photogrammetry tools to record dimensions of a shipwreck. Photo: NOAA

Shipwrecks offer valuable insight into past communities, their values, and their livelihoods. The process of shipwreck exploration begins with research. For example, in building an understanding of the maritime heritage of Wisconsin Shipwreck Coast National Marine Sanctuary, researchers use primary sources such as newspaper articles to compile a list of shipwrecks potentially located within the sanctuary boundary. Researchers record the vessel's name, cargo, and accounts of the wrecking events. They then research key pieces of information that could help with vessel identification if wreckage was found. For example, they use builder's plans to identify vessel dimensions such as length and width (referred to as “beam”), and features like the number of masts, deck machinery, and hull shape.


Sonar imagery of the schooner Gallinipper that sank in 1851. Photo: University of Delaware

Once the list of potential shipwrecks is created, researchers then establish a search location where the vessel remains may be located. Researchers primarily use eyewitness accounts that document the vessel’s last known position to generate a search area. This area is then refined using historical weather data, current and tidal models, and nautical charts that depict underwater terrain. Once the search area is defined, there are many technologies researchers may use to help locate wreckage. Sonar is a tool that uses acoustic echoes to visualize underwater features. Many shipwrecks have been found by local wreck explorers using single-beam sonar. Maritime archaeologists and other scientists often have access to more advanced sonar systems. Surveyors are looking for underwater features that appear human-made. Natural features rarely have the straight lines seen in human-made structures. The presence of straight lines and unnatural shapes may indicate a debris trail or the remnants of the shipwreck itself.

Once wreckage is located, divers may be sent to survey the shipwreck, or the survey may be completed using a submersible like a remotely-operated vehicle (ROV) or an autonomous underwater vehicle (AUV). By taking measurements, pictures, and video, and by making drawings, the survey carefully documents the wreckage and its artifacts. Scientists may make a detailed and scaled drawing called a site plan. Images may be used to make a three-dimensional map of the wreck site using a process called photogrammetry. If you deconstruct the word photogrammetry, you see it contains “photo,” meaning light, “gram,” meaning drawing, and “metry,” meaning measurement. Therefore, photogrammetry is the use of photographs to make measurements and models. Someone wishing to employ photogrammetry to model a shipwreck takes a series of overlapping images of the wreck site. Photogrammetry software then uses all the images to create an accurate model of the shipwreck, with the distance between the points plotted to scale.



A photomosaic, a type of image made using photogrammetry, of the schooner *Home*, made by stitching hundreds of individual images together. Photo: Wisconsin Historical Society

Once data has been collected, scientists try to identify the shipwreck by matching their observations to their research on the vessel's dimensions, cargo, and last known location. Sometimes researchers get lucky and the vessel’s name plate or its bell, which both show the vessel name, are located on site. Otherwise, scientists use the process of elimination to identify vessel candidates for the site. Once an identification has been made, artifacts may offer clues as to how the crew lived and worked. For example, the presence of cannon may suggest that the crew needed to defend their cargo while traveling through dangerous waters; recreational artifacts, such as game pieces or musical instruments, offer insight into how crew members relaxed. Similarly, objects like cooking pots, glass bottles, and ceramic dishes shed light on the foods the crew ate and their preparation while on board.

There are many regulations and laws governing how people interact with shipwrecks. Shipwrecks are best studied using non-invasive techniques such as sonar and photogrammetry. In rare cases, further excavation may be undertaken by trained archaeologists who recover artifacts for further study and preservation.

The University of Delaware autonomous underwater vehicle *Iver3* was used during the Maritime Heritage in America’s Inland Seas expedition, an effort to map the lakebed inside Wisconsin Shipwreck Coast National Marine Sanctuary. Photo: NOAA

Vocabulary	
AUV	autonomous underwater vehicle; an underwater robot that can complete a pre-planned mission without needing to be controlled by an operator
maritime heritage	the study of human interactions with the ocean and coastal lands and waters
photogrammetry	the name for a group of technologies that use images to make measurements and generate models
ROV	remotely-operated vehicle; an underwater robot connected to a ship through a series of long cables called a tether
shipping	the transport of goods via waterways
shipwreck	the remains of a vessel that is located sunken to the bottom of a body of water
site plan	an accurate and scaled depiction of a shipwreck showing the relationship of selected artifacts to other artifacts
sonar	stands for **so**und **na**vigation and **r**anging; a technology used to detect underwater objects and to measure water depth via emitting sound pulses and detecting and timing their return after being reflected
submersible	an underwater robot
technical diving	includes all diving methods that exceed the limits imposed on depth and/or bottom time for recreational scuba diving; recreational scuba diving is limited to a depth less than 130 feet and limits bottom time as not to require decompression stops

Preparation – *Classroom*

Review slide deck. Be aware of important information, as well as suggestions for instruction, located in slide notes.

Practice the use of the technology used in the photogrammetry simulation. Please keep in mind that most 3D scanning apps are intuitive, especially for students. In addition, many useful tutorials exist online. It is encouraged that you find an app that is available for both Apple and Android devices. Download the 3D scanning app onto the devices in advance. The simulation can be done as a demonstration at the discretion of the instructor.

Procedure

Introduction

Follow the prompts in the slide deck notes to introduce the following concepts:

- What are national marine sanctuaries and why are they important?
- Where is Wisconsin Shipwreck Coast National Marine Sanctuary and what resources does it protect?
- Why are the Great Lakes important?
- What is maritime heritage and why is it important?
- What tools and methods are used to explore shipwrecks?

Activity

Photogrammetry Simulation

Students should imagine that they are part of a team of divers on an expedition to use photogrammetry to make a 3D model of the shipwreck they have discovered in Wisconsin Shipwreck Coast National Marine Sanctuary. In photogrammetry, the diver takes a series of overlapping photographs of the shipwreck. Photogrammetry software then triangulates all those image points to create an accurate model of the shipwreck, with the distance between the points plotted to scale. Three-dimensional scanning apps use a similar method to create models.

1. Use the building blocks provided to construct a "shipwreck." Your wreck should be about the size of a tennis ball.
2. Place the "shipwreck" in the center of the printed scanning mat.
3. As directed by your instructor, follow the app directions to produce a 3D model of the "shipwreck."

Debrief

Discuss the activity using the questions below. These questions are also included in the slide deck. *Accept all reasoned responses.*

- Imagine you are diving a wreck and gathering images to be used to make a photogrammetric model. Predict how this task might impact your dive. *The additional task would likely make buoyancy control more challenging and perhaps result in greater gas consumption.*
- In addition to a camera, what other tools do you think are used by divers when surveying wrecks? *compass, ruler, slate, dive light, lift bag*

Preparation – *Pool Mission*

Place different colored weights or negatively buoyant objects (i.e., metal cutlery, bowls, utensils, etc.) on the pool bottom to simulate artifacts from a wreck. It is recommended that the site contain between three and five artifacts. Choose one object to represent the entry point.

Procedure

1. Inform students that they will work in buddy pairs to explore a simulated wreck site that includes multiple artifacts. Explain that their exploration will include making a site plan and taking photographs of artifacts.
2. Instruct students on how to take a compass heading. Explain that they will take underwater compass headings from the entry point to each artifact and count the number of fin kicks between the entry point and each artifact as a way to gauge distance. Model and practice these skills on the pool deck.
3. Each artifact must be measured, including length, width, and height (or other descriptive dimensions), sketched (top view), and photographed. Students need to position themselves directly above the artifact while neutrally buoyant in order to take a photograph that includes its entirety. Be sure that students are familiar with how to take a photo prior to entering the dive.

4. Instruct students to draw the site plan on the dive slate. The site plan should include the entry point, the compass heading from that point to each artifact, the number of fin kicks between each point of the site plan, a sketch of each artifact, and its pertinent measurements. The goal is for students to be able to add all of this information to the site plan underwater while directly observing the wreck site.

Dive Briefing

- Explain the simulation procedure and objectives. Model the simulation above water prior to student participation. Emphasize the importance of safety (air and buddy checks) and good buoyancy control. These objectives are more important than the objective of the simulation.
- Prior to entry, perform all standard safety and weight checks.

Dive

Participate in the dive mission as described above.

Debrief

Upon completion of the pool mission, assess student understanding by asking the following questions. Accept all reasoned answers:

- How well did you pay attention to your buddy and air? How was your buoyancy control? Why do you feel this way?
- How successful were you in making a detailed site plan and taking photographs of artifacts? Why do you feel this way?

Time permitting, provide students time to look at their photos and assess their success at documenting the artifacts.

Education Standards	
Dive Industry Standards	PADI Seal Team SSI Scuba Ranger NAUI Junior Scuba Diver or Passport Diver
Ocean Literacy Principles	#6: The ocean and humans are inextricably interconnected. (a,b,c) #7: The ocean is largely unexplored. (a,b,d,f)

Additional Resources

Linked Resources:

- Designation of Wisconsin Shipwreck Coast National Marine Sanctuary video
- Shipwreck Footage

NOAA's Office of National Marine Sanctuaries
This site contains information on each of the sites in the National Marine Sanctuary System.
http://sanctuaries.noaa.gov/

Ocean Literacy Principles
http://oceanliteracy.wp2.coexploration.org/

Wisconsin Shipwreck Coast National Marine Sanctuary
https://sanctuaries.noaa.gov/wisconsin/

Exploration in Wisconsin Shipwreck Coast National Marine Sanctuary
https://oceanexplorer.noaa.gov/explorations/21greatlakes/welcome.html

Photomosaics of Wrecks in Wisconsin Shipwreck Coast National Marine Sanctuary
https://sketchfab.com/wishipwreckcoast

Exploration Tools
https://oceanexplorer.noaa.gov/technology/technology.html

Maritime Archaeology Curriculum from Monitor National Marine Sanctuary
https://nmsmonitor.blob.core.windows.net/monitor-prod/media/archive/education/pdfs/maritime_curriculum.pdf

Maritime Heritage
https://sanctuaries.noaa.gov/maritime/

Discover Wisconsin Episode
Diving Into Our Maritime History: The Wisconsin Shipwreck Coast

The Cabin Podcast Episode - *Diving in The Dairyland: Wisconsin Shipwrecks and Sanctuaries*
https://the-cabin.simplecast.com/

Ocean Guardians Dive Club Lessons
Additional lessons available.
https://sanctuaries.noaa.gov/education/ocean_guardian/dive-club/
**The inclusion of links in this guide does not imply endorsement or support of any of the linked information, services, products, or providers.*

For More Information