



## Exploring Shipwrecks in Thunder Bay National Marine Sanctuary

### Lesson Specifications

#### Age

8 - 12

#### Timeframe

2-4 hours

#### Materials

##### Lesson:

- Full page color photos of *Kyle Spangler* schooner and shopping cart laminated or in reusable plastic sheet protectors
- Markers and poster paper
- Dry erase markers (thin) and a cloth for wiping
- Computer or projector with screen
- Paper clips (for quadrat practice on pool deck)
- Shipwreck props/ models (one without "mussel colon" and one with colony obscuring details)
- Weighted signs "2003," "2008," and "Time Warp"
- One laptop computer per buddy team

##### Scuba:

- All primary scuba gear
- Underwater camera
- Quadrat
- Slate with writing tool

#### Key Words

Maritime archaeology, invasive species, zebra mussel, quagga mussel, obscure, deterioration, colonization, preservation

#### Standards

Ocean Literacy Principles 2, 5, 6  
Climate Literacy Principle 7



A scuba diver explores a shipwreck in Thunder Bay National Marine Sanctuary. Photo: David Ruck/ NOAA

### Activity Summary

This lesson introduces students to Thunder Bay National Marine Sanctuary and the threat of the invasive Zebra and Quagga mussels on the integrity of the maritime historical shipwrecks of the *Monohansett* and the *Spangler*. Students will learn how these invasive mussels create difficulties in accurately documenting shipwrecks in the sanctuary and how the invasive mussel colonies could potentially damage and interfere in the preservation of the maritime archaeological sites. Students will also learn about the ways some marine protected areas address this threat.

### Learning Objectives

Upon completion of this lesson, students will be able to:

- Identify and compare the Zebra and Quagga mussels.
- Understand the threat mussel colonies pose to the shipwrecks and the ecosystem of the of the sanctuary in documenting and preserving these maritime sites.
- Learn what they can do to help preserve the maritime history of the sanctuary and its ecosystems.

## Essential Questions

1. What are Zebra mussels and Quagga mussels? How are they similar and different?
2. What threats do Zebra and Quagga mussel colonies pose to the documentation and preservation of the shipwrecks and the sanctuary ecosystems in Thunder Bay National Marine Sanctuary?
3. What can you do to help preserve the maritime history of the sanctuary?

## National Marine Sanctuary Diver Performance Requirements

At the surface, students will:

- Streamline gear prior to entry.
- Demonstrate proper descent techniques and awareness of the environment.

Underwater, students will:

- Identify Zebra and Quagga mussels.
- Use a quadrate and count the mussels to compare data between the 2003 model and the 2008 model.
- Identify one or two threats the mussel colonies pose to the preservation of the shipwrecks.



A map of the National Marine Sanctuary System in the U.S. and its territories.

## Background Information

Located in northwestern Lake Huron, Thunder Bay is adjacent to one of the most treacherous stretches of water within the Great Lakes system. Unpredictable weather, murky fog banks, sudden gales, and rocky shoals earned the area the name “Shipwreck Alley.” Today, the 4300-square-mile Thunder Bay National Marine Sanctuary protects one of America’s best-preserved and nationally-significant collections of shipwrecks. Fire, ice, collisions, and storms have claimed over 200 vessels in and around Thunder Bay. To date, nearly 100 shipwrecks have been discovered within the sanctuary. Although the sheer number of shipwrecks is impressive, it is the range of vessel types located in the sanctuary that makes the collection nationally significant. From an 1844 sidewheel steamer to a modern 500-foot-long German freighter, the shipwrecks of Thunder Bay represent a microcosm of maritime commerce and travel on the Great Lakes.



The propellor of a shipwreck in Thunder Bay National Marine Sanctuary. Photo: NOAA

Northeastern Michigan’s maritime landscape includes the hundreds of shipwrecks located on Lake Huron bottomlands. It also encompasses all of the cultural and natural features related to maritime heritage. Lifesaving stations, lighthouses, historic boats and ships, commercial fishing camps, docks, and working ports are among the more obvious historic and archaeological features. Many features are less visible and some remain unrecognized or unknown. Humans have used the waters of Thunder Bay and its shores for thousands of years. Geological and archaeological evidence suggests a high probability of prehistoric archaeological sites awaiting discovery. In addition to helping to protect and interpret individual sites, managing the sanctuary as a maritime cultural landscape reveals a broad historical canvas that can encompass many different perspectives to foster an interconnected understanding of the maritime past. The maritime cultural landscape allows Thunder Bay’s maritime heritage to continue to unfold as new discoveries are made and encourages an increasingly diverse public to find shared meaning in this nationally and internationally significant place.

For over 12,000 years, people have traveled on the Great Lakes. From Native American dugout canoes to wooden sailing craft and steel freighters, thousands of ships have made millions of voyages across the Great Lakes. The last 150 years have been particularly explosive, transforming the region into one of the world’s busiest waterways. Yet, with extraordinary growth comes adversity. Over 200 pioneer steamboats, majestic schooners, and huge steel freighters wrecked near Thunder Bay alone. Today, the sanctuary’s shipwrecks capture dramatic moments from centuries that transformed America. As a collection, they illuminate an era of enormous growth and remind us of risks taken and tragedies endured. Lake Huron’s cold, fresh water ensures that Thunder Bay’s shipwrecks are among the best preserved in the world. Many sites remain virtually unchanged for over 150 years. With masts still standing, deck hardware in place, and the crews’ personal possessions often surviving, sites located in deeper waters are true time capsules. Other shipwrecks lay well-preserved but broken up in shallower waters. Readily accessible by kayakers, snorkelers, and divers of all abilities, these sites often provide sanctuary users with their first shipwreck experience.

Thunder Bay’s shipwrecks are magnificent, yet vulnerable. Natural processes and human impacts threaten the long-term sustainability of our underwater maritime heritage. Through research, education, and community involvement, the sanctuary works to protect our nation’s historic shipwrecks

for future generations. Protecting Thunder Bay’s underwater treasures is a responsibility shared by the sanctuary, its many partners, and the public.

Thunder Bay National Marine Sanctuary protects a nationally significant collection of shipwrecks and related maritime heritage resources. By fostering an understanding that our past connections to the Great Lakes and ocean are critical to our future, the sanctuary works to ensure that future generations will continue to experience and value Thunder Bay’s irreplaceable underwater treasures.

Ice, waves, and aquatic invasive species such as zebra and quagga mussels could potentially harm maritime heritage resources. The sanctuary is working with university and NOAA scientists to develop long-term monitoring programs to better understand how the chemical, biological, and physical conditions found around Thunder Bay’s shipwrecks are affecting the corrosion and deterioration of these irreplaceable archaeological sites. The sanctuary’s education and outreach programs help people of all ages and back- grounds enrich their lives while learning about, physically experiencing, and working to preserve the Great Lakes and their maritime heritage. Because people preserve what they value, and value what they under- stand, Thunder Bay National Marine Sanctuary embraces education as a powerful resource preservation tool. Sanctuary education comes in many forms, from programs for teachers and students to imaginative exhibits, and from community boat building to remotely operated vehicle competitions. Although preservation is the central message, the sanctuary promotes learning across the curriculum.

<b>Vocabulary</b>	
Maritime archaeology	The scientific study of material remains of past human life and activities located under surface of the water.
Invasive species	Species that are not native to a particular area, but have now established populations in that area.
Zebra mussel	A small, fingernail-sized, freshwater mussel with zigzag markings on the shell that is originally from southern Russia and the Ukraine.
Quagga Mussel	A small freshwater mussel originally from the Ukraine.
Colonization	When a new type of plant or animal moves into and lives in a new place taking control of it.
Preservation	The act of keeping something safe from harm or loss.
Deterioration	The act or process of becoming worse.
Obscure	To hide or cover (something) – To be in front of (something) so that it cannot be seen.

## **Preparation – Classroom**

Before the activity, the instructor should print and laminate the provided photo sheets (or put in reusable sheet protectors), have poster paper (one sheet per group), have regular markers, and have thin dry-erase markers with cloths for wiping.

## **Procedure – Classroom**

1. (5 minutes) Instructor uses the PowerPoint to give the students an introduction to Thunder Bay National Marine Sanctuary. Pause on slide 4 and follow steps 2 through 4.
2. (2 minutes) Instructor introduces the Essential Questions and Student Outcomes.

3. (2 minutes) Instructor puts the students into pairs, giving each pair two 8x10 color photographs of the shopping cart, one without mussel colonies and one with mussel colonies. Explain to students that they are working together to compare the photographs.
4. (5-7 minutes) Students work together to identify the differences in the photos, making note of which parts of the shopping cart are obscured by the mussel colonies. They can do this by using dry erase markers to color-code and circle the similarities on the laminated photographs.
5. Instructor then has the students watch the next part of the presentation about how the Zebra and Quagga mussel colonies affect the ecosystems in the sanctuary.
6. (10 minutes) Then, two pairs of students combine to make groups of four. Instructor gives each group the color photos of the *Spangler* shipwreck, and students have a verbal discussion about the differences between the photographs, noticing which parts of the shipwreck are obscured in the 2008 photograph that were visible in the 2003 photograph.
7. (10-15 minutes) Instructor poses the question: How does the Zebra or Quagga mussel colony's presence affect the shipwreck and the sanctuary ecosystem?

The groups continue to work together to discuss impacts that the mussel colony can potentially have on the shipwreck structure and the preservation of the historical shipwreck. On poster paper, students make a list of their ideas of the potential impacts the mussel colony could have on the shipwreck. Also, students are to discuss how the mussel colonies are affecting the ecosystem of the *Spangler* wreck and the ecosystem of the sanctuary as a whole.

8. (5-10 minutes) Gallery walk: When the groups are finished, students walk around the room to see the other groups' ideas. Students can walk quietly around the room or discuss in low voices.
9. (5-10 minutes) Instructor brings students back to the group and poses the question:
  - What did you notice about the growth of the mussel colonies on the shipwreck from 2003 to 2008?
  - How do you think the Zebra or Quagga mussel colonies affect the integrity of the shipwreck? What negative effects do the Zebra and Quagga mussel colonies have on the shipwrecks and efforts to preserve the maritime archeology?
  - What negative effects do the Zebra and Quagga mussel colonies have on sanctuary ecosystems?

Instructor writes their answers on the board or a poster paper for all to see.

## **Preparation – *Pool Mission***

Students will:

- Practice dive skills while meeting diving performance requirements and sanctuary learning objectives.
- Work in pairs to complete the learning objectives.

- Use the underwater camera to take photos of the two time periods of the shipwreck, 2003 and 2008.
- Practice diving and using a quadrat to record the number of Zebra or Quagga mussels on the “shipwrecks.”

Prior to the mission, the instructor will set up the underwater environment in the pool. This will include setting up two separate sections for each year of student with its corresponding weighted replica: the 2003 replica with very little to no mussel colony growth and the 2008 replica with mussel colony growth. Also, instructors will place the “time warp” sign so that students will know 5 years has passed as they swim to the 2008 section. Depending on the number of students, multiple setups may be needed. Set up one laptop computer per pair for uploading and comparing their underwater photos of the wrecks.

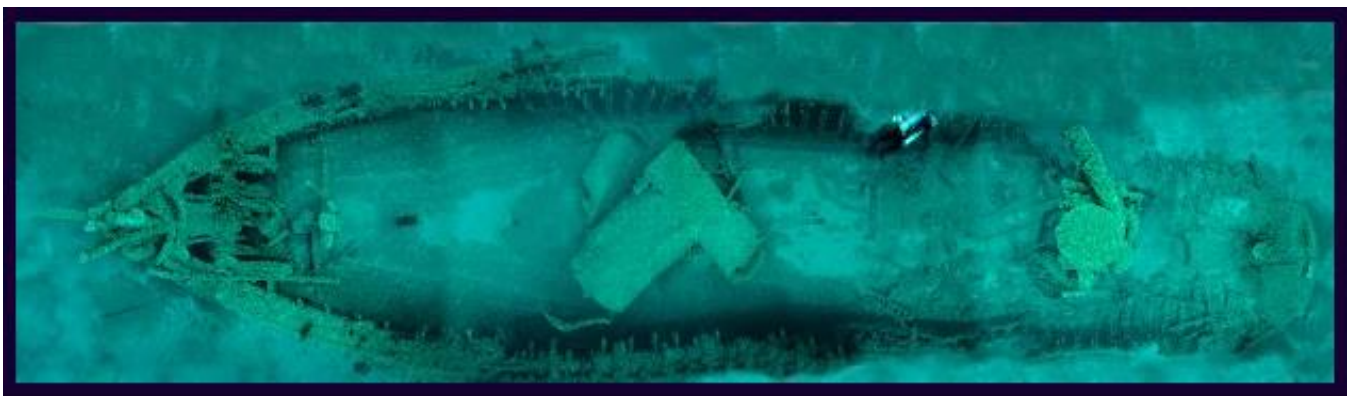
Detailed instructions for building a mock shipwreck can be found on pages 26 to 68 of [this document](#).

View a video simulation of the “mussel covered shipwreck” at [this link](#).

## Procedure

1. Before the pool dive, the instructor will introduce students to the quadrat and how to work in teams to record the number of mussels observed for each year of the wreck, making sure the teams record the number of mussels from the same section (and angle) of each wreck.
2. Prior to pool entry, the instructor will introduce students to scientific monitoring using quadrats. This will include outlining the process for using the quadrat to collect information (the number of mussels on a given part of the wreck), as well as how to record this information on the slates. Have students practice the procedure for counting and recording their data on the pool deck with their partner, using paper clips.
3. Instructor will also show the students how to use the underwater camera to take photos of the two wrecks, making sure the teams take pictures from the same section of each wreck. Students will practice uploading their photos to the computer prior to the drive.
4. While underwater, students will work in their buddy teams to swim each time period of the wreck, 2003 and 2008. One member of the buddy team should be the recorder and the other member should use the quadrat and count the Zebra or Quagga mussels.
5. Each buddy team swims to the 2003 wreck and carefully lays down the quadrat on the designated section of the wreck. The counter should count how many Zebra or Quagga mussels are in and partially in the quadrat and then signal this number to their buddy, the recorder.
6. The recorder will write the number of mussels in the quadrat on their slate.
7. Next, the counter/photographer will use the underwater camera to snap a picture of this section of the wreck.
8. Pairs will then swim past the ‘Time Warp’ sign to go to the 2008 model. They will pause at the ‘Time Warp’ sign to swap materials; the counter/photographer will become the recorder and the recorder will become the counter/photographer.

9. Pairs will repeat steps 5 to 7 for the 2008 shipwreck.
10. Once the underwater portion of the pool mission is complete, buddy teams will exit the pool and remove dive gear as instructed by instructor for proper care of the equipment.
11. Buddy teams will then go to a computer to upload their photos of the wrecks from their underwater cameras. Once uploaded, buddy teams are to study the differences between the wreck sections and using a drawing tool on the computer, circle or mark the places where the mussel colony is now obscuring details of the wreck in the 2008 photo.
12. Students answer and discuss the following questions:
  - a. What negative impacts does this mussel colony have on the shipwreck?
  - b. On the sanctuary ecosystem?
  - c. How can we help reverse or slow down these negative effects?
13. Upon completion of the pool mission assess student understanding by asking the group:
  - a. How do you recognize a colony of Zebra or Quagga mussels? Students describe characteristics of the Zebra and Quagga mussels noting their differences.
  - b. What threat do Zebra and Quagga mussel colonies pose to documenting and preserving the shipwrecks and sanctuary ecosystems in Thunder Bay National Marine Sanctuary? Students list and explain two or more threats to the preservation of the shipwrecks and ecosystem.
  - c. What can you do to help preserve the maritime history of the sanctuary and its ecosystem? Students list and explain one or two ways they can help the mission of preserving the maritime history and ecosystem of the sanctuary.



An aerial photo of a submerged shipwreck. Photo: Thunder Bay National Marine Sanctuary.

Education Standards	
Dive Industry Standards	This lesson could be paired with: PADI Snapshot Specialist SSI Buddy Ranger NAUI Junior Scuba Diver or Passport
Ocean Literacy Principles	2: The ocean and life in the ocean shape the features of the Earth. 5: The ocean supports a great diversity of life and ecosystems. 6: The ocean and humans are inextricably interconnected.
Climate Literacy Principles	7: Climate change will have consequences for the Earth systems and human lives.

## Additional Resources

**NOAA's Office of National Marine Sanctuaries:** This site contains information on each of the sites in the National Marine Sanctuary system. <https://sanctuaries.noaa.gov/>

**Thunder Bay *Monohansett*** A brief introduction to the *Monohansett* with photos. Check it out. <https://thunderbay.noaa.gov/shipwrecks/monohansett.html>

**Video; Thunder Bay Shipwrecks: *Monohansett*** Take a dive and visit the *Monohansett* shipwreck underwater in less than 2 minutes. <https://youtu.be/6mgfrJmAlIA>

**Thunder Bay *Monohansett* 3D video** In 1907, the wooden bulk freighter the *Monohansett* caught fire and sunk in Thunder Bay. Learn more about the *Monohansett* shipwreck with the animated 3D dive. <http://www.thunderbaywrecks.com/wrecks/monohansett/>

**Animated map of Zebra Mussels** This animated map shows the spread of the Zebra Mussel throughout the United States from 1986 to 2018. <https://nas.er.usgs.gov/queries/SpeciesAnimatedMap.aspx?speciesID=5>

**MATE Inspiration for Innovation (MATE II)** <https://materovcompetition.org/aboutmateii>

## For More Information

This lesson was developed by NOAA's Office of National Marine Sanctuaries. This lesson is in the public domain and cannot be used for commercial purposes. Permission is hereby granted for the reproduction, without alteration, of this lesson on the condition its source is acknowledged. When reproducing this lesson, please cite NOAA's Office of National Marine Sanctuaries as the source, and provide the following URL for further information: <https://sanctuaries.noaa.gov/education>. If you have any further questions or need additional information, email [sanctuary.education@noaa.gov](mailto:sanctuary.education@noaa.gov).