National Marine Sanctuaries

MARITIME ARCHAEOLOGY
Discovering and Exploring Shipwrecks

Educational Product	
Educators	Grades 6-12

NATIONAL MARINE
SANCTUARIES
MONITOR

Monitor National Marine Sanctuary
MARITIME ARCHAEOLOGY—DISCOVERING AND EXPLORING SHIPWRECKS

An Educator Guide with Activities in Science, Technology, Engineering, Math and Social Studies

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NATIONAL MARINE SANCTUARY SYSTEM

Olympic Coast
Greater Farallones
Cordell Bank
Papahānaumokuākea
Hawaiian Islands Humpback Whale
Monterey Bay
Channel Islands
American Samoa (U.S.) (Including Rose Atoll)

Wisconsin - Lake Michigan
Thunder Bay
Stellwagen Bank
Mallows Bay - Potomac River
Monitor
Gray's Reef
Florida Keys
Flower Garden Banks

● National Marine Sanctuary
△ Marine National Monument
▢ Proposed National Marine Sanctuary

Scale varies in this perspective. Adapted from National Geographic Maps.

The National Marine Sanctuary System includes a network of 13 national marine sanctuaries and Papahānaumokuākea and Rose Atoll marine national monuments. For more information visit http://sanctuaries.noaa.gov

For additional information about **Maritime Archaeology— Discovering and Exploring Shipwrecks**, contact Shannon Ricles at 757-591-7328 or monitor@noaa.gov.

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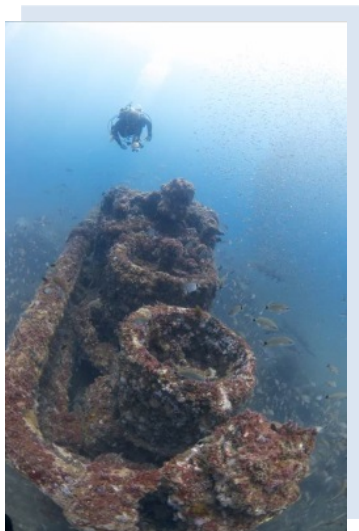
Diver swims over the *Dixie Arrow* located off the North Carolina coast. Photo: NOAA

http://monitor.noaa.gov

PROGRAM OVERVIEW

This curriculum introduces students to the world of NOAA and its Maritime Heritage Program. The order of the curriculum flows sequentially from learning why shipwrecks are important, to the study of the tools used by maritime archaeologists, to understanding the complex and sometimes costly process of recovering and conserving artifacts. After completing the curriculum, students will have an understanding of the value of protecting maritime heritage, conducting archaeology and NOAA's role in preserving our nation's precious underwater cultural resources.

Although, this curriculum guide has been designed to be taught as a unit, each lesson in the guide can stand on its own. Specifically, each lesson can be used independently to teach a particular objective, or lessons can be combined in multiple ways to create a plan tailored just for your students.

We hope that you find the guide an exciting way to motivate your students in learning about maritime heritage. Through a variety of activities, your students can explore the various science, technology, engineering, math, and social studies (STEMS) concepts. Please feel free to contact us if you have any questions, and we welcome your feedback.

Photomosaic of U-85, a German U-boat located off the North Carolina Coast. Photo: NOAA

Suggested Curriculum Outline

A. Introduction to NOAA
   1) Introduction to the National Oceanic and Atmospheric Administration (NOAA), Office of National Marine Sanctuaries (ONMS), Maritime Heritage Program (MHP) and Monitor National Marine Sanctuary (MNMS)
B. Shipwrecks Connect to the Past
   1) Students learn how ships changed over time
   2) Understand why ships sink
   3) Appreciate how shipwrecks connect us to our past
C. Maritime Archaeology
   1) History of maritime archaeology
   2) Leaders in maritime archaeology

D. Tools of Maritime Archaeology
   1) Using historical research to define the search area
   2) Remote sensing: Side scan sonar
   3) Remotely operated vehicles (ROV), Autonomous Underwater Vehicle (AUV), and Towfish
   4) SCUBA and the role it plays
   5) Detecting with magnetometers
   6) NOAA research vessels
E. Documenting Shipwrecks
   1) Knowing the parts of a ship
   2) Mapping a shipwreck
   3) Photomosaics and other imagery
F. What's Next?
   1) Determining historical significance of a shipwreck and why it matters
   2) Ethics in shipwrecks
   3) Recovery of artifacts—When and why
   4) Conservation of artifacts

OBJECTIVES

Throughout the unit, students will:

- Learn about NOAA and our nation's National Marine Sanctuary System
- Understand the historical significance of shipwrecks and their connection to our past
- Understand the importance of maritime archaeology and learn its history
- Identify key people in the development of maritime archaeology
- Dramatize and evaluate the complicated process of identifying unknown shipwrecks
- Recognize the essential role research (primary and secondary source documents) plays in shipwreck discovery
- Learn how side scan sonar works and is used to locate and document shipwrecks
- Interpret how remotely operated vehicles (ROVs) and other tools are used in marine science and underwater archaeology
- Learn the history of scuba diving and summarize its role in the development of underwater archaeology
- Discover how magnetometers are used in searching for shipwrecks
- Learn about NOAA research vessels and NOAA careers
- Identify and differentiate the parts of a ship
- Model how maritime archaeologists map shipwrecks
- Construct a photomosaic of a shipwreck and interpret the image
- Analyze policy protecting shipwrecks and ethical interaction between divers and shipwrecks
- Appreciate the complexity involved in artifact recovery
- Evaluate the value of artifact recovery and conservation with the associate costs

SUGGESTED IMPLEMENTATION STRATEGY

1. Review the suggested curriculum outline on page 4.
2. Review the various activities included in this guide and determine which activities work best for your students.
3. Review additional web and book resources for appropriate supplemental material.
4. Once ready to begin, give the students an overview of the unit and/or activity, and introduce students to NOAA, Office of National Marine Sanctuaries, Maritime Heritage Program, and Monitor National Marine Sanctuary.
5. Have students complete selected activities.

CAREERS

- Artifact illustrator
- Attorney for maritime or cultural resource law
- Casting machine operators
- Conservator
- Corrosion resistance engineer
- Corrosion technician
- Educator
- Electrician
- Forensic anthropologist
- Historian
- Historical interpreter
- Historical re-enactor
- Laboratory technician
- Machinist
- Maritime archaeologist
- Materials scientist
- Mechanical engineer
- Metallurgist
- Metal molding tenders
- Museum curator
- Policy analyst
- Reclamation expert
- Research engineer
- Research scientist
- Research vessel captain
- ROV pilot
- SCUBA diver
- SCUBA instructor
- Submersible pilot
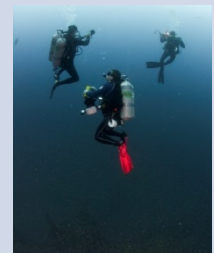
Divers ascending to the surface.
Photo: NOAA, Monitor NMS

Vocabulary—General (Each activity has associated vocabulary)

ARCHAEOLOGY — The study of human history and prehistory through the excavation of sites and the analysis of artifacts and other physical remains

ARTIFACT — Any object made by humans, typically an item of cultural or historical interest

AUV — Autonomous Underwater Vehicle; used to conduct underwater survey missions without operator intervention

BASE LINE— A line serving as a basis for measurement, calculation or location; a measured line through a survey area from which triangulations are made

BIO-HISTORICAL POEM — A type of poem that follows a 10- or 11-line format and focuses on factors that shape identities, such as experiences, relationships and interests

BOW — Forward part of the hull of a ship or boat; the point that is most forward when the vessel is underway

BUOYANCY — The upward force, caused by fluid pressure, that keeps things afloat

CONSERVATION — Preservation, repair, and prevention of the deterioration of archaeological, historical, and cultural sites and artifacts

CONSERVATOR — A person responsible for the repair and preservation of works of art, buildings, or other things of cultural or environmental interest

COORDINATE — A group of numbers used to indicate the position of a point, line, or plane

IN SITU — To leave an object in its original place

GRID — A network of squares placed over a site to assist with excavation and recording

MAGNETOMETER — An instrument used for measuring magnetic fields; an instrument for detecting the presence of magnetic materials by their influence on the local magnetic field

MARITIME ARCHAEOLOGY — A discipline within archaeology that specifically studies human interaction with the ocean, seas, lakes and rivers through the study of physical remains

MULTIBEAM SONAR — Emit sound waves in a fan-shape producing a swath of soundings for broad coverage of a survey area

NOAA — National Oceanic and Atmospheric Administration; agency in the Department of Commerce that maps the oceans and conserves their living resources; predicts changes in the earth's environment; and provide weather data and forecasts

NRHP — National Register of Historic Places; the U.S. federal government's official list of districts, sites, buildings, structures, and objects deemed worthy of preservation

ONMS — Office of National Marine Sanctuaries; part of NOAA that manages a national system of 15 underwater protected areas

PHOTOMOSAIC — A large-scale detailed picture or map built by combining photographs of small areas

PORT — A nautical term referring to the left side of a ship when facing the bow (front)

PRIMARY SOURCE — A source that contains raw, original, non-interpreted and unevaluated information

ROV — Remotely operated vehicle; robot that operates underwater and is tethered to and controlled from a boat or ship by an operator

SECONDARY SOURCE — A source that digests, analyzes, evaluates and interprets the information contained within the primary sources

SIDE SCAN SONAR — A type of sonar system that is used to efficiently create an image of large areas of the sea floor

SITE PLAN — An accurate scaled depiction of a shipwreck showing the relationship of selected artifacts to other artifacts

SCIENTIFIC DIVING —Diving performed solely as a necessary part of a scientific, research or educational activity to perform scientific research tasks

SCUBA— Self-contained Underwater Breathing Apparatus; a portable apparatus containing compressed air and used for breathing underwater

STARBOARD — A nautical term referring to the right side of a ship when facing the bow (front)

STERN — The rear or aft-most part of a ship; opposite the bow

TERTIARY SOURCE — A source that compiles, analyzes, and digests secondary sources

Resources

Web Resources:

NOAA's Office of National Marine Sanctuaries
Discover the marine life and extraordinary habitats that make up your national marine sanctuaries and learn about the continuing efforts to conserve these ocean and coastal treasures.
http://sanctuaries.noaa.gov/

NOAA's Maritime Heritage Program
Created in 2002, the program focuses on maritime heritage resources within national marine sanctuaries and promotes maritime heritage appreciation throughout the entire nation.
http://sanctuaries.noaa.gov/maritime/aboutmhp.html

Monitor National Marine Sanctuary
Visit this site to learn more about the USS *Monitor* and check out the teacher section for additional activities and lesson plans.
http://monitor.noaa.gov

NOAA National Ocean Service
Learn about side scan sonar and how scientists use it to map the ocean floor.
http://oceanservice.noaa.gov/education/seafloor-mapping/how_sidescansonar.html

NOAA Ocean Explorer
Learn about NOAA's remotely operated vehicles (ROVs) and discover how they are used. Read how ROV *Hercules* was built just for scientific research and can travel to depths of 4,000 meters!
http://oceanexplorer.noaa.gov/technology/subs/subs.html

Exploring WWII: Battle of the Atlantic Expeditions
Since 2008, NOAA and partners have documented and surveyed the various shipwrecks off the North Carolina coast associated with World War II's Battle of the Atlantic. Visit this site to learn more about the remains of German U-boats that plied America's waters and the ships they sank. Experience these shipwrecks firsthand through the divers' blogs and beautiful images.
http://sanctuaries.noaa.gov/missions/battleoftheatlantic/archives.html

Thunder Bay National Marine Sanctuary
With over 100 known shipwrecks in Thunder Bay National Marine Sanctuary, maritime archaeologists continuously document the sites for future study. Visit Thunder Bay's education site to download photomosaic images, site plans and lesson plans to dive deeper into the underwater world of shipwrecks. Lesson Plan:
http://thunderbay.noaa.gov/pdfs/piecetogetherteacher.pdf

Institute of Nautical Archaeology
An international organization working "to fill in the gaps of history and provide answers to challenging historical questions." This site is comprehensive and features over 80 maritime archaeological projects from around the world.
http://nauticalarch.org/

Nautical Archaeology Society
World leading charity providing help, resources, training and events for everyone interested in underwater and coastal archaeology.
http://www.nauticalarchaeologysociety.org/

SEE INDIVIDUAL ACTIVITIES FOR ADDITIONAL WEB RESOURCES

Book Resources

Adams, Simon. *Titanic (DK Eyewitness Books).* DK Children, 2009. ISBN-13: 978-0756650360.

Armstrong, Jennifer. *Shipwreck at the Bottom of the World: The Extraordinary True Story of Shackleton and the Endurance.* Crown Books for Young Readers, September 12, 2000. ISBN-10: 0375810498.

Babits, Lawrence E. and Hans Van Tilburg (Editors). *Maritime Archaeology: A Reader of Substantive and Theoretical Contributions.* Springer, January 31, 1998. ISBN-13: 978-030645331.

Baker, Beth. *Sylvia Earl (Just the Facts Biographies).* Lerner Publications, January 15, 2006. ISBN-10: 0822534223.

Ballard, Robert D. *Finding the Titanic Level 4.* Cartwheel, November1, 1993. ISBN-10: 0590472305.

Ballard, Robert D., Rick Archbold, and Ken Marschall. *Ghost Liners: Exploring the World's Greatest Lost Ships.* Little, Brown Young Readers, September 1, 1998. ISBN 10: 0316080209.

Bass, George Fletcher. *A History of Seafaring Based on Underwater Archaeology*. Book Club Associates, 1974. ASIN: B0007ATFU4.

Bowens, Amanda (Editor). *Underwater Archaeology: The NAS Guide to Principles and Practice*. Blackwell Publishing (2nd Edition), 2009. ISBN-13: 978-1405175913.

Broadwater, John D. *USS* Monitor*: A Historic Ship Completes Its Final Voyage*. Texas A&M University Press, February 14, 2012. ISBN10: 1603444734.

Catsambis, Alexis; Ben Ford; and Donny L. Hamilton (Editors). *The Oxford Handbook of Maritime Archaeology*. Oxford University Press, August 5, 2011. ISBN-13: 978-0195375176.

Cerullo, Mary M. *Shipwrecks: Exploring Sunken Cities Beneath the Sea.* Dutton Juvenile, 2009. ISBN-13: 978-0525479680.

Gibbons, Gail. *Exploring the Deep, Dark Sea*. Little, Brown Young Readers, April 1, 2002. ISBN 10: 0316755494.

Green, Cathy, Jefferson Gray, and Bobbie Malone. *Great Ships on the Great Lakes: A Maritime History*. Wisconsin Historical Society Press, September 23, 2013. ISBN-13: 978-0870205828.

Jefferis, David. *Super Subs: Exploring the Deep Seat (Megatech)*. Crabtree Publishing Company, September1997. ISBN-10: 0778700631.

Muckelroy, Keith. *Maritime Archaeology (New Studies in Archaeology)*. Cambridge University Press, February 28, 1979. ISBN-13: 978-0521293488.

Platt, Richard. *Eyewitness: Shipwrecks*. DK Children, June 1, 2000. ISBN 10: 0789458845.

Platt, Richard. *DK Eyewitness Books: Shipwrecks.* DK Children, 2005. ISBN-13: 978-0756610890.

Rose, Paul, Anne Laking, and Phillippe Cousteau. *Oceans: Exploring the Hidden Depths of the Underwater World.* University of California Press, April 15, 2009. ISBN 10: 0520260287

Smith, K.C. *Exploring for Shipwrecks (Watts Library).* Franklin Watts, 2000. ISBN-13: 978-0531164716.

Walker, Sally M. *Shipwreck Search: Discovery of the H. L. Hunley (On My Own Science)*. First Avenue Editions, November 30, 2006. ISBN 10: 0822564491.

Wall, Julia: *Mapping Shipwrecks with Coordinate Planes (Real World Math: Level 5)*. Capston Press, 2011. ISBN-13 978-1429666176.

SEE INDIVIDUAL ACTIVITIES FOR ADDITIONAL BOOK RESOURCES

Education Standards

The following pages list an overview of educational standards for

- ❖ National Council for Social Studies (NCSS)
- ❖ Common Core (CC)
- ❖ National Geography Standards (NGS)
- ❖ National Council of Teachers of English (NCTE)
- ❖ National Science Standards (Archived Standards from NSTA)
- ❖ Next Generation Science Standards (NGSS)
- ❖ Ocean Literacy Principles (OLP)
- ❖ National Mathematics Standards (NCTM)

The following list of standards is not comprehensive, but indicates the standards that are prominent within the curriculum guide. Within each activity, the standards are listed on the first page of the activity in the left-hand blue box at the bottom. To understand the format used for citing the standards in each activity, see the key to citing listed in parenthesis next to each standard on the following pages (e.g. NCSS: US.ERA.9 for National Council of Social Studies, U.S. History, Era 9).

Education Standards

National Council for Social Studies http://www.socialstudies.org	**NCSS STANDARDS:** • Standard I—Culture **(NCSS:I)** • Standard II—Time, Continuity, and Change **(NCSS:II)** • Standard III—People, Places, and Environments **(NCSS:III)** • Standard IV—Individual Development and Identity **(NCSS:IV)** • Standard VIII—Science, Technology, and Society **(NCSS:VIII)** • Standard IX—Global Connections **(NCSS:IX)** **NCSS HISTORY THINKING STANDARDS (NCSS:HS)** • Standard 1—Chronological Thinking (NCSS:HT:1) • Standard 2—Historical Comprehension (NCSS:HT:2) • Standard 3—Historical Analysis and Interpretation (NCSS:HT:3) • Standard 4—Historical Research Capabilities (NCSS:HT:4) • Standard 5—Historical Issues (NCSS:HT:5) **UNITED STATES HISTORY CONTENT STANDARDS FOR GRADES 5-12 (NCSS:US.ERA)** • Era 6—The Development of the Industrial U.S. (1870-1900) **(NCSS:US.ERA.6)** • Era 7—The Emergence of Modern America (1890-1930) **(NCSS:US.ERA.7)** • Era 9—Postwar U.S. (1945-1970s) **(NCSS:US.ERA.9)** • Era 10—Contemporary U.S. (1968 to the present) **(NCSS:US.ERA.10)** **WORLD HISTORY CONTENT STANDARDS FOR GRADES 5-12** • Era 3—Classical Traditions, Major Religions, and Giant Empires, 1000 BCE-300 CE **(NCSS:WH.ERA.3)** • Era 6—The Emergence of the First Global Age, 1450-1770 **(NCSS:WH.ERA.3)** • Era 8—A Half-Century of Crisis and Achievement, 1900-1945 **(NCSS:WH.ERA.3)**
Common Core http://www.corestandards.org/	**READING INFORMATIONAL TEXT GRADES 6-12 (CCSS.ELA.LIT.RI)** • Key Ideas and Details (1, 2 and 3) • Craft and Structure (4) • Integration of Knowledge and Ideas (7) (11-12.8) **WRITING GRADES 6-12 (CSS.ELA.LIT.W)** • Write narratives… (3.A, 3.B, 3.C, 3D, and 3.E) • Research to Build and Present Knowledge (7, 8, 9.A, and 9.B) **HISTORY/SOCIAL STUDIES (CCSS.ELA.LIT.RH)** • Key Ideas and Details (1, 2, and 3) • Craft and Structure (4 and 5) • Integration of Knowledge and Ideas (7, 8, and 9) **SCIENCE & TECHNICAL SUBJECTS (CCSS.ELA.LIT.RST)** • Key Ideas and Details (1, 2, and 3) • Craft and Structure (4) • Integration of Knowledge and Ideas (7 and 9)

Education Standards Continued

National Geography Standards Error! Hyperlink reference not valid.	• **NG: 1** — How to use maps and other geographical representations, geospatial technologies, and spatial thinking to understand and communicate ideas • **NG: 4** — The physical and human characteristics of places • **NG:9** — The characteristics, distribution, and migration of human... • **NG: 17** — How to apply geography to interpret the past
National Council of Teachers of English http://www.ncte.org/	• **Standard 1** — Read a wide range of print and non-print texts… **(NCTE:1)** • **Standard 3** — Apply a wide range of strategies to comprehend … **(NCTE:3)** • **Standard 4** — Students adjust their use of spoken, written… **(NCTE:4)** • **Standard 5** — Employ a wide range of strategies as they write…**(NCTE:5)** • **Standard 6** — Apply knowledge of language structure… **(NCTE:6)** • **Standard 7** — Conduct research on issues and interests… **(NCTE:7)** • **Standard 8** — Use a variety of technological … **(NCTE:8)**
National Science Standards Archived PDF: http://www.nap.edu/openbook.php?isbn=0309053269	• **NS.5-8.E** — Science and Technology – Abilities of technological design; Understanding about science and technology • **NS.5-8.F** — Science in Personal and Social Perspectives – Populations, resources, and environments; Science and technology in society; • **NS.5-8.G** — History and Nature of Science – Science as a human endeavor; Nature of Science; History of Science • **NS.9-12.E** — Science and Technology – Abilities of technological design; Understanding about science and technology • **NS.9-12.G** — History and Nature of Science – Science as a human endeavor; Nature of scientific knowledge; Historical perspectives
Next Generation Science Standards http://ngss.nsta.org/	**ENGINEERING DESIGN (MS-ETS1 AND HS-ETS1)** • MS-ETS1.1 Crosscutting Concept A and B • HS-ETS1.1, 3, and 4 Crosscutting Concepts Systems and Models A and B **PHYSICAL SCIENCE** • MS-PS4 Waves and Their Applications in Technologies for Information Transfer (PS4.A, 4.B, and 4.C) • MS-PS3 Matter and Its Interactions (PS3.A) • HS-PSR Waves and Their Applications in Technologies for Information Transfer (PSR.A, B and C)
Ocean Literacy Principles http://oceanliteracy.wp2.coexploration.org/	• **OL: 1** — The Earth has one big ocean with many features (a, e, and g) • **OL: 6** — The ocean and humans are inextricably interconnected (a, b, c, e, and g) • **OL: 7** — The ocean is largely unexplored (a, b, c, d, e, and f)

National Council for Social Studies http://www.socialstudies.org	**NCSS STANDARDS:** • Standard I—Culture **(NCSS:I)** • Standard II—Time, Continuity, and Change **(NCSS:II)** • Standard III—People, Places, and Environments **(NCSS:III)** • Standard IV—Individual Development and Identity **(NCSS:IV)** • Standard VIII—Science, Technology, and Society **(NCSS:VIII)** • Standard IX—Global Connections **(NCSS:IX)** **NCSS HISTORY THINKING STANDARDS (NCSS:HS)** • Standard 1—Chronological Thinking (NCSS:HT:1) • Standard 2—Historical Comprehension (NCSS:HT:2) • Standard 3—Historical Analysis and Interpretation (NCSS:HT:3) • Standard 4—Historical Research Capabilities (NCSS:HT:4) • Standard 5—Historical Issues (NCSS:HT:5) **UNITED STATES HISTORY CONTENT STANDARDS FOR GRADES 5-12 (NCSS:US.ERA)** • Era 6—The Development of the Industrial U.S. (1870-1900) **(NCSS:US.ERA.6)** • Era 7—The Emergence of Modern America (1890-1930) **(NCSS:US.ERA.7)** • Era 9—Postwar U.S. (1945-1970s) **(NCSS:US.ERA.9)** • Era 10—Contemporary U.S. (1968 to the present) **(NCSS:US.ERA.10)** **WORLD HISTORY CONTENT STANDARDS FOR GRADES 5-12** • Era 3—Classical Traditions, Major Religions, and Giant Empires, 1000 BCE-300 CE **(NCSS:WH.ERA.3)** • Era 6—The Emergence of the First Global Age, 1450-1770 **(NCSS:WH.ERA.3)** • Era 8—A Half-Century of Crisis and Achievement, 1900-1945 **(NCSS:WH.ERA.3)**
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Education Standards Continued

National Mathematics Standards

http://www.nctm.org/

- **NCTM 6-8 Numbers and Operations** — Understand numbers, ways of representing numbers, relationships among numbers, and number systems (Computation, D)
- **NCTM 6-8 Numbers and Operations** — Understand numbers, ways of representing numbers, relationships among numbers, and number systems (Computation, A and B)
- **NCTM 6-8 Geometry** — Specify locations and describe spatial relationships using coordinate geometry and other representational systems
- **NCTM 6-8 Measurement Standard** — Understand measurable attributes of objects and the units, systems, and process of measurement (A, B, and C)
- **NCTM 9-12 Geometry** — Specify locations and describe spatial relationships using coordinate geometry and other representational systems (A and B)
- **NCTM 9-12 Geometry** — Use visualization, spatial reasoning, and geometric modeling to solve problems (A, B and D)
- **NCTM 9-12 Measurement Standard** — Understand measurable attributes of objects and the units, systems, and process of measurement (A)
- **NCTM 9-12 Process Standards** — Problem solving; Connections; Representation

To learn about our past in order to better understand our future, maritime archaeologists document and survey shipwrecks both on land and underwater. Photos: NOAA, Monitor National Marine Sanctuary

http://monitor.noaa.gov

Activities and Worksheets

Activities and Worksheets Continued

Section A
Introduction

NOAA, ONMS, Monitor NMS, and
Maritime Heritage Program

®

NATIONAL MARINE
SANCTUARIES

MONITOR

Exploring NOAA

Grade Level

- 6-12

Timeframe

- 1-2 hours

Materials

- Computer with Internet access or
- Printed resources

Activity Summary

This activity explores the many missions of NOAA, ONMS, Monitor NMS and NOAA's Maritime Heritage Program.

Learning Objectives

- To understand the important work that NOAA does to provide valuable information to those who need it.
- To learn about our nation's first national marine sanctuary
- To understand the importance of our nation's maritime heritage

Key Words

NOAA, ONMS, USS *Monitor*, national marine sanctuary, line office, maritime heritage

National Standards:

NCSS:1.a; NS.5-8.F; NS.6-12.F; CCSS.ELA.LIT.RI6-8.1, 11-12.1; NCTE:1

Background

Residing under the Department of Commerce, the National Oceanic and Atmospheric Administration (NOAA) is an agency that enriches life through science. NOAA's research goes from the surface of the sun to the depths of the ocean floor as the agency works to keep citizens informed about the changing environment around them.

From daily weather forecasts, severe storm warning and climate monitoring, to fisheries management, coastal restoration and supporting marine commerce, NOAA's products and services support economic vitality. NOAA's dedicated scientists use cutting-edge research and high-tech instrumentation to provide citizens, planners, emergency managers and other decision makers with the reliable information they need when they need it.

NOAA has six line offices and a Program Planning and Integration Office. Each line office is involved in a different capacity, but all work together as well. The line offices are

- National Environmental Satellite, Data, and Information Service: http://www.nesdis.noaa.gov/
- National Marine Fisheries: http://www.nmfs.noaa.gov/
- National Ocean Service: http://oceanservice.noaa.gov/
- National Weather Service: http://www.weather.gov/
- Office of Marine and Aviation Operations: http://www.omao.noaa.gov/
- Office of Oceanic and Atmospheric Research: http://www.research.noaa.gov/

Within the National Ocean Service resides the **Office of National Marine Sanctuaries** (ONMS). ONMS serves as the trustee for a network of underwater parks encompassing more than 170,000 square miles of marine and Great Lakes waters from Washington state to the Florida Keys, and from Lake Huron to American Samoa. The network includes a system of 13 national marine sanctuaries and Papahānaumokuākea and Rose Atoll marine national monuments.

Our national marine sanctuaries are places of inspiration. Within their waters and along their shores, are vibrant tapestries of marine life, ancient mysteries of our past, and thriving communities of men and women who have relied on the sea for generations. Sanctuaries are places where anyone can go to experience the power and beauty of the ocean and form lasting memories in spectacular natural settings, from the vibrant coral reefs of American Samoa to the towering kelp forests of Monterey Bay. These underwater treasures are sources of national pride, and protecting them ensures they will be here for future generations.

On January 30, 1975, Monitor National Marine Sanctuary (MNMS) became our nation's first national marine sanctuary. The sanctuary protects the USS *Monitor*, a Civil War ironclad that sank off the North Carolina coast in 1862 and was discovered in 1973.

Activity Overview

In this activity students will explore one of the agencies within the Department of Commerce, the National Oceanic and Atmospheric Administration (NOAA), and its six line offices. Students will conduct an Internet scavenger hunt to learn how each line office supports our nation's economy. They will also explore Monitor NMS and learn how it became our nation's first national marine sanctuary. In the last activity, students will understand that America's greatest museum of our past as a seafaring nation lies on the bottom of our nation's ocean, seas, rivers and lakes. They will learn how NOAA and the Office of National Marine Sanctuaries work together through the Maritime Heritage Program to protect and conserve our history.

Objectives

Students will understand the important work that NOAA does to provide valuable information in support of our nation's economic stability. They will also learn about our nation's first national marine sanctuary, and the importance of our nation's maritime heritage.

Teacher Preparations and Implementation

1. Review the websites indicated and bookmark them for students or create a Livebinder. For more information visit http://www.livebinders.com/
2. Print copies of each activity sheet—*NOAA Who?*, Monitor *to the Rescue,* and *Museums of the Deep*
3. After students complete the scavenger hunts, discuss NOAA's mission and why the agency's work is important to our nation.
4. Discuss the USS *Monitor* and its role in saving the Union and changing naval warfare.
5. Discuss the importance of protecting and conserving our nation's maritime heritage.

Resources

Web Resources

National Oceanic and Atmospheric Administration (NOAA)
Access this website to learn more about NOAA and the role it plays in protecting life and property and conserving and protecting natural resources.
http://www.noaa.gov

NOAA Diving Program
The program trains and certifies scientists, engineers and technicians to perform the variety of tasks carried out underwater to support NOAA's mission.
http://www.ndc.noaa.gov/

Office of National Marine Sanctuaries (ONMS)
ONMS is the trustee for a network of marine protected areas encompassing more than 170,000 square miles.
http://sanctuaries.noaa.gov/

Monitor National Marine Sanctuary (MNMS)
The nation's first national marine sanctuary that protects the famed Civil War ironclad, USS *Monitor.*
http://monitor.noaa.gov

NOAA's Maritime Heritage Program (MHP)
MHP works to document and survey our nation's maritime heritage.
http://sanctuaries.noaa.gov/maritime/welcome.html

Extensions

1. Have each student visit one or more of NOAA's line offices' websites and share with the class the overall mission and objectives of the line office.
2. Have students share one thing they found most interesting about NOAA, ONMS, MNMS, or MHP.
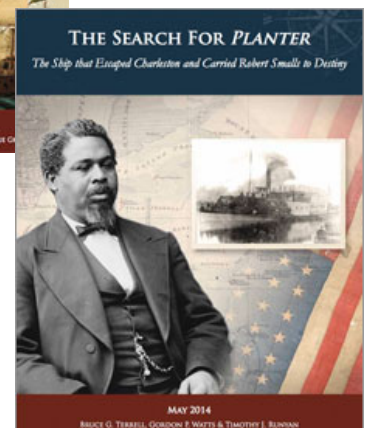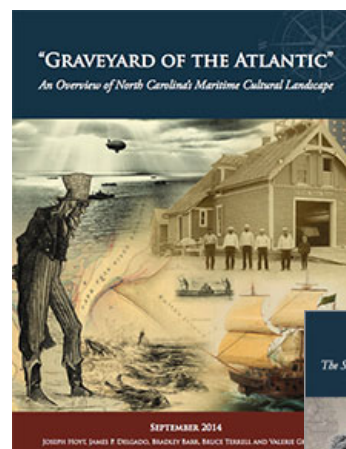
NOAA Who?

The **National Oceanic and Atmospheric Administration** (NOAA) is an agency that enriches life through science. NOAA's research goes from the surface of the sun to the depths of the ocean floor as the agency works to keep citizens informed of the changing environment around them. From daily weather forecasts, severe storm warning and climate monitoring, to fisheries management, coastal restoration and supporting marine commerce, NOAA's products and services support economic vitality. NOAA's dedicated scientists use cutting-edge research and high-tech instrumentation to provide citizens, planners, emergency managers and other decision makers with reliable information they need when they need it.

NOAA's roots date back to 1807, when the nation's first scientific agency, the Survey of the Coast, was established. Since then, NOAA has evolved in every state and emerged as an international leader on scientific and environmental matters. There are six line offices within NOAA: 1) National Environmental Satellite, Data, and Information Service (NESDIS); 2) National Marine Fisheries Service (NMFS); 3) National Ocean Service (NOS); 4) National Weather Service (NWS); 5) Office of Marine and Aviation Operations (OMAO); and 6) Office of Oceanic and Atmospheric Research (OAR).

Within the National Ocean Service (NOS), the **Office of National Marine Sanctuaries** serves as the trustee for a network of underwater parks encompassing more than 170,000 square miles of marine and Great Lakes waters from Washington state to the Florida Keys, and from Lake Huron to American Samoa. The network includes a system of 13 national marine sanctuaries and the Papahānaumokuākea and Rose Atoll marine national monument.

Our national marine sanctuaries are places of inspiration. Within their waters and along their shores, you can find vibrant tapestries of marine life, ancient mysteries of our past, and thriving communities of men and women who have relied on the sea for generations. National marine sanctuaries are places where anyone can go to experience the power and beauty of the ocean and form lasting memories in spectacular natural settings, from the vibrant coral reefs of American Samoa to the towering kelp forests of Monterey Bay. These underwater treasures are sources of national pride, and when we take care of them, we protect part of what makes America great.

NATIONAL MARINE SANCTUARY SYSTEM

Olympic Coast
Greater Farallones
Cordell Bank
Papahānaumokuākea
Hawaiian Islands Humpback Whale
Monterey Bay
Channel Islands
American Samoa (U.S.)
(Including Rose Atoll)

Wisconsin - Lake Michigan
Thunder Bay
Stellwagen Bank
Mallows Bay - Potomac River
Monitor
Gray's Reef
Florida Keys
Flower Garden Banks

United States
Pacific Ocean

National Marine Sanctuary
Marine National Monument
Proposed National Marine Sanctuary

Scale varies in this perspective. Adapted from National Geographic Maps.

Name: _____   Date: _____

NOAA Who?

Purpose: To explore the National Oceanic and Atmospheric Administration's many missions.

Searching for NOAA
Using *NOAA Who?* and the websites below, answer the following questions to learn more about NOAA, the National Marine Sanctuary System and the Monitor National Marine Sanctuary.

NOAA: http://www.noaa.gov/
NOAA Diving Program: http://www.ndc.noaa.gov/
Office of National Marine Sanctuaries (ONMS): http://sanctuaries.noaa.gov

1.   NOAA is part of the Department of _____.

2.   List one of NOAA's missions.

3.   How many line offices are there in NOAA? Name one.

4.   Which line office is the sole official voice of the U.S. government for issuing warnings during life-threatening weather situations?

5.   How many types of satellites does NOAA operate for the United States?

6.   On the NOAA Diving Program website, click on "General Information." What is the Diving Program's mission?

7.   Where is the NOAA Diving Center located?

8.   What line office supports the Office of National Marine Sanctuaries?

9.   How many national marine sanctuaries are there? How many marine national monuments?

10. On the ONMS website, in the top navigation bar, click on "Visit." Scroll down to the sanctuaries map and click on any of the sanctuaries listed. Explain what that sanctuary protects.

11. On the ONMS website, in the top navigation bar, click on "Explore." In the drop-down menu, click on "Maritime Heritage." Scroll down and click on "Battle of the Atlantic." Who wrote the blog for June 25? What ship did he dive on and how did it sink?

Monitor to the Rescue

As our nation's first national marine sanctuary, Monitor National Marine Sanctuary (MNMS) was established to preserve and protect our nation's first Civil War ironclad, USS *Monitor*. The *Monitor* and her brave crew helped to turn the tide of the Civil War and forever changed naval warfare when it fought the Confederate ironclad, CSS *Virginia*, also known as the *Merrimack*.

As the two ships fought in the Battle of Hamptons Roads on March 9, 1862, the battle also marked the first time that iron met iron and the age of the wooden ships came to an end. Another unique new invention that the *Monitor* ushered in was a rotating gun turret. The clever design gave warships more maneuverability during battle and became a standard on all future ships.

The *Monitor* did not see much action after the Battle of Hampton Roads. The ship was sent to support a small skirmish off Sewel's Point and it also participated in the Battle at Drewry's Bluff near Richmond. The crew, affectionately known as the *Monitor* Boys, spent most of their time in Hampton Roads waiting for a chance to once again battle the CSS *Virginia*.

On December 31, 1862, just 11 months after it launched from Greenpoint, Brooklyn, N.Y., the *Monitor* encountered a storm off Cape Hatteras, N.C., and sank. That night, sixteen brave men made the ultimate sacrifice. The *Monitor*'s exact location remained unknown until 1973, when John G. Newton and his team from the Duke University Marine Lab, using side scan sonar, identified an unknown shipwreck that they thought was the *Monitor*. They confirmed its identity in 1974. North Carolina petitioned Congress to protect this national treasure and on January 30, 1975, the *Monitor* became our nation's first national marine sanctuary.

In 2002, NOAA, in collaboration with the US Navy, raised the iconic gun turret. As Navy divers were excavating the turret, they found the remains of a *Monitor* sailor. Once the turret was on the barge's deck, a second set of remains was found. For the 150th anniversary of the USS *Monitor*, the Secretary of the Navy authorized their interment at Arlington National Cemetery on March 8, 2013. Today the recovered pieces of the USS *Monitor* are conserved at The Mariners' Museum in Newport News, Va.

Photos Clockwise: John Ericsson; Battle of Hampton Roads; *Monitor* crew on deck; *Monitor* sinking; Turret being raised on August 5, 2002; Burial at Arlington National Cemetery of two *Monitor* sailors. Photos: NOAA's M*onitor* Collection

Name: _____   Date: _____

Monitor to the Rescue
Class Activity

Purpose: To explore the historical significance of the USS *Monitor* and the important role it plays as our nation's first national marine sanctuary.

Searching for the *Monitor*
Using Monitor *to the Rescue* and the websites below, answer the following questions to learn more about the Monitor National Marine Sanctuary.

Monitor National Marine Sanctuary (MNMS): http://monitor.noaa.gov
Monitor Legacy Site: http://monitor.noaa.gov/150th

1. On the MNMS website, click on "About Your Sanctuary." What act gave authority to establish the Monitor National Marine Sanctuary? When was the sanctuary established?

2. Under "About Your Sanctuary," click on "History of the *Monitor.*" Who designed the USS *Monitor*? How long did it take to build the *Monitor*? When was it launched?

3. In the side bar, click on "Advisory Council." What is the role of the sanctuary advisory council?

4. In the left side bar, click on "New & Events" and then click on "Press Releases." Choose one press release and read it. Summarize the importance of the press release.

5. In the left side bar, click on "Image Gallery," and click on the link in the first paragraph "Online Image Gallery." Scroll through the images and choose your favorite. Describe the image and tell why you chose it.

6. Click on the website link above for the *Monitor* Legacy Site. Click on the top tab "Life Onboard" and then click on "Battle of Hampton Roads." Read the text and summarize the battle. Who won? What was the true significance of the battle?

7. In the top bar, click on "Life Onboard" and then click on "Sailors that Died." How many men died the night the ship sank? How many were officers? Enlisted? African American?

8. In the top bar, click on "News & Events," and then click on the video camera icon for Researchers Hope to Identify Remains of Unknown Men. How many human remains were found in the turret? What was the goal of creating the busts (clay facial reconstructions)?

9. Visit http://monitor.noaa.gov/150th/feature_burial.html to read about the *Monitor* sailors' interment at Arlington National Cemetery. What was significant about the date they were interred? Scroll through the pictures and summarize the events of the day by using the images.
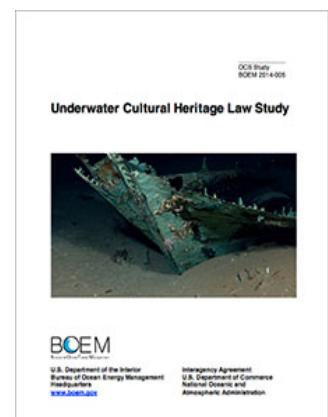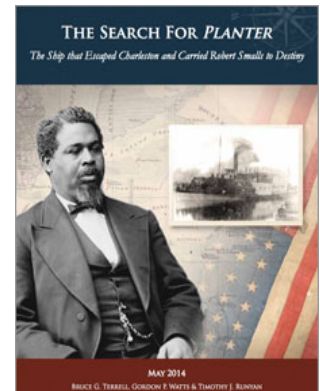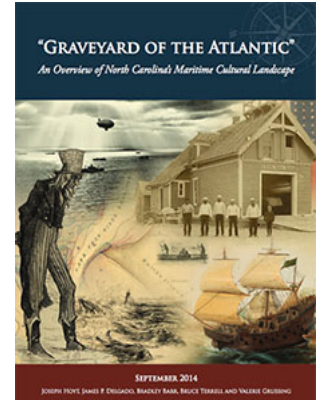
NOAA's Maritime Heritage Program

Museums of the Deep
Class Activity

Background

America's greatest museum of our past as a seafaring nation lies on the bottom of our nation's ocean, seas, lakes and rivers. They are places to explore, discover and appreciate our country's maritime cultural heritage. That heritage is a legacy of thousands of years of settlement, exploration, immigration, harvesting the bounty of the sea, and creating coastal communities and maritime traditions. Overall, it is an important link to our past and how we developed as a nation. Through NOAA's dynamic education and outreach programs, exhibits, visitors' centers and media, the importance of our unique heritage provide people with the knowledge they need to promote the preservation of these nonrenewable cultural resources.

In June 2000, the president recognized the need to increase ocean exploration and thus, he established the Office of Ocean Exploration and Research (OER). The office was created to coordinate the agency's exploration and research expeditions with the mission to enhance research, policy and management decisions, to develop new lines of scientific inquiry and to advise NOAA and the nation on critical issues. OER works with archaeologists, scientists, and oceanographers to explore the vast mysteries of our country's waterways.

Created in 2002, NOAA's Maritime Heritage Program is an initiative of the **Office of National Marine Sanctuaries** (ONMS). Each of our thirteen national marine sanctuaries and two marine national monuments, regardless of regulation and designation purposes, contain cultural resources. However, two sanctuaries, Monitor NMS and Thunder Bay NMS, were specifically designated to protect shipwrecks. Today through partnerships with the Office of Ocean Exploration and Research, other state and federal agencies and academia, the program continues to focus on maritime heritage resources within the National Marine Sanctuary System and promotes maritime heritage appreciation throughout our entire nation.

Visit the web site, http://sanctuaries.noaa.gov/maritime/aboutmhp.html, to read more about our nation's maritime heritage and learn about the laws that govern them.

NAME: _____   DATE: _____

Museums of the Deep
Class Activity

Visit the website, http://sanctuaries.noaa.gov/maritime/welcome.html, to learn more about how NOAA explores our nation's cultural resources.

1. In the grey navigation bar just below the top image, click on "About." What law is the most relevant to the National Marine Sanctuary Program? What does Section 106 require?

2. On the right under "More Information," click on "Projects." Click on the link for "*Duane*" under Florida Keys. What type of shipwreck is the *Duane* and where is it located? When was it built? How deep is the main deck?

3. Return to the main page, and in the grey navigation bark, click on "Projects," and then click on "*Monitor.*" What Union ship was converted into the CSS *Virginia*? What was the diameter of the gun turret? What was the date of the Battle of Hampton Roads when the *Monitor* and *Virginia* engaged?

4. Return to main page, click on "Projects," click on "USS *Macon*" under Monterey Bay. What type of ship was the USS *Macon*? What was the most significant outcome of the first phase of its expedition?

5. Return to the main page, and in the grey navigation bark, click on "Research Topics." Click on "*Titanic.*" When was the shipwreck discovered? Which office is the lead for dealing with the wreck of the RMS *Titanic*? Who do they work closely with to preserve the *Titanic*?

6. Under "Research Topics," click on "Native Cultures." The Maritime Heritage Program seeks to support research into seafaring traditions and the preservation of maritime folklore and knowledge. Choose one of the sanctuaries listed and explain what native culture it helps to preserve and protect.

7. Under "Research Topics," click on "Whaling." When was America's 'golden age' of whaling?

8. Under "Research Topics" click on "Preserve America" on the right under "More Information." In the top navigation bar, click on "What NOAA is Doing." What are the six top objectives of NOAA in preserving our nation's heritage?

9. Under "Research Topics," click on "Voyage to Discovery." On this site, read about Robert Smalls and the *Planter.* What did Robert Smalls do during the Civil War to make him famous in history? Why was his deed so spectacular?

10. Go to any area of the NOAA's Maritime Heritage Program's website and list one thing that you found most interesting.

http://monitor.noaa.gov

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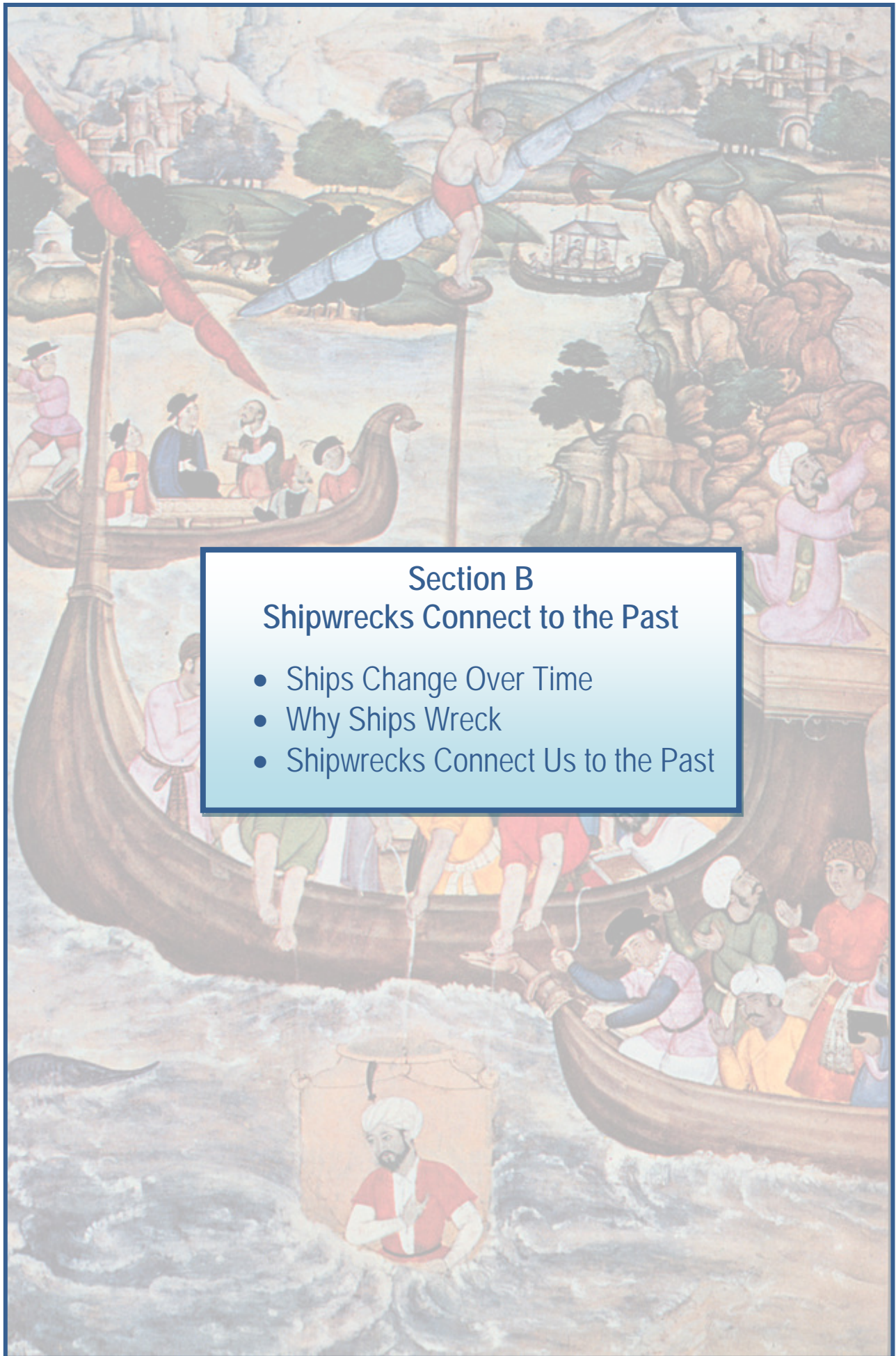
Section B
Shipwrecks Connect to the Past

- Ships Change Over Time
- Why Ships Wreck
- Shipwrecks Connect Us to the Past

Sailing Through the Ages

Artistic rendering of a Viking ship.
Courtesy Gbloquendox00black

Grade Level

- 6-12

Timeframe

- 2-4 hours

Materials

- Computer with Internet access
- Journal
- Rubric

Activity Summary

This lesson highlights the similarities and differences between ships through the ages.

Learning Objective

To develop a timeline of the construction of sailing ships

Key Words

See Vocabulary Box

National Standards:

NCSS:HT:1, 4, and 5; NCSS:I and II
CCSS.ELA.LIT.RI.1;
CSS.ELA.LIT.W.2, 4; NCTE:1, 7, and 8

Native cultures along the Olympic Coast continue to use canoes to support their traditional way of life. Photos: NOAA

Background Information

No one knows the exact date when sailing began, but it probably began the first time people saw water. The sea has always captured people's imaginations. Combined with our natural desire to explore and seek new adventures in faraway places, it is no doubt that boats were created very early in time. Through the ages, many factors, such as a desire to trade, wars and need influenced the development of vessels.

The first water craft were probably logs. It is easy to imagine early man sitting on a log floating in the water. Logs float easily and can be tied together to create a raft. Eventually, logs were hollowed out to make canoes, and when trees were not available, other materials were used to build boats, such as animal skins and reeds. Early on, vessels were simple and people relied upon paddles or poles to help push them through the water.

Like a lot of inventions, the creation of the sail probably started as an accident. Someone probably held up a piece of cloth and noticed that the wind made a vessel move faster. From there, the idea of using a sail changed the world and how we traveled forever.

Activity Overview

In this activity, students will conduct research to explore changes in boats/ships over time to answer an overarching question: How did sailing vessels change over time? Using LiveBinders (teacher created), TimeToast or other resources, students will create a timeline that depicts sailing ships from about 6,000 BC to present day. The information is then shared though Animoto presentations, written report, posters, video, or other media of choice.

Objective

To explore and learn how ship design has advanced over time.

http://monitor.noaa.gov

Teacher Preparations and Implementation

Overarching question: "How have sailing vessels changed over time?"

- Visit http://www.livebinders.com, to become familiar with how to use Livebinders and create a LiveBinders for student use.
- Visit http://animoto.com, http://www.wallwisher.com or similar sites to become familiar with how to use each. Accounts are free, and a teacher may set up a wall for each class with the overarching question.
- Review suggested resources and/or conduct a search for additional resources to help students answer the overarching question. Add resources to the students' LiveBinders or print a list of resources for students.
- Introduce to Livebinders to students, and instruct students on how to use Livebinders.
- Demonstrate to students how to use WallWisher.
- Students use WallWisher to brainstorm questions as a class to determine what information is needed in order to answer the over-arching question.
- Group students in groups of 2-4 students.

Note: LiveBinders (http://www.livebinders.com); Animoto (http://animoto.com); and Wallwisher http://www.wallwisher.com) are all free resources, but are only a few of the available options; additional options are also effective tools. If technology is not available, use print resources and images for students to create a paper project.

- Students will use LiveBinders (teacher created), a search engine and/or hard copies of materials to research the topic and to answer the questions generated on WallWisher.
- Demonstrate to students how to use Animoto.
- Prepare a folder of 20-30 digital images that is accessible for student use in the creation of their Animoto presentation. *NOTE: Animoto is a great resource to help students learn to be concise in their presentations due to the limited number of characters allowed per page.*
- Final product is an Animoto (or other format) presentation where students debate and defend their findings.

Time Management Tips

- Set predetermined time for research, summaries and for creating the video. Assign one student the job of timekeeper for the group.
- To reduce the amount of time spent surfing the Internet, create a LiveBinders that is student friendly and has several tabs identifying information found in the sources, as well as graphics from various sites.

Optional Assessment

A rubric is provided to aid in scoring the project based on the effectiveness of the project in answering the project questions, thoroughness of research, and presentation.

Vocabulary

BARK, BARC OR BARQUE – Originally a barge

BRIGANTINE – With pointed ends often refers to a ship with two masts and one having a square rigged sail

CANOE – A narrow, keelless boat with pointed ends, propelled by a paddle or paddles

DHOW – A lanteen-rigged ship with one or two masts, used in the Indian Ocean

GALLEON – a sailing ship in use from 15th to 17th centuries, originally a warship, later for trade; mainly square-rigged and usually had three or more decks and masts

IRONCLAD – a ship covered in protected by an iron covering

JUNK – An ancient Chinese sailing ship; design is still in use today

SAILING SHIP – A ship driven by wind; often having masts

SLOOP – A small square-rigged sailing warship with two or three masts (historical)

STEAMER – A ship or boat powered by steam

VIKING SHIP – A ship built by Vikings; usually slender and flexible boats with symmetrical ends with a true keel

Resources

Websites

Monitor National Marine Sanctuary
Explore this legacy website to learn about the Civil War ironclad, USS *Monitor*, which changed naval warfare forever. Read about the men who made her, the men who commanded her and the men that served and died on her.
http://monitor.noaa.gov/150th

The Mariners' Museum: Exploration Through the Ages
Visit this website to examine the various types of ships used for exploration and the explorers who used them.
http://ageofex.marinersmuseum.org/index.php?page=ships

U.S. Naval Historical Center
The U.S. Navy has an extensive library of historic ship images. Visit this page to view images of the USS *Monitor.*
http://www.history.navy.mil/photos/sh-usn/usnsh-m/monitor.htm

History World: History of Boats and Ships
Explore this site to learn how boats have evolved over the centuries.
http://www.historyworld.net/wrldhis/PlainTextHistories.asp?groupid=102&HistoryID=aa14&gtrack=pthc

Explain that Stuff: Ships and Boats
Learn why boats float, and scroll to the bottom for a timeline with links to learn more about the advancement of boats.
http://www.explainthatstuff.com/how-ships-work.html

ScienceNordic
Learn how Vikings navigated the word and why.
http://sciencenordic.com/how-vikings-navigated-world

Books

Chatterton, E.: *The History of Sailing Ships: The story of their development from the earliest times until the 19th century.* Salzwasser-Verlag, 2010. ISBN-13: 978-3861953081.

Davis, Charles G.: *American Sailing Ships: Their Plans and History.* Dover Publishing, 2012. ISBN-13: 978-0486246581.

DK Publishing: *Ships and Sailing (DK Visual Dictionaries).* DK Children, 1991. ISBN-13: 978-1879431201.

Paine, Lincoln: *The Sea and Civilization: A Maritime History of the World.* Knoph Doubleday Publishing Group. 2013, ISBN-0307962253.

Woodman, Richard: *The History of the Ship: The Comprehensive Story of Seafaring from the Earliest Times to Present Day.* Lyons Press, 2002. ISBN-13: 978-1585746217

LiveBinder resources may include:

- The Mariners' Museum
  http://ageofex.marinersmuseum.org/index.php?page=ships
- Navy Historical Center — USS *Monitor* Construction and images
  http://www.history.navy.mil/photos/sh-usn/usnsh-m/monitr-u.htm
- U.S. Navy History and Heritage Command — Navsource Online
  http://www.navsource.org/archives/01/monitora.htm
- Navy History and Heritage Command — CSS *Virginia* Images
  http://www.history.navy.mil/photos/sh-us-cs/csa-sh/csash-sz/virginia.htm
- YatchPals—Sailing Boats Through the Ages — History of Sailing Boats
  http://yachtpals.com/sailing-boats-9621
- American Sailing Association — The Evolution of Sail
  https://asa.com/news/2012/01/30/sail-evolution/
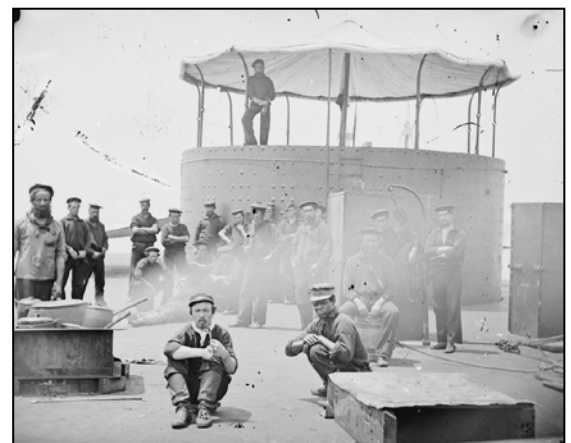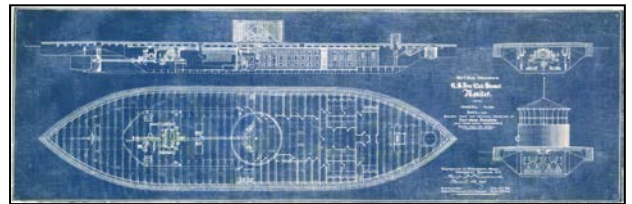
The USS *Monitor* was the Union's first ironclad. Launched on January 30, 1862, the revolutionary design included iron plating and a rotating gun turret that forever changed naval warfare.

Top: Print of the *Monitor* plan drawing. Photo: NOAA's *Monitor* Collection.
Bottom: One of eight known photos of the *Monitor* crew taken on July 9, 1862, in Hampton Roads, Va. Photo: Library of Congress

Name: _____ Date: _____

Sailing Through the Ages
Class Activity

Engage

1. As a class, start a discussion to understand how the first boat might have been made, and how boats/ships have developed over time. Brainstorm questions about the development, innovations, functions and advantages of different types of ships. What purpose did early ships serve? Did their purpose change? Why or why not? What events might have influenced a change in ships' design (commerce, war, famine, etc.)?
2. Your assignment is to thoroughly answer the question, "How did sailing vessels change over time?"
3. In your group, use http://www.wallwisher.com (or a KWL chart) to brainstorm and post questions you will need to find answers for in order to complete the assignment. Each group must come up with at least 3-4 questions. *(NOTE: If technology is limited, then do this exercise as a class.)*
4. As a class, combine all groups' questions. Delete any duplicate questions and group the questions in categories. If needed, add more questions. Continue until there is a consensus that the questions are complete to answer the overarching project question.

   Types of ships that might be included are: Canoe, Dhow, Viking, Junk, Galleon, Sloop, Barc, Steamer, Brig, Ironclads, etc.

Explore
5. Put the questions from WallWisher into a Word document. (*NOTE: If you do not have the technology, use the Cornell note taking format to organize and answer the questions.*)
6. Use the teacher-created LiveBinders, a search engine, and/or other materials to explore answers to each question. Answers do not need to be complete sentences, but rather they can be notes taken from your sources. You may agree, disagree or decide to add more information to any of the answers. Regardless, all information must site the source.
7. As you progress through the activity, determine if there are other questions that need to be answered in order to complete the assignment.
8. Define all vocabulary words, as these will need to be included in your final presentation.

Explain
9. Once your group has completed answering all the questions, carefully consider and debate all the information and decide on a final answer to the overarching question.
10. Come to a consensus on what information to use to create your Animoto video to best answer the project question. *(NOTE: If a team has difficulty coming to a consensus, use placemat consensus (http://cooperativelearningstrategies.pbworks.com/w/page/28234907/Placemat%20Consensus) or another format to help move it forward.)*

Elaborate
11. Use the teacher created image folder and choose 6-10 images to strengthen and illustrate the points that you chose to cover in the video.
12. Create an outline and a storyboard to organize the information for your video.
13. Using Animoto or other media program, create a digital imaging video. The presentation will include images, title, subtitles for explanation, and music appropriate to convey the intended message of the presentation.
14. Site all sources appropriately.

Evaluate
15. When complete, present your group's video to the class. Be ready to defend why you answered the question as you did.

Extend
16. Explore famous shipwreck designers and discuss any inventions or innovations that made their ship's design unique. Explore the U.S. Navy and create a timeline of the different classes of naval ships.

NAME: _____   DATE: _____

Sailing Through the Ages
Scoring Rubric

	Academy Award Winning Video!	Oscar Nomination	Average Ticket Sales	Box Office Bust	Score
	5 points	4 points	3 points	2 points	
Collaboration and Communication	* Worked diligently on task until it was completed *Highly engaged in conversation and discussion while working on task *Continued working on the task even when it became difficult or the solution was not evident *Did not waste time or bother other classmates *Highly flexible and willing to understand other points of view	*Worked on the task until it was completed *Engaged in conversation and discussion while working on task *Worked on the task even when it became difficult or the solution was not evident *Did not waste a lot of time or bother other classmates *Flexible and willing to understand other points of view	*Worked on task until it was mostly completed *Somewhat engaged in conversation and discussion while working on task *Frequently stopped working on the task when it became difficult or the solution was not evident *Wasted time by being frequently off task *Somewhat flexible and willing to understand other points of view	*Did not complete the task *Off task, little or no discussion *Stopped working on the task when it became difficult or the solution was not evident *Did not use time efficiently and distracted other students. *Not flexible and not willing to listen to other points of view	
Research	*Analysis was complete, accurate, and in depth showing understanding of content and vocabulary	*Analysis was accurate and complete; however, it could have shown more in depth understanding of content and vocabulary	*Analysis was somewhat complete with some inaccuracies showing little understanding of content and vocabulary	*Analysis was incomplete, inaccurate and lacked understanding of content and vocabulary	
Information Literacy	*All resources (networks, databases, and print materials) were used in an ethical manner *Identified all relevant sources	*Most resources (networks, databases, and print materials) were used in an ethical manner *Identified most relevant sources	* Some Resources (networks, databases, and print materials) were used in an ethical manner *Identified some relevant sources	*Resources used in an unethical manner *Resources were not included	
Images and Music	*Relation of music and images to the topic enhances message throughout the presentation	*Relation of images and music to the topic was evident in much of the presentation	*Some relation of images and music to the topic was evident in the presentation	*Relation of music and images to the topic was not evident	
Text	*Information was accurate with all of the pictures	*Most of the information was accurate with pictures	*Inaccurate information and related to very few pictures	*Inaccurate information and images not related	
Organization	*Organization of images and text flows to ensure viewer understanding	*Organization of most images and text flows	*Organization of images and text somewhat confusing	*Lack of any organization of images and text	
TOTAL POINTS					____/30

*Adjust point values and add categories as needed.

NAME: _____   **DATE:** _____

K	W	L
What do you think you KNOW?	What do you WANT to learn?	What did you LEARN?

*Use additional paper if needed.

Abandon Ship!

German U-boat, U-*701*, is located off the North Carolina coast. Photo: NOAA's Monitor NMS

Grade Level

- 6-12

Timeframe

- 2-4 hours

Materials

- Computer with Internet access or
- Printed resources for students to use to prepare their media report

Activity Summary

This lesson explains the various reasons why ships sink. Using primary, secondary and tertiary sources, students will create posts, tweets, videos, or other news media to describe a shipwreck in history.

Learning Objectives

- To understand how and why ships wreck.
- To learn about some of the most famous shipwrecks
- To interpret the facts of a shipwreck and to disseminate the information to the public

Vocabulary

See Vocabulary Box

National Standards:

NCSS:HT:1, 2, and 4; CCSS.ELA.LIT.6-8.1, 2, and 3; CCSS.ELA.LIT.9-12.1 and 3; CSS.ELA.LIT.RH.1, 2 and 3; CCSS.ELA.LIT.W.2 and 4; NCSS:I and II; NCTE:1, 4, 5, 7, and 8

Background

Why do ships wreck? The answers are almost as numerous as the number of shipwrecks, because many factors can contribute to the sinking of a ship. Some shipwrecks are even intentional, sunk to become artificial reefs. However, storms are often a common reason for ships sinking. Storms can blow ships off their anchorage and into dangerous rocks. They can be so fierce to cause a ship to break apart or to take on water and eventually sink. Storms can also blow ships off course causing them to beach or hit shoals or reefs.

Other factors that make ships wreck might include the improper storage of cargo, piracy, mutiny, sabotage, fire, war, or bad weather, such as fog. Sometimes even a shipwreck can be a hazard and cause a ship to sink if the wreck site is unknown and does not appear on nautical charts. Occasionally, a ship's captain might not know his ship's location at sea and run aground or into another ship. However today, technology can help to prevent that from happening, but technology is dependent upon having people who know how to use it and it must have power to work. And even though all ships are required to have nautical charts onboard, charts can get damaged in fire or in other ways become unusable.

Another factor that caused thousands of ships to sink through the ages is war. Many ships were sunk from cannon fire, machine guns, depth charges, torpedoes, or by numerous other means. Globally in World War II alone, over 1500 merchant ships were sunk, along with hundreds of Allied ships. World War II especially played a role in the vast number of shipwrecks off the North Carolina coast.

The answer as to why ships sink is not an easy one! However, each shipwreck has a unique story to tell. Some stories make national headlines, such as the *Titanic* and some never make the news. But no matter how big or how small the story may seem to be, each one has special meaning to the folks who were either on the ship or who had loved ones on it when it sank. Many shipwrecks are also gravesites for those who went down with the ship. For those whose friend or relative perished at sea, the wreck site will have a very significant meaning. So as you learn about shipwrecks and explore some of the famous and not-so-famous wrecks look for each ship's story and how its sinking affected those that were associated with it.

Activity Overview

In this activity students will use primary, secondary and tertiary sources to research selected or assigned shipwreck(s). Through research, students will answer key questions and give an account of the shipwreck by creating a news article, newscast video segment, tweets, and/or Facebook post, to be shared.

Objective

Students will understand that there are many reasons why ships sink and that each shipwreck has a unique story to tell.

Teacher Preparations and Implementation

1. This project may be completed individually or in small groups. After determining how it is to be completed, check out the **Resource Section** for recommended websites or use a search engine to select an appropriate number of historic shipwrecks that are of interest to the class. These may be grouped by themes, such as World War I or luxury liners, or may be a random mix of all shipwrecks.
2. Review the different types of resources available for research and the significance of each.
3. Next, determine the requirements for the project—will they report the news by writing a news article, a series of tweets, produce a video or use all mediums? You can have students report the news in multiple mediums or just one depending on the class and time constraints.

4. Ask students how news is received today. Explain that today news is reported in many different ways. Technology brings news in the form of tweets, blogs, videos, newspapers, online papers and more. Discuss which ones are primary, secondary or tertiary sources.
5. Once you have set the parameters for your class, have the students explore and determine what tools they need to complete the activity.

Vocabulary

PRIMARY SOURCE – Source that contain raw, original, non-interpreted and unevaluated information

SECONDARY SOURCE – Source that digests, analyzes, evaluates and interprets the information contained within the primary sources. They tend to be argumentative.

TERTIARY SOURCE – Source that compiles, analyzes, and digests secondary sources. They tend to be factual.

	Primary	Secondary	Tertiary
Timing of Publication	Tend to come first in the publication cycle	Tend to come second in the publication cycle	Tend to come last in the publication cycle
Formats	Often newspapers, diaries, letters, blueprints and oral histories	Often scholarly periodicals and books	Often reference books
Example Sources that Might be Used by Historian Studying Shipwrecks	Vessel registries, insurance documents, log books, diaries, letters, enrollments, newspapers, oral histories, ship blueprints, wreck reports, biographies, interview, poetry, short stories, photographs, lithographs, paintings, lifesaving station logs	Articles in scholarly journals, such as the Society for Historical Archaeology, or the International Journal of Nautical Archaeology, published books, criticism and interpretation, history, government policy, law and legislation, political aspects, public opinion, religious aspects, social policy	A glossary for maritime archaeologists, atlas of the world's submerged sites, abstracts, bibliographies, chronologies, dictionaries, encyclopedias, guidebooks, handbooks, registers, statistics, tables, index

Resources
Websites

ClassTools.net
This site offer useful tools for the classroom, such as Fakebook, which can be used to create fake Facebook posts. http://www.classtools.net/FB/home-page and SMS Generator, that can be used to create conversations, such as text messages. http://www.classtools.net/SMS/.

Teachthought
With cell phones and digital cameras, videos are simple to create, and there are many programs and apps that can help. Here is a site with 22 apps that can get you started. http://www.teachthought.com/apps-2/22-newest-best-apps-make-videos-classroom/

Edtechteacher
If you want to have your students learn the art of video production, check out this site. There is a video curriculum to teach storyboarding, filming, editing and publishing. Also, there is a good explanation of video file formats and how to share videos on various sites. http://edtechteacher.org/tools/multimedia/video-classroom/

Suggested Shipwreck Sites:

Monitor National Marine Sanctuary
http://monitor.noaa.gov and
http://monitor.noaa.gov/150th

NOAA's Battle of the Atlantic Expedition Site
http://sanctuaries.noaa.gov/missions/battleoftheatlantic/archives.html

Thunder Bay National Marine Sanctuary
http://thunderbay.noaa.gov/

10 Famous Shipwrecks of the World
http://www.enkivillage.com/famous-shipwrecks-of-the-world.html

Amusing Planet—12 Famous Shipwrecks that You Can Still Visit
http://www.amusingplanet.com/2014/04/12-famous-shipwrecks-that-you-can-still.html

Listverse—10 Shipwrecks Frozen in Time
http://listverse.com/2013/04/23/10-shipwrecks-frozen-in-time/

uboat.net
Site dedicated to the German U-boats of both World Wars, their commanding officers and operations. http://www.uboat.net/

WreckSite
The world's largest online wreck database with over 165,580 wrecks. http://wrecksite.eu/

Suggested Shipwrecks

- USS *Monitor*
- RMS *Titanic*
- Blackbeard's *Queen Anne's Revenge*
- German U-boats off North Carolina's coast: U-*85*, U-*352*, U-*576*, and U-*701*
- *World Discoverer*
- SS *America*
- *Edmund Fitzgerald*
- *Andrea Doria*
- USS *Arizona*
- Others shipwrecks of your choice
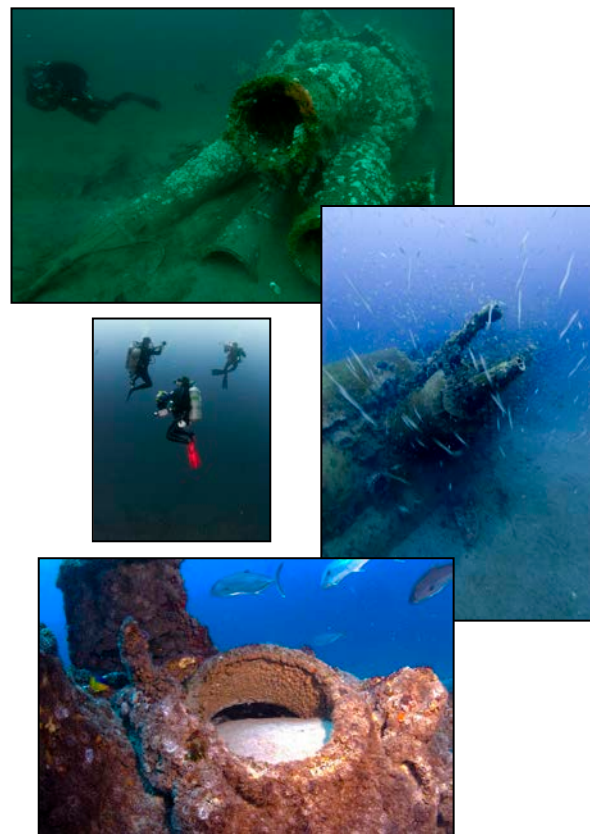
Counter Clockwise:
U-*85*, U-*352*, U-*701*, NOAA divers ascending to surface. All Photos: NOAA

Name: _____   Date: _____

ABANDON SHIP!
Class Activity

Often it is asked why ships wreck. The answers to that question are almost as numerous as the number of shipwrecks, because many factors can contribute to the sinking of a ship; and each shipwreck has a unique story to tell. In this activity, you will explore a shipwreck to learn about its life, determine why it sank, and what story it tells.

Today society gets its news differently than it did 10-20 years ago. We no longer hear news just from the television, radio or newspaper. In order to reach the maximum number of people, news agencies use many different types of media. Sometimes news is distributed by individuals that happen to be there when news is in the making. Today, many individuals even use cell phone cameras to capture an event as it is happening in real-time.

After researching your shipwreck, you are tasked to tell the ship's story through one or more mediums, such as Facebook, Twitter, blogs, YouTube, Podcasts, television, newspaper articles, or other media. You may elect to be a news reporter, individual on the street or another person wanting to share the story.

SHIPWRECK: _____

MEDIA: _____

Procedure:

1. Using books, the Internet and other sources, research your shipwreck.
2. Create a concept map or other type of graphic organizer to depict the ship's history — type, construction, date launched, builder, designer, use, date sank, reason for sinking, people onboard and any other related information. In your research, look for the ship's story and what might make it interesting to people.
3. Using the concept map and any additional information collected create an outline for your news article, Facebook post, tweets, video, podcast, or whatever media you are using.
4. Create your article/post/video.
5. In small groups or as a class, share each ship's story.
6. As you learn about the various shipwrecks, are there unanswered questions? What else would you like to know about the ship? Keep a list of questions for further research.

Left: Bow of the *Titanic*. Photo: Emory Kristof, National Geographic
Center: NOAA diver on *Manuela*, a merchant freighter that was sunk by German U-boat off North Carolina's coast on June 25, 1942. Photo: NOAA Monitor NMS
Right: The location of the *Windiate* was a mystery for over 100 years until found in Thunder Bay, Michigan. Photo: NOAA

Past Connections

Two-masted schooner, *Defiance*, Thunder Bay National Marine Sanctuary. Photo: NOAA

Grade Level

6-12

Timeframe

2-4 hours

Materials

- Computer with Internet access*
- Plastic tubs with sand and water
- Toothpicks and string
- Modeling clay and graph paper
- Various objects for artifacts

  *Optional — Print web pages if no Internet or use other resources

Activity Summary

This lesson illustrates how artifacts offer historical information of the past.

Learning Objectives

- To describe types of artifacts found on ancient shipwrecks.
- To understand the valuable historical information artifacts offer
- To interpret the historical significance of artifacts and the importance of professional maritime archaeologists in their interpretation.

Key Words
See Vocabulary Box

National Standards:

NCSS:HT:1 and 4; NCSS:I, II and III; NCSS:WH:Era1.1a and 1.b; NCTE: 1, 7 and 8; CCSS.ELA.LIT.RI.1; CCSS.ELA.LIT.W.3 and 4

Background

Humans, ships and the ocean have long been intricately bound together. Even in ancient times, ships provided the fastest and most economical method to move goods, people, and ideas from one place to another. However, the ocean can be an unforgiving place and some ships will inevitably wreck.

Shipwrecks offer an exciting window into the study and preservation of our past. They are a random sampling of voyages, a record of past trade and communication. It is almost as if they are frozen in time.

These submerged cultural resources give us a fresh perspective on history and are valuable classrooms offering a vast array of knowledge, beauty and heritage. The story of each shipwreck is woven into the intricate tapestry of its regional history. The preservation and research of sunken vessels provide a variety of information, such as the history of shipbuilding, a better sense of the physical development of the area, an understanding of innovations of the day, a look at the culture of the people on the ship, the identification of products that were coming into and through a region, the social structure in ship construction, and so much more.

Much of what we know about a region comes from historic documents, such as journals, newspapers, and first hand-accounts written in letters by those who lived during the time. However, shipwrecks contain a wealth of information that is not found in the documentary record. They help tell us what people did at a very specific moment in time. If a ship sank in 1200 BCE, everything onboard at the time of the sinking came from 1200 BCE or earlier. Clothing, tools, navigational instruments, cargo, personal items, and even the ship itself, tell us the story of how people lived and worked at that specific time in the past. If later items are found on a shipwreck, then they too tell another story. They offer clues as to what has happened to the ship since it sank.

Shipwreck exploration is a wonderful adventure, and underwater archaeologists are committed to studying the history on the ocean floor as well as preserving it for future divers. Protecting these resources allows for the continued interpretation and understanding of the lives of mariners and the struggles and successes they encountered.

Activity Overview

In this activity, students will research shipwrecks from the Bronze Age (2,900 – 1,200 BCE); Classical and Hellenistic periods (500 – 330 BCE); and the Byzantine period (300 – 1,450 CE). From their research, they will create a fictitious shipwreck; write a short story that depicts the ship, its passengers, cargo, and route; and create an underwater archaeological site for exploration and excavation.

Objective

To describe types of artifacts found on ancient shipwrecks and explain the types of information that may be obtained from them.

Teacher Preparations and Implementation

1. Review each ship listed in the resource section.
2. Determine if the project will be done individually or in small groups. Assign a shipwreck to each student/group.
3. Gather all materials including the correct number of small plastic tubs (one for each group) and enough sand to create a 1-2 inch layer on the bottom of each.
4. If providing objects/artifacts for the students, collect and place them in large container. **Optional:** Have students bring objects from home to represent their artifacts.
5. If needed, review how to make a coordinate grid system.

6. If Internet is available, give students the links to their assigned shipwreck. Links are for suggested sites, but other sites/resources may be used. If Internet is not available, review the website and print the required information needed for each group.

Extension

Have students create a site plan from their graph paper grid. See an example of a site plan at http://nauticalarch.org/projects/all/southern_europe_mediterranean_aegean/uluburun_turkey/site_plan/

Diver on the *City of Atlanta*, a WWII shipwreck located off North Carolina's coast. Photo: NOAA

Vocabulary

ARCHAEOLOGICAL EXCAVATION – The exposure, processing and recording of archaeological remains. Through the movement of artifacts and contexts, excavation permanently and irretrievably changes a site and its aesthetic, recreational and environment values are diminished, if not lost, forever. Today, excavation is therefore often limited to sites that have the potential to answer important research questions or those that are under threat of destruction. However, much of the work of maritime archaeologists is not related to excavation but involves surveying maritime sites, assessing archaeological potential, making management recommendations and introducing maritime sites to the wider community.

ARTIFACT – Any object made by humans, typically an item of cultural or historical interest

CONCRETION – A combination of sand, sediment, marine life, and iron oxides (rust) that bonds to the surface of an artifact

CONSERVATION – Preservation, repair, and prevention of deterioration of archaeological, historical, and cultural sites and artifacts

CONSERVATOR– A person responsible for the repair and preservation of works of art, building, or other things of cultural or environmental interest

COORDINATE – A group of numbers used to indicate the position of a point, line or plane

GRID – A network of measured squares placed over a site to assist excavation and recording

IN SITU– Latin phrase that means in its original place or position

Shipwreck Resources

Bronze Age

Cape Gelidonya — Sank near Turkey ~1200 BCE
- Institute of Nautical Archaeology: http://nauticalarch.org/projects/cape-gelidonya-late-bronze-age-shipwreck-excavation/
- Texas A&M University: http://nautarch.tamu.edu/class/316/gelidonya/

Uluburun — Sank near Kaš in southern Turkey ~1306 BCE
- Institute of Nautical Archaeology: http://nauticalarch.org/projects/uluburun-late-bronze-age-shipwreck-excavation/
- Ancient Origins: http://www.ancient-origins.net/ancient-places-asia/uluburun-one-oldest-and-wealthiest-shipwrecks-ever-discovered-001962
- Texas A&M University: http://nautarch.tamu.edu/class/316/uluburun/

Classical and Hellenistic Periods

Kyrenia — Sank off north coast of Cyprus between 310 and 300 BCE.
- Institute of Nautical Archaeology: http://nauticalarch.org/projects/kyrenia-shipwreck-excavation/
- *Kyrenia* Shipwreck Museum: http://www.cypnet.co.uk/ncyprus/city/kyrenia/castle/shipwreck/

Porticello — Sank on the Italian side of the Straits of Messina in about the fifth century BCE.
- Institute of Nautical Archaeology: http://nauticalarch.org/projects/all/southern_europe_mediterranean_aegean/porticello_wreck_italy/full_report/

Byzantine Period

*Serce Limani* — Ssank on the southern shores of Turkey around 1025 CE
- Institute of Nautical Archaeology: http://nauticalarch.org/projects/serce-limani-shipwreck-excavation/

- Simerg—Insights from Around the World: http://simerg.com/literary-readings/excavation-of-a-byzantine-shipwreck-and-the-discovery-of-fatimid-artefacts/

Uluburun—The Ellis School Project

Teacher constructed website with four sections: 1) Face the Challenges, 2) Explore the Wreck (interactive site plan of wreck), 3) View the Artifacts and 4) Tell Me More (interactive map of eastern Mediterranean region). On artifact page, there is a list of artifacts found on the *Uluburun* shipwreck and clickable links for more information and an image.
http://sara.theellisschool.org/shipwreck/ulusplash.html
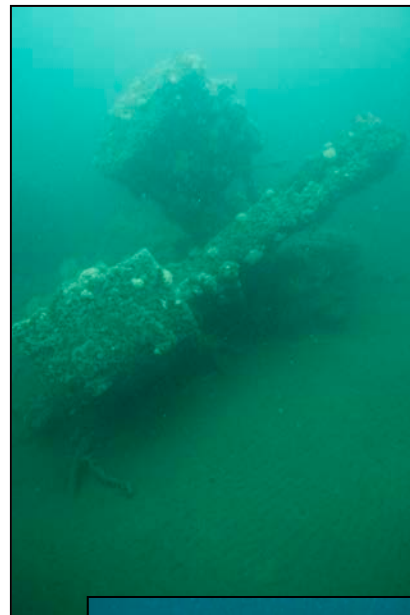
In 2010, NOAA and partner divers documented and surveyed merchant ships that were sunk by German U-boats off North Carolina's coast in 1942 during the Battle of the Atlantic.
**Left:** *City of Atlanta*
Bottom: *Dixie Arrow*
All Photos: NOAA

Name: _____   Date: _____

Past Connections
Class Activity

"Man hoisted sail before he saddled a horse. He poled and paddled along rivers and navigated the open seas before he traveled on wheel along a road. Watercraft were the first of all vehicles." -- Thor Heyerdahl, *Early Man and the Ocean*

Since the Neolithic times, mariners have traveled the seas to trade, explore, and engage in warfare. Remnants of ancient ocean voyages can provide a plethora of information about trading patterns, sociopolitical networks, technology of the day, cultures and much more. When a shipwreck is found, it can be a treasure trove of information. However, an archaeological site can only be excavated once, because after you disturb the site, it can never again be looked at in its original context. Therefore, it is important that a shipwreck is only disturbed by professional archaeologists that have a knowledge of artifacts, history and the culture of a region or historic period, and that they document their work thoroughly at all stages to preserve an accurate record of the site.

Most shipwrecks are left *in situ* (in place). To recover artifacts takes a great deal of time, commitment and money. Artifacts are never taken for "treasure," but should only be recovered for historical purposes. And if artifacts are recovered, they must be properly conserved and kept together as a collection. Conservation can be a lengthy process and in some instances, it requires decades and millions of dollars.
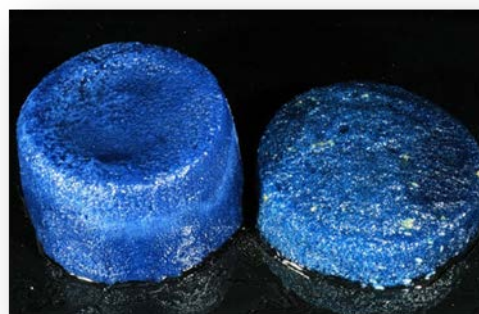
All images are from the Turkish wreck site *Uluburun*
Left: Excavating cedar and ebony logs.
Center: Displaced anchors originally stowed near the bow.
Right: Earliest intact glass ingots of disc shape.
All Photos: Institute of Nautical Archaeology

For this exercise, you and your team are archaeologists. You have discovered a historically significant shipwreck and have received the authority of the governing country to excavate the site. You have also received funds to ensure it will be properly conserved and kept together throughout time.

1. Research the shipwreck _____ to discover the type of ship, where it traveled, who sailed on it, and more.
2. Create a fictitious shipwreck similar to the one you researched and from the same time period. Give it an appropriate name: _____.
3. Write a short story (5-6 paragraphs) about your fictitious shipwreck and its final voyage. The story should include a description of those onboard and what type of objects they would have brought with them (personal items, items of their trade/job, etc.) Also, include the type of cargo the ship carried and what that cargo represented (was it for a king, royalty, or to be sold to commoners). Include where the ship's final voyage originated and what would have been its final destination.
4. From your story, make a list of at least ten artifacts found on the ship. Give a detailed description of each including size, weight, color, etc.
5. Either bring items from home or use ones provided to represent the artifacts on your list.

6. Wrap each artifact in modeling clay. The clay represents the marine encrustations (concretion) that are typically found on marine artifacts. The concretion is delicately removed when conserving artifacts and can be a lengthy and costly process.
7. In a shallow tub, place a layer of sand and fill the tub with water.
8. Using the information from the story you created, arrange each artifact under the sand.
9. Once all shipwrecks are complete, each group will explore and excavate a **different** shipwreck.
10. Before excavation, remember that the position of artifacts relative to each other often gives archaeologists clues. Therefore, archaeologists use a grid system to help document where various artifacts are located in relationship to each other and their placement in the wreck. Use toothpicks and string to create a grid (similar to longitude and latitude lines) in the sand over the shipwreck. Label the grid with letters across the top and numbers down the side.
11. Using the grid system and graph paper, record the location where each artifact is discovered by drawing the artifact on the graph paper in the proper coordinates. Be sure to show how it is positioned as accurately as possible.
12. Recover the artifact and place in a shallow pan of water until conservation can begin. (Artifacts must remain wet until conserved.)
13. Once all artifacts have been documented and recovered, create a log to record the location and description of each artifact found.
14. Before beginning conservation, observe the shapes and sizes of the artifacts covered in "concretion," and hypothesize what each artifact might be.
15. Select one artifact from the pan of water and use plastic utensils to carefully remove the concretion from the artifact.
16. Draw the artifact and record any new observations. Confirm or deny your hypothesis.
17. Continue until all artifacts have been conserved.

These images are from a Turkish shipwreck named *Serce Limani*, popularly known as the Glass Wreck which sank about 1025 CE.

Top left image shows a maritime archaeologist using a 2 meter metal grid system and recording the ship's hull. Because of the fragile condition of the wood, it is kept in storage tanks of water until conservation can begin (center top). Drawing of the hull timbers as they were uncovered on the sea floor (top right). One of three copper buckets found (bottom left). A wooden delousing comb and scissors were part of the personal items found. All Photos: Institute of Nautical Archaeology.
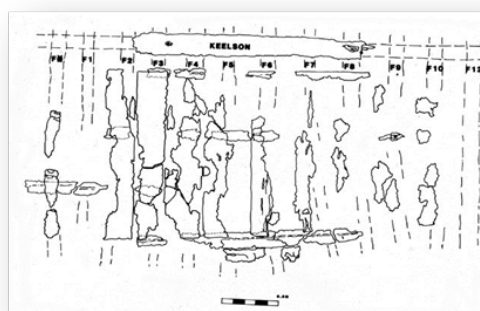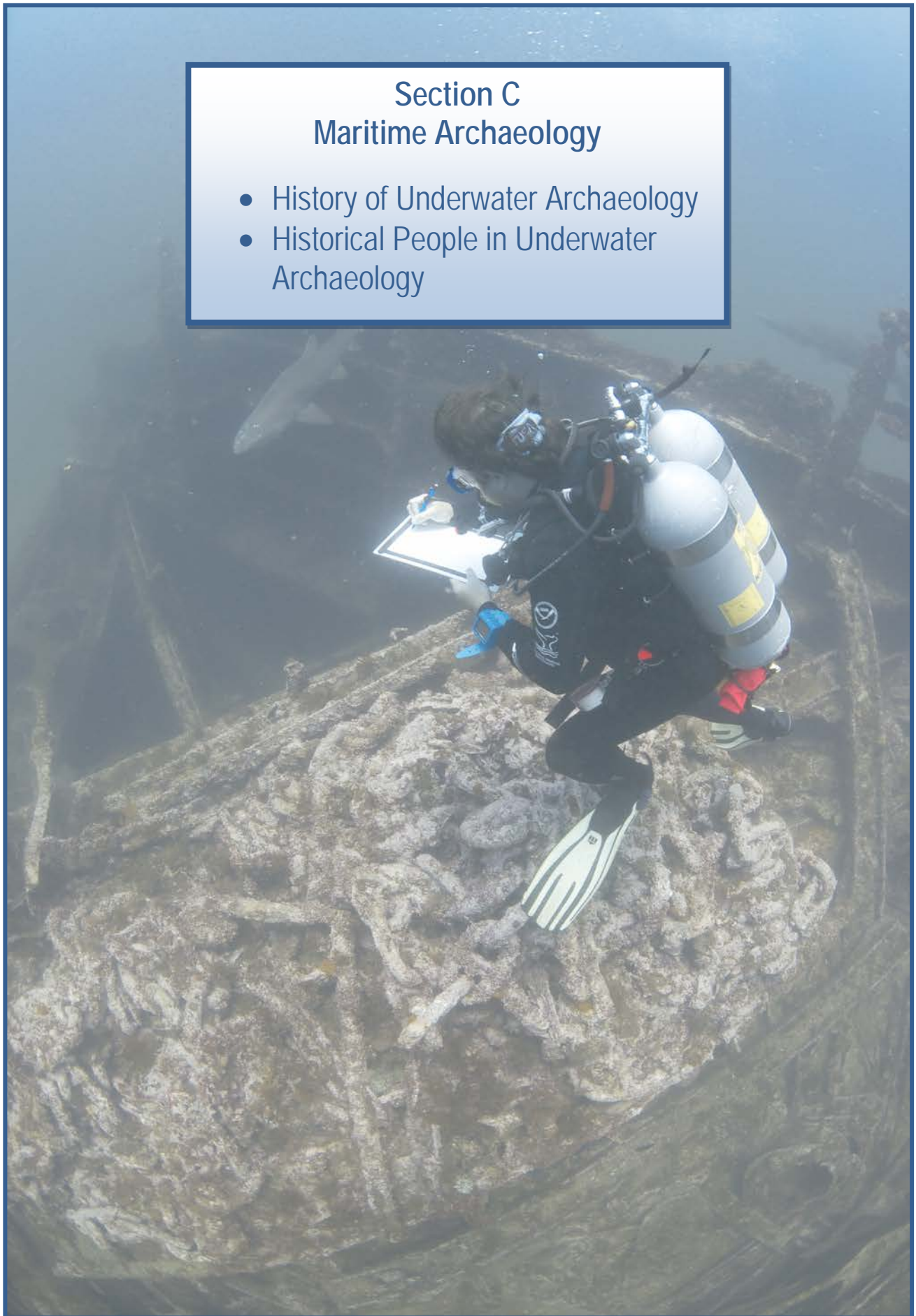

If an archaeologist walked into your bedroom, what would they learn about you?

Just as the items in your room show who you are, ancient artifacts tell about the people who made them or used them.

What do these artifacts tell you?

Section C
Maritime Archaeology

- History of Underwater Archaeology
- Historical People in Underwater Archaeology

Maritime Archaeology

Maritime archaeologist documents HMT *Bedfordshire*'s boiler. Photo: Tane Casserley, NOAA

Grade Level

- 6-12

Timeframe

- 1-2 hours

Materials

- Internet (printed resources if Internet is not available
- Worksheet pages

Activity Summary

This lesson highlights the development of maritime archaeology as a disciplined study

Learning Objectives

- To compare and contrast terrestrial and maritime archaeology.
- To create a timeline of the major events in maritime archaeology.
- To summarize and write succinctly.

Vocabulary

See Vocabulary Box

National Standards:

NCSS:HT.1 and 4; NCSS:II, VIII; NCTE:1, 7 and 8; CCSS.ELA.LIT.RI.1, NS.5-8.F

Background

Archaeology is the study of the ancient and recent past through material remains. As a subfield of anthropology, the study of all human culture, archaeology offers unique perspectives on human history and culture. Furthermore, archaeology helps us to understand when and where people lived, as well as why and how they lived. Where much of history relies on written records and documents to interpret the past, archaeology allows us to go back in time even before written language. Through the analysis of objects left behind, we are able to glimpse at what everyday life might have been like in the past.

Underwater, maritime or nautical archaeology are terms to describe archaeology conducted under water. Although each discipline is slightly different from the other, they all basically study human interaction with the sea, lakes, and rivers through the study of physical remains. Whether on land or in the water, the tools, techniques and products for each location are essentially the same—although, different environments may require different tools, such as SCUBA gear. Nonetheless, the goal to understand the past is always the same—to connect to real people and everyday life including evidence of both the mundane and the extraordinary.

Although most people think of shipwrecks when they think of maritime archaeology, it is so much more. Today, maritime archaeologists study complete systems, including the natural environment, referred to as the "'maritime cultural landscape" of an area. Specifically, this consists of a combination of archaeological resources related to maritime activity, whether they are on land or in the water. Looking at the region, landscapes can encompass shipwrecks and associated sites on shore, such as docks and wharves, harbor and fishing structures, warehouses and shipyards, lighthouses, military forts, sites of religious significance and more. It also includes the natural geography of an area taking into account the coasts, routes, roads, harbors, and even the direction of prevailing currents and winds. Incorporating all elements of a place provides a perfect framework to assess the varied and extensive collection of structures, sites, and material culture of a project area. Collectively, they tell a more complete story.

Maritime archaeology is important because shipwrecks offer a rare glimpse into the past, and contain information about the people and life onboard the ship. Shipwrecks are non-renewable resources, and once destroyed or disturbed, they are gone forever. Many factors can cause the disturbance or destruction of a shipwreck, such as storms, dredging, war, divers and more. Even an archaeologist recovering objects from a site using careful scientific methods of archaeology, is causing a controlled destruction. However, it is important to study these microcosms of history to better understand our past cultures. The information obtained from a site may outweigh the cost of minimal disturbance. Moreover a deeper understanding of a culture may help us learn more than we can from written history alone.

Activity Overview

In this activity students will participate in an engagement activity to discover how archaeology is performed underwater. As they explore the evolution of maritime archaeological, they will determine significant milestones in the development of the discipline and create a chart that details important event dates. After completion of the chart, students will review the chart with their group and come to a consensus on ten events that they think are the most important to include in a timeline. Each item should then be summarized, and using the summary and images/graphics, an interactive timeline is created on paper or in a timeline creation tool, such as Timetoast.

Objectives

To recognize that maritime archaeology is an evolving discipline and technology advancements aid in its development.

Teacher Preparations and Implementation

- Print the appropriate number of *Class Reading, Class Activity, K-W-L Chart,* and *Scoring Rubric* pages for each student. Determine groups.
- Print *Photo* page (USS *Monitor*'s turret) or copy/save images to view as a class on computer screen or TV monitor. Optional: Cut the images apart.
- There are many free timeline creation tools for teachers. Choose one of your own or find one at this site http://elearningindustry.com/top-10-free-timeline-creation-tools-for-teachers If Internet is not available, students will create a paper timeline.
- Review suggested resources and/or conduct a search for additional resources that best meets your students' needs.
- Create a LiveBinder with resources (websites, images, etc.) for student use. To become familiar with how to use Livebinders visit http://www.livebinders.com. If you do not want to use Livebinder, the websites are listed for the students on the worksheet. If Internet is not available, print resources for each student/group.
- Add an "image" tab to the Livebinder to include drawing, paintings, and photos.
- Introduce Livebinder to students. Instruct students on how to use Livebinder, such as how to copy, paste, and save images.
- Demonstrate how to use the interactive timeline tool to create an online timeline.
- Begin activity by engaging students using steps 1-8 of the *Class Activity Worksheet* and *Photo* page.

- After engagement, have students conduct research using the links provided or other links that you have identified. They must visit at least two sites. If Internet is not available, distribute print copies of information.
- Have students complete the activity and share their timeline with the class.
- Use *Scoring Rubric* to assess students' work or have students use the rubric to critique others' projects.

Resources
Websites

Office of National Marine Sanctuaries
Explore maritime archaeology and learn how NOAA works to protect our cultural resources.
http://sanctuaries.noaa.gov/maritime/arch.html

Florida Department of State
Great explanation of maritime archaeology and lesson plans for teachers.
http://dos.myflorida.com/historical/archaeology/underwater/

Australian Institute of Maritime Archaeology
Learn more about the international realm of maritime archaeology.
http://www.aima-underwater.org.au/what-is-maritime-archaeology/

Maritime Archaeology Trust
Maritime archaeology explained.
http://www.maritimearchaeologytrust.org/whatismaritimearchaeology
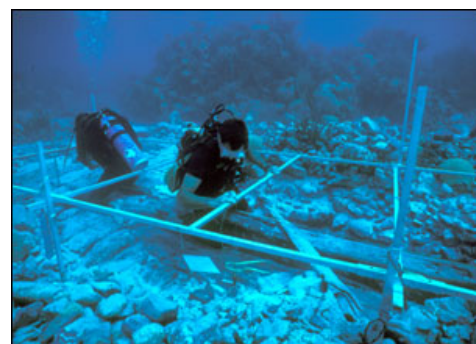
East Carolina University — Program in Maritime Studies
If maritime archaeology interests you, visit this site to learn what it takes to get a degree in maritime studies.
http://www.ecu.edu/cs-cas/maritime/

Texas A&M (TAMU) — Nautical Archaeology
Visit this site to learn more about the programs offered and the research conducted by TAMU's program.
http://nautarch.tamu.edu/

Maritime archaeologists setting up a gird system over a shipwreck site. Photo: Tane Casserley, NOAA

Vocabulary

ARCHAEOLOGICAL EXCAVATION – The exposure, processing and recording of archaeological remains

ARCHAEOLOGIST – A scientist who studies human history through the analysis of human remains and artifacts

MARITIME ARCHAEOLOGY – The study of material culture related to human interaction with the sea involving the study of ships and shipwrecks, maritime infrastructure, maritime exploitation, maritime identities and landscapes, seascapes, and other types of heritage; both tangible and intangible.

MARITIME CULTURAL LANDSCAPE – How maritime cultures viewed their world. A landscape can include a combination of archaeological resources related to maritime activity, whether they are on land or in the water; can encompass shipwrecks and associated sites on shore, such as docks and wharves, harbor and fishing structures, warehouse and shipyards, lighthouse, military forts, and more; also includes the natural geography of an area

NAUTICAL ARCHAEOLOGY – Primarily focused on the 'ship', including its technical and social aspects, whether the ship is on land, underwater or in a museum

TIMELINE – A graphic representation of the passage of time as a line; a listing of important events for successive years within a particular historical period

UNDERWATER ARCHAEOLOGY – Generally concerned with the archaeology of sites located underwater, regardless of their connection to the sea; it includes shipwreck sites, aircraft wrecks, sunken cities, submerged indigenous habitation sites, garbage sites, etc.

Books

Bass, George F.: *Beneath the Seven Seas.* Thames & Hudson, November 1, 2005. ISBN-13: 978-0500051368.

Bass, George F.: *Ships and Shipwrecks of the Americas: A History Based on Underwater Archaeology.* Thames & Hudson, December 31, 1996. ISBN-13: 978-0500278925.

Bowens, Amanda (Editor): *Underwater Archaeology: The NAS Guide to Principles and Practice 2nd Edition.* Wiley-Blackwell, August 11, 2008. ISBN-13: 978-1405175913.

Broadwater, John D.: *USS* Monitor*: A Historic Ship Completes Its Final Voyage.* Texas A&M University Press, February 14, 2012. ISBN-13: 978-1603444736.

Delgado, James P.: *Encyclopedia of Underwater and Maritime Archaeology.* Yale University Press, January 21, 1998. ISBN-13: 978-0300074277.

Time Management Tips

- Set predetermined time for research, summaries and for creating the timeline. Assign one student as the timekeeper for the group.
- To reduce the amount of time spent surfing the Internet, create a LiveBinder that is student friendly and has several tabs identifying information found in the sources, as well as graphics from other sites.

Assessment

A rubric is provided to aid in scoring the project based on the effectiveness of the project in answering the project questions, thoroughness of research, selection of items to include on the timeline, summaries, graphics, and completion of the timeline. Students can also critique each other's projects.

Diver shines light on USS *Monitor*'s bow during an archaeological expedition conducted in 2011. Photo: NOAA, *Monitor* Collection

Name: _____ Date: _____

The Evolution of Maritime Archaeology
Class Activity Worksheet

Engage
1. In your group, define archaeology based on what you currently know.
2. View Photo A. This is a photo of a recovered Civil War artifact.
3. Discuss the artifact with your group. What do you think it is? Come to a consensus, to the best of your ability, on the identity of the artifact, and speculate on its possible uses. Record answers in your journal.
4. As a group, view Photo B. This image shows the recovery of the Civil War artifact in Photo A. It was recovered from a shipwreck about 16 miles off the North Carolina coast. Reexamine the photos and make any changes to your answers in steps 3 and 4.
5. In your group, discuss how you think the artifact was recovered. What clues does the photo give? Record in your journal. Speculate why the artifact was recovered. Record in your science journal.
6. As a group, create a K-W-L chart and list everything you know about maritime archaeology.
7. The artifact was recovered by maritime archaeologists. Based on your currently knowledge and on your definition of archaeology, develop a definition for 'maritime archaeology'. Other than the obvious, how might it differ from archaeology done on land (terrestrial archaeology)? Tools? Methods?
8. It is impossible to know the origins of archaeology as a disciplined study, but excavations of ancient monuments have occurred for thousands of years. Maritime archaeology, however, is more recent with early beginnings from around the 15th century. Discuss why maritime archaeology might have taken longer to develop.

Explore
9. Individually, read *The Evolution of Maritime Archaeology, Class Reading* information provided. Add any new information you learned to your K-W-L chart
10. Conduct further research on the evolution of maritime archaeology by visiting two or more of the links below:
    a. Office of National Marine Sanctuaries: http://sanctuaries.noaa.gov/maritime/arch.html
    b. Florida Department of State: http://dos.myflorida.com/historical/archaeology/underwater/
    c. Australian Institute of Maritime Archaeology: http://www.aima-underwater.org.au/what-is-maritime-archaeology/
    d. Maritime Archaeology Trust: http://www.maritimearchaeologytrust.org/whatismaritimearchaeology
11. Complete a chart or concept map to organize your research. Add any new information to your K-W-L chart.

Explain
12. Once each group member has completed his/her chart, discuss as a group what you each have each learned.
13. As a group, come to a consensus to determine the criteria (major milestone, breakthrough in technology, etc.) for choosing the ten most important events for the timeline. Use the list of criteria to score each item.
14. As a group, come to a consensus to determine the ten most important events in the evolution of maritime archaeology.
15. For each event, write the date of the event, an appropriate title, and a 60-word summary. The summaries may not exceed 60 words, so each sentence must be well thought out and every word carefully chosen.

Elaborate
16. Use the ten events to create a timeline with the help of an interactive timeline tool. If Internet is not accessible, design a paper timeline. On the timeline, be sure to include the dates in chronological order, their titles and summaries.
17. Using the Internet, or images provided, to find images that characterize each event. Add images to the timeline.

Evaluate
18. When complete, present your group's timeline to the class. Be ready to defend why you chose the events on your timeline!

Extend
19. Explore famous inventors of the various technology used in maritime archaeology.
20. Refine your definition of maritime archaeology.

The Evolution of Maritime Archaeology
Class Reading

People have always been fascinated by the past. The desire to know more about our ancestors and what life was like in the "old days" is just part of our human nature. In search for answers, we have explored tombs, unearthed forgotten cities, and searched for numerous relics thought to be lost forever. This pursuit, overtime, became the academic discipline of archaeology.

Early Interest in Shipwrecks
Through the centuries, sunken ships carrying gold, silver or other vast treasures have been of special interest. Those that beached or sank in shallow water could easily be salvaged. Conversely, ships in deeper water were a bit more difficult. Some shipwrecks were accessed by free divers, who could dive to more than 75 feet just holding their breath. Ships that were deeper were sometimes reached through the use of a diving bell. It is even said that in 332 BCE, Alexander the Great went down in a diving bell, while Roman free divers apparently salvaged cargo from a wreck in about 65 feet of water south of France. Early historical examples, like these, were all for salvage purposes. Moreover, it would be centuries before shipwrecks were recognized for the wealth of historical information they held about past cultures.

In the 15th century, a new interest in shipwrecks occurred when Cardinal Colonna and architect Leon Battista Alberti started searching for two Egyptian ships from around 37 – 41 CE. Eventually discovered in a small lake called Nemi just southeast of Rome, the two reportedly lavish ships that once belonged to Emperor Caligula are now known as the Nemi ships. Divers located the remains of the ships, but attempts at salvage failed. The excitement soon ended, but resurged in 1535, when Guglielmo de Loreno made an attempt in what was considered the first true diving bell. In 1827, Annesio Fusconi made another major attempt with a diving bell. Although some artifacts were retrieved, the ships remained unsalvageable.

Technology Changes
In the late 1820s, Charles and John Deane produced the first successful diving helmet. The helmet was based on a design that they had originally created for firemen called a "smoke helmet." In 1828, they converted the smoke helmet into a diving helmet. In 1834, Charles Deane used the helmet and a "diving suit" in a successful attempt to salvage the wreck *Royal George* at Spithead, England. Two years later, John Deane dove on the *Mary Rose*, and salvaged a few items. In that same year, the Dean Brothers produced the world's first diving manual, "Method of Using Deane's Patent Diving Apparatus," which explained how it worked and safety precautions. This new technology opened the door to exploring shipwrecks.

For the next 70 years, many ships were salvaged and looted by divers, but mostly for commercial reasons. Anything of value was sold and the rusty iron cannons or smaller less valuable objects were given to museums. Because the salvage was not done as an archaeological investigation, so much of the information that we might have learned from the shipwrecks is forever lost.

Early Maritime Archaeology
The first systematic archaeological underwater investigation probably occurred with the Nemi Ships. After the numerous attempts and removal of artifacts, the Italian government wanted to put an end to the degradation of the ships. They tasked Italian Naval Engineer, Commendatore Vittorio Malfatti to survey the entire site. Between 1896 and 1905, Malfatti and his team accurately surveyed and charted the wrecks and filed an extensive report. However, he deemed them too fragile to be raised and suggested lowering the surface of the lake.

With World War I raging in Europe, it was not until 1928 that the pumps were first switched on to drain the lake. The top of the first ship was revealed in March 1929, but it was not until October 1931 that the lake dropped sufficiently enough to uncover one of the boats. Throughout the 1930's the ships were documented, recovered, moved to land and conservation began on many artifacts. In 1944, Italy was taken by the Allies and unfortunately, German soldiers leaving the area may have set the ships on fire and they were burned into ashes.

The first case of underwater archaeology done by divers (helmet divers) may have been from 1933 to 1939 when the Swedish warship *Elefanten* (1564) was partially excavated and salvaged by Carl Ekman, a Swedish naval officer. His work was methodical, thorough, and remarkably modern in that it was performed for reasons of research and heritage preservation rather than salvage for commercial gain. Ekman worked together with historians and saw the ship as so significant to Sweden's past that he was passionate about its preservation in a museum setting.

The Big Breakthrough
After World War II, the underwater world became accessible due to diving equipment developed by French engineer, Emile Gagnan and Jacques-Yves Cousteau. Cousteau was a French naval officer drawn to undersea exploration and diving because of his deep love for the ocean. In 1943, he and Gagnan partnered to develop the first self-contained underwater breathing apparatus (SCUBA), which allowed divers to swim freely underwater for extended periods of time. With SCUBA equipment many new ancient wrecks were found at a rapid pace. Although Cousteau was not an archaeologist, he made a huge contribution to maritime archaeology by exciting people's interest for underwater mysteries.

A test case for archaeology with SCUBA divers came in 1951 on a wreck in France known as *Grand Congloué*. The expedition was led by Cousteau and Fernand Benoît, Director of Antiquities of Provence. First, it was believed to be only one wreck, but a second layer of planking was discovered with more cargo under it. It has now been concluded that the site is actually two wrecks superimposed and sinking about a century apart (200-100 BCE). One author, William Stiebing, said, "The work at *Grand Congloue* demonstrated the value of SCUBA divers, carefully planned diving schedules, and the air hose in underwater archaeology. By default it also showed the importance of careful measurements, photographs, and plans of all objects *in situ*." (William H. Stiebing, Jr.: Uncovering the Past: A History of Archaeology. Oxford University Press, 1993. ISBN 0-19-508921-9)

Underwater Archaeology Takes Hold
After the *Grand Congloue*, *Uluburun* and *Cape Gelidonya* many underwater sites have been investigated by pioneer underwater archaeologists, such as Nino Lamboglia, George F. Bass, Peter Throckmorton, and many others. Through the ingenuity and dedicated work of individuals such as these, maritime archaeology methods have improved so that today, even the smallest objects can be documented and recorded.

However, even with many advancements in technologies and techniques, the same problems exist today as in the past: time and money. Underwater archaeology offers valuable insight into the people of the past and the information gained is important to better understand historic cultures. However, it is unprofitable and therefore, it cannot survive on a purely commercial basis.

Academic institutions, state and federal agencies, and private organizations investigate some of the more historically important shipwrecks, but there are thousands that remain untouched. Shipwreck sites can be ravaged by time, weather, storms, and even treasure hunters. It is a dilemma that has no easy answer, but perhaps with new laws for protection and areas set aside for protection, such as national marine sanctuaries, these maritime treasures will have a better chance to someday be investigated by a maritime archaeologist.

Photo A

Photo B

Name: _____   Date: _____

The Evolution of Maritime Archaeology
Cooperative Group Project

Contribution to Group	Beginning 1	Developing 2	Focused 3	Exemplary 4	Score
Is Punctual (5 pts*)	Does not hand in assignments	Hands in many assignments late	Hands in most assignments on time	Hands in all assignments on time	
Researches Information (5 pts)	Does not collect information	Contributes little information	Contributes information that mainly relates	Contributes a good deal of relevant information	
Shares Information (5 pts)	Shares no information with group	Shares some information with group	Shares important information with group	Communicates and shares all information with group	
Cooperation within Group					
Cooperates with Group Members (5 pts)	Never Cooperates	Seldom cooperates	Usually cooperates	Always cooperates	
Listens to Group Members (5 pts)	Always talks and never allows others to speak	Talks much of the time and rarely allows others to speak	Talks too much at times, but usually is a good listener	Balances listening and speaking well	
Makes Fair Decisions (5 pts)	Always wants things his/her way	Often sides with friends and does not consider all viewpoints	Usually considers other viewpoints	Total team player	
Responsibility to Group					
Fulfills Duties (5 pts)	Does not perform any duties	Performs very little in the way of duties	Performs nearly all duties	Performs all duties	
Shares Responsibility (5 pts)	Always relies on others to do the work	Rarely does work and needs constant reminding	Usually does the work and seldom needs reminding	Always does assigned work without being reminded	
Timeline					
All Content Questions Answered (15 pts)	Didn't answer any of the project questions	Answered some of the project questions, but missed the main points	Answered most of the project questions	Answered all project questions thoroughly and completely	
Relevant Milestones Included (15 pts)	Doesn't include any relevant milestones in timeline	Included some relevant content in timeline, but missed many major milestones	Included most of the significant milestones on the timeline	Included all significant milestones on the timeline	
Images Used Appropriately for Each Milestone (15 pts)	Didn't use any images	Used some images, but not all were appropriate	Used images for each milestone and most were appropriate	All milestones included images and they were all used appropriately	
Timeline is Presented Well (15 pts)	Used more than 60 words, had many spelling and or grammar errors	Used more than 60 words and/or had a few spelling and grammar errors	Used only 60 words and had few spelling and grammar errors	Used only 60 words and had no spelling and/or grammar errors	

Name: _____   Date: _____

K	W	L
What do you think you KNOW?	What do you WANT to learn?	What did you LEARN ?

Use additional paper if needed.

Who's Who in Maritime Archaeology

Captain Barbara "Bobbie" Scholley, U.S. Navy (Ret.), during the expedition to recover the USS *Monitor*'s gun turret. Photo: NOAA, *Monitor* Collection

Grade Level

6-12

Timeframe

4-8 hours

Materials

- Internet (printed resources if Internet is not available
- Digital story software, PowerPoint, or other
- Worksheet pages

Activity Summary

Students conduct research to produce a digital story or multimedia presentation highlighting the people of maritime archaeology and shipwreck exploration.

Learning Objectives

- To research people who are significant in maritime archaeology and shipwreck exploration.

Vocabulary

See Vocabulary Box

National Standards:

NCSS:HT.1 and 4; NCSS:I, II, IV and VIII; NCTE:1, 7 and 8; CCSS.ELA.LIT.RI.1, CSS.ELA.LIT.W..2, 3, 4, 6, 8 and 9; NS:F

Background

With over three million shipwrecks resting on the world's seabed, much of human history lies hidden beneath the water. Until the 1960s, most shipwrecks were inaccessible to archaeologists. SCUBA diving was new and used only for commercial or recreational activities. Archaeologists had to depend on professional divers for information about a shipwreck. Furthermore, because professional divers were not trained in archaeology that information could never be counted as totally reliable. Then along came George F. Bass.

Bass started out as an English major at John Hopkins University, but while spending his sophomore year in England at the University of Exeter, he was suspended for pulling a prank. With nowhere to go, he went to Sicily with some friends for spring break, and there among the Roman theater with Mount Etna in the background, he thought about how great it would be to earn a living as a terrestrial archaeologist studying ancient cultures.

Bass soon began to realize that much could be learned from the many shipwrecks laying on the sea floor; and shipwrecks had advantages over terrestrial sites—they were not easily accessed by humans. In the 1960s, Bass began to apply rigorous excavation techniques to underwater wrecks. Along the way, he transformed underwater archaeology from an amateur's pastime to a modern scientific discipline.

Other early pioneers, such as Peter Throckmorton, who is often described as the "Father of Underwater Archaeology," helped to develop maritime archaeology into the discipline it is today. These early leaders led the way for the many secrets held beneath the waves to finally be revealed offering valuable insight into past cultures.

Activity Overview

In this activity, students will explore some of the great maritime archaeologists and shipwreck explorers of the 20th and 21st centuries. Using their research, students will create a bio-historical and acrostic poem and generate a storyboard. From their storyboard, students will create, produce, publish and present the biographical information they have learned using digital stories, PowerPoint, or other software.

Objectives

Students will use primary sources and biographical information in a research-based, multimedia project. Students will produce, publish and present digital stories or multimedia projects on various historically significant maritime archaeologists and shipwreck explorers.

Teacher Preparations and Implementation

1. *Review background information, list of maritime archaeologists and explorers, all resources and student materials. NOTE: At least one resource is given for each person listed, but there are other good resources not listed for students to use in their research.*
2. Determine which maritime archaeologists or shipwreck explorers students will research and the appropriate resources.
3. Determine software program students will use to create a digital story or multimedia presentation (PowerPoint, Animoto, Keynote, etc.). See *Website Resource* section for digital storytelling software ideas.
4. If a library is available, ask a librarian to pull additional encyclopedias, articles, and other resources for students to use.
5. Print copies of *Class Activity, Storyboard,* and *Scoring Guide* for each student/group.
6. Create a Livebinder with resources adding additional resources as desired. To learn more about Livebinders visit http://www.livebinders.com.
7. If Internet is not available, print resources for students.
8. Introduce activity to students and review vocabulary as needed. Go over *Scoring Guide*.
9. Review how to conduct research, write a journal entry, what constitutes a reliable source, etc. The research portion of the activity should take about 3-4 class periods or about four hours.
10. If students are not familiar with writing acrostic poems and/or bio-historical poems, review and demonstrate by example.
11. If students are not familiar with storyboarding, review the goals and objectives of a storyboard and go over the steps listed in the *Class Activity*. This portion of the activity may take up to two hours.
12. If students are not familiar with software for creating a digital story or multimedia presentation, review and demonstrate. Creating the presentation and rehearsing may take 2-3 hours.

Suggested Maritime Archaeologists

- Dr. George Bass
- John Broadwater
- James P. Delgado
- Susan Langley
- Keith Muckelroy
- Della Scott-Ireton
- Peter Throckmorton

Suggested Shipwreck Explorers
- Bob Ballard
- James Cameron
- Barbara L. (Bobby) Scholley

Resources
Websites

Web Tools for Teachers: Digital Storytelling
Over 25 different tools for teachers to use with students to create digital stories; many of which are free.
http://evscicats.com/blog/web-tools-for-teachers-digital-storytelling/

George Bass — Nautical Archaeology at Texas A&M
- http://nautarch.tamu.edu/academic/FACULTY/bass.shtml

Discover — **Interview with George Bass**
- http://discovermagazine.com/2012/jun/07-interview-deep-underwater-george-bass-pieces-past

John Broadwater
- http://www.chesapeakebaywriters.org/personal_web_pages/Broadwater_John.htm.

James P. Delgado
- http://www.jamesdelgado.com/
- http://sanctuaries.noaa.gov/maritime/contact_us.html

Susan Langley
- http://advanced.jhu.edu/about-us/faculty/susan-langley/
- http://monitor.noaa.gov/advisory/membership_bios.html

Keith Muckelroy
- https://en.wikipedia.org/wiki/Keith_Muckelroy

Vocabulary

ACROSTIC POEM – A type of poetry where the first, last, or other letters in a line spell out a particular word or phrase

BIO-HISTORICAL POEM – A type of poem that follows a 10- or 11-line format and focuses more deeply on factors that shape identities, such as experiences, relationships and interests

DIGITAL STORYTELLING – A short form of digital media production that allows people to share information in a story format

JOURNAL ENTRY – Used as a tool for student reflection

MARITIME ARCHAEOLOGY – The study of material culture related to human interaction with the sea involving the study of ships and shipwrecks, maritime infrastructure, maritime exploitation, maritime identities and landscapes, seascapes, and other types of heritage; both tangible and intangible.

MULTIMEDIA – Using more than one medium of expression or communication (generally the combination of text, sound and/or motion video); the use of a variety of artistic or communicative media

Della Scott-Ireton

- https://www.archaeological.org/lecturer/dellascottireton
- http://www.acuaonline.org/deep-thoughts/a-matter-of-ethics-by-della-scott-ireton/

Peter Throckmorton

- http://www.faneromeni.gr/en/pages/view/peterthrockmorton/mid:127
- http://www.nytimes.com/1990/06/11/obituaries/peter-throckmorton-archeologist-of-ancient-shipwrecks-dies-at-61.html

Bob Ballard

- http://www.nationalgeographic.com/explorers/bios/robert-ballard/

James Cameron

- http://www.imdb.com/name/nm0000116/bio?ref_=nm_ov_bio_sm
- http://www.deepseachallenge.com/the-team/james-cameron/

Barbara (Bobbie) Scholley

- http://sanctuaries.noaa.gov/news/features/barbara_scholley.html
- http://oceanexplorer.noaa.gov/explorations/monitor01/background/bios/bios.html.
- http://nautiluslive.org/people/robert-ballard
- http://www.wdhof.org/memberroster/memberroster4.shtml

Extension

1. Have students research maritime archaeology and create their own list of the people who have helped to develop maritime archaeology as a disciplined study.
2. Have student write to one of the living maritime archaeologists to find out more about their career and life.

Clockwise Top to Bottom: Bobbie Scholley (Photo: NOAA), Susan Langley (Photo: NOAA), Bob Ballard (Photo: Bob Ballard), James (Jim) Delgado (Photo: NOAA), and John Broadwater (Photo: NOAA)
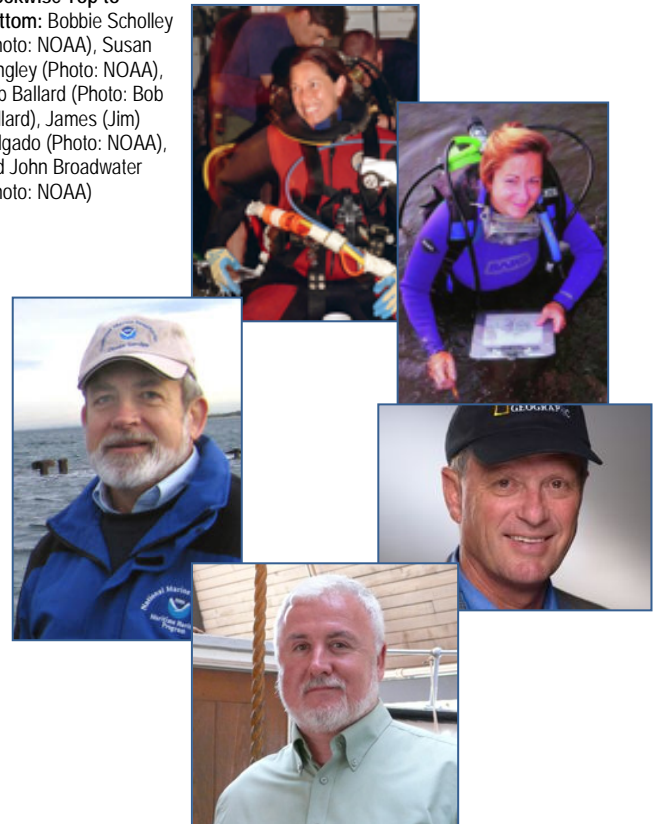
Name: _____   Date: _____

Who's Who in Maritime Archaeology
Class Activity

Background

With over three million shipwrecks resting on the world's seabed, much of human history lies hidden beneath the water. Until the 1960s, most shipwrecks were inaccessible to archaeologists. SCUBA diving was new and used only for commercial or recreational activities. Archaeologists had to depend on professional divers for any information about a shipwreck. Furthermore, because professional divers were not trained in archaeology that information could never be counted as totally reliable. Then along came George F. Bass.

Bass started out as an English major at John Hopkins University, but while spending his sophomore year in England at the University of Exeter, he was suspended for pulling a prank. With nowhere to go, he went to Sicily with some friends for spring break, and there among the Roman theater with Mount Etna in the background, he thought about how great it would be to earn a living as a terrestrial archaeologist studying ancient cultures.

Bass soon began to realize that much could be learned from the many shipwrecks laying on the sea floor; and shipwrecks had advantages over terrestrial sites—they were not easily accessed by humans. In the 1960s, Bass began to apply rigorous excavation techniques to underwater wrecks. Along the way, he transformed underwater archaeology from an amateur's pastime to a modern scientific discipline.

Other early pioneers, such as Peter Throckmorton, who is often described as the "Father of Underwater Archaeology," helped to develop maritime archaeology into the discipline it is today. These early leaders led the way for the many secrets held beneath the waves to finally be revealed offering valuable insight into past cultures.

Activity Overview

In this activity you will explore various influential maritime archaeologists and shipwreck explorers. After researching the person you chose, you will 1) write five journal entries outlining his/her career; 2) create a bio-historical and acrostic poem; and 3) use PowerPoint or another program to create a digital story or multimedia presentation that gives a complete overview of your person's life. The presentation should include the significant contributions the person has made to maritime archaeology or in the discovery of shipwrecks. Before you begin, review the *Scoring Guide*.

You will research _____.

Maritime Archaeologist or Shipwreck Explorer

Left: George F. Bass
Center: George Bass (left) and Peter Throckmorton (right)
Right: Peter Throckmorton
All Photos: Texas A&M University, Nautical Archaeology Program

Research

Now it is time to start the research. Using Internet, books, journal articles and other reliable information sources, conduct research to learn about the person you are exploring. Create at least five journal entries that answer the following questions. Additional entries may be created for other interesting facts or events in the person's life.

- How did this person begin his/her career in maritime archaeology / shipwreck exploration? Why did he/she choose this career? What degrees did he/she earn?
- What are the major milestones in this person's career as a maritime archaeologist /shipwreck explorer? What shipwrecks have he/she documented or discovered? Did he/she invent any new techniques or technology that advanced maritime archaeology?
- Has this person won any awards for their contributions to maritime archaeology or shipwreck exploration? Other awards?
- What was the most significant contribution that this person made to the advancement of maritime archaeology or shipwreck exploration?
- What impressed you the most about this person? Would he/she be someone you would like to meet? Why or why not?

Journal Entry Guidance

1. Read the prompt carefully.
2. Consider requirements — Number of words, due date, format, etc. (Teacher determines these parameters.)
3. Reflect — Reflect on specific elements, examples, or experiences you would like to include in your entry. Use other prewriting techniques to get ideas flowing.
4. Outline — Write a thesis to give the entry an area of focus. Next, outline the points you will cover. Include a brief introduction and conclusion (one sentence each).
5. Draft — Use your outline as a starting point as you write. Give credit to outside sources.

Bio-Historical Poem

After you learn about a maritime archaeologist/shipwreck explorer, write a bio-historical poem that gives a synopsis of his/her life. Follow these guidelines:

Line 1: Write first name
Line 2: Three or four adjectives that describes the person
Line 3: Important relationship (e.g.: friend, daughter of, mother of, etc.)
Line 4: Two or three things, people or ideas that the person loved
Line 5: Three feelings the person experienced
Line 6: Three fears the person experienced
Line 7: Accomplishments
Line 8: Two or three things the person wanted to see happen or wanted to experience
Line 9: His or her residence
Line 10: Write last name

Acrostic Poem

Write an acrostic poem that follows these guidelines:

1. Write the first, last or full name of the maritime archaeologist / shipwreck explorer vertically down your paper.
2. Brainstorm words or phrases that describe the person.
3. Place the words or phrases on the lines that begin with the same letters.
4. Fill in any remaining lines to create a poem

Example:

Lanky and tall

Intelligent

Noteworthy speeches

Civil War President

Oral communication skills

Lawyer by profession

Nicknamed Honest Abe

Digital Story or Multimedia Presentation—Storyboarding

To begin a digital story or multimedia presentation, first create a storyboard that outlines what you want to convey about the person. For instance, include facts such as his/her life, career, major milestones, family, death, etc. Here are some simple steps to help guide you with your storyboard:

1. Establish a timeline. Decide what order the events happen chronologically. Will you present the information linear as it happened in his/her life? Or will you flash forward, shifting perspectives? What are key events?
2. Identify key scenes in the story. Demonstrate important key parts that will draw the viewer in (what is most interesting?). Think your story through and brainstorm a list of the key moments that you want to illustrate.
3. Decide how detailed to get. Remember that the point of the storyboard is to provide visual clarity and to keep the story focused.
4. Write a description of what each slide in your presentation will show. Now think about how to depict the action in each illustration.
5. Add any other important information and finalize the storyboard.

Use the provided *Storyboard Template* to storyboard your multimedia presentation.

Digital Story or Multimedia Presentation—Animoto, PowerPoint or Other Media Tool

Now it is time to create your presentation.

1. Using your storyboard, create a slide for each cell you developed. Be sure to include an opening and closing slide.
2. If adding links to click on during the presentation, be sure each link works.
3. Add music if desired.
4. Practice your presentation. If your presentation is timed, and you are using PowerPoint, rehearse using the "Rehearse Timings" button under the "Slide Show" tab.
5. If printing is an option, print a copy of your presentation to review and have as a guide during presentation.
6. Present to your teacher and class.

Name: _____   Maritime Archaeologist/Explorer: _____

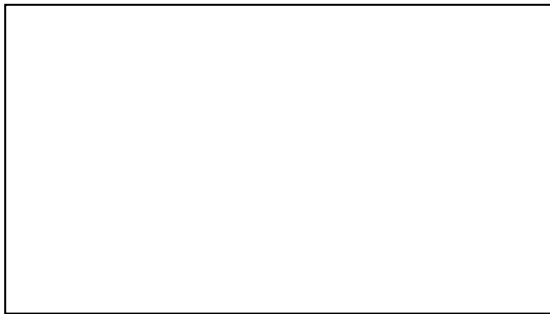## Storyboard

Slide #1: Title Slide
Buttons/Links_____
_____
_____
Notes (music, text, images): _____
_____
_____
_____
_____

Slide #2: Bio-Historical Poem
Buttons/Links_____
_____
_____
Notes (music, text, images): _____
_____
_____
_____
_____

Slide #3: Journal Entry 1
Buttons/Links_____
_____
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Notes (music, text, images): _____
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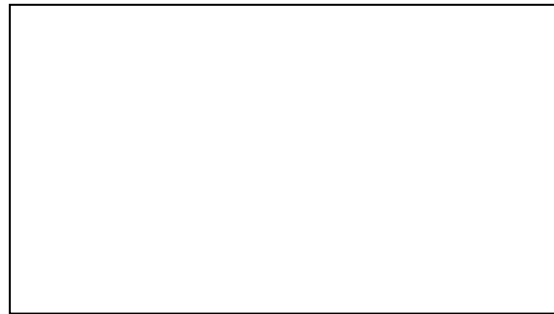
Slide #4: Journal Entry 1 Continued
Buttons/Links_____
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Notes (music, text, images): _____
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_____

Name: _____   Maritime Archaeologist/Explorer: _____

Storyboard Continued

Slide #5: Journal Entry 2
Buttons/Links_____
_____
_____
Notes (music, text, images): _____
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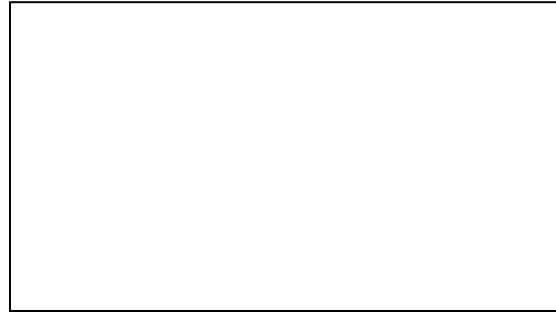
Slide #6: Journal Entry 2 Continued
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Notes (music, text, images): _____
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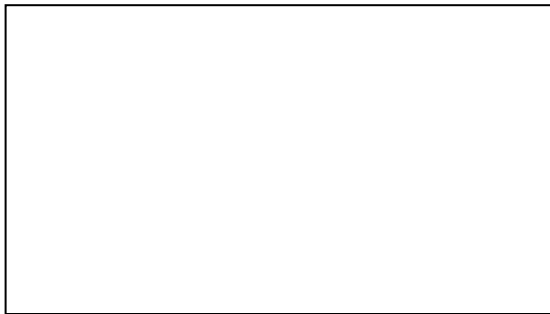
Slide #7: Journal Entry 3
Buttons/Links_____
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Notes (music, text, images): _____
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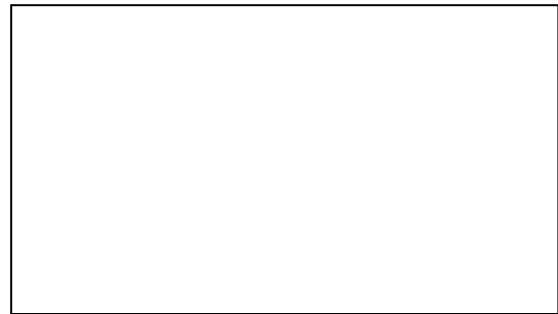
Slide #8: Journal Entry 3 Continued
Buttons/Links_____
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Notes (music, text, images): _____
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_____
_____
_____

Name: _____   Maritime Archaeologist/Explorer: _____

Storyboard Continued

Slide #9: Journal Entry 4
Buttons/Links_____
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_____
Notes (music, text, images): _____
_____
_____
_____
_____

Slide #10: Journal Entry 4 Continued
Buttons/Links_____
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Notes (music, text, images): _____
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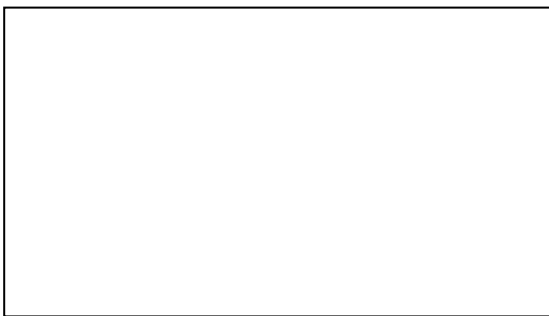
Slide #11: Journal Entry 5
Buttons/Links_____
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Notes (music, text, images): _____
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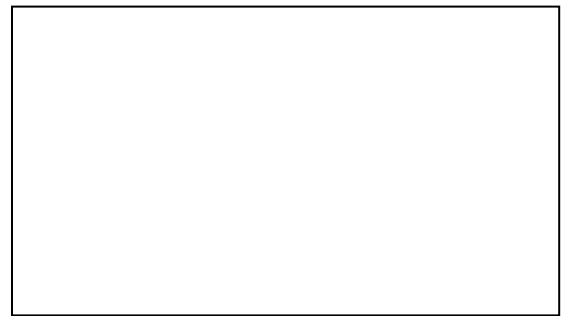
Slide #12: Journal Entry 5 Continued
Buttons/Links_____
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Notes (music, text, images): _____
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Name: _____   Maritime Archaeologist/Explorer: _____

Storyboard Continued
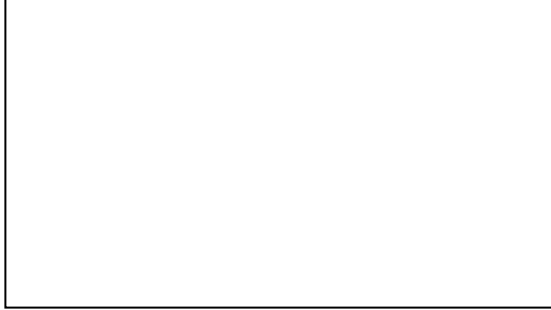
Slide #13: Additional Slide
Buttons/Links_____
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Notes (music, text, images): _____
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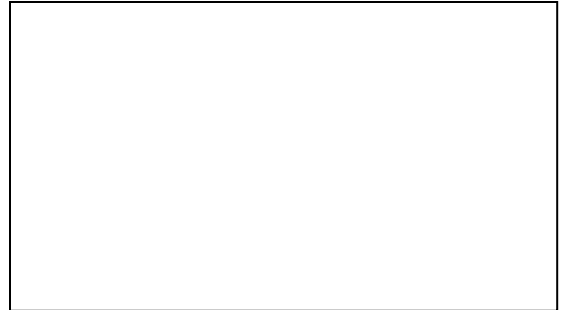
Slide #14: Additional Slide
Buttons/Links_____
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Notes (music, text, images): _____
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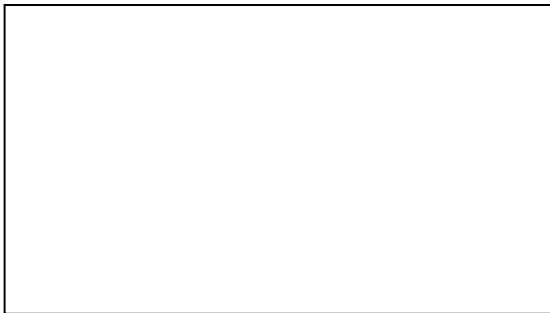
Slide #15: Work Sited
Buttons/Links_____
_____

Notes (music, text, images): _____
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_____
_____
_____

Slide #16: Credits (Optional)
Buttons/Links_____
_____

Notes (music, text, images): _____
_____
_____
_____
_____

Student Name: _____   Date: _____

Maritime Archaeologist/Explorer: _____

Scoring Guide
Multimedia Project

	Possible Points	Points Earned
Poems (20)		
Bio-Historical Poem has Accurate Details	10	
Acrostic Poem has Accurate Details	10	
Journal Entries (60)		
Historically Accurate Details	40	
Historical Point of View	10	
Dates/Locations/Events	10	
Storyboard (30)		
Major Events Included	20	
Sufficient Information for Creating Slides	10	
Slide Format Layout (55)		
Title Slide: Maritime Archaeologist, Student Name	5	
Poetry Slide: Acrostic Poem or Bio-Historical Poem	5	
Journal Slides: 5 Entries	25	
Works Cited Slide: 4 Sources	5	
Visual Appearance	10	
Text and Image Layout (Audio if Applicable)	5	
Presentation (15)		
Presentation Style	15	
Work Cited (20)		
Accurate References	10	
Correct Format (MLA, APA, etc.)	10	
TOTAL	200	

Comments:

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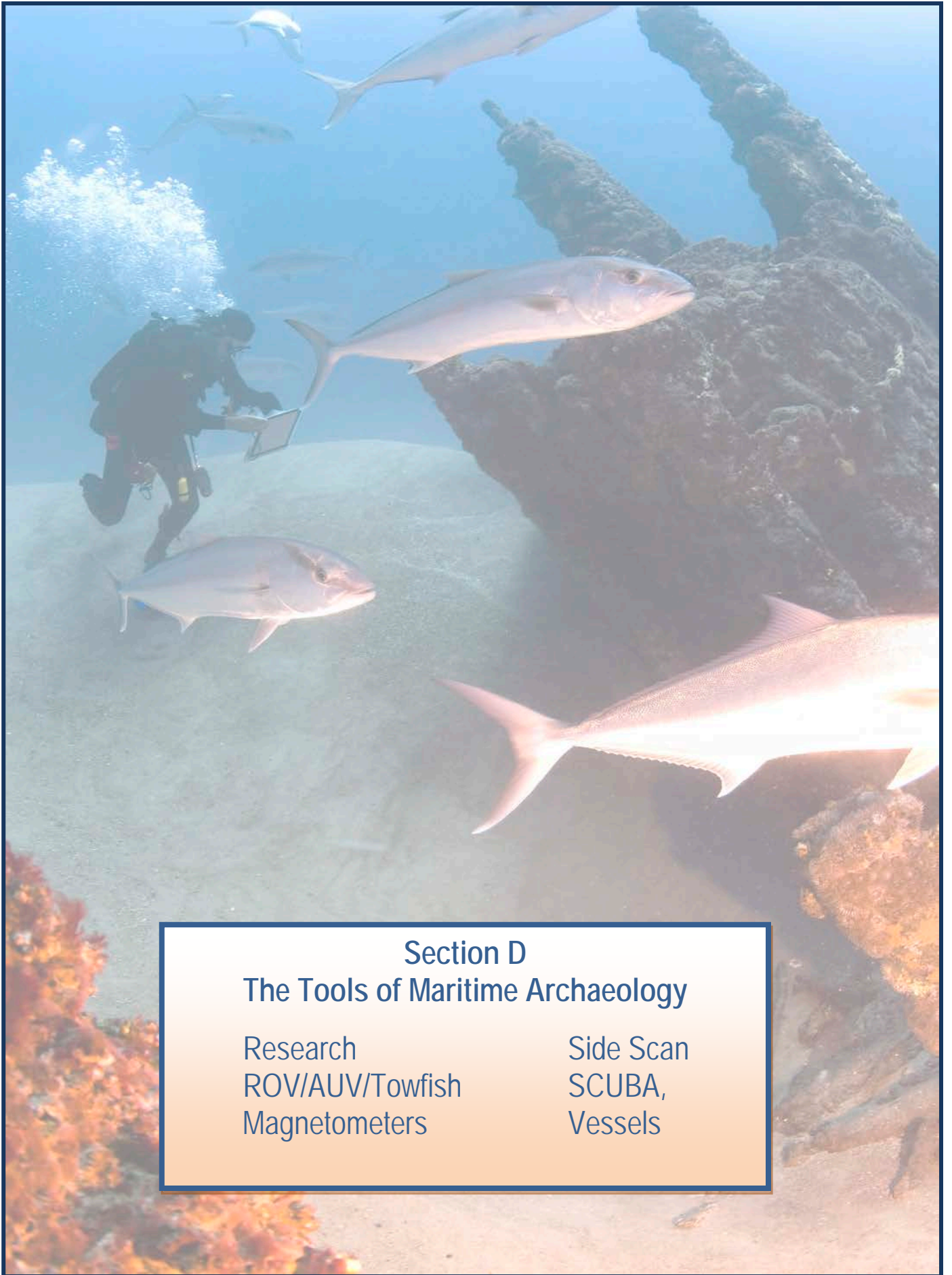
Section D
The Tools of Maritime Archaeology

Research   Side Scan
ROV/AUV/Towfish   SCUBA,
Magnetometers   Vessels

Searching the Deep

Divers survey a shipwreck. Photo: NOAA

Grade Level

- 6-12

Timeframe

- ~1 hour per activity

Materials

- See each activity for a list of materials

Unit Summary

This unit is divided into six individual activities that introduce students to the basic process of searching for a lost shipwreck and the tools used. Students learn about research, side scan sonar, ROVs, towfish, AUVs, magnetometers, science of SCUBA, and NOAA's ships and submersibles.

Learning Objectives

See unit overview for a list of objectives.

Key Words

See vocabulary for each unit section.

National Standards:

See individual activities for specific standards

Protecting Our Nation's Maritime Heritage Resources

For over forty years, NOAA and Monitor National Marine Sanctuary (MNMS) have worked to conserve and protect the Civil War ironclad, USS *Monitor*. The experience and knowledge gained through the decades have assisted NOAA and sanctuary staff to explore, survey, document, and search for other shipwrecks located within the National Marine Sanctuary System and beyond. Over the years, these efforts have supported ongoing historical and archaeological research to preserve some of our nation's most treasured underwater cultural resources.

Since 2008, MNMS has led archaeological, biological, and historical surveys of World War II (WWII) heritage resources off the North Carolina coast associated with the Battle of the Atlantic. Although WWII's Battle of the Atlantic is not well known by the general public, it has been extensively studied by historians. Beginning in 1939 and continuing until Germany surrendered in 1945, it was the war's longest military campaign. Once the U.S. entered the war in 1941, U-boats began to ply the waters off its coast. In 1942, their presence was intently felt off the East Coast, and off Cape Hatteras, N.C., in particular, in an area that became known as "Torpedo Alley." Casualties in Torpedo Alley included four U-boats, a British naval trawler and roughly 52 merchant ships on the continental shelf (or 90 if you go out hundreds of miles).

In 2008, when MNMS led the first Battle of the Atlantic expedition, the whereabouts of one U-boat, U-*576*, was unknown. After years of research and methodical searching, it was located in the summer of 2014. During this multi-year endeavor, the sanctuary partnered with various federal and state agencies, universities and others to find the elusive U-*576*.

A variety of tools and techniques are used to locate and document shipwreck off the North Carolina coast. With depths ranging from 65 to 1500 feet, sophisticated equipment is often needed to conduct archaeological research. NOAA researchers use SCUBA, side scan and multi-beam sonar, remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), magnetometers, NOAA ships, and submersibles to search for, document, and survey shipwrecks. With these cutting-edge tools and the abundant expertise of our NOAA research team, NOAA has led the way to protect our ocean's cultural resources.

Unit Overview and Objectives

In this six part unit, students will understand the basic process of searching for a lost shipwreck and the tools used. They will

- Discover how maritime archaeologists conduct research in order to narrow the search area;
- Simulate using side scan and multi-beam sonar to cover large areas of the ocean floor;
- Learn the difference between an ROV, towfish, and AUV and how they are used in searching for shipwrecks;

- understand how SCUBA diving developed over time:
- Learn how a magnetometer works: and
- Identify the wide array of NOAA ships and submersibles used in underwater exploration.

In this unit, each activity can stand alone to teach the concept presented in the activity. Conversely, for a more comprehensive experience, the unit can be used to study the complexities of finding a lost shipwreck.

Activity A
In the first activity, students will plot the coordinates of 19 German U-boats that sank off U.S. shores. Then, they will learn how to thoroughly conduct research, in order to narrow a search area, by looking at primary source documents, such as naval and ships' records, photos, firsthand accounts and more.

Activity B
In the second activity, students will learn how side scan sonar works and they will simulate mapping the ocean floor in search of the lost shipwreck.

Activity C
The third activity introduces students to remotely operated vehicles (ROVs), towfish and autonomous underwater vehicles (AUVs). They will also study real images from a recently discovered shipwreck. Students will discover the complexities of SCUBA diving and summarize the limitations to using SCUBA diving in search of shipwrecks. They will also explain why ROVs, towfish and AUVs are important tools in maritime archaeology. Included is an optional activity to design, engineer and build an ROV (See Extensions).

Activity D
Next, the students can learn about the people who developed SCUBA diving and how it has changed over the years and aides in maritime archaeology.

Activity E
In the fifth activity, students will develop an understanding of how magnetometers work and are used to search for shipwrecks.

Activity F
In the final activity of this unit, students can learn that NOAA's marine operations have a wide array of ships that play a critical role in the collection of oceanographic, atmospheric, hydrographic, and fisheries data. They will identify the types of ships, their uses and summarize how they aid in maritime archaeology.

Teacher Preparations and Implementation

- Review the six activities and determine how best to use them with your students. Using all six activities will simulate real-world application to show how maritime archaeologists search for shipwrecks. Specifically, each activity simulates the tools used during the actual search for the U-576, which was discovered in summer 2014.
- Review associated links for selected activity(ies).
- Gather materials needed for the activity(ies).

Extensions

A great way to engage students in science, technology, engineering and mathematics (STEM) and history is to build an ROV. Visit the **Teacher** section of Monitor National Marine Sanctuary's website at http://monitor.noaa.gov/education/teachers.html to learn how to get into engineering and history by designing, building, and testing ROVs. An ROV team competition is the culminating event.

Resources

Books and Websites
See individual activities for a list of related resources.

Vocabulary
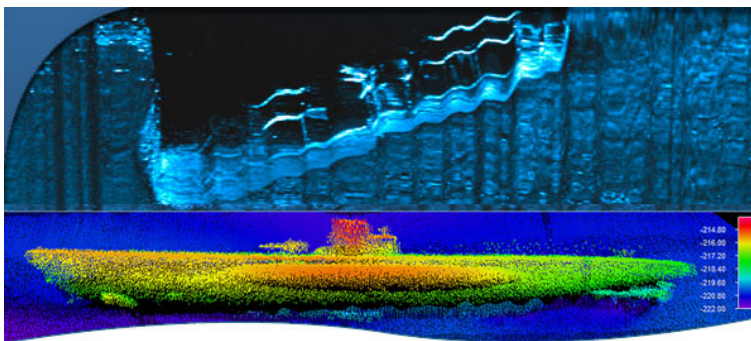
Divers surveying a shipwreck. Photo: NOAA
Sonar images of the *Bluefieds* (top) and the U-57. Both Images: NOAA

Searching the Deep — Plotting the Course

U-*576* Captain Hans-Dieter
Heinicke (left). Photo: Ed Caram

Grade Level

- 6-12

Timeframe

- 1-2 hours

Materials per Group

- Activity Sheet: Plotting the Course
- Colored pencils
- Copy of *Convoy KS*-576
- Two copies of map

Activity Summary

This activity simulates the first stage of searching for a lost shipwreck—research. Students conduct research to narrow the search area of an underwater battlefield.

Learning Objectives

Discover how maritime archaeologists conduct research when searching for a shipwreck in order to narrow the search area.

Key Words

See Vocabulary Box

National Standards:

NG:1, 13 and 17; NCSS:I, II; NCSS:HT.2, 3 and 4; NCSS:WH.ERA8.2B and 4B; NCTE:1, 3, 7 and 8; CCSS:ELA:LIT.RI.8.1; NCTM:6-8:G; NCTM:9-12:G.A, B; OL.6 and 7

Activity A

Battle of the Atlantic

Although World War II's Battle of the Atlantic is not well known by the general public, it has been extensively studied by historians. Beginning in 1939 and continuing until Germany surrendered in 1945, it was the war's longest military campaign and pivotal in winning the war.

Once the U.S. entered WWII in 1941, U-boats began to ply the waters off its coast. In 1942, their presence was intensely felt off the East Coast, and in particularly just off Cape Hatteras, N.C., in area that became known as "Torpedo Alley." Ship casualties in Torpedo Alley included four U-boats, a British naval trawler, and roughly 50 merchant ships. Four of these casualties were a result of a battle between Convoy KS-*520* and U-*576*. For decades, wreck divers and maritime archaeologists searched for this lost battlefield. With its discovery, a wealth of new information will be obtained giving historians greater insight into the events that happened that day in July 1942.

Since 2008, the Monitor National Marine Sanctuary (MNMS) has led archaeological, biological, and historical surveys of World War II heritage resources off the North Carolina coast associated with the Battle of the Atlantic. For six years, the researchers attempted to locate U-*576* and the *Bluefields*, an Allied ship that sank the same day. During this multi-year endeavor, the sanctuary partnered with various federal and state agencies, universities, and others in search of the elusive U-*576*. After years of research and methodical searching, the U-*576* and *Bluefields* were located in the summer of 2014.

When searching for lost shipwrecks, extensive research is done using primary, secondary and tertiary sources in order to narrow the search field. Once an area is identified, NOAA maritime archaeologists use a variety of tools and techniques to search for the shipwreck, such as SCUBA, side scan sonar, multi-beam sonar, remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), towfish, magnetometers, and NOAA ships and submersibles. With these cutting-edge tools and the abundant expertise of our NOAA research team, NOAA has helped to lead the way to protect our ocean's cultural resources.

Activity Overview

In this activity students learn the important role that research plays in the discovery of shipwrecks. They look at primary and secondary source documents so as to understand the importance of WWII's Battle of the Atlantic. Students conduct research on U-boat activity in U.S. waters and use coordinates to create a map of sunken U-boats off the East Coast. They also learn about the battle of Convoy KS-*520* as they begin to simulate the search for U-*576*.

Objective

- To use primary, secondary, and tertiary resources to narrow the search area for a lost shipwreck.
- To create a map of sunken U-boats off the East Coast.

Teacher Preparations and Implementation

- Review all resources and determine which ones to use, or use your own resources.
- If Internet is available, you can create a Livebinder of all resource you want the students to use. This will concentrate and limit their searches. For more information visit http://www.livebinders.com/
- If Internet is not available, print copies of resources for each student/group.
- Print copies of *Convoy KS-520*, *Map A and Map B* (2), and activity page, *Plotting the Course*.
  NOTE: For best results, enlarge Map B so as to include only the area around Cape Hatteras, N.C.
- With students, review primary, secondary, and tertiary sources. Review latitude and longitude lines and plotting coordinates. Discuss importance of determining relevant details from articles.
- Have students read the background section and the activity summary of *Plotting the Course.*
- Have the students conduct research to answer the provided questions.
- Use the chart and *Map A* and have the students plot the coordinates for the sunken German U-boats and then analyze their maps.
- The article *Historical Accounts of Battle of Convoy KS-520* is a technical paper. Read and select any terms that the students might be unfamiliar with, such as depth charge and general quarters, and review them with students.
- Have students read *Battle of Convoy KS-520* and answer questions.
- Next, they will analyze their research and use *Map B* to outline a search area for the U-*576*.
- Have students/groups share their maps and explain their rationale for their search area.

Resources

Websites

NOAA's Battle of the Atlantic Expeditions
From 2008 to 2015, NOAA and partners documented and surveyed WWII cultural resources located off North Carolina's coast. This site details the expeditions from 2008 to 2011.
http://sanctuaries.noaa.gov/missions/battleoftheatlantic/archives.html

NOAA's Monitor National Marine Sanctuary — U-*576*
Visit this page to read a synopsis of the battle between Convoy KS-*520* and U-*576*. Included are images and fact sheets for download.
http://monitor.noaa.gov/science/u-576.html

NOAA's Outer Banks Maritime Heritage Trail
A series of short videos that depict North Carolina's rich, maritime cultural landscape. The site includes videos for WWII's Battle of the Atlantic, oral histories from people who experienced the war first hand, and corresponding educational activities.
http://monitor.noaa.gov/obxtrail/welcome.html

History Channel
Summary of the Battle of the Atlantic.
http://www.history.co.uk/study-topics/history-of-ww2/battle-of-the-atlantic

Uboat.net
Specifications and other information pertaining to U-*576*.
http://uboat.net/boats/u576.htm

Uboat.net
Map of U-boats lost off the U.S. coast.
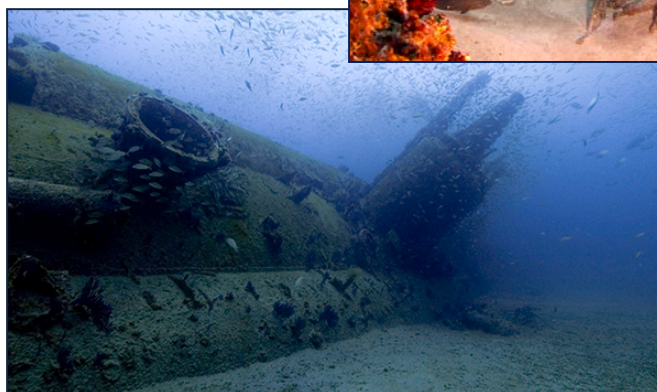http://uboat.net/maps/us_east_coast.htm
NBC News
Archive photos of German U-boat crew of the U-*576*.
http://www.nbcnews.com/news/world/archive-photos-show-german-u-boat-crew-world-war-ii-n231596

German U-boats
.
Right: U-*701* located off Cape Hatteras, N.C. Photo: NOAA

Bottom: U-*352* located off Beaufort, N.C. Photo: NOAA

Books

Bunker, John. *Heroes in Dungarees: The Story of the American Merchant Marine in World War II*. Naval Institute Press, January 2013. ISBN-13: 978-1591140993.

Offley, Edward. *The Burning Shore: How Hitler's U-Boats Brought World War II to America*. Basic Books, March 2014. ISBN-13: 978-0465029617.

Video

Hitler's Secret Attack on America—National Geographic
This 44-minute video details World War II's Battle of Atlantic and NOAA's search for the lost German U-boat – U-*576*.
https://www.youtube.com/watch?v=PKXkkEPimJw

Extensions

1. Have students visit the "Science" section of Monitor National Marine Sanctuary's web site http://monitor.noaa.gov/science/u-576.html to learn more about the Battle of Convoy KS-*520* and U-*576*. Read the fact sheets, legal status, and learn more about the *Bluefields*. Have students become a maritime archaeologist on the expedition that discovered the U-*576* and *Bluefields* and write a first person account of the day. You can also read the press release in the "News" section http://monitor.noaa.gov/news/pdfs/pr102114.pdf
2. Have students explore the four websites detailing the Battle of the Atlantic Expeditions from 2008-2011. The 2008 expedition focused on three U-boats off North Carolina' coast. http://sanctuaries.noaa.gov/missions/battleoftheatlantic/archives.html Have students read the blogs from one expedition and then create a daily blog of their own.
3. Create a timeline of events based on class reading.

Vocabulary

BATTLE OF THE ATLANTIC — Longest continuous military campaign in World War II, running from 1939 to 1945; at its core was the Allied naval blockade of Germany and Germany's subsequent counter-blockade

CONVOY – A group of ships traveling together, typically accompanied by warships for protection

COORDINATE – A number in an ordered pair that names the location of a point on the coordinate plane

DEPTH CHARGE – An explosive charge designed to be dropped from a ship or aircraft and to explode under water at a preset depth, used for attacking submarines

LOGBOOK – An important written record of activity and events in the management, operation, and navigation of a ship.

MERCHANT VESSEL – A ship that transports cargo and is engaged in commercial trade

MILITARY TIME – A method of measuring time based on the full 24 hours of the day rather than two groups of 12 hours; the 24-hour clock.

RESEARCH – The systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions

TORPEDO ALLEY – Also known as Torpedo Junction, is an area off North Carolina and is one of the ship graveyards of the Atlantic Ocean; named for the high number of attacks by German U-boats on Allied shipping during World War II

U-BOAT– A German submarine; name is derived from German word Unterseeboot, which literally means "undersea boat"

Name: _____   Date: _____

Plotting the Course
Class Activity

Background

World War II's Battle of the Atlantic is not well known by the general public, but it has been extensively studied by historians. Beginning in 1939, and continuing until Germany surrendered in 1945, it was the longest continuous military campaign. The campaign was to end the Allied naval blockade of Germany and to block war supplies from going to Britain. Germany pitted their U-boats and other naval warships against the Allies, including Allied merchant vessels. Once the U.S. entered the war in 1941, U-boats began to ply American waters. In 1942, their presence was intently felt off the East Coast, and off Cape Hatteras, N.C., in particular, in an area that became known as "Torpedo Alley." As the war raged off the North Carolina coast, ship casualties included four U-boats, a British naval trawler and roughly 50 merchant ships.

Since 2008, Monitor National Marine Sanctuary (MNMS) has led archaeological and historical surveys of these World War II heritage resources associated with the Battle of the Atlantic off North Carolina's coast. When the expeditions first began, the locations for several merchant ships and one of the U-boats, U-*576*, were unknown. Over the years as teams of maritime archaeologists, photographers, and others documented and surveyed the known shipwrecks, a hunt for the elusive U-*576* also began.

With depths reaching thousands of feet, sophisticated equipment is often needed. Therefore, to locate and document shipwreck sites, NOAA maritime archaeologists use a variety of tools and techniques, such as side scan sonar, remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), towfish, magnetometers, SCUBA and NOAA ships and submersibles. With these cutting-edge tools and the abundant expertise of our NOAA research team, NOAA has helped to lead the way to protect our ocean's cultural resources. And, after years of research and methodical searching, the U-*576* and *Bluefields* were located in the summer of 2014.

Activity Summary

In this activity, you will begin the search for U-*576*. To begin searching for a shipwreck, thorough research must be done. You will start by researching the Battle of the Atlantic in order to better understand the conflict and U-boat activity off the United States' East Coast. You will plot the approximate locations of U-boats in U.S. waters. You will learn about the Battle of Convoy KS-*520* and use your research to help narrow the U-*576* search field for NOAA's maritime archaeologists.

Procedure
1. Using books, websites, and other resources provided, conduct research on the Battle of the Atlantic to answer the following questions:
    a. Why was it critical to control the shipping lanes that stretched for thousands of square miles across the Atlantic Ocean?
    b. Early in the war, Germany had the tactical advantage. Why?
    c. Why did the Allies begin to use convoys when moving war supplies and goods?
    d. What tactics did German U-boats use to attack Allied convoys?
    e. When did the Allies gain the tactical advantage and why?
    f. Did the Allies maintain that advantage? Why or why not?
    g. What was the cost of the Battle of the Atlantic in men and ships to both sides?
2. Using the chart with German U-boats' latitude and longitude coordinates and the map (A) provided, plot the approximate locations of sunken German U-boats in U.S. waters. Use a different color for each year and complete the key. Analyze the map. Where was the highest concentration of U-boats? Why?
3. Read the article, *Battle of Convoy KS-520*. The article focuses on four areas 1) Details of the departure of Convoy KS-520, 2) the whereabouts of German U-boat, U-576, 3) description of the battle that occurred, and 4) an assessment of the historical accounts from each perspective.
4. Once you have completed reading the article, answer the following questions:
    a. How many total ships were in the convoy (merchant and escort)? Which ship was out in front at the bow of the convoy?
    b. Approximately, where did the Battle of Convoy KS-520 take place?
    c. Why did Kplt. Heinicke attack the convoy when his U-boat was damaged?
    d. After reading the article and the first-hand accounts, who do you think sank the U-*576*?

5. Analyze your research and using a different color to represent each ship involved, illustrate the battle on a map or graph paper.
6. On the map you created, define an area for NOAA to begin the search for the U-*576*.
7. Explain why you defined that specific area. In your research, what clues did you use to help define the area?
8. On the *Bathymetry and Topography of Cape Hatteras* map, outline the search zone. What is the range of water depths in which the ship might be found? Would depth affect the search for the ship? Why or why not? How would depth affect the way that maritime archaeologists study a shipwreck? Explain.
9. Share your map with the class and explain your rationale for the search area you defined.

U-*576* crew gathered around the conning tower. Photo: Ed Caram

German U-boats Shipwrecks in U.S. Waters

U-Boat	Date Sank	U.S. Area	Known Coordinates
1942			
U-*85*	April 14, 1942	Cape Hatteras, NC	35.55N, 75.13W
U-*352*	May 9, 1942	Beaufort, NC	34.21N, 76.35W
U-*157*	June 13, 1942	NE of Havana, Cuba	24.13N, 82.03W
U-*158*	June 30, 1942	W of Bermuda	32.50N, 67.28W
U-*215*	July 3, 1942	E of Boston, MA	41.48N, 66.38W
U-*701*	July 7, 1942	Cape Hatteras, NC	34.50N, 74.55W
U-*576*	July 15, 1942	Cape Hatteras, NC	34.51N, 75.22W
U-*166*	July 30, 1942	Gulf of Mexico	28.50N, 89.00W
U-*754*	July 31, 1942	N of Boston, MA	43.02N, 64.52W
1943			
U-*176*	May 15, 1943	NE of Havana, Cuba	23.21N, 80.18W
U-*521*	June 2, 1943	North Atlantic	37.43N, 73.16W
U-*84*	August 7, 1943	North Atlantic	27.55N, 68.03W
1944			
U-*856*	April 7, 1944	E of New York	40.18N, 62.22W
U-*550*	April 16, 1944	E of New York	40.09N, 69.44W
1945			
U-*869*	Feb. 11, 1945	New Jersey	39.33N, 73.02W
U-*866*	March 18, 1945	NE of Boston	43.18N, 61.08W
U-*548*	April 19, 1945	SE of Halifax, Canada	42.19N, 61.45W
U-*879*	April 30, 1945	Cape Hatteras, NC	36.34N, 74.00W
U-*853*	May 6, 1945	SE New London, CT	41.13N, 71.27W

Historical Accounts of the Battle of Convoy KS-*520****
North Carolina, 15 July 1942

KS-*520* Convoy Departs

Beginning at 0430 EWT, on July 14, 1942, the 19 merchant ships and five escorts of convoy KS-*520* prepared for departure from Lynnhaven Roads, Virginia. Convoy code KS designated groups moving south along the East Coast, and their destination was Key West, Fl. Once assembled beyond the minefield that protected the approaches to the Chesapeake Bay, the convoy began making way at its assigned 8 knot speed and was expected to arrive in Key West by July 21.

As per standard procedure, a Convoy Commodore, Capt. N.L. Nichols USN (retired), was assigned to direct convoy movement and oversee merchant vessels within the convoy. Additionally, an Escort Commander, LCMD Leland R. Lampman USN, was placed in command of the naval and Coast Guard craft that protected the convoy (Escort Group Easy). Each of their orders specified signal number and convoy position, time of departure, navigation instructions for safe exit of the Chesapeake Bay minefield, and directions for convoy assembly and movement. Once 14 miles past the Chesapeake Lighted Buoy, a course change to 78 degrees, followed by a 32 mile transit to a whistle buoy, each vessel would be clear of the mined channel and ready for assembly. After assembled, the convoy continued to travel south and at 0700 on the morning of July 15, the KS-*520* rounded Cape Hatteras, N.C. Through midday, the convoy proceeded within a hundred fathom curve, and by 1600 hours, was 20 miles from Ocracoke Inlet. Unfortunately, the convoy did not know that it was steaming right into the path of a German U-boat.

U-*576* Heads to Cape Hatteras

Earlier that summer, U-*576* also set a course for Cape Hatteras and arrived on July 10. Overall, there was limited action for the German U-boats that sat off the coast due to a drop in shipping traffic and increased defense measures. However, on July 13 that quiet ended when U-*576* was attacked. The ship's captain, Kplt. Heinicke, reported damage to its main ballast tank. Kplt. Heinicke had no choice but to abort the patrol. Having completed two patrols without a single kill, and making only marginal gains during his third and fourth patrol, Heinicke was no doubt disappointed.

The Battle

Then on that fateful morning of July 15, U-*576* spotted KS-*520*, and now Heinicke faced a difficult decision. The U-*576*'s damage left the ship at a disadvantage and not in prime condition for battle. Nonetheless, that did not stop the captain. Reasonably, Kplt. Heinicke's decision to attack must have been based upon a sober assessment of the limitations of his boat and crew, the terrain of the ocean floor, his tactical advantages and disadvantages, and administrative pressure upon him to carry out his orders. However, Heinicke was a cavalier and reckless captain bent on success at all costs, and the fate of his boat and crew were sealed the moment KS-*520* came into view.

Left: U-*576* getting underway
Center: U-*576* crew,
Right: U-*576* crew gathered around the conning tower's wintergarden..
All Photos Courtesy: Ed Caram

Convoy KS-*520* consisted of 19 merchant ships: *Mount Pera, Bluefields, Zouave, Tustem, Gulf Prince, Robert H. Colley, American Fisher, Para, Mount Helmos, Jupiter, Hardanger, Nicania, Toteco, Clam, Egton, J.A. Mowinckel, Unicoi, Rhode Island,* and *Chilore.* There were also five support vessels that made up Escort Group Easy: USS *Ellis*, USS *McCormick*, USS *Spry*, USCG *Triton* and USCG *Icarus*.

At 1600 hours, USCG *Triton* picked up a contact with its sonar gear and raised its crew to general quarters to prepare for battle. Five minutes later, *Triton* dropped three depth charges over the contact, followed by five more at 1610 hours. The second depth charge apparently damaged the *Triton*'s sonar and contact was lost. The convoy's aircraft escort observed freighter *Chilore* 600 yards ahead of its station in the lead of column two. Meanwhile, the other four escorts were in their positions.

In an instant, the monotony and routine of convoy operations over the past 36 hours was shattered. Sometime between 1615 and 1620 hours, two torpedoes rocked *Chilore.* A minute later, a third torpedo struck the port stern of the *J.A. Mowinckel.* Barely a minute later, a fourth torpedo struck the *Bluefields* amidships on its port side. In less than five minutes, U-*576* fired four torpedoes that all met their mark. For the three ships hit, the ordeal had only just begun.

Over the next hour, the Escort Group Easy and the patrol aircraft hunted the U-boat. USS *Spry*, patrolling at the port stern of the convoy immediately saw smoke and made for the center of the convoy at full speed, raising the crew to general quarters. USS *McCormick* slightly ahead of the convoy, reversed course to hunt for the submarine. USS *Ellis* also headed for the center of the convoy and did not have to go far because in less than two minutes, the destroyer made a sound contact off the convoy's port quarter and dropped two depth charges. Stationed on the outer screen on each side of the convoy, *Icarus* and *Triton* responded, but were far enough away that most of the action passed before they arrived on the scene.

From 1641 to 1745 hours, *Ellis* pursued the contact and made four depth charge runs along the convoy's port quarter dropping 13-15 depth charges. Despite *Ellis*'s efforts, it is doubtful that the ship was responsible for sinking U-*576*. According to Captain Griffiths, Master of the *J.A. Mowinckel*, "immediately following the explosion of the torpedo which struck the *Chilore*, a submarine partly surfaced, bow first. Possibly she was forced upward by the concussion." (Standard Oil Company [SOC] 1946:365).

Top (left to right): *J.A. Mowinckel* (Photo: uboat.net); USS *McCormick*, DD-223 (Photo: NAVSOURCE); USCG *Icarus,* WPC-110 (Photo: US Coast Guard); USS *Spry*, PG-64 (Photo: NAVSOURCE). **Bottom** (left to right): USS Ellis, DD-154 (Photo: National Archives); USCG *Triton*, WPC-116 (Photo: National Archives); *Chilore* (Photo: uboat.net)

Two Navy patrol aircraft made a depth charge run against the surfaced submarine astern of the *J.A. Mowinckel* dropping two depth charges each -- they reported the U-boat sunk. It is also reported armed US freighter *Unicoi*, stationed between *Chilore* and *J.A. Mowinckel*, assisted in the fight. In concert with the aircraft, a *Unicoi* gun crew scored a solid hit on the U-boat's conning tower. The force of depth charge attacks, combined with rounds from *Unicoi*'s deck gun, made quick work of the U-*576*.

Assessment of the Facts

These historical accounts, although illustrative, are somewhat vague. To complicate matters, the most detailed firsthand accounts, those in the logbooks of the Escort Group Easy, do not mention any visual contact with the U-boat. *Triton*, *Ellis*, *Spry*, and *Icarus* were at stations distant from the presumed origin of the attack: the convoy's port bow. The only escort in a position to have witnessed the U-boat was the destroyer, USS *McCormick*, however, it reversed course and sped to the aid of sailors abandoning the rapidly sinking *Bluefields*. Navy aircraft reported destroying, with four depth charges, a surfaced submarine in the middle of the convoy. This is corroborated by the first-hand account from the Master of *J.A. Mowinckel*. Captain Griffiths (SOC 1946:365) later recalled

> The submarine's appearance was the signal for our escort to go into action. Planes dived over the spot. Our airplane escort continued to drop bombs or depth charges…credit for the kill was given to the Navy plane VS-9 and to a ship in the convoy, the SS U*nicoi*, owned by the War Shipping Administration.

Some eyewitness accounts even suggested that the U-boat survived the attack and safely got away. One account by Edwin P. Hoyt's (1978:168) account in "U-Boats Offshore" reports

> The U-boat was in the middle of the convoy. The two planes came in to bomb near the stern of the *Mowinckle* [sic]…Up to the surface came the U-boat, just yards from the convoy flagship, but almost immediately she went down again, apparently blown to the surface but not out of control. For 40 minutes, the ships of the convoy milled about while escort searched for the enemy.

Nonetheless, if U-*576* had survived, it certainly never returned home. The U-boat was reported sunk with all hands down, and stricken from the German war journal in the days following. Kplt. Heinicke's decision to attack with a damaged boat, and surfacing moments following the attack, are quite puzzling; surfacing in the center of a convoy was probably not intentional, yet it is unclear if this resulted from mechanical failure precipitated by damage inflicted by aircraft or from the force of torpedo explosions, or perhaps an escape tactic. Archaeological examination of the sunken U-boat might answer many of these questions … stay tuned as the NOAA's Maritime Heritage Program investigates the site.
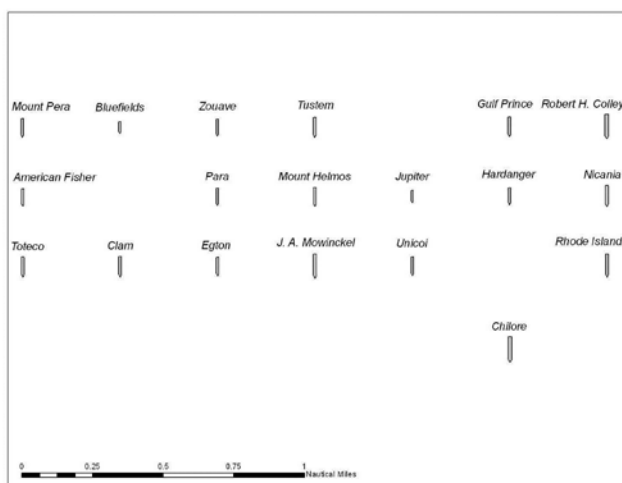
Left: Scaled representation of the merchant ships' locations within KS-*520* as they began the battle. Drawing by Stephen Sanchagrin.
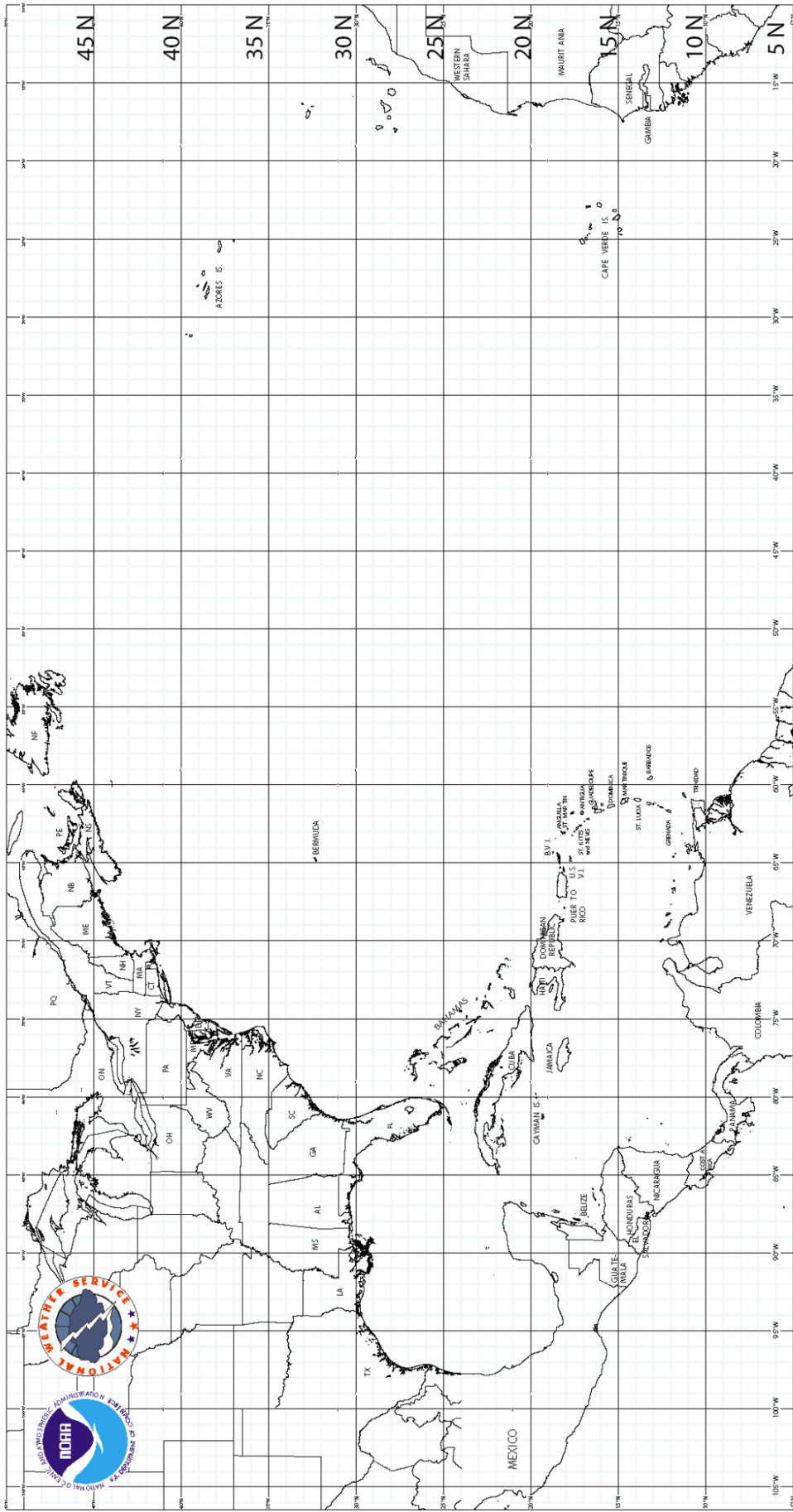**Right:** Sonar images of *Bluefields* (top) and U-*576* (bottom). Image: NOAA
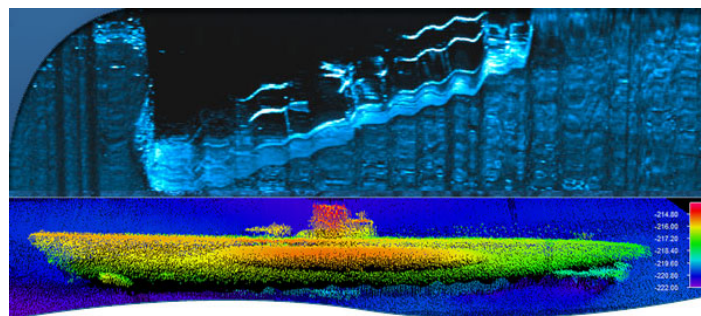
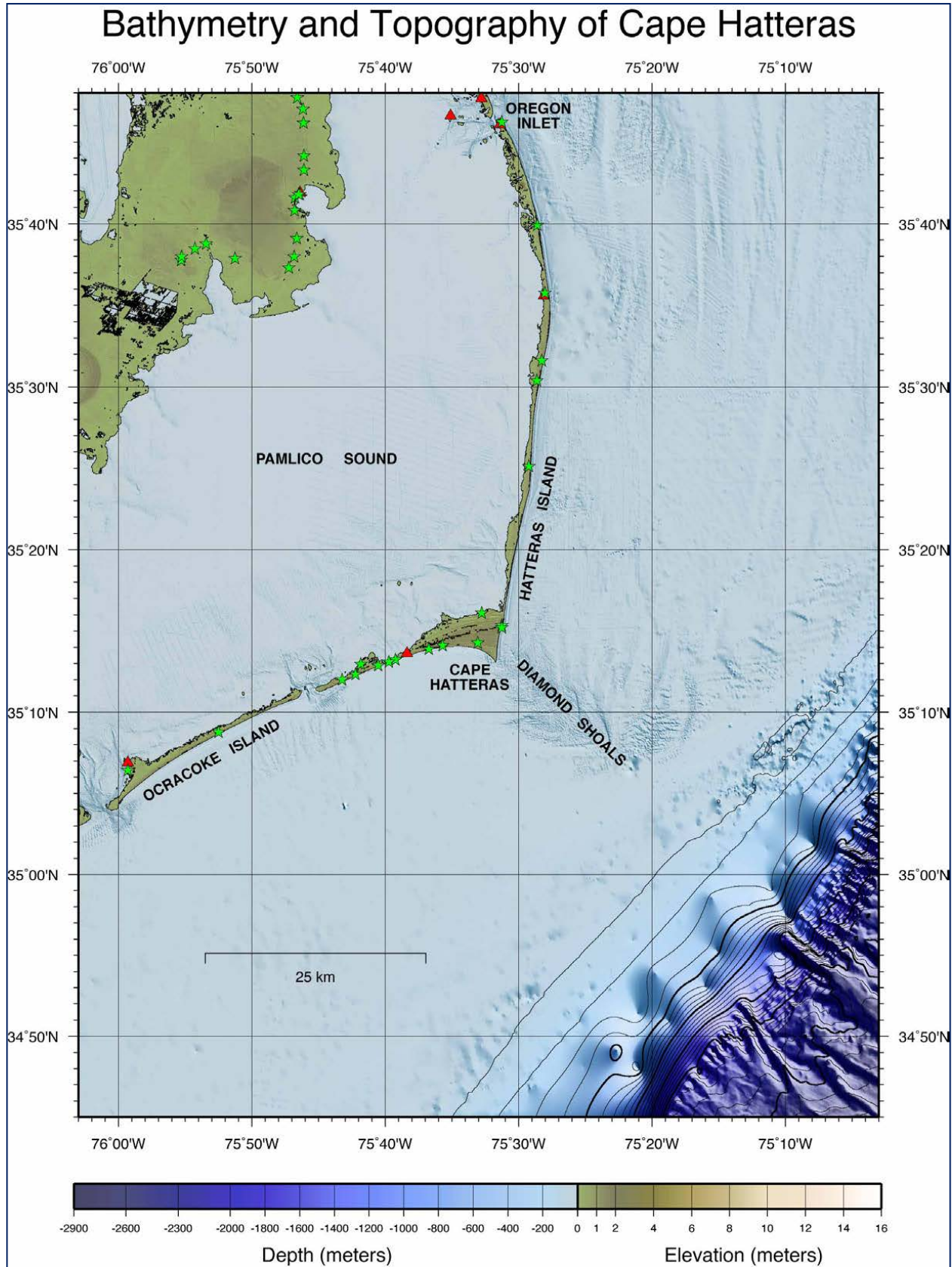Map A

Location of German Submarines Sunk in U.S. Waters

Color Key—German U-boats

1942

1943

1944

1945

Map B Use the bathymetry and topography map below to indicate the search zone you have determined is the best area for NOAA maritime archaeologists to search for U-*576*.

Bathymetry and Topography of Cape Hatteras

Map NOAA

Searching the Deep — Sonar Imaging

SIDE SCAN SONAR

Grade Level

- 6-12
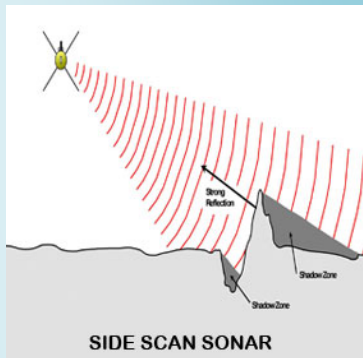
Timeframe

- 2-4 hours

Materials per Group

- Prepared box—See Teacher Prep Section
- Masking tape
- Different colored pencils
- Graph paper (or use provided)
- Wooden skewer (~ 30 cm)

Activity Summary
Students will simulate how side scan sonar works.

Learning Objectives

- Use a coordinate grid system to map a simulated ocean floor
- To have an understanding of how side scan sonar works
- To learn how side scan sonar is used to locate shipwrecks
- To make inferences about the topography of an unknown and invisible landscape

Key Words

Echo; side scan sonar; topography

National Standards:

NG:1 and 3; NCSS:III and VIII; NCTE:1; CSS.ELA.LIT.RST.7; NCTM:6-8:NO.D; NCTM:6-8:MS.A; NCTM:9-12:G.A and B; NGSS:HS-ETS1.B; OL.6 and 7

Activity B

Side Scan Sonar

Side scan sonar is a specialized system to detect objects on the seafloor. Sonar is short for "sound navigation and ranging." Thus, sonar uses sound waves to locate underwater objects by measuring the time it takes for a transmitted sound wave to be reflected back to its source. The sound wave is transmitted through a transducer, which is comparable to a speaker in a radio. Side-scans use a transducer housed in a hollow container called a towfish that is towed through the water 10 to 20 feet above the bottom. The transducer emits sound waves to either side of the towfish and measures the time it takes for the waves to be reflected back to the towfish.

These sound waves are processed into an image that resembles an aerial photograph and can be viewed in real-time on a computer monitor aboard the towing vessel. A global positioning system (GPS) is used to guide the towing vessel along predetermined search paths, as well as to identify points of interest on the side scan image. This allows scientists to return to any point on the image for further investigation.

In a side scan, the transmitted energy is formed into the shape of a fan that sweeps the seafloor from directly under the towfish to either side. Typically, this distance is about 100 meters (~330 feet), but actual distance is based on frequency. The strength of the return echo is continuously recorded, creating a picture of the ocean bottom. Side scan sonar does not depend upon light and can be used under conditions that would make searching by divers dangerous or impossible. Because it covers a swath of up to 183 meters (600 feet) or more at about 2-4 miles per hour, it is a very efficient way to search large areas.

Experimental side scan sonar systems began during the 1950s by both the military and commercial industry. Dr. Harold Edgerton was a professor of electrical engineering at the Massachusetts Institute of Technology. He was intrigued with the unique challenges of underwater research and worked to design and develop many tools used in underwater exploration including side scan sonar. In 1973, he and John G. Newton from Duke University teamed together to see if side scan sonar imaging could be used to locate shipwrecks. Working off the North Carolina coast, the one ship that had a unique distinct "signature" was the USS *Monitor*. In August 1973, the team began to map the ocean floor in an area where they thought the *Monitor* might lay. On August 27, the side scan sonar recorded a "long amorphous" echo, and in April 1974, the location of the *Monitor* was verified for the first time in 112 years!
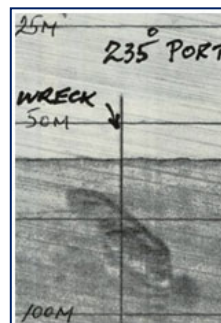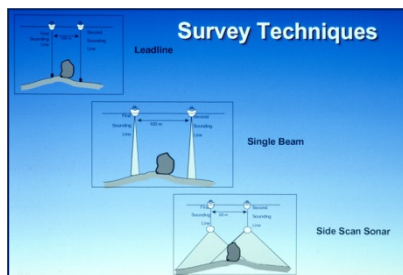
Left: Diagram illustrating survey techniques Photo: NOAA

Right: First side scan sonar image of the USS *Monitor*, August 27, 1973. Photo: NOAA, *Monitor* Collection

Activity Overview

In this activity students will use a prepared box to simulate the ocean floor. Using dowels and graph paper, they will map the simulated ocean floor to understand how side scan sonar works.

Objectives

Students will use a coordinate grid system to simulate mapping the ocean floor. After completing the simulation, students will make inferences about the topography of an unknown and invisible landscape. The simulation will give students an understanding of how side scan sonar works and how it is used in locating shipwrecks.

Teacher Preparations and Implementation

1. For each student group, prepare one box (shoe box or larger) by lining the bottom of the box unevenly with mounds of clay, spray insulating foam, or plaster-of-Paris. *NOTE: Alternative is to use a small plastic tub, spray paint it, and drill holes in the lid. Copy paper boxes work well for larger terrains. An alternative for the box lids is to cut out the top of the box along the outer edge and then cut and tape an air filter to the inside (see image below right).*
2. Add objects to the box, such as Ping-Pong balls, toy boats, etc. Objects should be secure, and each box should have areas of different reliefs.
3. In the lid of the box, use a nail or similar sharp object to punch 5-7 rows of holes 3-4 mm in diameter and spaced 2 cm apart.
4. Temporarily fasten the lids to the completed box with masking tape.
5. Lightly sand skewers until smooth. Mark skewers from pointed tip upward in 2 cm increments. Color each increment a different color. Color in the Sounding Pole Keys (or have students color).
6. Make copies of the *Activity* page (with Depth Table) for each student. For each group make copies of *Sounding Pole Key* (two to a page), *Topographic Map*, *Profile Graph*, and *Sonar Image* pages.

Answer Key

On the sonar image page, the top and right (middle) images are the same. They depict the *Herbert D. Maxwell* located in the Chesapeake Bay, MD.

Resources
Websites

NOAA Ocean Service Education
Learn about side scan sonar and watch a movie of a NOAA survey ship using a multibeam and side scan sonar.
http://oceanservice.noaa.gov/education/seafloor-mapping/how_sidescansonar.html

Lead Line — The Mariners' Museum
Learn more about the history and use of the lead line
http://ageofex.marinersmuseum.org/index.php?type=navigationtool&id=3

NOAA Office of Coast Survey
Great explanation of how side scan sonar works and how NOAA uses it.
http://www.nauticalcharts.noaa.gov/hsd/SSS.html

NOAA USS *Monitor* Legacy Website
Learn more about side scan sonar and the discovery of the USS Monitor.
http://monitor.noaa.gov/150th/discovery.html

Harold "Doc" Edgerton
Read about the life of Doc Edgerton, MIT professor, who designed and developed various underwater instruments including side scan sonar.
http://edgerton-digital-collections.org/stories/features/fathoming-the-oceans-3-under-water-sonar-acoustics

Books
Morrison, Taylor. *The Coast Mappers.* Houghton Mifflin Books for Children, April 2004. ISBN: 10-0618254080.

Oleksy, Walter G. *Mapping the Seas (Watts Library: Geography).* Franklin Watts, March 2003. ISBN 13: 978-0531166345.

Smith, K.C. *Exploring for Shipwrecks (Watts Library).* Franklin Watts, 2000. ISBN 13: 978-0531164716.

Walker, Sally M. *Shipwreck Search: Discovery of the H. L. Hunley (On My Own Science).* First Avenue Editions, November 30, 2006. ISBN 10: 0822564491.

Wall, Julia. *Mapping Shipwrecks with Coordinate Planes (Real World Math: Level 5).* Capston Press, 2011. ISBN 13: 978-1429666176.

Simulating sonar imaging
Left: Plastic tub spray painted.
Right: Copy paper box with filter inset in lid.
Photos: NOAA

Name: _____   Date: _____

Detecting the Deep
Class Activity

Sounding Lead, 7 lbs, marked in 25 fathom increments (156 feet). Photo: The Mariners' Museum

Setting the Stage

Historically, mariners lowered a lead weight attached to a measured line into the water until the weight touched the bottom (or some object resting on the bottom). Then, they would note the length of line and call it out to the captain to make him aware of the water depth so as to not run a ship aground. Known as a "lead line," the device was first used in about 3400 BCE by the oldest known boat trading peoples, the Egyptians.

Today, a conventional sonar system provides a continuous record of depth directly beneath a ship. This type of sonar improves resolution along the search path, but there are still gaps between the paths that are much greater than the area actually imaged. Side scan sonar fills in these gaps and gives an almost continuous picture of the search area. When mapping ocean floor topography and identifying objects, such as shipwrecks, it is important to have a high resolution of an image for more accurate identification.

The Expedition

A group of scientists, researchers, and maritime archaeologists, led by NOAA's Monitor National Marine Sanctuary, are conducting an expedition onboard NOAA's 90 foot. Small Research Vessel (SRVx), *Sand Tiger*, to search for a German U-boat. The U-boat sank off the North Carolina coast during a battle in 1942, and it has never been found. The expedition team used side scan sonar to explore a large ocean area near Cape Hatteras, N.C. The sonar images show several anomalies that are areas of interest. Just before the end of the expedition, the team goes back to one area to take a closer look.

Your team's mission is to conduct the side scan sonar imaging of the area of interest and to interpret the image. Follow the directions below.
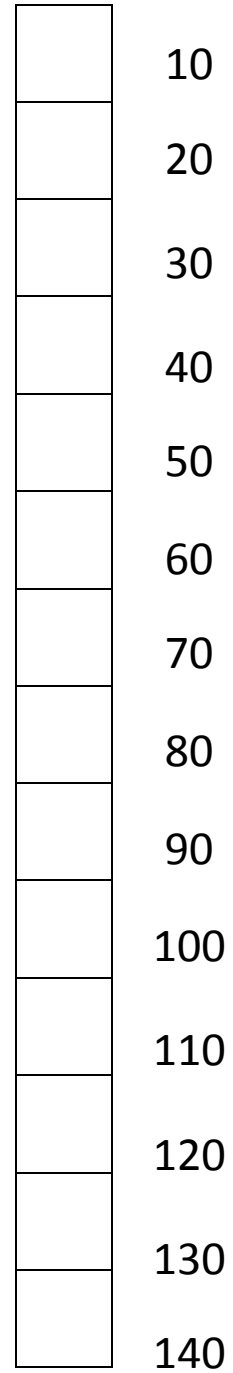
1. Starting at the top, insert the sounding pole (wooden skewer) into the first hole in the first row.
2. Use your finger to mark where the sounding pole exits the surface (lid). Don't move your fingers, and pull the sounding pole out of the box. Note the color that your fingers are touching.
3. Using the *Sounding Pole Key*, determine the depth and record this measurement in the *Depth Table*. Be sure to record in meters. Repeat for all rows.
4. Once you have found the depth measurements for all rows, use the data from the table to create a topographic map of your ocean floor. Using the *Sounding Pole Key*, color the map key the correct corresponding colors. Then, color each square the correct color according to the data.
5. When finished, analyze your topographic map. Where are the peaks and valleys? Hypothesize what your ocean floor looks like and note any distinguishing features that are helpful.

6. To create a profile of your ocean floor, label the graph with a title and label the x axis and y axis. *NOTE: This is a profile; therefore, the x-axis should correspond to the numbers of holes in each row. For example, the first hole should correspond to number 1 on the x axis, the second hole to number 2 and so on. The y axis of your graph should correspond to the depth measurements.*
7. Create a key that indicates the depth each square represents. Example: 1 square = 10 m. The unit per square is determined by the overall depth you measured, the number of squares on the graph, and the unit of measure you are using.
8. From the *Depth Table*, choose a row and plot the depths on the graph.
9. Connect the dots on your graph using a colored pencil/marker. This is the profile of the ocean floor topography.
10. Based on these measurements from the first plotted row and the topography map, predict what the topography is like inside the shoebox. Record your predictions in your science journal.
11. Repeat steps 7-8 for two or more rows using a different color for each. Is your data for the second and subsequent rows the same? What does this new information reveal?
12. Analyze your graph. Write in your science journal any predictions you have about your mystery landscape.
13. Present your graph and report the conclusion you made describing the mystery landscape.
14. After each group has reported its conclusions, open your box and compare the actual topography with your prediction.
15. Write in your science journal how your investigation could be improved.
16. Discuss, as a class, the methods that were used to map the topography and how the ocean floor is mapped today with sonar.
17. Look at the sonar images on the sonar image page of the unknown shipwreck(s) and record any identifiable parts.

Use the table below to record your depth measurements.

Depth Table

	A	B	C	D	E	F	G	H	I
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									

**Sounding Pole Key
All Depths Measured
in Meters**

10

20

30

40

50

60

70

80

90

100

110

120

130

140

Topographic Map

Complete the *Sounding Key* by filling in the boxes with correct corresponding colors. To create a topographic map, use your recorded measurements in the *Depth Table* and the key to color each square with the correct corresponding color.

	A	B	C	D	E	F	G	H	I
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									

Sounding Key

☐ 10 meters
☐ 20 meters
☐ 30 meters
☐ 40 meters
☐ 50 meters
☐ 60 meters
☐ 70 meters
☐ 80 meters
☐ 90 meters
☐ 100 meters
☐ 110 meters
☐ 120 meters
☐ 130 meters
☐ 140 meters

Profile Graph

Title:

Y Axis
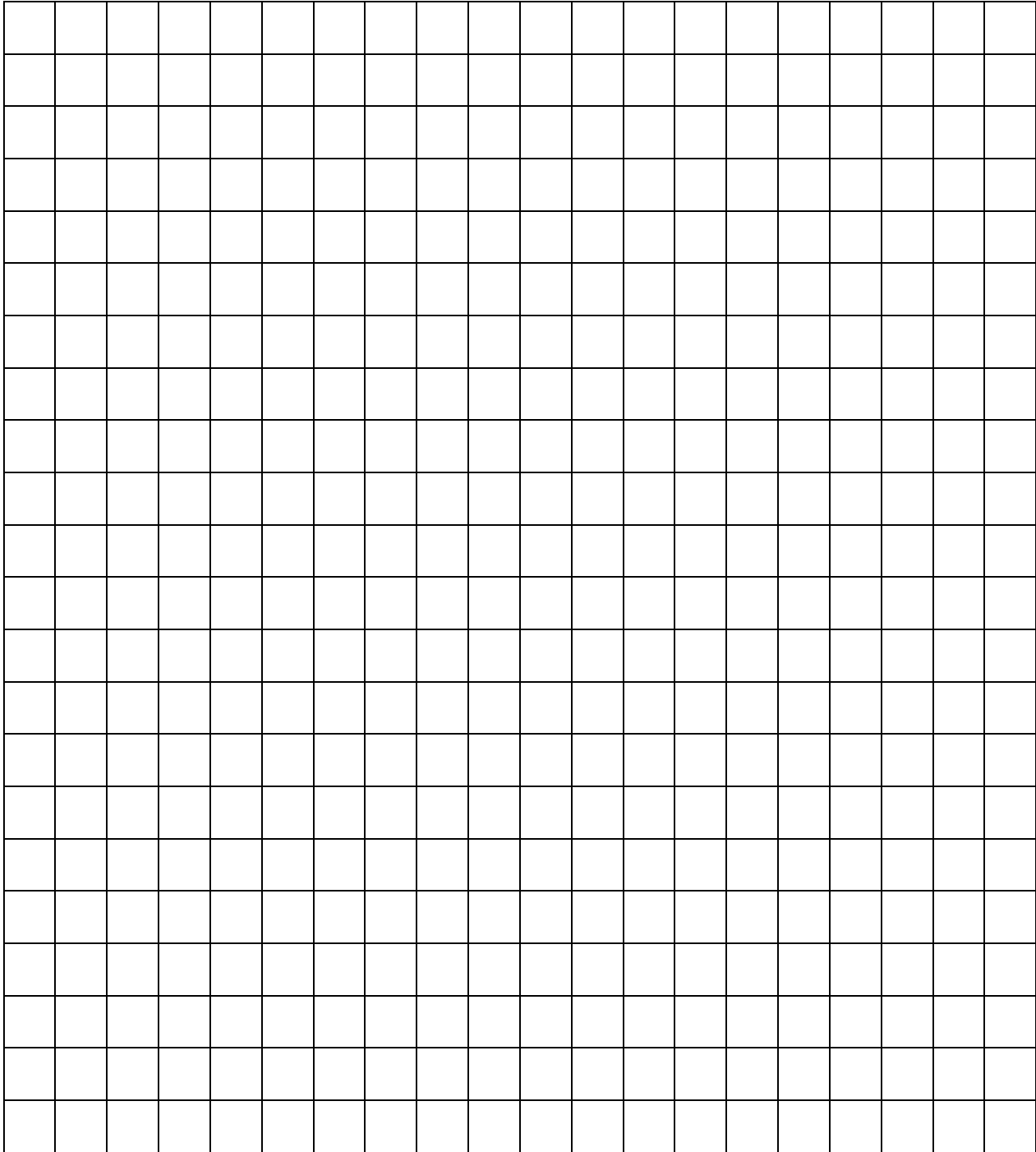
X Axis

Sonar Images
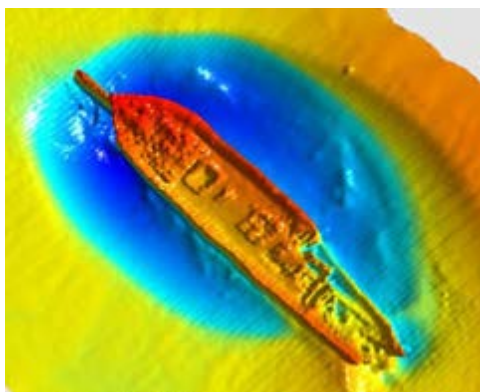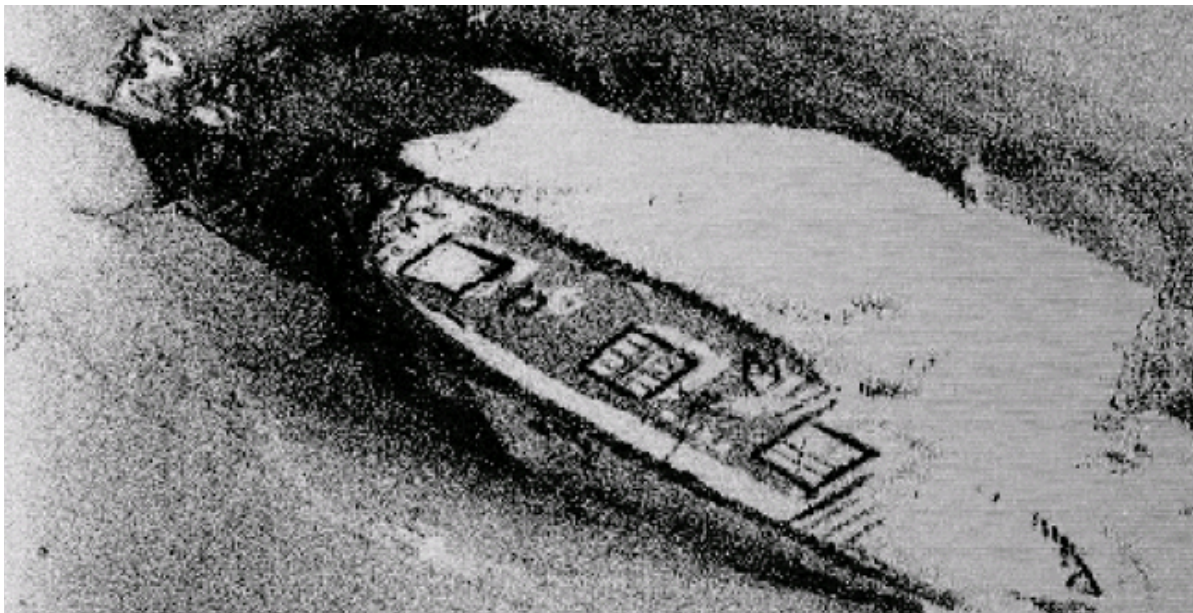
1. Observe the image above and label any parts of the ship that are identifiable.
2. From this image, can you determine why the ship sank? Explain.
3. Observe the image to the left and label all recognizable parts.
4. Can you determine why the ship sank? Explain.
5. Compare the two images (top and left). Do they have any similarities? Explain and discuss.
6. Observe the image of the USS *Monitor* below. Compare and contrast the three images. Which one has the best detail?
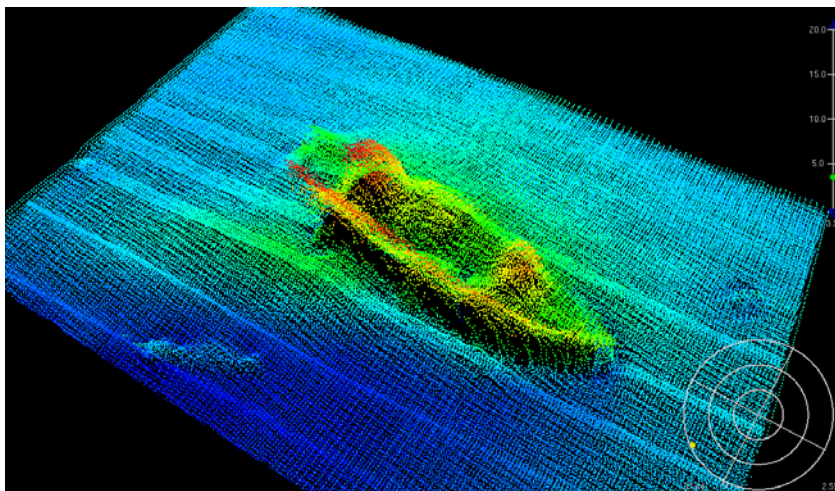
Scientists use computer-mapping software to turn sonar echoes or soundings into rainbow-colored maps and 3-D models. This multibeam rainbow sonar image is of the USS M*onitor* taken in April 2015 by NOAA Ship *Thomas Jefferson.* All Images: NOAA

Searching the Deep — Roving Along

Researchers look on as the ROV sends images from the ocean floor. Photo: NOAA

Grade Level

- 6-12

Timeframe

- 1-2 hours

Materials per Group

Activity 1
- Internet

Activity 2
- 2-liter bottle
- Nail
- Duct tape
- Water

Activity 3
- 2-liter bottle
- Eyedropper
- Water

Activity Summary

To learn how ROVs, AUVs and towfish are used in maritime archaeology; and how increasing pressure at increased depths affect divers.

Learning Objectives

To describe how and why ROVs, AUVs and towfish are used in maritime archaeology.

Key Words

See Vocabulary Box

National Standards:

NG:1 and 17; NCSS:III and VIII; NCSS:HT:2; CCSS.ELA.LIT.RH.7, NS:5-8.A, E and F; NS:9-12.B, E and F; NGSS:MS-PS4.A and C; NGSS:HS-PS4.A and C; NGSS:HS-ETS1.B; OL.6 and 7

Activity C

ROVs, AUVs and Towfish

Remotely operated vehicles (ROVs) are robots that are remotely operated underwater by a person on a ship or boat. They are maneuvered through the water and are linked to the ship by a group of cables that carry electrical signals back and forth between the operator and the ROV.

At a minimum, most ROVs have a camera and lights. Depending upon an ROV's mission, additional equipment is often added to the ROV to increase its capabilities. For example, additional equipment might include sonars, magnetometers, a still camera, a manipulator or cutting arm, water samplers, and instruments that measure water clarity, light penetration, and temperature.

Although ROVs were first developed for industrial purposes, such as inspections of pipelines and testing the structure of offshore platforms, today ROVs are used for numerous applications. For instance, they have proven extremely valuable in ocean exploration and in the search and exploration of shipwrecks.

An **Autonomous Underwater Vehicle** (AUV) can be used to perform underwater survey missions such as to detect and map submerged wrecks, rocks, and obstructions that pose a hazard to navigation. Unlike an ROV, an AUV is autonomous, meaning that once it is programed, it can work independently and has no connecting cables. It is programmed to conduct its mission without operator intervention. When a mission is complete, the AUV returns to a pre-programmed location and the data collected can be downloaded and processed. AUVs can be equipped with a wide variety of sensors or sonar systems.

A **towfish** is a side scan sonar system or magnetometer that is towed behind a ship by an attached cable. Used by maritime archaeologists, it is an effective tool for underwater exploration because it can search large areas quickly and produce detailed images of anything on the bottom, regardless of water clarity. Side scan sonar units have either high or low frequency capabilities depending upon the requirements of the mission and the depth at which it operates.

Activity Overview

In this activity, students will learn how remotely operated vehicles (ROVs) allow people to research bodies of water, marine life, and natural and artificial formations with minimum impact to the ecosystem. They will explore a real-life scenario where these important tools were used to discover and explore a World War II shipwreck off the North Carolina coast. Students will also conduct experiments to better understand air pressure and the role it plays in diving. Through these experiments, students will better comprehend why ROVs and towfish are invaluable to maritime archaeologists.

Objective

To learn how and why ROVs, AUVs and towfish are used in maritime archaeology; and to understand how increasing pressure at increased depths affect divers.

Teacher Preparations and Implementation

Activity 1
1. Review the video and press release for the YP-*389* at http://sanctuaries.noaa.gov/missions/battleoftheatlantic2/.
2. If Internet is available, bookmark the website for the students. If Internet is not available, print copies of the press release and download the video.
3. Print copies of *Roving the Deep*.
4. When students complete the activity, go over the discussion questions.

Activity 2
1. Each group will need a 2-liter bottle, basin pan (to collect the water), nail, duct tape and water source to fill the bottle.
2. As an alternative, students can use a small plastic water or soda bottles; however, the effect of the streaming water is not as good. You can also create a set of bottles (any size) that can be used for multiple classes. In this latter instance, the students would delete step 1 of the procedure.

Activity 3
1. Each group will need a small plastic bottle (16 or 20 ounce) with cap, filled with water, and an eyedropper.

Resources
Websites

NOAA's 2009 Battle of the Atlantic Expedition
During the 2009 expedition, an ROV was used to help identify a shipwreck, YP-*389*, that had been found in an earlier survey. Read blogs from the divers that participated and learn more about the hunt for the U-*576*.
http://sanctuaries.noaa.gov/missions/battleoftheatlantic2/

NOAA Ocean Explorer
Discover how NOAA uses ROVs and learn more about the various NOAA ROVs currently in use. Read how ROV *Hercules* was built just for scientific research and can travel to depths of 4,000 meters!
http://oceanexplorer.noaa.gov/technology/subs/rov/rov.html

ROV Footage of the YP-*389*
http://sanctuaries.noaa.gov/missions/battleoftheatlantic2/videos/yp389.mov

Monitor National Marine Sanctuary
ROV in a bucket! Use easy to follow directions and simple materials to design and construct your own ROV.
http://monitor.noaa.gov/publications/education/rov_manual.pdf

NOAA's Office of Coast Survey
Visit this site to learn more about how NOAA uses AUVs in scientific research.
http://www.nauticalcharts.noaa.gov/csdl/AUV.html

NOAA National Ocean Service — How Does Pressure Change with Ocean Depth?
This site explains the changes in pressure as you go deeper in the ocean.
http://oceanservice.noaa.gov/facts/pressure.html

Marine Advanced Technology Education (MATE)
A national partnership of educational institutions and organizations that work to improve marine technical education in the U.S. The MATE Center and its partners have developed several curriculum modules and programs including: an introduction to aquaculture; career scenarios (problems) for the classroom; technology rich lab exercises; a new Associates of Science degree program; high school pathways; and a careers course. Some of these materials are available on-line.   http://www.marinetech.org/home.php

Woods Hole Oceanographic Institution
Though ROVs have been used extensively by the oil and gas industry for several decades, *Jason/Medea* was the first ROV system to be adopted and extensively used by ocean researchers. Visit this site to learn how scientists and researchers use *Jason/Medea* to conduct underwater expeditions.
http://www.whoi.edu/page.do?pid=8423

SeaPerch
An underwater robotics program sponsored by the US Navy that equips teachers and students with the resources they need to build an ROV.
http://www.seaperch.org/about

Bermuda Institute of Ocean Sciences — Dead Reckoning
Want to add some math to your ROV unit? This lesson uses vectors, speed, distance, time and drift to understand "dead reckoning" as a navigation technique.
http://www.bios.edu/uploads/2014_lesson_plan_pilot_a_glider.pdf

Creating Neutral Buoyancy in an ROV
Calculate the mass and volume of a small piece of PVC pipe and determine how much foam is needed for neutral buoyancy.
http://www.bios.edu/uploads/2014_lesson_plan_neutral_buoyancy_in_ROVs.pdf

Dive and Discovery
A kid-friendly site that explains ROVs, AUVs and submersible.
http://www.divediscover.whoi.edu/robotics/vehicles.html

Books

Ballard, Robert D. *Finding the Titanic Level 4.* Cartwheel, November1, 1993. ISBN-10: 0590472305.

Ballard, Robert D. Rick Archbold, and Ken Marschall. *Ghost Liners: Exploring the World's Greatest Lost Ships.* Little, Brown Young Readers, September 1, 1998. ISBN 10: 0316080209.

Cerullo, Mary M. *Shipwrecks: Exploring Sunken Cities Beneath the Sea.* Dutton Juvenile, December 1, 2009. ISBN 10: 0525479686.

Rose, Paul; Anne Laking; and Phillippe Cousteau. *Oceans: Exploring the Hidden Depths of the Underwater World.* University of California Press, April 15, 2009. ISBN 10: 0520260287

Walker, Sally M. *Shipwreck Search: Discovery of the H. L. Hunley (On My Own Science).* First Avenue Editions, November 30, 2006. ISBN 10: 0822564491.

Extensions

A great way to engage students in STEM and history is through the building of an ROV. Visit the "Teacher" section of the Monitor National Marine Sanctuary's website at http://monitor.noaa.gov/education/teachers.html to learn how to get into engineering and history by designing, building and testing ROVs. And learn how to host an ROV team competition as the culminating event.

NOAA AUV being deployed and the data it recorded. All Photos: NOAA, Office of Coast Survey
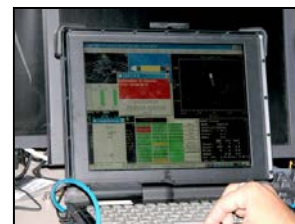
Towfish with sonar used during the 2009 Battle of the Atlantic Expedition All Photos: NOAA
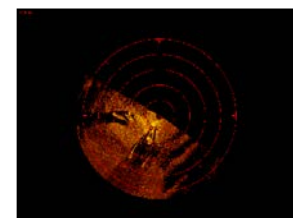
Vocabulary

ATMOSPHERIC PRESSURE – The pressure exerted by the weight of air in Earth's atmosphere (or that of another planet); the standard atmosphere is a unit of pressure equal to 14.7 pounds per square inch (psi); for every 33 feet in depth below the ocean's surface pressure increases by 14.7 psi

AUV – Autonomous Underwater Vehicle is an untethered vehicle used in survey missions such as a mission to detect and map submerged wrecks, rocks, and obstructions that can be hazardous to navigation.

FREQUENCY – The rate at which a vibration occurs that constitutes a wave, either in a material (as in sound waves), or in an electromagnetic field (as in radio waves and light), usually measured per second.

ROV – A remotely operated underwater vehicle, commonly referred to as an ROV, is a tethered underwater vehicle; common in deep water industries and used in searches for shipwrecks

SENSOR – A device that detects or measures a physical property and records, indicates, or otherwise responds to it

TOWFISH – A side scan sonar system that is towed behind a vessel by an attached cable

YP – Abbreviation for Yard Patrol; boats are designated YP in the Hull classification symbol system; during WWII, these ships patrolled America's coasts.

Name: _____   Date: _____

Roving the Deep
Class Activity

Remotely Operated Vehicles (ROVs) are unoccupied robots operated underwater by a person on a ship or boat. They are maneuvered through the water and linked to the ship by a group of cables that carry electrical signals back and forth between the operator and the ROV. At a minimum, most ROVs have a camera and lights. Depending upon an ROV's mission, additional equipment is often added to the ROV to increase its capabilities. For example, additional equipment might include sonars, magnetometers, a still camera, a manipulator or cutting arm, water samplers, and instruments that measure water clarity, light penetration, and temperature. Although, ROVs were first developed for industrial purposes, such as inspections of pipelines and testing the structure of offshore platforms, today ROVs are used for numerous applications. For instance, they have proven extremely valuable in ocean exploration and in the search and exploration of shipwrecks.

An **Autonomous Underwater Vehicle** (AUV) can be used to perform underwater survey missions such as to detect and map submerged wrecks, rocks and obstructions that pose a hazard to navigation. Unlike an ROV, an AUV does not have connecting cables or tethers. Conversely, it is programmed to conduct its mission without operator intervention. When a mission is complete, the AUV returns to a pre-programmed location and the data collected can be downloaded and processed. AUVs can be equipped with a wide variety of sensors or sonar systems.

A **towfish** is a side scan sonar system or magnetometer that is towed behind a ship by an attached cable. Used by maritime archaeologists, it is an effective tool for underwater exploration because it can search large areas quickly and produce detailed images of anything on the bottom, regardless of water clarity. Side scan sonar units have either high or low frequency capabilities depending on the requirements of the mission and the depth at which it operates.

With thousands of shipwrecks in the ocean, lakes and rivers, some of them lie at depths where the atmospheric pressure equals that on Venus's surface. For example the RMS *Titanic* lies at 12,415 feet and the pressure is too much for unprotected diving. Why is the pressure so great? At sea level, air exerts 14.7 pounds of pressure per square inch (psi). For every additional 33 feet of salt water, another atmosphere of pressure (14.7 psi) is exerted. At *Titanic*'s depth, a diver would be subjected to approximately 377 atmospheres of pressure! Therefore, diving is limited with increased depths and makes towfish, AUVs and ROVs essential.

ROVs, AUVs and towfish help maritime archaeologists search for shipwrecks. When equipped with sonar and magnetometers, they can help narrow the search area by sweeping large sections of the seafloor much more quickly than a diver or submersible. They can also operate at deeper depths, and thus cover a deeper and wider swath of seafloor. The images received from their sonar or magnetometer will show unique characteristics when a shipwreck is present, and thus, help to identify specific areas in which maritime archaeologists may concentrate their search.

Once a shipwreck or site of interest in deep or dangerous water is discovered, an ROV can also help to explore the wreck site itself. Generally, ROVs fitted with still and/or video cameras can move over a wreck and capture images that can lead to an identification (if unknown) and also provide a survey of the site that shows the he shipwreck's current state.
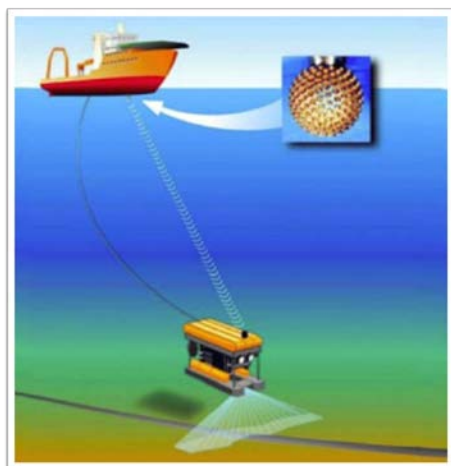
Left: ROV with side scan sonar

Right: A towfish with side scan sonar

All Photos: NOAA

Wide Area Survey

Activity 1
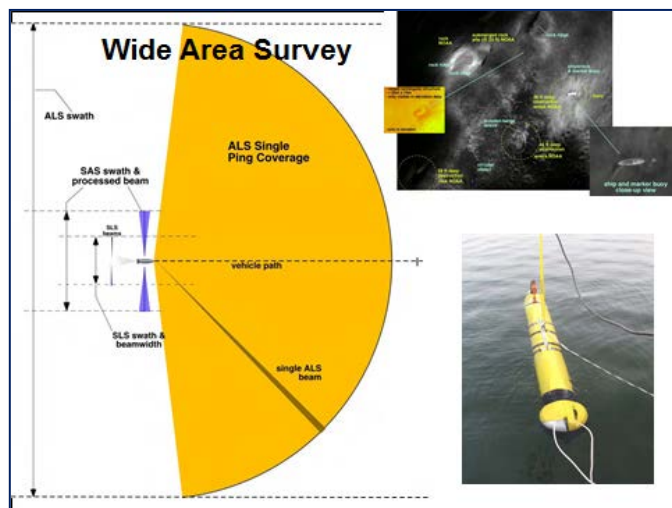
1. Go to http://sanctuaries.noaa.gov/missions/battleoftheatlantic2/ and click on the link "Video of the YP-*389*" and watch the video.
   a. Is the ship intact? Explain.
   b. Which parts of the ship were you able to identify? Was it difficult or easy?
   c. What artifacts did you see on the ocean floor? Are they easy to identify? Why or why not?
   d. Was there clear visibility in the water surrounding the shipwreck? What factors could affect water clarity?
   e. The video was recorded by a camera on an ROV. What other equipment do you think was on the ROV?
2. Click on the link for "Press Release" and read the press release about the YP-*389*.
   a. What type of ship was the YP-*389* when it sank? Originally? Why did it change? What was its original name?
   b. What caused the ship to sink? Where and when did it sink?
   c. What laws/policy protect(s) this ship as a war grave?
   d. What is the purpose(s) for NOAA's Battle of the Atlantic expeditions?
3. Looking at the crew list on the right, how many men died? How many are missing? How many were injured and/or seriously injured?
4. Compare the two images: the original ship's photo and the photomosaic of the shipwreck. Are there any defining features that helped researchers identify the shipwreck?
5. What would be the disadvantages to using an ROV?
6. What other data might be important to collect when exploring a shipwreck and what types of tools would be needed on an ROV?

Above: Am ROV is lowered over the side of NOAA Ship *Nancy Foster*. Photo: NOAA
Below: Crew list of the YP-*389*. Photo: US Navy

Left: Photo of original YP-*389*. Photo: Library of Congress
Below: Photomosaic of the YP-*389* shipwreck. Photo: NOAA

Activity 2

Water has mass and exerts pressure. At sea level, air exerts 14.7 pounds of pressure per square inch (psi). For every additional 33 feet (10 meters) of salt water, another atmosphere of pressure (14.7 psi) is exerted.

1. Using a 2-liter bottle, puncture a hole near the top of the bottle and a second hole near the bottom.
2. Place masking or duct tape over each hole.
3. Fill the bottle with water and hold it over a sink or basin and remove the tape from both holes at the same time.
4. Observe the streams of water and write your observations in your science journal.
5. Which stream went the farthest? Why?
6. Repeat with two additional holes spaced evenly between the top and bottom holes.
7. Were the results the same? Why or why not?
8. On the diagram to the right, draw what happened to the streams of water.
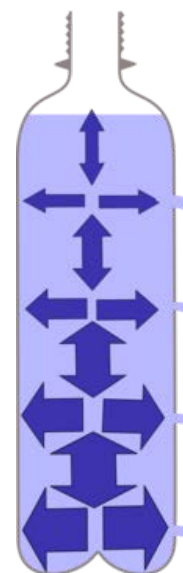
Activity 3

As a diver enters the water, he/she experiences one atmosphere of pressure. For every 33 feet (10 meters) a person dives, another atmosphere of pressure pushes on his/her body. A diver's lungs are filled with air and as the diver descends, that air is affected. Conduct the following experiment to learn the effect of pressure on a diver's lungs.

1. Fill a plastic bottle with water.
2. Fill an eyedropper two-thirds full of water and place the dropper in the bottle. The eyedropper should float about 1-2 inches from the top of the bottle. If not, repeat changing the amount of water in the dropper until you obtain neutral buoyancy. Place the cap on the bottle and tighten.
3. Observe the eyedropper and bottle and record your observations in your journal.
4. Your task is to make the dropper become negatively buoyant so that it sinks to the bottom of the bottle without turning the bottle upside down or shaking it.
5. Once the dropper sinks, then make the dropper become positively buoyant and return to its neutral buoyant position.
6. Observe the water level in the dropper as it sinks and rises.
7. Write your observations in your science journal.
8. Explain what happened inside the bottle and dropper to create different buoyancies.
9. What role did air density play in making the dropper dive and rise?

Conclusion
Based on these two experiment (Activities 2 and 3), describe what you think happens to divers as they dive deeper into the ocean. What happens to the air in their lungs?

Extension
1) Research record-setting dives. What is the deepest dive? Longest dive? What are the "safe" limits for diving?
2) Research diving certification. When can a person become certified to SCUBA dive? What levels of certification are there?

SCUBA, SCUBA, SCUBA — DO!

Divers wait to dive on a shipwreck. Photo: NOAA

Grade Level

- 6-12

Timeframe

- 1- 2 hours

Materials

- Computer with Internet access
- Or printed resources for students to use to prepare their media reports

Activity Summary

This activity challenges students to use the format of modern social media technology to create a complete history of an import figure in SCUBA diving, while learning about the development of modern day SCUBA diving.

Learning Objectives

- To understand the development of SCUBA.
- To summarize the lives of famous divers using modern social media technology.

Key Words

See Vocabulary Box

National Standards:

NCSS:III and VIII; NCSS:HT:1, 2 and 4; NCTE:1,3, 4, 5, 6, 7 and 8; NS:5-8.E, F and G; NS:9-12.E, G; CCSS.ELA.LIT.W.4, OL6 and 7

Activity D

History of SCUBA Diving

SCUBA is the acronym for Self-Contained Underwater Breathing Apparatus. Today, most people do not know the acronym, but they do know what it means to be a SCUBA diver. SCUBA diving is not only a popular recreational activity, but it is also a profession. Divers are trained, and depending on their level of training and experience, they may work in a variety of industries, such as academia, the military, fire and police departments, marine companies, federal agencies and many more. Scientific divers are divers that dive to do research and gather data. They might work in the fields of marine biology, geology, hydrology, fisheries, oceanography, underwater archaeology or underwater photography, just to name a few.

Diving dates back to ancient swimmers that used cut hollow reeds to breathe air and enhance their underwater abilities. Persian divers, around 1300, made basic eye goggles from thinly sliced tortoise shells. By the 16th century, primitive diving bells were made from wooden barrels. In 1771, John Smeaton, a British engineer, invented the first air pump that pumped air to a diver in a barrel. Just a year later, Sieur Freminent of France invented a device that recycled the exhaled air from inside of a barrel, which became the first self-contained air device. Unfortunately, it did not work very well, as Freminent died from lack of oxygen after 20 minutes!

It was almost 50 years later when William James of England designed another self-contained apparatus: a cylindrical iron belt attached to a copper helmet. The belt held enough air for a seven-minute dive. In 1873, Benoît Rouquayrol and Auguste Denayrouze invented a rigid diving suit with an air supply. Unfortunately, it weighed 200 pounds.! A few years later in 1876, Englishman, Henry Fleuss, invented a closed circuit, oxygen rebreather. Regrettably, he also died from his invention when he dove to 30 feet because h did not know that pure oxygen is toxic to humans under pressure.

In 1942, Emile Gagnan and Jacques Cousteau co-invented the modern demand regulator and a much improved autonomous diving suit. They redesigned a car regulator to invent the demand regulator that would automatically release fresh air when a diver breathed. They termed the regulator the Aqua-Lung, the first successful Self-Contained Underwater Breathing Apparatus. They soon began selling it to divers and then, recreational, commercial and scientific diving became popular around the world.

Today, SCUBA diving is a growing recreational activity and tool for science. With advancements in technology, archaeology went under the water, and maritime archaeology is an exciting career to pursue!

Activity Overview

Students can learn the history of SCUBA diving, through important inventors and divers. After students chose a historical figure in diving, they will create a complete summary of his/her life and tell his/her story through modern social media technology. Students will simulate creating Facebook profiles and status updates, tweets, and posting images to Instagram. Through these platforms, they will tell their person's story.

Once completed, students exchange social media updates and comment on other students' Facebook statuses. They will also indicate if they would retweet the tweet and explain why or why not. And finally, they will comment on Instagram photos and either "like" or not like them.

Templates to create fake Facebook, Twitter, and Instagram accounts can be found in many locations on the Internet. Here are two:

Mr. Akans Online
Templates for Twitter, Facebook, and Instagram
http://www.mrakansonline.com/20132014/templates-for-fake-twitterfacebookinstagram-pages

Fakebook on Classtools.net
http://www.classtools.net/FB/home-page

NOTE: If Internet is not available, provide students with fact sheets on selected dive-related individuals (sample provided). Have students use the fact sheets to create social media posts on paper or poster board (sample provided).

Objective

Students will learn how technology developed over time to modern day SCUBA diving. Students will use modern social media technology to summarize the lives of famous divers.

Teacher Preparations and Implementation

1. From the list provided or from your own, select the inventors and/or divers that you want the students to explore.
2. The assignment can be completed individually or in small groups. Print the number of activity sheets needed as per your arrangement.
3. If Internet is not available, create individual biographies for each historical individual that the students will research (see sample). Be sure to include multiple images for students to use and enough information for a complete accounting of the individual's life. Print copies of the fact sheets and of the sample Facebook, Twitter and Instagram templates for students to follow.
4. Visit Monitor NMS's Facebook page for up-to-date information and historical facts at https://www.facebook.com/pages/Monitor-National-Marine-Sanctuary/75101577927

Vocabulary

SCIENTIFIC DIVING – Diving performed as a necessary part of a scientific, research or educational activity to perform scientific research tasks

SCUBA – A portable breathing device for free swimming divers, that consists of a mouthpiece joined by hoses to one or two tanks of compressed air that are strapped onto a diver's back

SOCIAL MEDIA – Websites and other online means of communication that are used by large groups to share information and to develop social and professional contacts

Web Resources

NOAA Ocean Explorer
Learn how NOAA uses SCUBA diving in research.
http://oceanexplorer.noaa.gov/technology/diving/scuba/scuba.html

Professional Association of Diving Instructors (PADI)
Visit this site to learn more about recreational SCUBA diving and snorkeling for all ages.
http://www.padi.com/Scuba-Diving/

2009 Battle of the Atlantic
Watch this video to learn more about how maritime archaeologists survey shipwrecks.
http://sanctuaries.noaa.gov/missions/battleoftheatlantic2/bed_archaeology.mov

The Strange and Wonderful History of Diving Suits
Visit this site to see images of the various diving suits invented from 1715 to the present.
http://io9.com/the-strange-and-wonderful-history-of-diving-suits-from-1262529336

American Academy of Underwater Sciences
http://www.aaus.org/

NOAA Diving Program
http://www.ndc.noaa.gov/
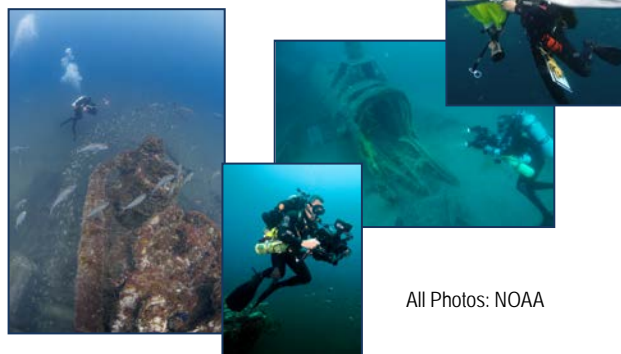
All Photos: NOAA

Name: _____   Date: _____

The People of SCUBA
Class Activity

In this lesson you will highlight the actions of specific individuals associated with SCUBA diving. You will research the following individual: _____

1. Use the Internet or provided fact sheets to research your selected individual. In your science journal, keep track of all websites visited. Make sure that any webpage that you cite is a relevant and reliable source.

2. After conducting your research, join the group(s) that is researching the same historical person and come together into an "expert" group.

3. In your expert group, discuss significant events, facts, and other pertinent information that should be included in your historical person's profile. Remember that each individual student will complete his/her own social media profile for the historical diver.

4. Once your group finishes discussions, come to a general consensus regarding the relevant items to be included in the profile.

5. Use the social media profile template to individually complete the profile. The profile should include 1) biographical information about the chosen individual; 2) work and education; 3) places he/she lived; 4) family and relationships; 5) life events; and 6) other details you determine are important.

6. On the Facebook page, complete the profile, by adding a profile image (chose from the ones given) and a cover photo. Add any friends, ads and links, as appropriate.

7. Create at least two Facebook posts (status updates) that your SCUBA diver might have posted about an important event in his/her life as a SCUBA diver.

8. Create a minimum of three tweets for Twitter. Each tweet should reflect an important milestone in your diver's career.

9. Chose a photo for your diver and post it to Instagram. Write a caption for the image citing additional details about your diver and his/her career.

10. When all the profiles, tweets, and Instagrams are completed, exchange Facebook profiles with someone who has a different diver. Write a comment on the status update that he/she created

11. Next, exchange tweets and Instagram photos with someone different. For each tweet, indicate whether you would retweet it or not and why. For the Instagram photo, indicate if you like it ♡ and write a comment about the photo.

12. Repeat steps 10-11 until you have commented on all featured divers (or as your teacher directs).

13. Write one thing that you learned about a diver (other than your own) that was of interest to you.

Historical Inventors and Divers

Pioneers of Diving
- John Smeaton (1724-1792): Air pump
- Sieur Freminent (1700s): Recycled air
- William James (lived 1800s): Iron belt
- Benoît Rouquayrol (1826 -1875) and Auguste Denayrouze (1837-1883): Rigid diving suit
- Henry Fleuss (1851-1932): Closed circuit breather
- Victor Berge (1891–1974): Helmet diving
- Émile Gagnan (1900–1979): Inventor of demand regulator
- Philippe Tailliez (1905–2002): Skin and SCUBA diving
- Philippe Diole (1908–1977): Undersea exploration
- Teseo Tesei (1909–1941): Inventor of human torpedo
- Jacques-Yves Cousteau (1910–1997): Co-inventor AquaLung
- Frédéric Dumas (1913–1991): Spearfishing, wreck diving
- Arne Zetterström (1917–1945): Mixed gas diving
- Hans Hass (1919-2013): Underwater photography
- Eduard Admetlla i Lázaro (born 1924): Inventor of SCUBA diving device and deep diving
- James F. Cahill (1926–2008): SCUBA diving
- Nick Icorn (1929-2013): SCUBA and rebreathers
- Robert Sténuit (born 1933): First Aquanaut
- Gary Gentile (born 1946): Wreck diving
- E. Lee Spence (1947-): Underwater archaeology
- Sheck Exley (1949–1994): Cave diving
- Bret Gilliam (1951-): Technical diving
- Bill Nagle (1952–1993): Wreck diving
- Wesley C. Skiles (1958–2010): Cave diving
- Jarrod Jablonski (born 1969): Technical diving
- Dick Rutkowski: (~1932) Diving medicine, diver training
- Tom Mount (DOB unknown): Technical diving

Record Holders for Depth or Cave Diving
(SCUBA and surface supplied)
- Simon Mitchell (DOB unknown)
- Claudia Serpieri (DOB unknown)
- Jim Bowden (DOB unknown)
- John Bennett (1959–2004)
- Mark Ellyatt (DOB unknown)
- Nuno Gomes (born 1951)
- Pascal Bernabé (DOB unknown)
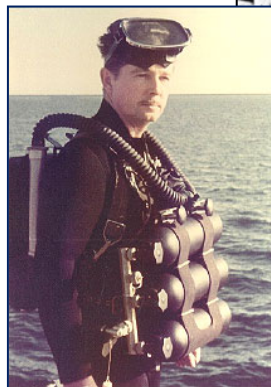
Notable for Other Reasons
- Craig B. Cooper (born 1949?): Aquanaut
- George F. Bass (born 1932): Early underwater archaeologist
- Berry L. Cannon (1935–1969): Aquanaut
- Dominic Landucci: Aquanaut
- Dewey Smith (1972–2009): Aquanaut
- Karen Kohanowich: Aquanaut
- Lionel Crabb (1909--1956): British frogman
- Carl Brashear (1931-2006): First African American US Navy Diver
- Michael C. Barnette (born 1971): Diver
- Willard Franklyn Searle (1924–2009): Inventor and diver
- Agnes Milowka (1981–2011): Technical diver
- Bob Halstead (born 1944): Diving instructor
- David Shaw (1954–2005): Technical diver
- Deon Dreyer (1974–1994): Diver
- Joachim Wendler (1939--1975): Aquanaut
- Keith Jessop (1933–2010): Salvage diver
- Leigh Bishop (born 1968): Technical diver
- Stephanie Schwabe (born 1957): Cave diver and geomicrobiologist
- Steve Lewis (born 1950): Cave and wreck diver
- Ted Eldred (1920–2005): Pioneer diver in Australia
- Trevor Jackson (born 1965): Inventor, diver
- Billy Deans (DOB unknown): Wreck and technical diver
- Fabien Cousteau (born 1967): Aquatic filmmaker and ocean explorer
- Graham Jessop (born 1957): Deep sea diver
- John Chatterton (born 1951): Wreck diver
- Jean-Michel Cousteau (born 1938): explorer, film producer, diver, environmentalist
- Richie Kohler (DOB unknown): wreck diver, historian
- Oscar Gugen (born 1910): diver
- Philippe Cousteau (1940–1979): Filmmaker, diver
- Mark Hulsbeck (born 1956): Aquanaut

Left to right: Nick Icorn, Henry Fleuss , and Jacques Cousteau

Facebook—Sample Template

Social Media Profile

Date of Birth:

Date of Death:

Work and Education:
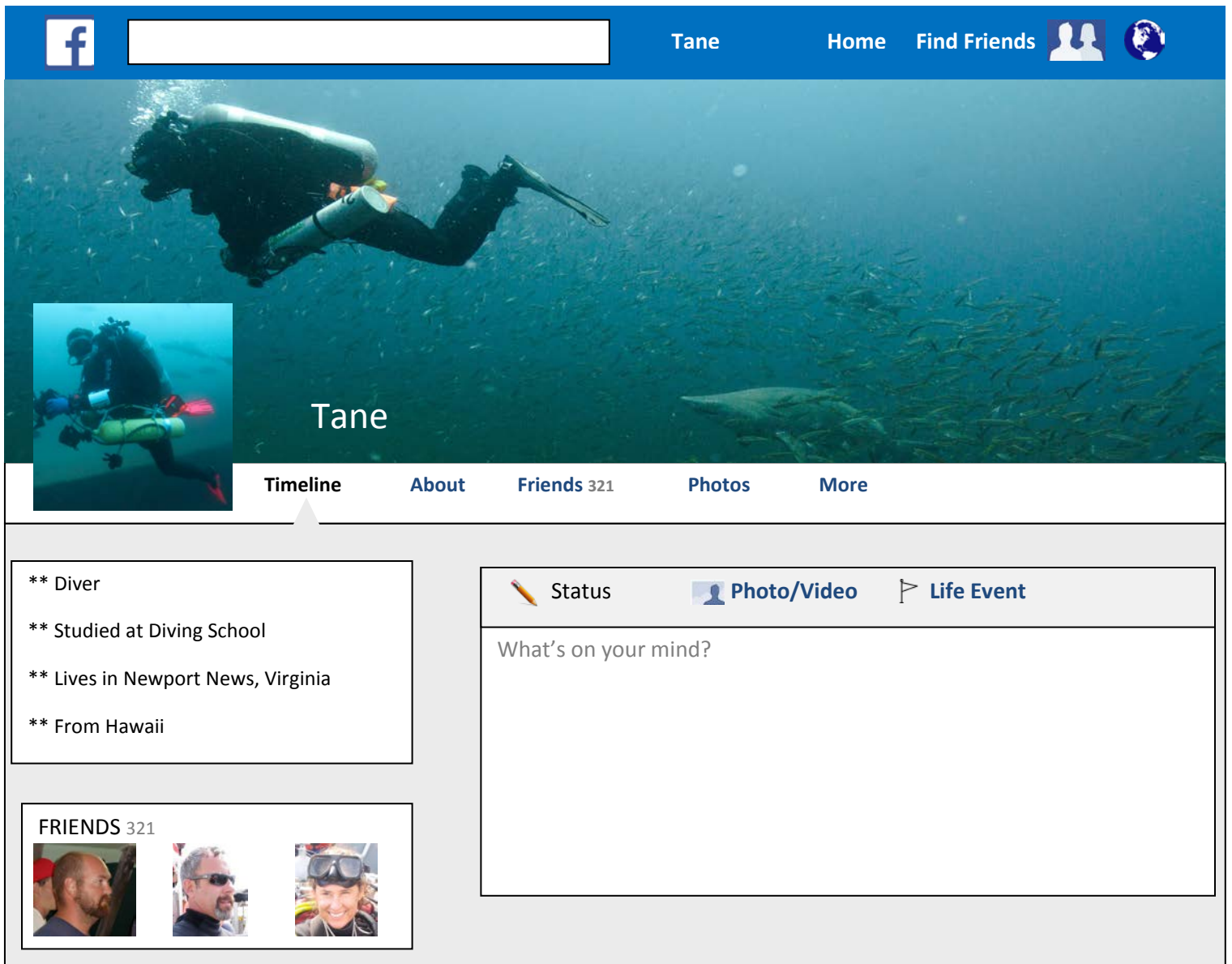
Places Lived:

Basic Information:

Family and Relationships:

Details of Life:

Major Life Events:

| f | [   ] | **Tane** | **Home** | **Find Friends** 👥 🌐 |

Tane

Timeline **About** **Friends** 321 **Photos** **More**

** Diver

** Studied at Diving School

** Lives in Newport News, Virginia

** From Hawaii

FRIENDS 321

| ✏️ Status | 👤 **Photo/Video** | 🚩 **Life Event** |

What's on your mind?

twitter

Tane
@NOAADiver

Tweets   Followers
117   5,403

Trends – Change

#WorldEmojiDay
World Emoji Day previews 36 new emojis for 2016
113K Tweets about this trend

#SHIPWRECKSARECOOL
Tane on Twitter
1.02M Tweets about this trend

Joe Hoyt
NOAA announces it finds U576: "U576 is off NC coast"
Just started trending

What's happening?

Tane @NOAADiver 14 Aug 2014
Diving on the Dixie Arrow today. Great visibility.

Tane @NOAADiver 13 Aug 2014
Gearing up to head out on the SRVx to the Dixie Arrow tomorrow.

Instagram

noaaocean   Follow

NOAA National Ocean Service
Official feed for NOAA's National Ocean Service, the nation's premier federal science agency for our ocean and coasts. Find us on Twitter@noaaocean **oceanservice.noaa.gov**

48 posts   **924** followers   **15** following

155 likes   Follow

Dixie Arrow shipwreck offers beautiful images for divers. http://monitor.noaa.gov
#DixieArrow

__missdiver__Love to dive on this wreck!

Log in to like or comment

Sample Fact Sheet

George F. Bass—SCUBA Diver and Founder of Marine Archaeology

Images of George F. Bass

From the website of the Institute of Nautical Archeaology: http://nauticalarch.org/ina-key-figures/
"George Fletcher Bass." (n.d.): n.pag. Web. May 2015.
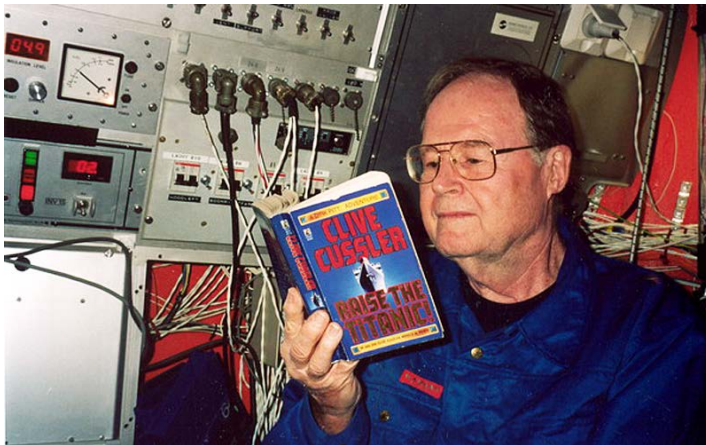
The following text is cited directly from the website of the Institute of Nautical Archeaology: http://nauticalarch.org/ina-key-figures/ "George Fletcher Bass." (n.d.): n.pag. Web. May 2015.

Biography of George Fletcher Bass, Ph.D.

"Although he began reading everything he could find on diving at an early age, and had more books about the underwater world than about archaeology even when he was a graduate student, George Bass never dreamed that he would ever dive. Certainly not that one day he would receive the Historical Diving Society's Pioneer Award.

His diving began in 1960, shortly after he began doctoral studies in classical archaeology at the University of Pennsylvania. He already had an M.A. in Near Eastern archaeology from The Johns Hopkins University, and between 1955 and 1957 had attended the American School of Classical Studies at Athens, where he gained field experience by assisting on preclassical terrestrial excavations in Greece and Turkey. From 1957 to 1959 he had learned how to direct and take care of people in remote camps while serving as the lieutenant-in-charge of a 30-man U.S. Army detachment in Korea.

So George already had the interest and most of the needed experience when, soon after his arrival in Philadelphia, he was asked by his department chairman if he would learn to dive in order to excavate a Late Bronze Age shipwreck reported by journalist Peter Throckmorton off the Turkish coast. In early 1960, after taking six diving lessons at a local YMCA, he left with Peter for Turkey, where he directed the excavation of the wreck, about a hundred feet deep off Cape Gelidonya. It was the first ancient wreck excavated in its entirety on the seabed, and the first shipwreck excavation directed and published by a diving archaeologist. At the end of the excavation, with permission from the Turkish government, George started a museum of underwater archaeology in the Bodrum castle; now fully Turkish, it is the nation's most visited archaeological museum.

George concluded that the ship, which sank around 1200 B.C. with a cargo of copper and tin ingots, and scrap bronze, was Near Eastern in origin. He further claimed, based on contemporary cuneiform documents and Egyptian tomb paintings, that such ships were common in the Mediterranean, although most scholars then believed that Canaanite, or early Phoenician, maritime commerce began only in the following Iron Age. George believed the Semites had not been recognized because their goods, raw materials like tin, copper, ivory, and gold, left no traces once they reached port and were manufactured into artifacts typical of the importing cultures. His controversial view was widely scorned.

George devoted the rest of the 1960s to the development of new techniques for underwater research while excavating Byzantine, Late Roman and Ottoman shipwrecks at Yassı Ada, Turkey: a submersible decompression chamber without surface support; a method of mapping wrecks by stereo-photogrammetry; and a two-person submersible, the *Asherah*, launched in 1964, the year he received his doctorate and joined the University of Pennsylvania faculty. To tend *Asherah*, the first commercially built American research submersible; he acquired on loan from the U.S. Navy an Army T-boat, *Virazon*, which he shipped to the Aegean. In 1967 his team was the first to locate an ancient wreck with side-scan sonar, a 280-foot-deep site inspected from *Asherah*.

In 1968, George returned to land to assist the Greek excavation at of a Bronze Age city covered by volcanic ash on the island of Santorini. Then, after another campaign at Yassi Ada, and a sabbatical year at the University of Cambridge, he decided to return to terrestrial archaeology and in 1971 began excavating a preclassical site in southern Italy.

He soon regretted leaving a field with such promise and formed the American Institute of Nautical Archaeology in 1972, when he gave the University of Pennsylvania a year's notice of his resignation. AINA's first field project was a Turkish coastal survey that located a dozen ancient shipwrecks, three since excavated, including a cargo of large jars lost around 1600 B.C. at a place called Sheytan Deresi, or Devil Creek. AINA was based on Cyprus, but war on the island in 1974 forced it to seek another home, which it found at Texas A&M University, with which it affiliated in 1976. Texas A&M in turn initiated a graduate program in nautical archaeology, which George headed until 1993.

AINA, which dropped the "American" to reflect its international staff and board of directors, becoming simply INA, quickly expanded its research to four continents. George began the first excavations of shipwrecks of the American War of Independence, the American *Defence* in Penobscot Bay, Maine, and one of General Cornwallis's British ships in the York River, Virginia, before turning them over to other scholars.

Between 1977 and 1979 George excavated at Serçe Limanı, Turkey, an 11th-century A.D. ship with three tons of broken glass; mended from a million shards over 20 years, it is the largest collection of medieval Islamic glass in existence. The site also yielded the largest collections of Byzantine tools and weapons, the world's oldest dated chess set, and the earliest known modern hull, as opposed to Greco-Roman hulls. In 1979, INA bought the old *Virazon* and outfitted it with a double-lock recompression chamber and equipment for underwater surveys and excavations.

In 1984, George began excavating a ship lost around 1300 B.C. at Uluburun, Turkey. Its cargo of raw materials— elephant and hippopotamus ivory, nearly 200 glass ingots, half a ton of terebinth resin (used as incense), ebony logs, a ton of tin ingots, and ten tons of copper ingots—as well as Near Eastern personal possessions, provided evidence that George's theory of Bronze Age Near Eastern trade, presented in his book on the Cape Gelidonya wreck, was likely correct. After 1985, George turned the Uluburun excavation over to graduate student Cemal Pulak, now on the Texas A&M University faculty.

Between 1999 and 2003, George excavated fifth- and six-century B.C. wrecks in Turkey with Deborah Carlson and Elizabeth Greene. During that time, INA acquired the two-person submersible *Carolyn* and built a 45-foot catamaran to transport, launch and retrieve it. In just one month in 2001, archaeologists in the submersible located 14 wrecks and ten possible wrecks, while revisiting a dozen wrecks known from earlier surveys.

In 1986 George received the Archaeological Institute of America's Gold Medal for Distinguished Archaeological Achievement, and a Lowell Thomas Award from the Explorers Club. The next year he received an honorary doctorate from Boğaziçi University in Istanbul, and in 1998 another from the University of Liverpool. The National Geographic Society awarded him its La Gorce Gold Medal in 1979 and, in 1988, one of its fifteen Centennial Awards. In 1999 he received the JC Harrington Medal from The Society for Historical Archaeology. President George W. Bush presented him with the National Medal of Science in 2002.

George has written or edited ten books and over a hundred articles. He and his wife Ann divide their time between College Station, Texas, and Bodrum, Turkey, where they have a house next to the INA Research Center."

Searching the Deep—Magnetometers

Crew prepares to deploy a magnetometer. Photo: NOAA

Grade Level

- 6-12

Timeframe

- 1-2 hours

Materials per Group

Activity 1
- Small bar magnet
- Clear plastic box (petri dish works well)
- Iron filings

Activity 2
- 10-cm piece of plastic straw
- 2 straight pins
- Masking tape
- 30-cm of sewing thread
- Bar magnet with poles marked

Activity Summary

Students will observe a magnetic field and make a simple magnetometer.

Learning Objectives

To understand how a magnetometer is used to search for shipwrecks.

Key Words

magnetometer

National Standards:

CCSS:ELA.LIT.RST.4 and 7; NS.5-8.F; NS.9-12.B, E and G; NGSS:HS:PS4.B.,C; OL.6 and 7

Activity E
Magnetometer

When you want to figure out the strength or direction of a magnetic field, a magnetometer is the tool you need. A magnetometer is used for two general purposes. One is to measure the magnetization of magnetic materials, such as ferromagnetic materials, which include iron, nickel, cobalt, some alloys of rare earth metals and some naturally occurring minerals such as lodestone. The second purpose of a magnetometer is to measure the strength and, in some cases, the direction of the magnetic field at a point in space.

An important distinction to note is that in remote sensing, sonar is **active**, meaning that it sends out a signal and is actively searching. Magnetometers are **passive**, meaning that they do not send out any signal or wave; they just sense the variations in a field.

Magnetometers range from the simple to the complex. The first magnetometer was created by Carl Friedrich Gauss in 1833. Mr. Gauss is often called the "Prince of Mathematics." He published a paper in 1833, describing a new device he called a "magnometer." His design was a simple one, but it led the way for the more complex magnetometers used today.

Magnetometers are widely used in geophysical surveys to detect various types of magnetic anomalies. They are also used by the military to detect submarines and can even be used as metal detectors.

There are two basic types of magnetometers measurement. First, vector magnetometers measure the vector components of a magnetic field. Second, scalar magnetometers measure only the magnitude of the vector magnetic field. Magnetometers may also be classified by their situation or intended use. Stationary magnetometers are installed to a fixed position and measurements are taken while the magnetometer is stationary. Portal or mobile magnetometers are used while in motion and may be manually carried or transported by a moving vehicle. Laboratory magnetometers are used to measure the magnetic field of materials placed within them and are typically stationary. Survey magnetometers are used to measure magnetic fields in geomagnetic surveys and may be fixed base stations or mobile to scan a geographical region.

Although you may not know it, you encounter magnetometers in your daily life. They are used at airports to screen boarding passengers for metallic weapons. They have also been miniaturized and are incorporated in integrated circuits at very low costs and are increasingly used as compasses in devices such as mobile phones and tablet computers.

Magnetometers are often used to search for shipwrecks made from iron components or other ferrous materials. A magnetometer is towed behind a research vessel to detect variations in the Earth's magnetic field that be may be caused by the iron or other magnetic materials on or embedded in the seafloor. Scientists then interpret the data looking for anomalies that might indicate a shipwreck — or a pile of ferrous rocks!

Activity Overview

In this activity, students will use iron filings and a bar magnet to observe and describe a magnetic field. Next, the students will make a simple magnetometer to better understand how it detects a magnetic field. Optional extension is to create a more complex magnetometer and collect data (see Extension section).

Objectives

Students understand a magnetic field and how magnetometers are used to search for shipwrecks.

Teacher Preparations and Implementation

1. Determine group size and collect materials needed for number of groups.
2. If needed, review magnetic fields and magnetism with students.
3. Using the background information provided or research of your own, explain to students how magnetometers are used in maritime archaeology to search for and explore shipwrecks.
4. Print copies of *There's a Meter in My Magnet Class Activity* worksheet.
5. In *Activity 1*, have students use a bar magnet and iron filings to observe a magnetic field. Students may experiment with the magnet to create different fields, such as standing the magnet on one end.
6. In *Activity 2*, cut 30 cm of sewing thread for each group. Also, pre-cut masking tape for each group.
7. Have each group build its magnetometer and experiment with the bar magnet to observe the movements of the magnetometer.

Resources
Websites

EngineersGarage
Visit this site to learn more about magnetometers and what they measure.
http://www.engineersgarage.com/articles/magnetometer

WHOI: Ocean Instruments
Understand why scientists use magnetometers, how they work, and the advantages and disadvantages of using each.
http://www.whoi.edu/instruments/viewInstrument.do?id=14847

National Geographic
Complete lesson plans for building a magnetometer and collecting data.
http://education.nationalgeographic.com/activity/build-a-magnetometer/

NOAA Ocean Explorer
A comprehensive guide with activities focused on how magnetometers survey for shipwrecks.
http://oceanexplorer.noaa.gov/explorations/15lostwhalingfleets/background/edu/magnatom_2015.pdf

Explore the Seafloor
Site has resources, interactive map, image bank, and more.
 http://ets.wessexarch.co.uk/

Kids' Resource Center
DIY fluxgate magnetometer for experimenters
http://motivationtolearn.org/wordpress/?p=1347#more-1347

YouTube
A short video that shows the basics of how to build your own magnetometer.
https://www.youtube.com/watch?v=qvHzprMSjXA

Books

Aspinall, Arnold; Christ Gaffney; and Armin Schmidt. *Magnetometer for Archaeologists.* AltaMira Press, January 16, 2009. ISBN-13: 978-0759113480.

Johnson, Jay K. (Editor). *Remote Sensing in Archaeology.* University of Alabama Press, March 19, 2006. ISBN-13: 978-0817353438.

Stanley, Bruce. *Magnetometer 158 Success Secrets: 158 Most Asked Questions on Magnetometer – What You Need to Know.* Emereo Publish, May 24, 2014. ISBN-13: 978-1488527005.

Extensions

1. Build a soda bottle magnetometer and learn how to set up and collect data. Visit this site for detailed instructions on how to create a magnetometer from a soda bottle and use a laser to collect data. This site also has algebra problems!
http://image.gsfc.nasa.gov/poetry/workbook/magnet.html
2. Have students research three different types of magnetometers and explain their differences. What are the pros and cons of each?
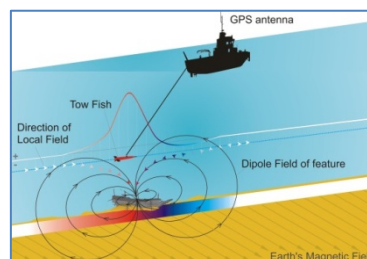
Drawing of magnetometer being towed over shipwreck. Photo: Explore the Seafloor.

Name: _____   Date: _____

There's a Meter in My Magnet
Class Activity

Magnetic field lines are invisible. We can only see the effects of the magnetic force that they exert. Magnetometers are devices used to detect and measure the strength of magnetic fields. Like compasses, magnetometers give you information about magnetic fields. They can also detect variations in the magnetic field that are caused by the presence of objects that contain iron and geological formations that contain ferrous material. A magnetometer will dip or point toward a source of magnetism.

Magnetic surveys have proven to be extremely useful in the excavation and exploration of terrestrial and underwater archaeological sites. Magnetometers were first used in the 1950s by terrestrial archaeologists in the search for ancient archaeological sites. In 1965, the first magnetometer was used in maritime archaeology in Turkey, but the results were inconclusive because of equipment problems. However, in October 1966, a magnetometer was used to locate several archaeological targets, and they have since been widely used for to locate underwater cultural heritage sites, such as shipwrecks.

Marine magnetometers come in two types: surface towed and near-bottom. Connected by cable, both are towed by a vessel and follow behind the ship by a sufficient distance so that the ship's magnetic field does not interfere with magnetic measurements. There are trade-offs to using each. Surface towed magnetometers have a wider range of detection, where near-bottom magnetometers are more accurate. The magnetic information collected is usually displayed as a numerical readout and a graph. Some systems generally use laptop computers to collect data, rather than the logging device provided by the manufacturers of the magnetometer, thus processing the data quickly.

Activity 1: Follow the directions below to observe the magnetic field around a bar magnet.

A magnet is surrounded by a magnetic field that exerts a magnetic force. When an object made of iron or another magnet is placed in the magnetic field, it reacts to the magnetic force. The magnetic field is strongest close to the magnet and weakest far away. Lines of force, or magnetic field lines, can represent the magnetic field.

1. Place the bar magnet on a flat surface.
2. Place the small, clear plastic box on top of the bar magnet.
3. Sprinkle the iron filings in the box so that they cover the area in and around the bar magnet.
4. Tap the box gently to make the pattern appear more clearly.
5. Observe and record your observations in your journal.
6. Using the diagram of a bar magnet below, draw a picture of the magnetic field lines created by the iron filings.
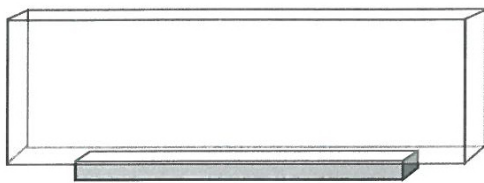
small clear box sitting on top of a magnet

N	S

Bar Magnet

Activity 2—Follow the directions to make a simple magnetometer.

1. On a small piece of masking tape, stick the straight pins so that they point in opposite directions. See Diagram 1.
2. Lay the sewing thread crosswise to the masking tape and pins so that it sticks to the tape. See Diagram 2.
3. Thread the other end of the sewing thread through the straw.
4. Pull the thread from the top to adjust the tread so that the pins at the bottom have just enough clearance to swing freely.
5. Tape the threads in place at the top of the straw. See Diagram 3.
6. Lay the tape on a flat surface with the pins facing up.
7. To magnetize the pins, stroke the pins from left to right several times with the bar magnet.
8. Pick up the straw and hold the straw so that the pins move freely.
9. Bring the north end of the bar magnet near the pins and observe what happens. If they are repelled, mark that end of the tape with an "N" for north. If they are attracted to each other, mark with an "S" for south.
10. Use the magnetometer to find magnetic objects in your classroom.

tape

straight pins in opposite directions

Diagram 1

thread

Diagram 2

thread goes through straw

tape securing thread

straw

thread
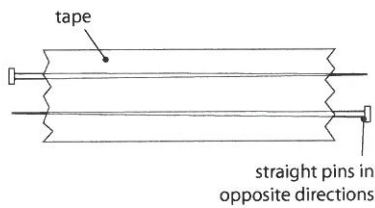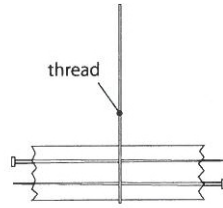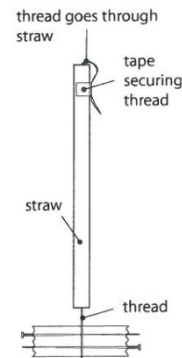
Diagram 3

A magnetometer often encounters problems when it is used in coastal waters to search for shipwrecks. What would cause the magnetometer to have issues in coastal waters that are used by people and ships and/or close to cities and towns? Write your answer below and share with your class to create a list of possible problems.

GPS antenna

Tow Fish

Direction of Local Field

Dipole Field of feature

Earth's Magnetic Field
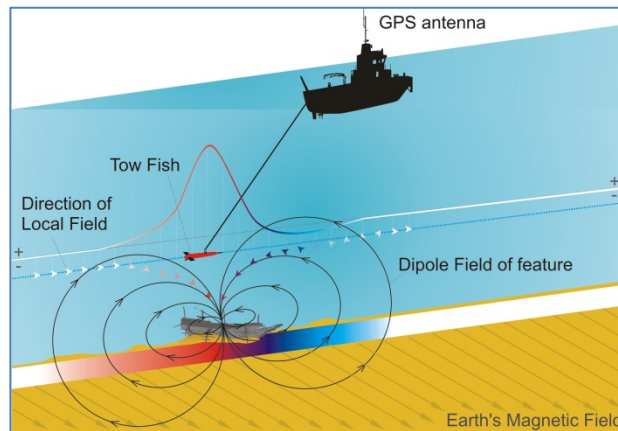
Drawing of magnetometer being towed over shipwreck. Photo Courtesy: Explore the Seafloor.

Searching the Deep — NOAA Vessels

SRVx *Sand Tiger* hosting an open house to showcase underwater archaeological research conducted off North Carolina's coast.

Grade Level

- 6-12

Timeframe

- 1-2 hours

Materials per Group

- Internet
- If Internet is not available, print copies of information needed to complete the activities

Activity Summary

Students will explore NOAA's fleet and small boat program.

Learning Objectives

To understand the types of NOAA vessels used in scientific research and to learn how small boats are used throughout U.S. waters to conduct research projects that protect our natural and cultural resources.

Key Words

Fleet, small boat, SRVx, research, mission

National Standards:

CCSS:ESL.LIT.RST.1; NCTE:1, 7; NS:5-8.E, F and G; NS:9-12.E and G; NGSS:MS-ETS1.A and B, OL.6 and 7

Activity E

NOAA Vessels

NOAA ships and aircraft play a critical role in the collection of oceanographic, atmospheric, hydrographic, and fisheries data. The NOAA fleet is managed and operated by the Office of Marine and Aviation Operations (OMAO), an office composed of civilians and officers of the NOAA Commissioned Corps. OMAO also manages the NOAA Diving Program and the NOAA Small Boat Program.

OMAO's research and survey ships compose the largest fleet of federal research ships in the nation. The fleet ranges from large oceanographic research vessels capable of exploring the world's deepest ocean, to smaller ships responsible for charting the shallow bays and inlets of the United States. The fleet supports a wide range of marine activities including fisheries research, nautical charting, and ocean and climate studies.

OMAO's aircraft operate throughout the world to perform a wide range of services including hurricane reconnaissance and research, marine mammal and fisheries assessment, and coastal mapping. NOAA aircraft carry scientists and specialized instrument packages to conduct research for NOAA's missions.

In addition to research and monitoring activities critical to NOAA's mission, OMAO ships and aircraft provide immediate response assistance for unpredictable events. Following Hurricanes Katrina and Rita, NOAA ships conducted emergency surveys for navigation hazards that helped Gulf ports reopen quickly. Aerial images of disaster-torn areas—taken by NOAA aircraft—enabled residents and emergency workers to verify the condition of houses, bridges and roads.

NOAA's fleet is divided into three regions: 1) Atlantic; 2) Pacific; and 3) Pacific Islands. The Atlantic Fleet has nine vessels: *Ronald H. Brown, Henry B. Bigelow, Ferdinand Hassler, Nancy Foster, Gordon Gunter, Okeanos Explorer, Thomas Jefferson, Oregon II,* and *Pisces.* The Pacific Fleet has five vessels: *Oscar Dyson, Bell M. Shimada, Rainer, Fairweather,* and *Reuben Lasker.* There are two vessels in the Pacific Islands Fleet: *Hi'ialakai* and *Oscar Elton Sette.*

NOAA's small boat program has over 600 boats in inventory. These boats are used to conduct research at a variety of field sites. To see the inventory of boats, visit http://www.sbp.noaa.gov/inventory/index.html.

Activity Overview

In this activity students will use the Internet or fact sheets to explore the vessels used to support NOAA's missions. Through various websites, students can also learn about the 50+ small boats that are used for research throughout U.S. waters.

Objectives

To explore NOAA fleet vessels and the missions they support. To understand the types of research conducted by NOAA and the Office of National Marine Sanctuaries (ONMS). To discover the various types of boats in the small boat program.

Teacher Preparations and Implementation

1. Review the websites listed in the activity. Bookmark the sites or create a Livebinder for students to access. For more information on Livebinders visit http://www.livebinders.com/.
2. If Internet is not available for students, visit the sites and print the necessary information for students to answer the questions. In Activity 1, enlarge the map before printing and print the information box for each small boat that you want students to explore as they follow the class activity student directions.
3. Print copies of *Where's the Boat? Class Activity* for each student.
4. Discuss with the students the importance of scientific research and how research helps us to understand our world and to better protect our natural and cultural resources.
5. Give an overview of NOAA's fleet and small boat program and the important role they play in our nation's waterways and ocean.

Resources
Websites

NOAA's Marine Operations
Visit this site to learn about the vessels in NOAA's fleet and the missions that they accomplish.
http://www.moc.noaa.gov/

NOAA's Commissioned Officer Corps
As one of the seven uniformed services, NOAA Corps is an integral part of NOAA. Learn more about the Corps, its mission and history.
http://www.noaacorps.noaa.gov/

NOAA's Ocean Explorer
A collection of educational materials to use with your students as you dive into ocean exploration.
 http://oceanexplorer.noaa.gov/edu/welcome.html

NOAA's Teacher at Sea
A program that provides teachers hands-on, real-world research experiences working at sea with NOAA scientists onboard NOAA vessels. Visit the site for more information on how to apply.
http://teacheratsea.noaa.gov

NOAA's Small Boat Program
View a map that depicts the location of over 50 small boats and learn about their mission.
http://www.sbp.noaa.gov/geo/map.html

NOAA's Office of National Marine Sanctuaries
ONMS conducts research in 13 national marine sanctuaries and two marine national monuments. Discover the various missions and the boat that supports them.
http://sanctuaries.noaa.gov/about/vessels/welcome.html

YouTube — NOAA Small Boat Program
Watch a three minute video on the various boats and research conducted in the sanctuary program.
http://youtu.be/lP8DV8_S4XQ

Extensions

A research design is the blue print of a study that defines the research question, hypotheses, independent and dependent variables, experimental design, data collection, analysis, peer review, and other parameters set by the researcher(s). To extend the learning, have students determine an ocean research project, such as exploring and documenting the newly discovered German U-boat, U-*576*. Then have them write a research plan; the plan can be from simple to detailed, depending on the grade level. Once a research plan is developed, have the students explore the NOAA ships and boats to determine the best vessel to use to conduct their research.

SRVx *Sand Tiger* typically operates along the East Coast. Photo: NOAA

Name: _____   Date: _____

Where's the Boat?
Class Activity

NOAA ships and aircraft play a critical role in the collection of oceanographic, atmospheric, hydrographic, and fisheries data. The NOAA fleet is managed and operated by the Office of Marine and Aviation Operations (OMAO), an office composed of civilians and officers of the NOAA Commissioned Corps. OMAO also manages the NOAA Diving Program and the NOAA Small Boat Program.

OMAO's research and survey ships compose the largest fleet of federal research ships in the nation. The fleet ranges from large oceanographic research vessels capable of exploring the world's deepest ocean, to smaller ships responsible for charting the shallow bays and inlets of the United States. The fleet supports a wide range of marine activities including fisheries research, nautical charting, and ocean and climate studies.

NOAA's fleet is divided into three regions: 1) Atlantic, 2) Pacific and 3) Pacific Islands. The ships are run by a combination of NOAA Commissioned Officers and wage marine civilians. The wage marine personnel include licensed masters, mates and engineers, and unlicensed members of the engine, steward, and deck department. In addition, survey and electronic technicians operate and/or maintain the ship's mission, communication and navigation equipment. The ship's officers and crew provide mission support and assistance to embarked scientists from various NOAA laboratories, as well as the academic community.

NOAA Atlantic Fleet

Ronald H. Brown

Henry B. Bigelow

Ferdinand Hassler

Nancy Foster

Gordon Gunter

Okeanos Explorer

Thomas Jefferson

Oregon II

Pisces

NOAA Pacific Fleet

Oscar Dyson

Bell M. Shimada

Rainier

Fairweather

Reuben Lasker

NOAA Pacific Islands Fleet

Hi'ialakai

Oscar Elton Sette

Activity 1—Exploring NOAA's Fleet

1. Go to http://www.moc.noaa.gov/. If Internet is not available, review the fact sheets given.
2. Select a ship to explore and write its name here _____.
3. What type of ship is it (classification)? When was it commissioned? Where is its home port?
4. What type of scientific equipment does it carry?
5. What are its cruising speed, range, and endurance? What limits its endurance?
6. Go to the photo gallery and select your favorite image and describe it or copy and paste it into a document to print.

Activity 2 — NOAA's Small Boat Program

1. Go to NOAA's map that shows the location of over 50 small boats in NOAA's operations. http://www.sbp.noaa.gov/geo/map.html

2. Scroll to zoom in on Virginia. Use your mouse and scroll over the red balloon located in Newport News, Va. What boat does the balloon represent? _____

3. Click on the red balloon. What is the overall length of the vessel? What is its mission? Who is the Vessel Operations Coordinator?

4. Scroll back to the larger-scaled map. Choose a boat to explore on the West Coast and answer the questions in step 3.

5. Repeat step 4 with a boat in Alaska, the Pacific Ocean, the Gulf of Mexico, Florida, and New England.

6. Which boat is located on Lake Michigan?

7. Which state has the most NOAA small boats? Why do you think they have more than other states? To view an image of a small boat, visit http://www.sbp.noaa.gov/inventory/index.html.

8. In Washington State, there is one boat that is not directly on the coast. Click on the red balloon. Where is its home port? Do research on the town and explain how it is connected to Lewis and Clark.

9. Go to http://sanctuaries.noaa.gov/about/vessels/welcome.html and scroll down to "Our Current Fleet." Read about the Office of National Marine Sanctuaries' (ONMS) fleet of boats. Where does the SRVx and Manta typically operate? How many class III boats are there?

10. Watch the national marine sanctuaries' YouTube video on the small boat program. http://youtu.be/IP8DV8_S4XQ

    a. Where do they operate (how many marine protected areas)? How many square miles?
    b. Name three things the program offers on its boats.
    c. What type of research is conducted on small boats?
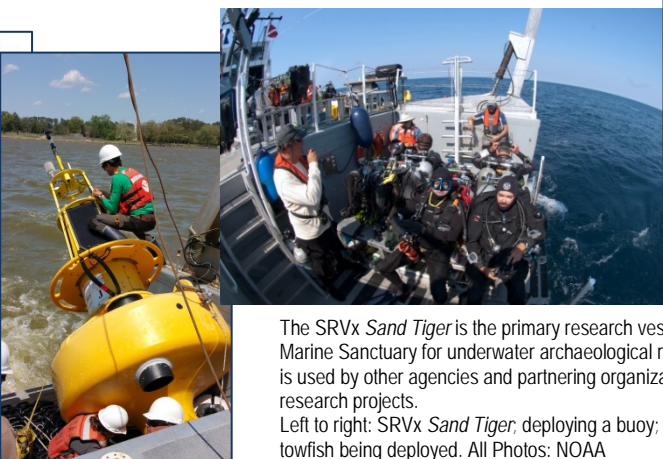
The SRVx *Sand Tiger* is the primary research vessel used by Monitor National Marine Sanctuary for underwater archaeological research. The boat, however, is used by other agencies and partnering organizations for a variety of research projects.
Left to right: SRVx *Sand Tiger*; deploying a buoy; divers waiting to dive; and a towfish being deployed. All Photos: NOAA

http://monitor.noaa.gov

Section E
Documenting Shipwrecks

- Parts of a Ship
- Photomosaics
- Mapping and Site Plans

I Can Name that Part

USS *Constitution* Photo: U.S. Navy

Grade Level

- 6-12

Timeframe

- 1-2 hours

Materials

- Internet (optional)
- Books, articles and other resources for nautical terms

Activity Summary

This lesson helps students to learn the terminology associated with ships and to identify a ship's parts.

Learning Objectives

Students will learn the names of various parts of a ship; become familiar with nautical terms and their etymology; and learn the origin of phrases used today.

Key Words

amidships	keel
anchor	line
bow	mast
deck	port
fore and aft	starboard
hull	stern

National Standards:

NCTE:1 and 9; CCSS:ELA.LIT.RL.4; CCSS:ELA.LIT.W.3; CCSS:ELA.LIT.RH.4; OL.6 and 7

Background

Every profession has its own terminology and jargon, and sailing is no exception. The English language is well-known for its tendency to borrow words and phrases from other languages and to adapt them for its own. Many words and phrases come from our maritime history and have distinctly nautical overtones that are still recognized today. Words like bow, stern, port, starboard, jibe, head, yardarm, sheet, and scuttlebutt are just a few.

Where did these terms come from? Many and varied places. Since our country's beginning, England and the United States have shared a common language and a long maritime heritage, so it is only natural that many words have survived to the present day. Other seafaring nations have even contributed a few of their own. And although many of the terms and phrases are spoken today, most people probably have no idea where they came from. For example, stern is the back of a boat or ship and it comes from the Old Norse *stjorn* or Old Frisian *stiarne*, which means steering; the oar used to steer a Norse vessel was usually located at the stern.

As a maritime archaeologist, it is important to have a working knowledge of nautical terms, so in this activity, dive in and see if you can learn the lingo.

Activity Overview

Students use books, articles, websites and other resources to identify the various parts of a ship and become familiar with nautical terms, phrases and their origins.

Objectives

Students will learn the names of various parts of a ship. They will become familiar with nautical terms and their etymology. Students will look at phrases used today to learn about their origins in maritime history.
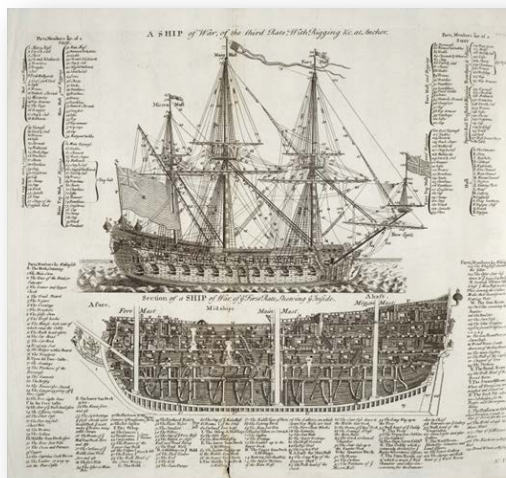
Diagram of various parts of a ship. From Cyclopaedia, Volume 2, 1728

Teacher Preparations and Implementation

- Gather books, articles or other resources that describe the parts of a ship and explain the origins of nautical terms.
- Visit the suggested websites and review each or use websites of your choosing.
- Print activity sheet, *I Can Name that Part*, for each student.
- Have students review the resources and identify as many parts of the ship as possible and label the diagram.
- When finished, have students choose five words and/or phrases and research their origins to share with the class. Create a class chart of nautical terms and phrases. **Possible terms and/or phrases**—took the wind out of his sails; wallop, scuttlebutt; S.O.S; port hole; mayday; log book, hunky-dory; he knows the ropes; feeling blue; devil to pay; cup of Joe; eight bells; chewing the fat; above board; listless; head; three mile limit; starboard; splice the main brace; pea coat; long shot; holystone; and others you choose.

Extensions

- Have students create an illustrated book of nautical terms and share them with younger students.
- Using nautical terms, create a digital story that depicts a day in the life of a sailor.

Resources
Websites

Boatsafe
http://www.boatsafe.com/nauticalknowhow/gloss.htm
and for origins of terms
http://www.boatsafe.com/nauticalknowhow/terms0101.htm

The Phrontistery
http://phrontistery.info/nautical.html

Glossary of Nautical Terms (circa. 1814)
http://www.woronorafire.org.au/maritime/Glossary.html

National Marine Institute
http://www.marineinstitute.org/nautical%20terms.htm

Nautical & Sailing Terms & Nomenclature
Great diagrams with an extensive glossary.
http://www.photographers1.com/Sailing/NauticalTerms&Nomenclature.html

U.S. Navy — Origins of Navy Terminology
http://www.navy.mil/navydata/traditions/html/navyterm.html

The Goat Locker — Naval Terms & Phraseology
Download this PDF file for an extensive list of terms and their origins.
http://goatlocker.org/resources/nav/navyterms.doc

See-the-Sea
List of terms and their origins.
http://see-the-sea.org/nautical/naut-body.htm

Web Tools for Teachers: Digital Storytelling
http://evscicats.com/blog/web-tools-for-teachers-digital-storytelling/

Books

Isil, Olivia. *When a Loose Cannon Flogs a Dead Horse There's the Devil to Pay: Seafaring Words in Everyday Speech.* International Marine/Ragged Mountain Press, April 1996. ISBN 13: 978-0070328778.

Paasch, Heinrich. *Paasch's Illustrated Marine Dictionary: Originally Published as "From Keel to Truck".* Skyhorse Publishing, July 2014. ISBN-13: 978-1628738018.

Smyth, Admiral W. H. *The Sailor's Word Book: The Classic Source for Over 14,000 Nautical and Naval Terms.* Conway, February 2010. ISBN 13: 978-0851779720.

Blackbeard the Pirate. Photo: North Carolina Department of Cultural Resources

Name: _____   Date: _____

Parts of a Ship
Class Activity

There are many parts to a ship, and ships have changed through time. Centuries ago, the age of wooden ships and sails ruled the sea. Soon steam powered ships came into power and wood changed into metal. Today, many ships, especially military ships, are even nuclear powered. However, no matter what century a ship sailed, there are certain parts of the ship that have remained constant. See how many parts of the ship pictured below you can match with the following definitions.

_____**amidships** — The middle of the ship, either lengthwise or widthwise, or both

_____**anchor** — A large hook attached to the ship which is cast overboard and digs into the sea bed to keep the ship from moving

_____**bow** — The front of the vessel

_____**deck** — Floors on a ship; each level is called a deck.

_____**fore and aft** — From the bow to the stern; fore is towards the front and aft is towards the back.

_____**hull** — The main body of the boat; it may have more than one level.

_____**keel** — The timber or metal at the very bottom of the hull that runs from the bow to the stern, often called the ship's backbone

_____**line** — Sailor's word for rope

_____**mast** — The tall vertical pole on a boat which supports the spars and sails

_____**port** — When facing the bow, the left side of a ship

_____**starboard** — When facing the bow, the right side of a ship

_____**stern** — The back of a vessel

K — Left Side of Ship

L — Right Side of Ship

C

G

E
(an area of the ship)

B
(the thing you stand on)

A

D

J

I

F

H

I
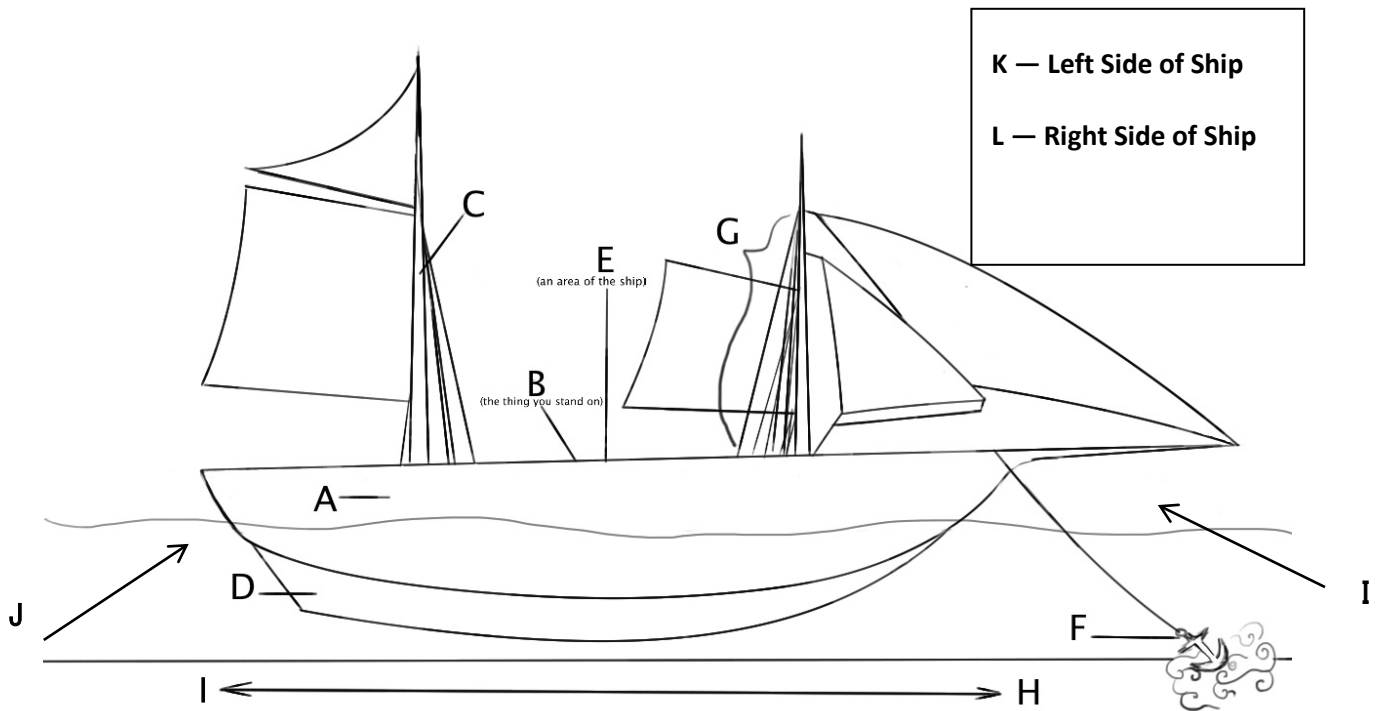
Name: _____   Date: _____

Parts of a Ship—Continued
Nautical Terms—Class Activity

Every profession has its own terminology and jargon, and sailing is no exception. The English language is well-known for its tendency to borrow words and phrases from other languages and to adapt them for its own. Many words and phrases come from our maritime history and have distinctly nautical overtones that are still recognized today. Words like bow, stern, port, starboard, jibe, head, yardarm, sheet, and scuttlebutt are just a few.

Where did these terms come from? Many and varied places. Since our country's beginning, England and the United States have shared a common language and a long maritime heritage, so it is only natural that many words have survived to the present day. Other seafaring nations have contributed a few of their own. And although many of the terms and phrases are spoken today, most people probably have no idea where they came from. For example, stern is the back of a boat or ship and it comes from the Old Norse *stjorn* or Old Frisian *stiarne*, which means steering; the oar used to steer a Norse vessel was usually located at the stern.

As a maritime archaeologist, it is important to have a working knowledge of nautical terms, so in this activity, dive in and see if you can learn the lingo.

Nautical Terms: took the wind out of his sails; wallop, scuttlebutt; S.O.S; port hole; mayday; log book, hunky-dory; he knows the ropes; feeling blue; devil to pay; cup of Joe; eight bells; chewing the fat; above board; listless; head; three mile limit; starboard; splice the main brace; pea coat; long shot; holystone; and others you choose.

1. Using various resources, identify the origin of five nautical terms.
2. Define the term and explain how it is used by sailors.
3. Give a description of how and where the term originated.
4. As a class, share the nautical terms defined and create a class chart of all terms.
5. Write a creative story that uses the nautical terms you learned.

Left: Scuttlebutt. **Center:** Devil to Pay. **Right:** Holystone.
All images: Naval History and Heritage Command

Putting the Pieces Together—Photomosaics

Photomosaic of the *Monitor*'s turret.
Photo: NOAA's *Monitor* Collection

Grade Level

- 6-12

Timeframe

- 1 hour or less

Materials per Group

Activity A

- Photomosaic image
- Scissors
- Tape

Activity B

- Digital camera
- Ability to print
- Scissors
- Tape
- Internet (optional)

Activity Summary

Students simulate how archaeologists document and survey a shipwreck.

Learning Objectives

To recognize the importance of archaeology in documenting shipwrecks and to simulate creating a photomosaic.

Key Words

See Vocabulary Box

National Standards:

NCSS:VIII; CCSS.ELA.LIT.RST.3; OL.6 and 7

Background Information

How do maritime archaeologists study shipwreck sites? One way is for SCUBA divers to dive down to a wreck to observe and record what they see. When archaeologists study a site, they carefully document the shipwreck and its artifacts. That means they take many measurements, make drawings, and take pictures and video of the site.

When archaeologists make a carefully measured drawing of a shipwreck, it is called a site plan. If archaeologists piece together the video or pictures from a shipwreck site, they create a photomosaic. Photomosaics are made of several overlapping pictures taken in sequence and then put together, like a jigsaw puzzle, to create a much larger picture. Photomosaics are very useful in studying shipwreck sites, because archaeologists can see exactly what the wreck looks like on the bottom of the ocean or a lake.

Sometimes when a shipwreck site, such as the *Monitor*, is in very deep water and archaeologists cannot spend a long time underwater at the site, they use remotely operated vehicles (ROVs) to take pictures and video for them. ROVs are a useful way to document a shipwreck site because they do not require air, like SCUBA divers, so they can stay on the bottom for a very long time.

In 1974, National Geographic and *Monitor* National Marine Sanctuary created a complete photomosaic of the wreck of the USS *Monitor*. Photos of small sections of the sunken ironclad were joined together to form a detailed image of the entire wreck site. The task of fitting all the images together was a difficult and lengthy process, but the product provided invaluable information for scientists and managers that study the site.

From the early 1990s to 2002, archaeologists recovered numerous artifacts from the *Monitor*, including the steam engine, propeller, cannons and its famous rotating gun turret. With all the changes to the site, it was imperative that an updated photomosaic be created to document the changes and status of the wreck site. In the summer of 2006, MNMS worked with the University of Rhode Island and the Institute for Exploration to create a new partial photomosaic of the *Monitor*. In 2015, dive teams continued to document and survey the *Monitor* and a new photomosaic and site plan will be created.

Photomosaics are like snapshots in time of a shipwreck and aid maritime archaeologists in studying the site, the ship, its past and the culture of its day. Photos capture details that are often unseen or not remembered days, weeks, or years later.

Activity Overview

Students will simulate creating a photomosaic by using a photomosaic of the USS *Monitor* and cutting it into pieces and then having another student reassemble it. The students will also research and discuss how photomosaics are made today and why it is important to document a shipwreck with images.

Objectives

Students will 1) simulate creating a photomosaic to understand the different facets of researching and documenting a shipwreck; 2) describe how photomosaics help archaeologists document and interpret shipwrecks; and 3) visually identify parts of a ship based on photographic evidence.

Teacher Preparations and Implementation

1. For each group, download and make copies of the *Monitor* photomosaic from this website: http://monitor.noaa.gov/publications/education/mosaics/mosaic_image.jpg
2. Be sure to retain one original copy of the photomosaic for comparison.
3. Make copies of the *Class Activity* page.
4. Use the background information and other resources to lead students in a class discussion of how maritime archaeologists document shipwrecks and why. Explain the importance of taking pictures of a shipwreck so as to capture things that divers might not see or forget they saw in years to come.
5. Describe the process of creating a photomosaic. One example is to ask the students if they can take panoramic images with their cell phones or digital cameras and then explain that the "stitching" process is similar, just on a larger scale and with the aid of computer software.
6. Allow students to work individually or in groups and begin the activity.

Resources

Web Sites

Monitor National Marine Sanctuary
Visit the 150th anniversary legacy website to learn more about the sailors who died and the efforts taken to identify them.
http://monitor.noaa.gov/150th

NOAA's National Marine Sanctuaries: Photomosaic Gallery
Here you will find examples of photomosaics created for the various shipwrecks located in some of the national marine sanctuaries.
http://sanctuaries.noaa.gov/missions/2006fknms/photomosaicgallery.html

NOAA's Battle of the Atlantic
Visit this site to learn more about the expeditions from 2008-2011 to document World War II shipwrecks located off the North Carolina coast.
http://sanctuaries.noaa.gov/missions/battleoftheatlantic/archives.html

Thunder Bay National Marine Sanctuary
With over 200 shipwrecks in Thunder Bay NMS, maritime archaeologists continuously document the sites for future study. Visit Thunder Bay's education site to download photomosaic images, site plans, and lesson plans to delve deeper into the underwater world of shipwrecks.
http://thunderbay.noaa.gov/pdfs/piecetogetherteacher.pdf

Immersion Learning: Mapping Shipwrecks
Online interactive activity where you choose any one of five shipwrecks and then try your hand at piecing together the photomosaic.
http://www.immersionlearning.org/index.php?option=com_wrapper&Itemid=215

Gizmo's Freeware
Free image stitching software. Featured are Microsoft Image Composite Editor, Autostitch, Windows Live Photo Gallery, and Panorama Perfect Lite.
http://www.techsupportalert.com/best-free-digital-image-stitcher.htm

U.S. Navy, YP-*389*
In 2009, the shipwreck was discovered by NOAA maritime archaeologists lying at about 400 feet below the ocean's surface. An ROV (below) with cameras was deployed to the site to take images that were stitched together to create this photomosaic (right). Both Photos: NOAA

Vocabulary

MARITIME ARCHAEOLOGY — A discipline that studies human interaction with the sea, lakes and rivers through the study of vessels, shore side facilities, cargoes, and human remains

IMAGE STITCHING — A process of combining multiple photographic images with overlapping fields of view to produce a segmented panorama or high-resolution image; commonly performed through the use of computer software.

PANORAMA — An unbroken view of the whole region surrounding an observer; a picture or photograph containing a wide view

PHOTOMOSAIC — An image composed of many smaller photographs, which are stitched together using a computer to create one large picture

ROV — Remotely Operated Vehicle; underwater vehicle that is operated remotely from a ship through a tether and does not carry a crew; ROVs help archaeologists to document shipwreck sites.

SITE LAN — A scaled drawing of a shipwreck and its artifacts as they lay on the bottom of the sea or a lake

Books

Adams, Simon. *Titanic (DK Eyewitness Books).* DK Children, 2009. ISBN-13: 978-0756650360.

Bowens, Amanda (Editor). *Underwater Archaeology: The NAS Guide to Principles and Practice.* Blackwell Publishing (2nd Edition), 2009. ISBN-13: 978-1405175913.

Cerullo, Mary M. *Shipwrecks: Exploring Sunken Cities Beneath the Sea.* Dutton Juvenile, 2009. ISBN-13: 978-0525479680.

Platt, Richard. *DK Eyewitness Books: Shipwrecks.* DK Children, 2005. ISBN-13: 978-0756610890.

Smith, K.C: *Exploring for Shipwrecks (Watts Library).* Franklin Watts, 2000. ISBN-13: 978-0531164716.

Wall, Julia. *Mapping Shipwrecks with Coordinate Planes (Real World Math: Level 5).* Capston Press, 2011. ISBN-13 978-1429666176.

Extensions

1. Have students create their own photomosaic by taking many pictures of any item of their choice and then overlapping the images to create one large picture.
2. Send an email to Monitor NMS to find out more about the *Monitor*'s current status and what other archaeological expeditions are planned for the future.
3. Have students visit the 2009 Battle of the Atlantic website to learn how an ROV helped to identify an unknown WWII shipwreck. http://sanctuaries.noaa.gov/missions/battleoftheatlantic2/

Above: Photomosaic of German U-boat, U-*85.* Photo: NOAA

Above: Photomosaic of German U-boat, U-*352.* Photo: NOAA

Name: _____ Date: _____

Putting the Pieces Together
Class Activity

Photomosaics

A photomosaic is an image created by piecing together hundreds of other images from photos or video. The photomosaic allows maritime archaeologists to document and survey shipwrecks more clearly.

Activity A:
1. Using scissors carefully cut around the dotted lines of the mosaic.
2. Cut the mosaic apart into 5-10 puzzle pieces.
3. Exchange your puzzle pieces with another group.
4. Look carefully at the other group's puzzle pieces and complete the puzzle.
5. Use tape to hold the pieces together.
6. Compare your puzzle to the original image.
7. Does your puzzle look the same or different?
8. Compare the photomosaic to the site plan.
9. Using the USS *Monitor* 1974 Site Plan, identify various parts of the ship on the photomosaic.

Activity B:
1. Select an area of your classroom and use a digital camera to take at least 5-10 photos of the area in different locations.
2. Download and print the images onto regular copy paper.
3. Repeat steps 3-7 from Activity A.
4. Optional: If image stitching software is available, stitch your pictures together digitally.

Discussion:
1. How might archaeologists use photomosaics to better understand shipwrecks?
2. What was most difficult about putting the puzzle pieces together? What would have made it easier?
3. Describe the process for how you identified parts of the ship using the site plan.
4. What factors may have caused deterioration of the *Monitor*?
5. Was it easier or more difficult putting your own pictures together? Why or why not?

USS *Monitor* 1974 Photomosaic

USS *Monitor* 1974 Site Plan

The USS *Monitor* sank on December 31, 1862. When the ship sank, it flipped upside down. The turret fell off and the ship landed on top of the turret. In 1974, the site plan below shows that much of the ship was intact, but there were many deteriorated areas.

Bow

Mid-ships Bulkhead

Starboard

Lower Hull
(Engineering Space)

Propeller Shaft

Anchor Well

Port

Skeg

Armor Belt

Turret

Stern
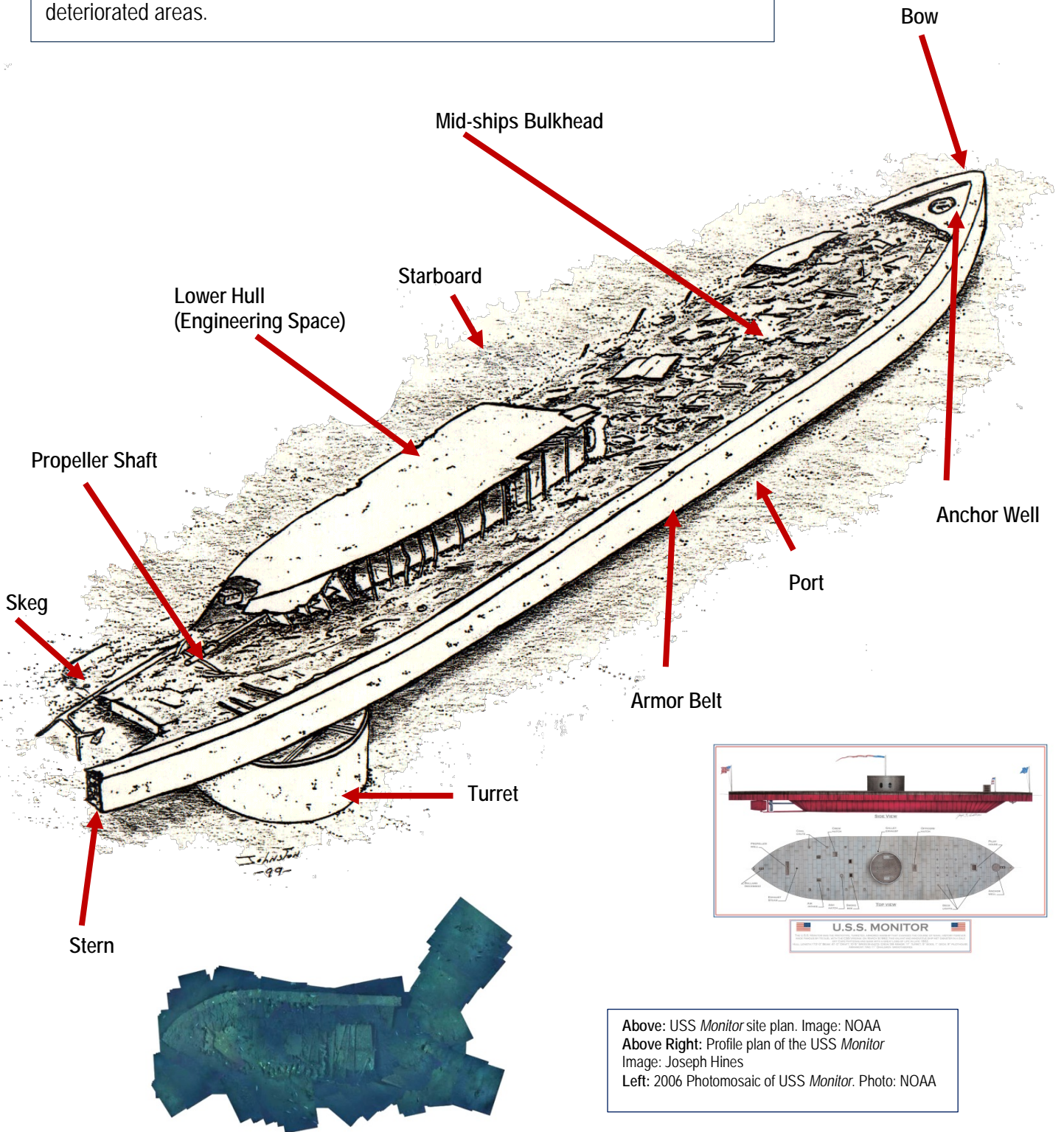
Above: USS *Monitor* site plan. Image: NOAA
Above Right: Profile plan of the USS *Monitor*
Image: Joseph Hines
Left: 2006 Photomosaic of USS *Monitor*. Photo: NOAA

U.S.S. MONITOR

Mock Shipwreck: Mapping the Past

Students map a mock shipwreck.
Photo: NOAA

Grade Level

- 6-12

Timeframe

- 45-90 minutes

Materials

- Mock shipwreck tarp/outline
- Tape (Scotch/duct)
- 30 ft. of measuring tape
- Shorter measuring tape (one for each group)
- *Log Sheets* (provided)

Activity Summary

This lesson engages students to map a mock shipwreck to create a site plan using scale drawings

Learning Objective

To understand maritime archaeology and describe its importance in preserving our maritime heritage. To measure and draw to scale. To make inferences based on observations.

Key Words

See Vocabulary Box

National Standards:

NCTM:9-12:G, M; NCTE:4 and 5; NS.5-8.E, F and G; NS.9-12.E and G; NGSS:HS-ETS1.C; OL.6 and 7; NCSS:VIII

Background

During World War II, many battles were fought on foreign shores. However, few people know about those fought closer to home. The Battle of the Atlantic consisted of several skirmishes and decisive maneuvers between German U-boats and Allied and merchant ships all along the shorelines of the Atlantic Ocean including the United States.

The German U-boats were under orders to prevent merchant vessels from getting supplies to Allied nations. The United States deployed their own ships to act as defensive escorts armed with anti-submarine weapons. Many German and Allied and merchant ships fought and sank off the North Carolina and Virginia coasts.

The wrecks of these sunken ships still lie at the bottom of the ocean. It is the job of maritime archaeologists to find and study these links to our past in order to better understand our history, conserve our heritage, and honor the memory of those who died defending our nation's future.

To better understand these cultural resources, maritime archaeologists document them by physically mapping the shipwrecks. Once the shipwreck is mapped, a site plan is created. During the dives, numerous images are taken to enhance the detail of the site plan and to provide a complete photo documentation of the resource. This thorough documentation gives researchers a complete snapshot of the shipwreck at that moment in time, thus allowing them to study the site, learn about its history and even gather information on how shipwrecks deteriorate over time.

Activity Summary

Maritime archaeology is a field of study that provides many career opportunities based in science, technology, engineering, and mathematics (STEM). The focus of this lesson is the creation of a shipwreck site plan. The students engage in teamwork as "divers" to create sectioned, scaled drawings of a mock shipwreck. The students make connections to maritime history, mathematics, and technology.

NOTE: Extension activities incorporate English language and social studies.

http://monitor.noaa.gov

Learning Objectives

Students will be able to:

- Define maritime archaeology and describe its importance to our national maritime heritage.
- Employ measuring and scaling techniques to sketch drawings of a mock shipwreck to better understand how divers document an actual shipwreck.
- Determine the scale factor of their drawing in relation to the mock shipwreck.
- Make inferences about the mock shipwreck based on observations.

Teacher Preparations and Implementation

- Set-up the mock shipwreck
  - Use diagram on *Teacher's Page* or create your own shipwreck outline on canvas, bed sheets, pavement, or another large surface (approximately 20 ft. in size) using tape, chalk, markers, or another medium of your choice.
- Download and print *Log Sheets*.
- Optional: Place 3-dimensional objects on template to represent key artifacts
- Provide background information on shipwrecks, the Battle of the Atlantic, the role of maritime archaeology in the study of history, the use of a site plan as a visual aid to archaeologists, and the purpose of scaling a large object as a smaller image.
- See *Activity 1: Sketching Sections of the Wreck* for detailed implementation procedure.
- Optional: Use images given to create a PowerPoint so that students have visual clues to map a shipwreck. Have students view video listed in Resource Section to learn how maritime archaeologists document shipwrecks.

Activity 1: Sketching Sections of the Wreck

1. Give each student a *Mapping a Shipwreck Student Activity Sheet.*
2. Group the students into pairs with one as the Measurer and the other as Recorder.
3. Give each pair of students a measuring tape, clipboard, and *Log Sheet*. Have students write their names on the back of their log sheet. Each Log Sheet designates a specific section of the ship. Students should note their section.
4. Discuss the scaling required: 1 square on the Log Sheet grid is equivalent to 2 inches on the tape measure.
5. Have the students identify the BOW, STERN, STARBOARD side and PORT side of the shipwreck.
6. Students with the Starboard Side Log Sheets stand on the starboard side of the mock shipwreck template. Students with the Port Side Log Sheets stand on the port side.
7. While the students observe, the instructor sets up the BASELINE, securing the measuring tape from the bow to the stern. (Use tape to secure to floor.)
8. Have students identify the baseline on their Log Sheet, and stand along the edge of the mock shipwreck template in accordance with their measured section.
9. Once each group is positioned in its section, the Measurer begins to measure the BASELINE OFFSETS of the edges of the wreck. The Recorder sketches the indicated edges on the Log Sheet using scale.
10. Once the edges of the wreck are finished, the Measurer measures the BASELINE OFFSETS of any key structural features/artifacts, while the Recorder sketches the indicating points for each key feature/artifact.

Vocabulary

BASELINE – Reference line running along the length of a ship through the center from the bow to the stern

BASELINE OFFSET – Measure of perpendicular line from baseline to point of interest

BOW – Front of a ship

MARITIME ARCHAEOLOGY – A discipline that studies human interaction with the sea, lakes and rivers through the study of vessels, shore side facilities, cargoes, and human remains

PORT – Left side of a ship when facing the bow

SITE PLAN – A scaled drawing of a shipwreck and its artifacts as it lies on the bottom of the sea or lake

STARBOARD – Right side of a ship when facing the bow

STERN – The back of a ship

SCALE FACTOR – Ratio of scaled figure/image to original figure/image

Discussion Questions

- Why is a uniform scale (1 square = 2 inches) important?
- Why should the work be split among teams? Consider limited dive time, size of the wreck, weather conditions, etc.
- What are the key structural features divers should focus on?

Extension

- As an added challenge, specify that as divers, they may not speak while taking measurements. Instead, they must communicate using pre-arranged hand signals; monitor time with a stopwatch; and create a "dive plan."

Activity 2: The Site Plan

1. Once all students have completed their sketches, the class should come together to create the site plan.
2. The port side Log Sheets are lined up on the grids (overlap pages). The starboard side Log Sheets are lined up on the grids (overlap pages). Attach the Log Sheets with tape.
3. Have the port and starboard sides come together, lined up on the baseline, and then tape them together.
4. The result will be a scaled class sketch of the mock shipwreck.

Discussion Questions

- Does the site plan look like the mock shipwreck? Are key structural features and/or artifacts represented?
- What techniques did you use to measure? Were some methods more efficient than others?
- In looking at the site plan created, is there any damage noted on the shipwreck? If so, is it from natural erosion? A battle? A storm?
- For the diving extension
  o How did you and your partner communicate?
  o How did you manage the time constraint? Did you feel rushed? Did it help you focus on key details?
  o Did having a dive plan help you with communication and time limits? Did you follow the dive plan? If you deviated from the plan, why?

Activity 2 Extensions

- Instructor scans/takes pictures of the individual Log Sheets. The students use a computer/Smartboard to line up the sketches into a site plan.
- Show students copy of the HMT *Bedfordshire* Dive Slate (hard copies of these can be requested at monitor@noaa.gov). Explain that maritime archaeologists use the site plan to create dive slates, which are used to inform and educate recreational divers on the history of the shipwreck.
- Students create a dive slate with information on their ship (when it was built, when it sank, why it sank, etc.). Students can research and use the actual history of a known shipwreck, or they can create a history (using what they inferred about the damage to the ship and artifacts found).
- Create a map with coordinates of the shipwreck and include on the dive slate.
- English Language: Go to NOAA's Monitor National Marine Sanctuary website, http://sanctuaries.noaa.gov/missions/battleoftheatlantic/archives.html, and read the mission logs/blogs detailing real divers' experiences on an expedition. Have students write an article about the "diving expedition," including divers' methods, observations and inferences.
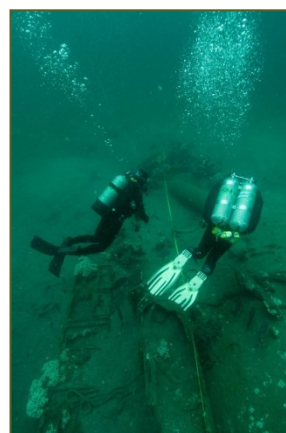
Divers secure a baseline to map the U-*85*. All Photos: NOAA
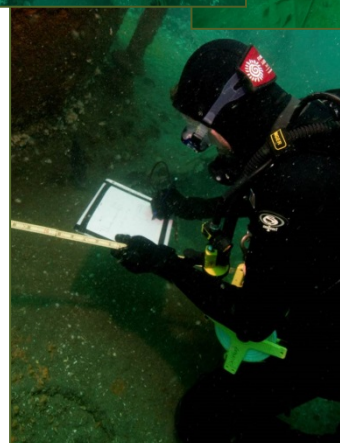
Resources

Websites

Monitor National Marine Sanctuary
Read about the Battle of the Atlantic, including the German, Allied and merchant vessels involved. Read blogs chronicling first-hand experiences during diving expeditions on the shipwrecks.
http://sanctuaries.noaa.gov/missions/battleoftheatlantic/archives.html

NOAA's Office of National Marine Sanctuaries
Learn about the National Marine Sanctuary System; educational resources; science data/research; maritime heritage projects; management policies; photo and video catalog; and publications.
http://sanctuaries.noaa.gov/library/welcome.html

University of North Carolina Coastal Studies Institute (UNC CSI)
Learn how UNC CSI partner with NOAA to explore WII shipwrecks.
http://csi.northcarolina.edu/content/research/battleofatlantic.htm

Video

Watch this video to learn How Maritime Archaeologists Document Shipwrecks
http://sanctuaries.noaa.gov/missions/battleoftheatlantic2/log_082009.html

Learn more about careers in maritime archaeology:

- Nautical Archaeology at Texas A&M University http://nautarch.tamu.edu/
- Program in Maritime Studies at East Carolina University http://www.ecu.edu/cs-cas/maritime/
- NOAA's Ocean Explorer http://oceanexplorer.noaa.gov/edu/oceanage/
- NOAA's Office of National Marine Sanctuaries — Spotlight on Careers http://sanctuaries.noaa.gov/news/features/tane_casserley.html

- University of West Florida http://uwf.edu/cassh/departments/anthropology-and-archaeology/

Books

Bowens, Amanda (Editor). *Underwater Archaeology: The NAS Guide to Principles and Practice.* Blackwell Publishing (2nd Edition), 2009. ISBN-13: 978-1405175913.
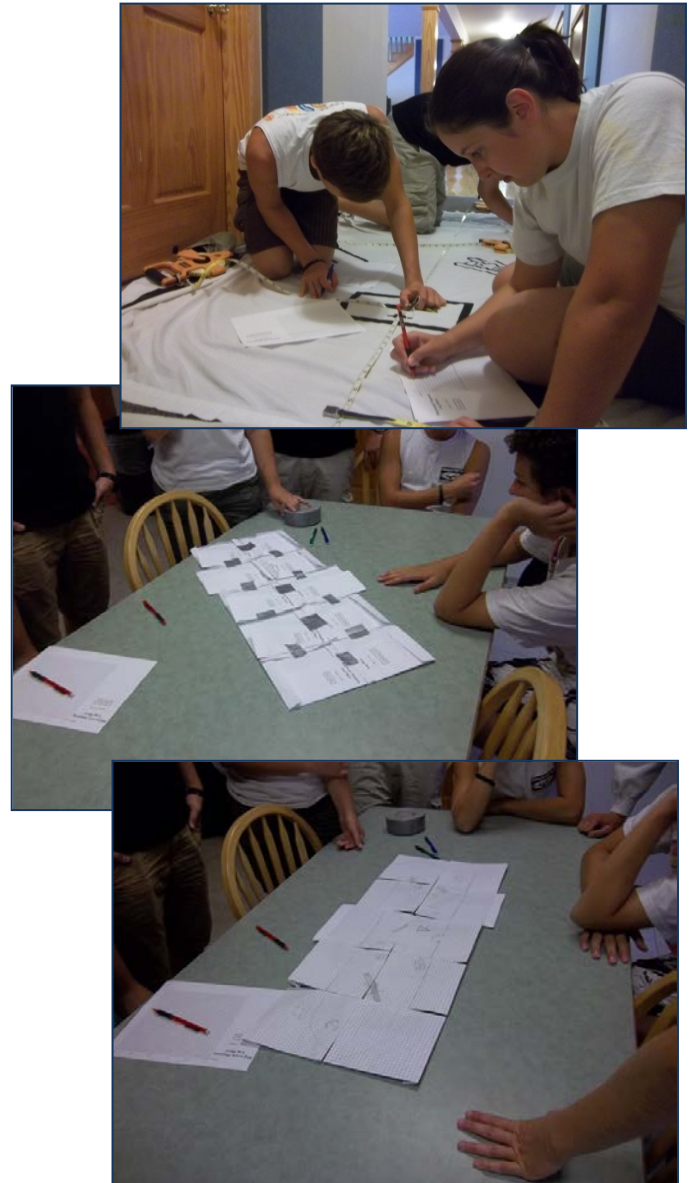
Above: Students map a mock shipwreck and then bring their sections together to create a site plan of the shipwreck. Photos: NOAA

Left: Site plans of U-85, U-352, and U-701 created from the 2008 archaeological survey by maritime archaeologists. Image: NOAA

Teacher Page

Outline of a Shipwreck with Vocabulary Words
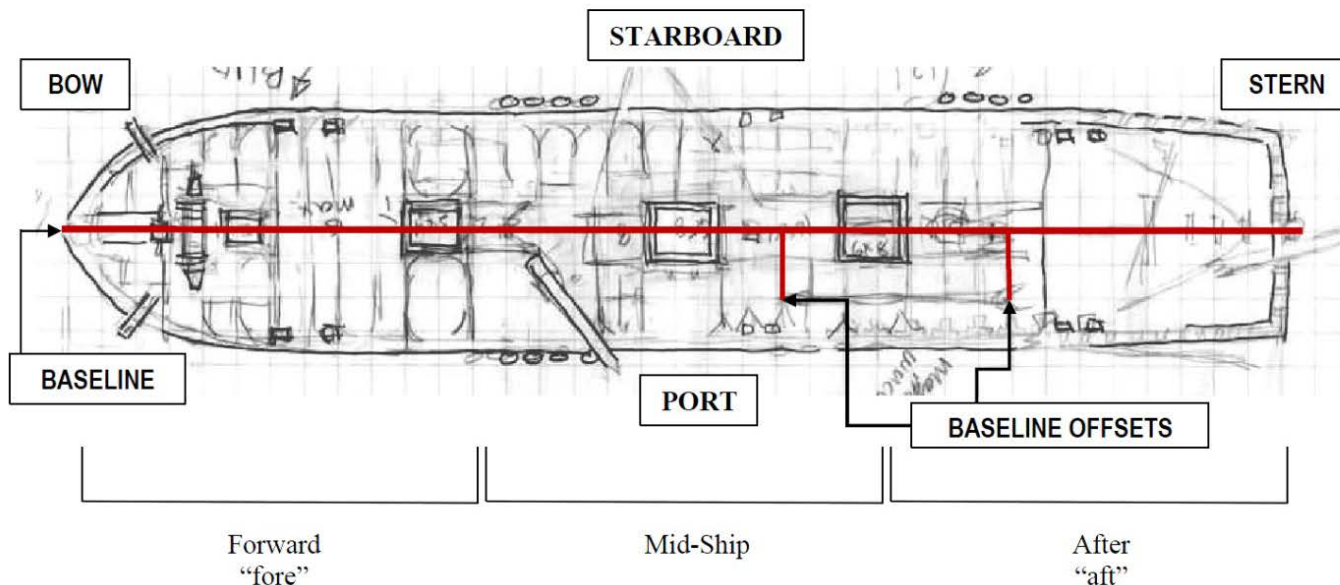
Sample Log Sheet sections based on larger template of mock shipwreck
- ❖ The number of sections can be modified based on the length of the mock shipwreck and/or number of students participating in the activity. (Ex: For 24 students, divide 30ft into six 5ft sections for a total of 12 sections [starboard and port] with two students per section.)

Starboard Group 1 (0-5ft)   St. Grp. 2 (5-10ft)   St. Grp 3 (10-15ft)   Etc.
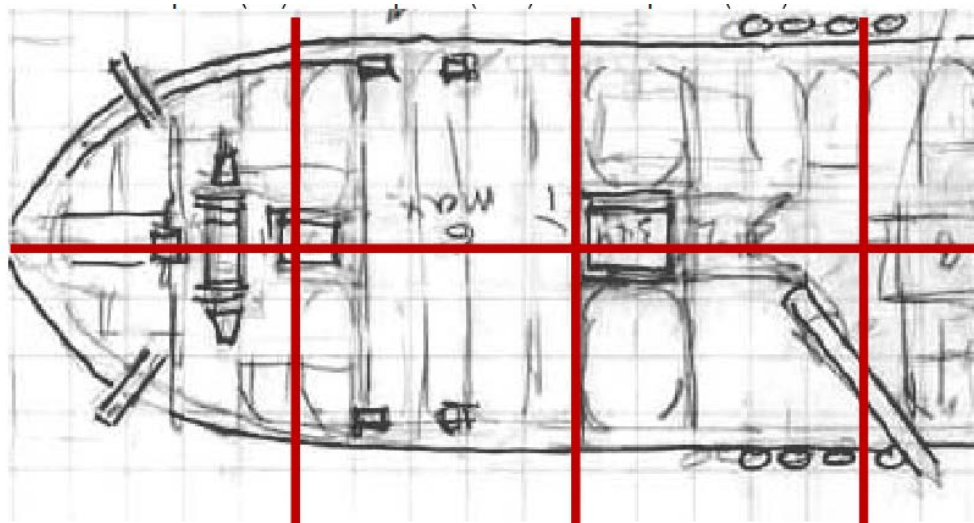
Port Grp. 1 (0-5ft)   Port Grp. 2 (5-10ft)   Port Grp. 3 (10-15ft)   Etc.

Pictures

U-*85* shipwreck photomosaic — made from hundreds of images stitched together Photo: NOAA, Monitor NMS

Dixie Arrow: Torpedo hit by U-*71.* Photo: Library of Congress
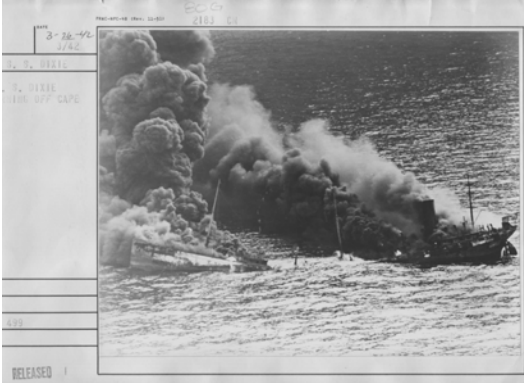
Diver with dive computer. Photo: NOAA, Monitor NMS

U-*85:* Mapping conducted by team of divers. Photos: NOAA, Monitor NMS
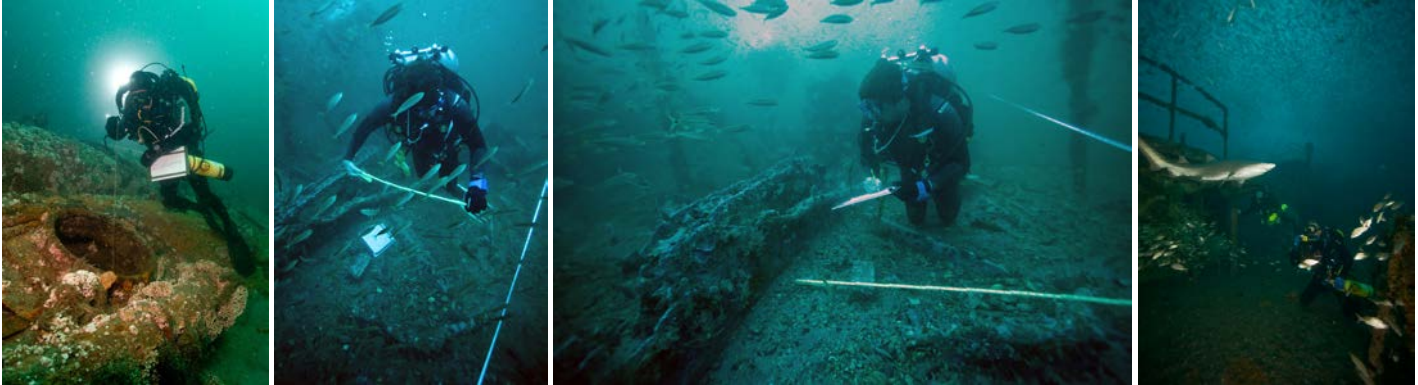
Site Plans: Sections drawn by individual divers**.** Photo: NOAA, Monitor NMS

Completed Site Plan: U-*85,* U-*352,* and U-*701.* Photo: NOAA, Monitor NMS
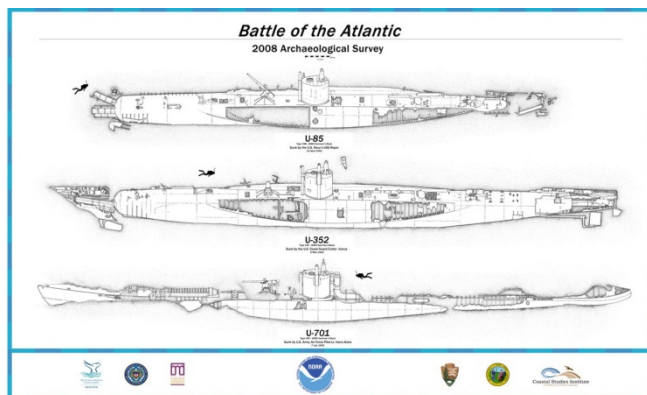
Front and back of dive slate for British ship, HMT *Bedfordshire* that sank off the North Carolina coast in 1942. Image: NOAA

To request a hard copy of the dive slate or slates for U-*85*, U-*352*, U-*701*, or *Keshena,* email monitor@noaa.gov

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Graveyard of the Atlantic Shipwreck Guides provided by NOAA's Monitor National Marine Sanctuary

HMT Bedfordshire
Archaeological Site Plan

GPS Coordinates:
N35° 54.810'/W75° 17.215'
Depth: 95 fsw
Skill Level: Intermediate
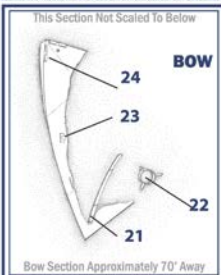
1 Sacrificial Zinc Anode
2 Stern Post
3 Liver Boiler Deck Combing
4 Exposed Depth Charge
5 Depth Charge Support
6 Stern Depth Charge Rack
7 Buried Depth Charge
8 Wiring Harness for Vessel
9 Starboard Side High Point
10 Exposed Deck Plating
11 Port High Point/Deck Level
12 Main Trawl Winch
13 Starboard Outer Hull
14 Deck Support Stanchions
15 Original Deck Level
16 Reinforced Boiler Room Wall
17 Port Side Outer Hull Plate
18 Disarticulated Machinery
19 Exposed Main Boiler
20 Likely Torpedo Strike Area
21 Forward Bulkhead
22 Forward Deck Gun Mount
23 Towing or Docking Bit
24 Bow Line Fairleads
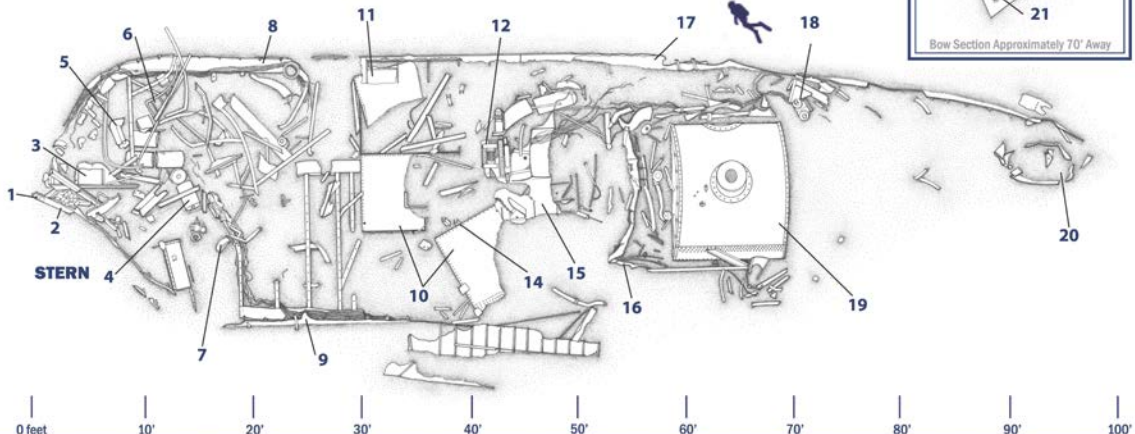
This Section Not Scaled To Below
BOW
Bow Section Approximately 70' Away

0 feet   10'   20'   30'   40'   50'   60'   70'   80'   90'   100'

Take Only Pictures ~ Leave Only Bubbles

Graveyard of the Atlantic Shipwreck Guides provided by NOAA's Monitor National Marine Sanctuary

HMT Bedfordshire
Royal Navy Patrol Service

You Should Know

This wreck is federally protected by the SUNKEN MILITARY CRAFT ACT.

Visitation and enjoyment of this cultural resource is encouraged. Removal of artifacts or alteration of the site is strictly prohibited.

This site is owned by the United Kingdom and is considered a war grave. Please respect it as such and refrain from alteration or penetration of the site.

You are encouraged to enjoy this resource responsibly and to leave the site unaltered for the enjoyment of future divers.

Vessel History

Launched: July 17, 1935, in Middlesbrough, England

Commander: Lt. Russell B. Davis, Royal Naval Reserve

Actions: A veteran of the Battle of the Atlantic, this converted trawler conducted antisub operations as part of the Royal Naval Patrol Service around the British Isles. While on loan to the U.S., *Bedfordshire* performed convoy escort service between Capes Lookout and Hatteras.

Loss: In the early morning hours of May 12, 1942, HMT *Bedfordshire* was returning alone from an escort detail to Hatteras. While preparing to round Cape Lookout, a torpedo from U-558 slammed into her port side. The vessel sank in seconds, sending no distress signal.

Fate: The entire 37-man crew was lost as a result of this action. Shortly after the sinking, several bodies began washing up on the shores of North Carolina. A total of six men were recovered and buried near Hatteras and Ocracoke. The gravesites are honored by the British Navy and the U.S. annually. This wreck is a war grave for the remaining crewmen.

North Carolina
U-85
U-701
Cape Hatteras
Keshena
HMT Bedfordshire
Cape Lookout
U-352
Atlantic Ocean

Marine Life Commonly Found on the *Bedfordshire* Site

http://sanctuaries.noaa.gov/missions
Visit us online to learn more!

Blue Angelfish — Holacanthus bermudensis
Summer Flounder — Paralichthys dentatus
Gray Triggerfish — Balistes capriscus
Little Tunny — Euthynnus alletteratus
Black Sea Bass — Centropristis striata
Tomtates — Haemulon parral

Name: _____   Date: _____

Mapping a Shipwreck
Class Activity Sheet

Maritime Archaeology is

_____

_____.

Maritime archaeologists locate shipwrecks and record visual information in the form of photos, video, and sketches. This information is recorded in pieces that can be used to form a larger picture of the shipwreck.

Your job is to create a scaled drawing of a mock shipwreck by 1) sketching sections of the wreck and 2) combining the sections into a whole picture called a Site Plan.

Fill in the blocks with the correct vocabulary.
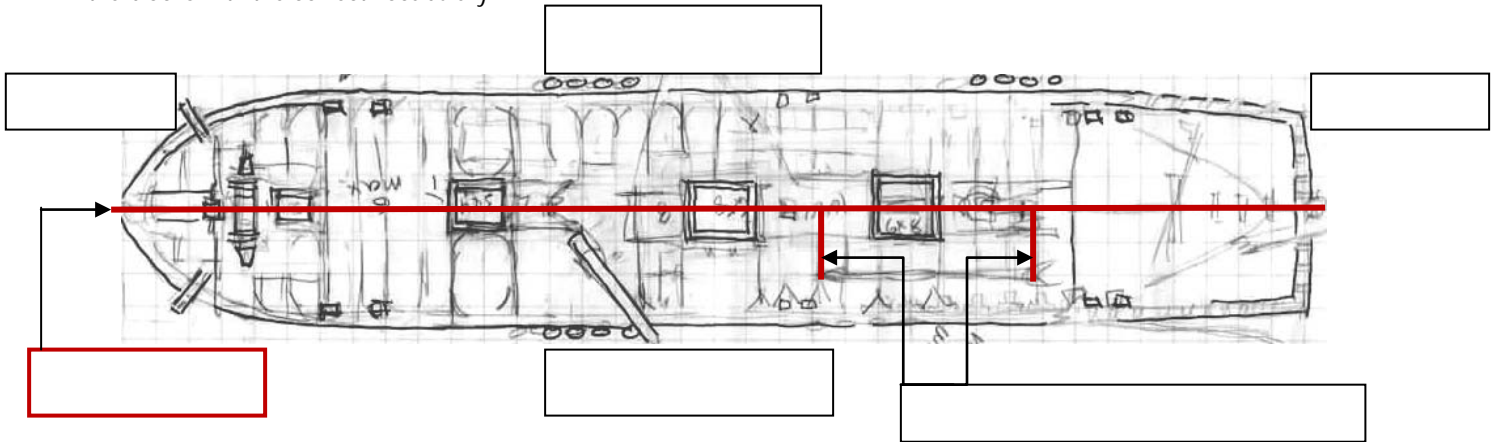
Identify the section your group is responsible for: Side: _____   _____ft → _____ft

Are you the   **Measurer**   or   **Recorder**?   (Circle one)

The mock shipwreck has an overall length of _____ft. and a width of _____ft.

The site plan shipwreck has an overall length _____ft. and a width _____ft.

The **scale factor** is _____ : _____

Did you observe any areas that were damaged? If so, what can you infer from your observations?

Shipwreck Mapping Log Sheet
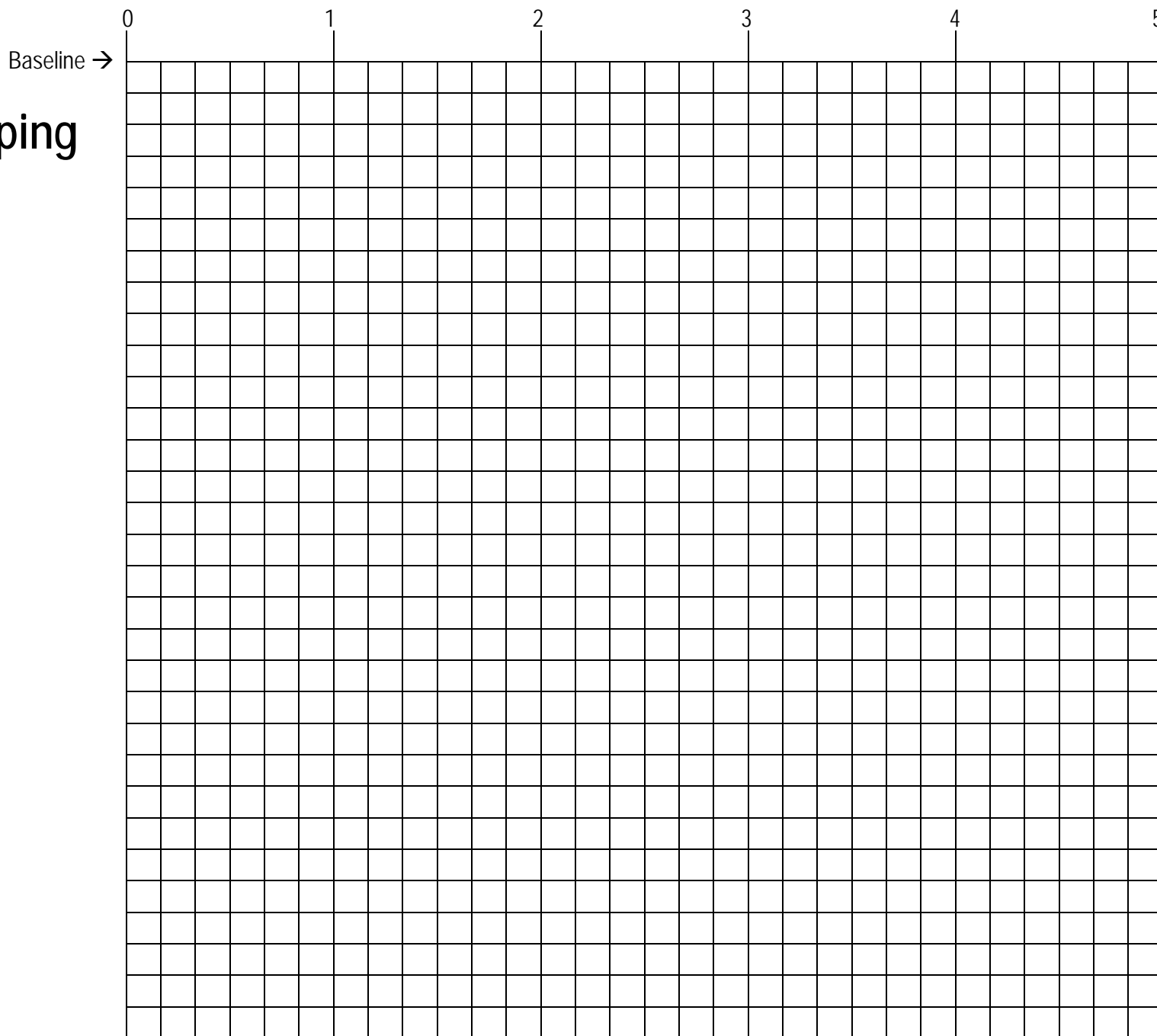
1 square = 2 inches

Port Side

Baseline →

0   1   2   3   4   5

Shipwreck Mapping
Log Sheet

1 square = 2 inches

Port Side

Baseline →

5   6   7   8   9   10

Shipwreck Mapping Log Sheet

1 square = 2 inches

Port Side

Baseline →

10   11   12   13   14   15

Shipwreck Mapping Log Sheet

1 square = 2 inches

Port Side

Baseline →

15   16   17   18   19   20

Shipwreck Mapping Log Sheet

1 square = 2 inches

Port Side

20 21 22 23 24 25

Baseline →

Shipwreck Mapping Log Sheet

1 square = 2 inches

Port Side

Baseline →

25   26   27   28   29   30

5   4   3   2   1   0

←Baseline

Shipwreck Mapping Log Sheet

1 square = 2 inches

Starboard Side

10   9   8   7   6   5

←Baseline

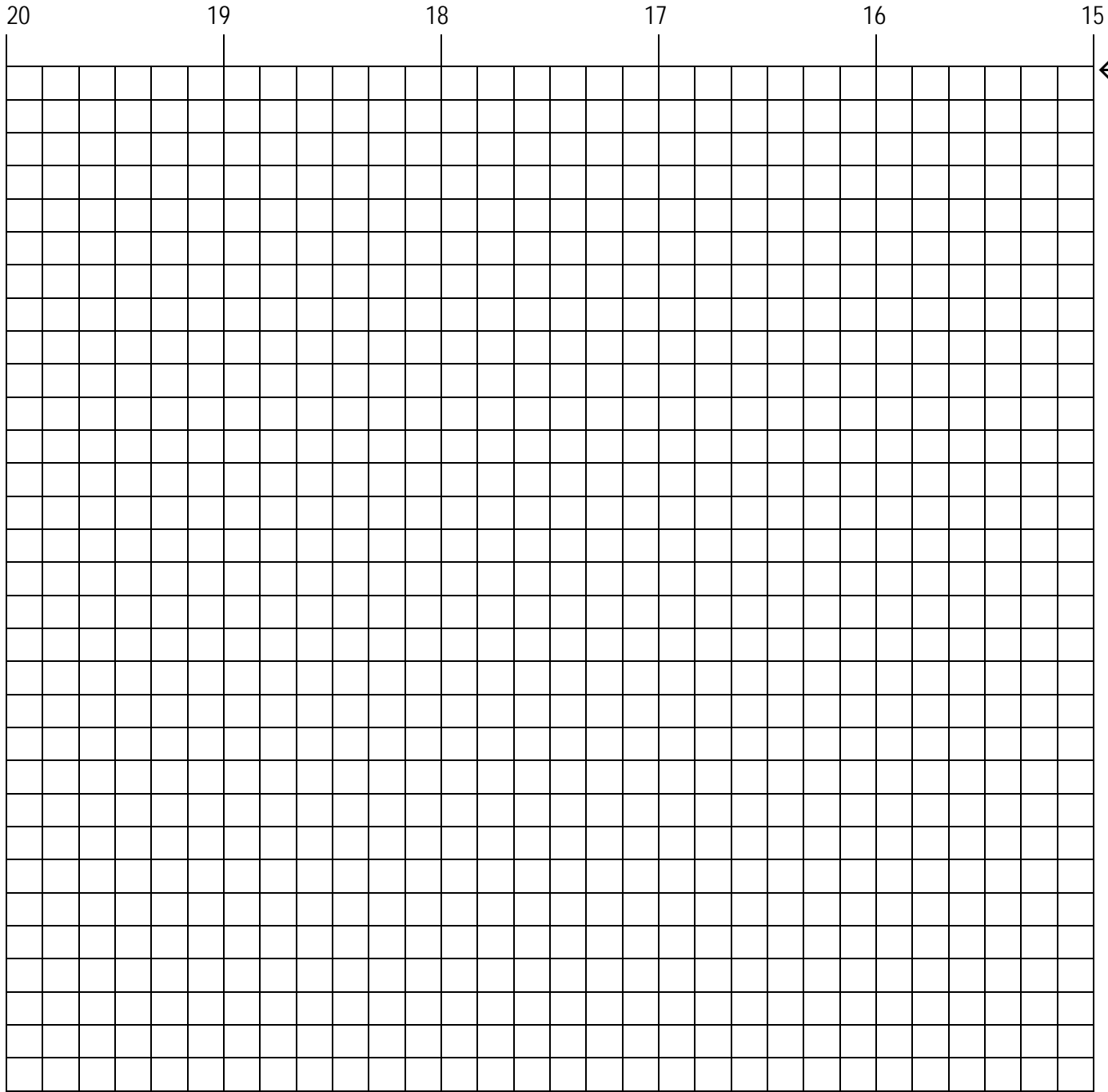# Shipwreck Mapping
Log Sheet
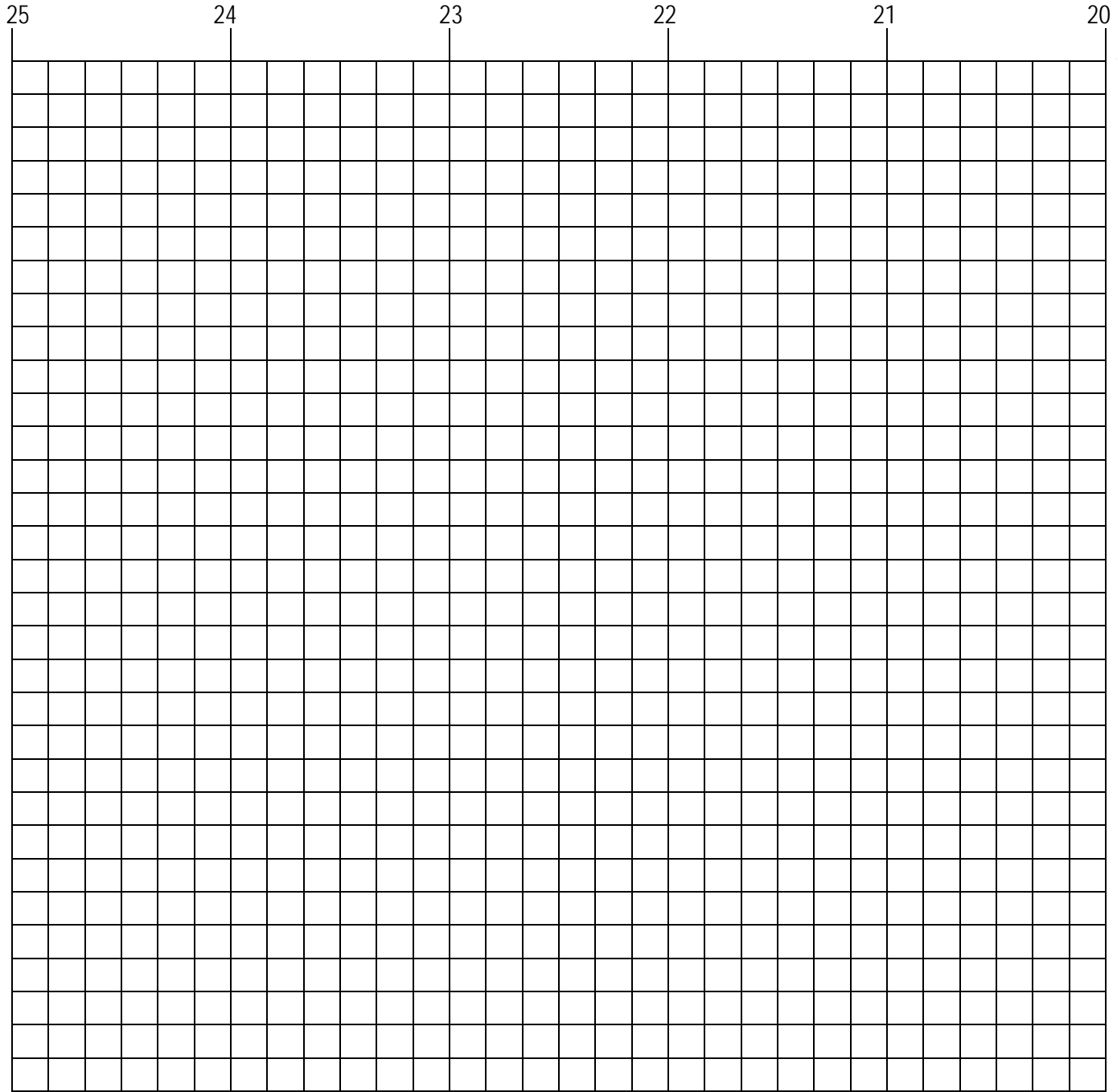
1 square = 2 inches

Starboard Side

15　　　14　　　13　　　12　　　11　　　10

←Baseline

Shipwreck Mapping
Log Sheet

1 square = 2 inches

Starboard Side

20   19   18   17   16   15

←Baseline

Shipwreck Mapping
Log Sheet

1 square = 2 inches
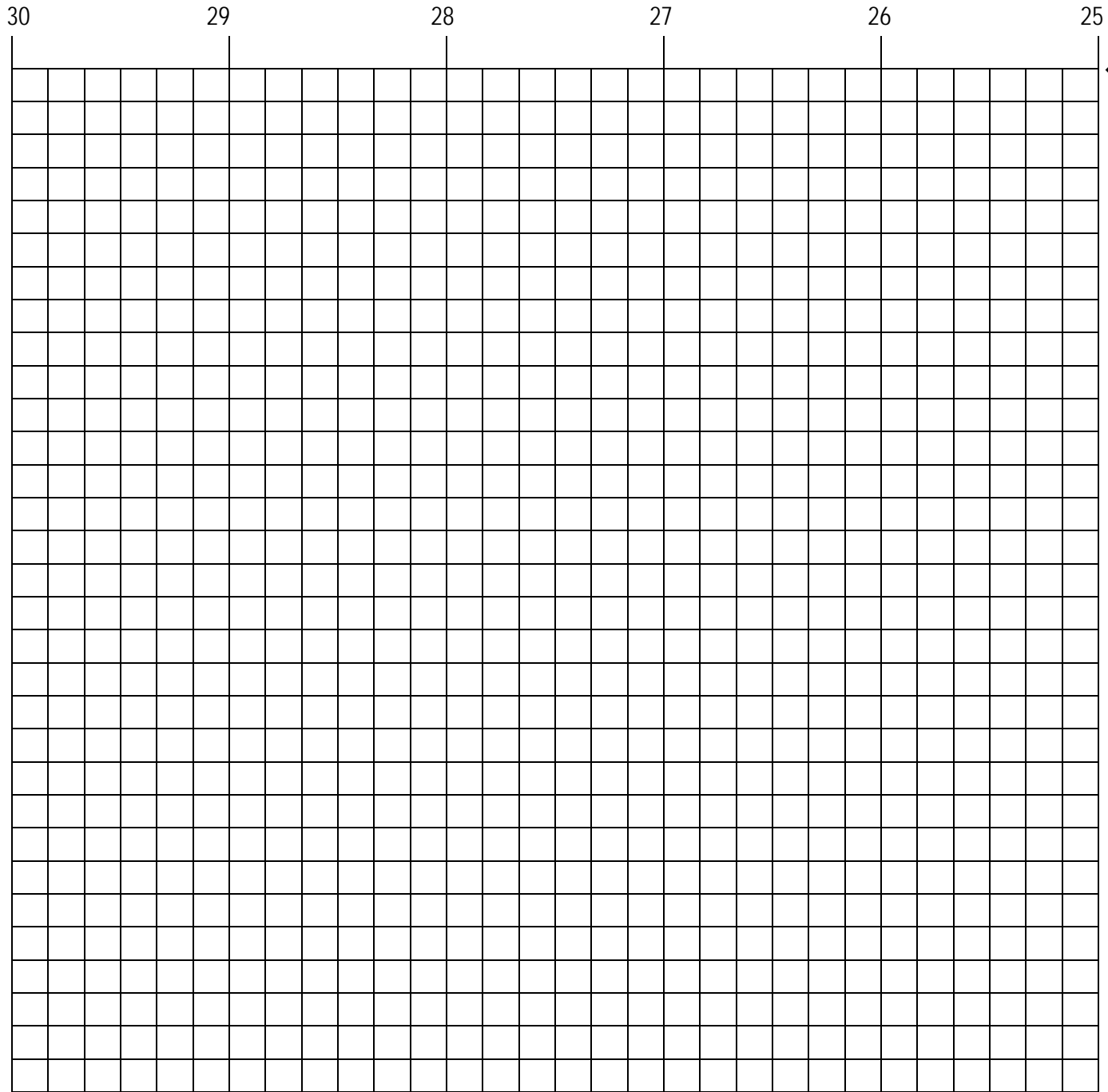
Starboard Side

25 24 23 22 21 20
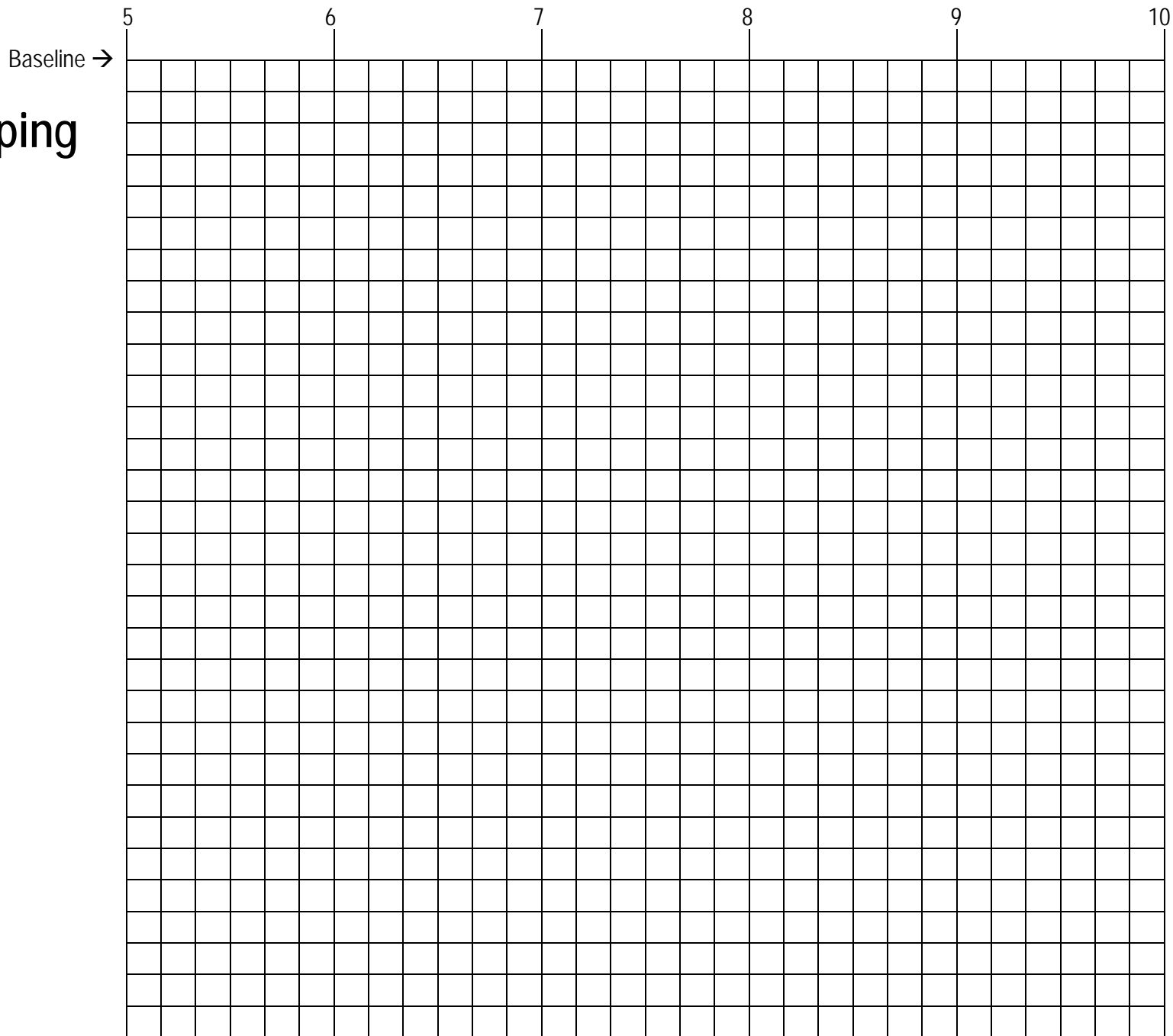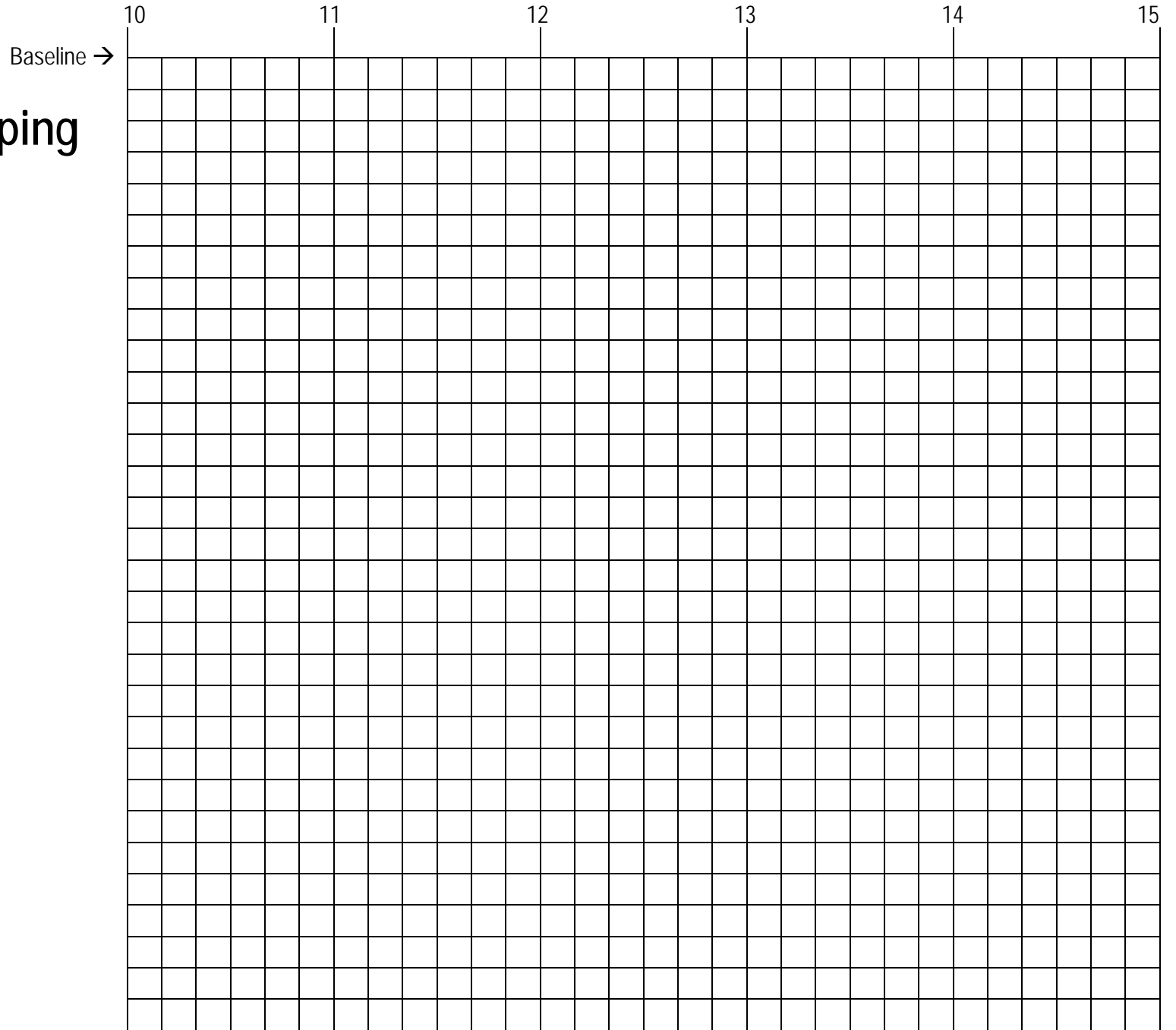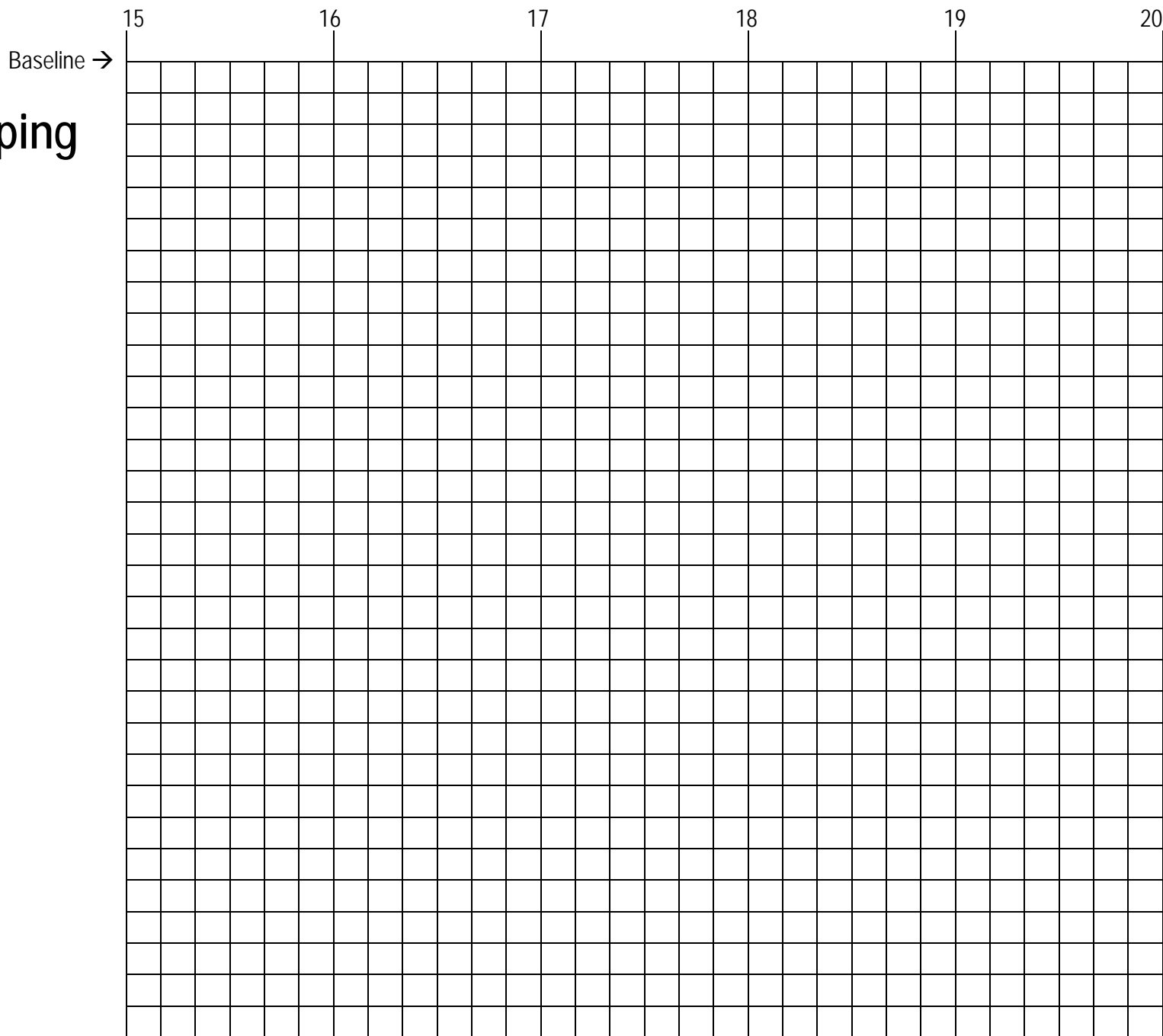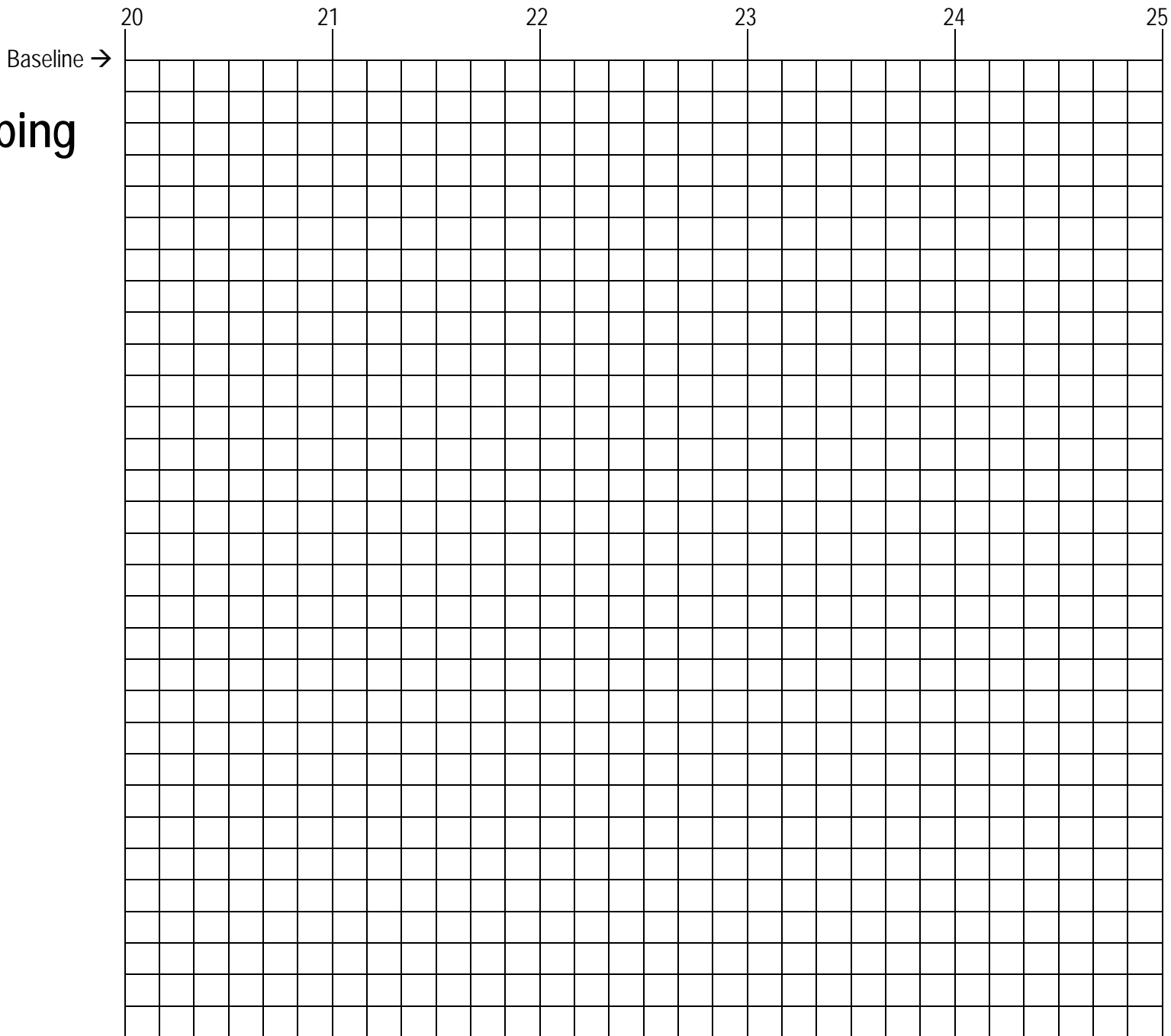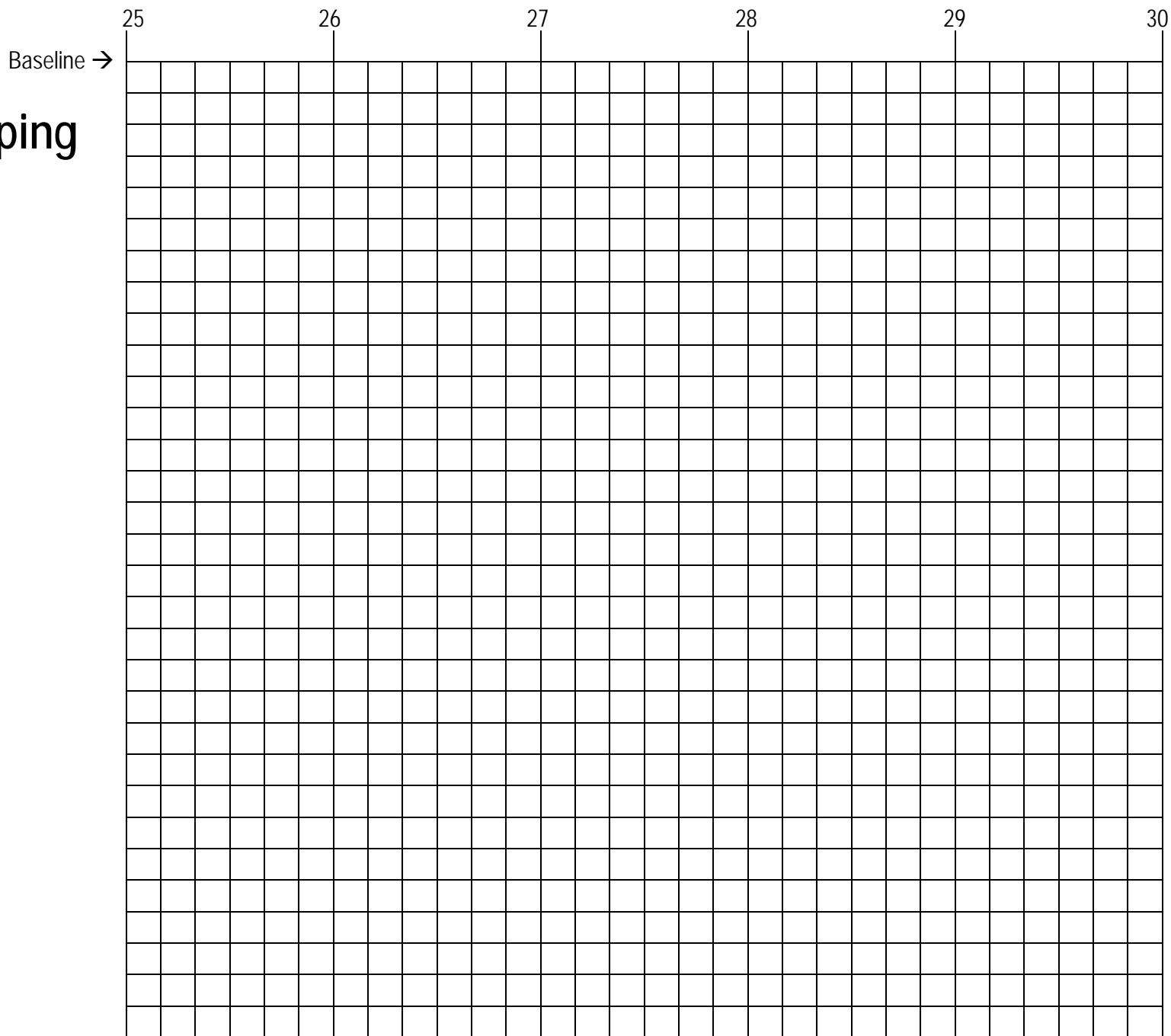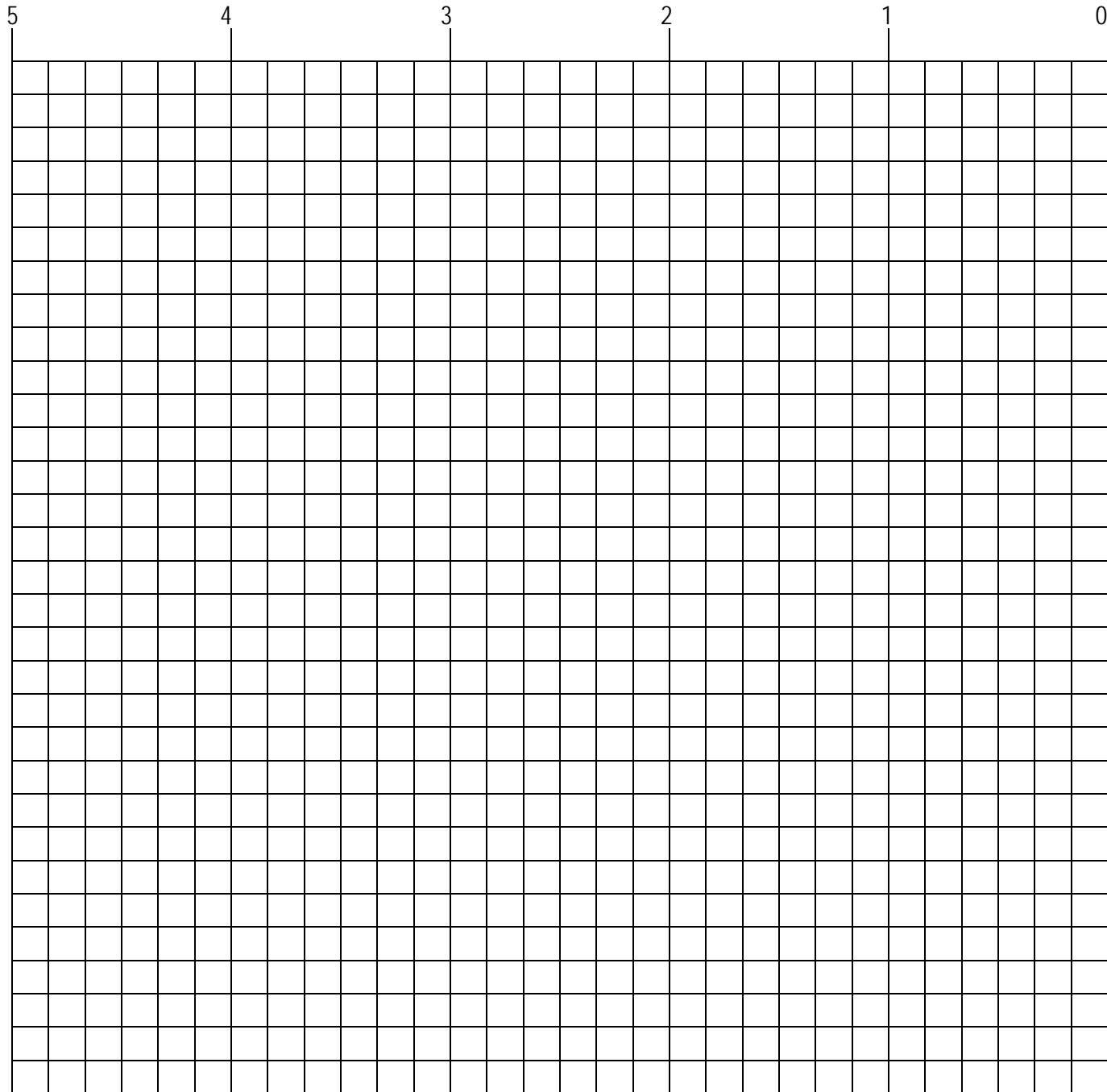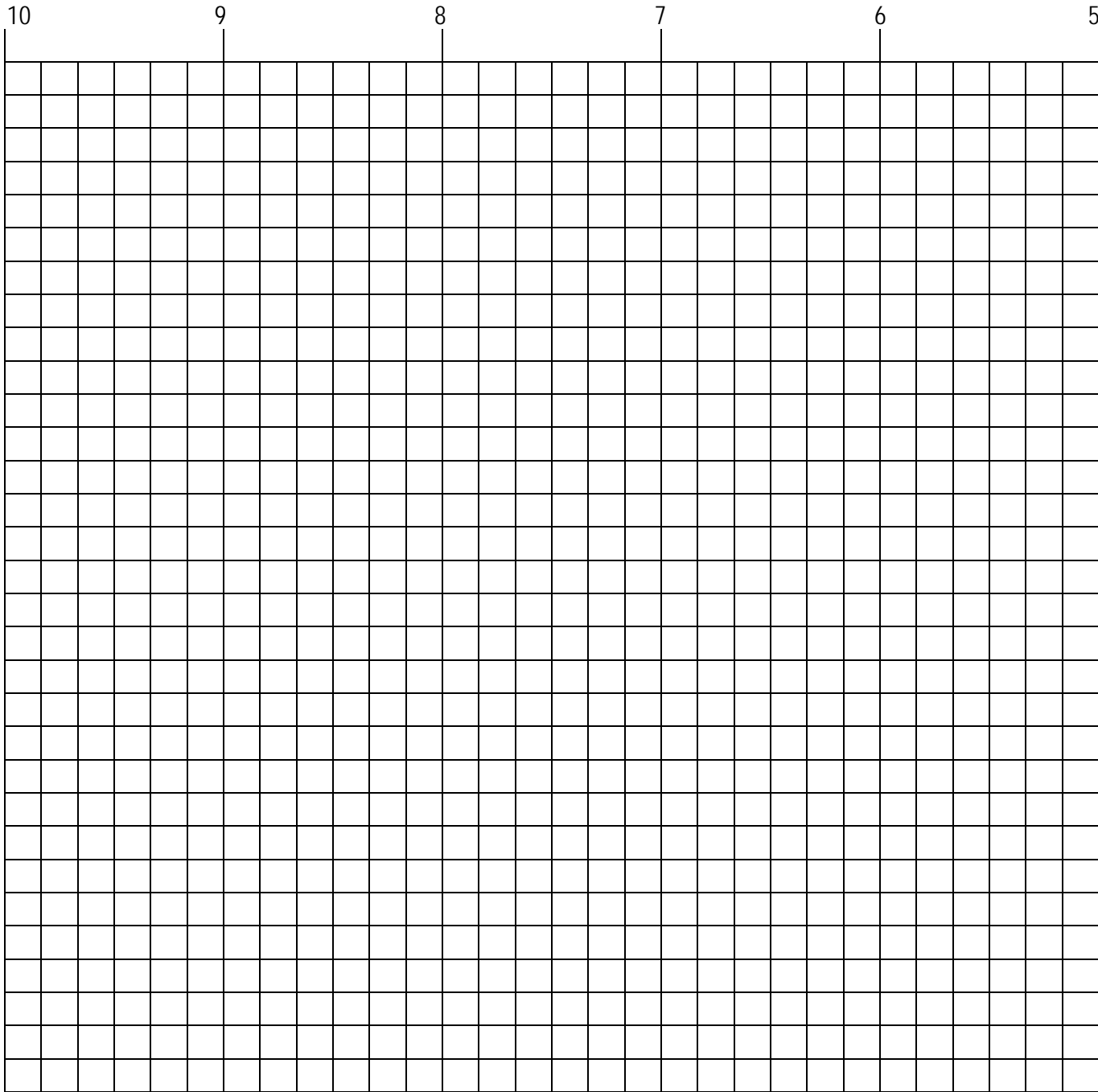
←Baseline

Shipwreck Mapping Log Sheet

1 square = 2 inches

Starboard Side

←Baseline

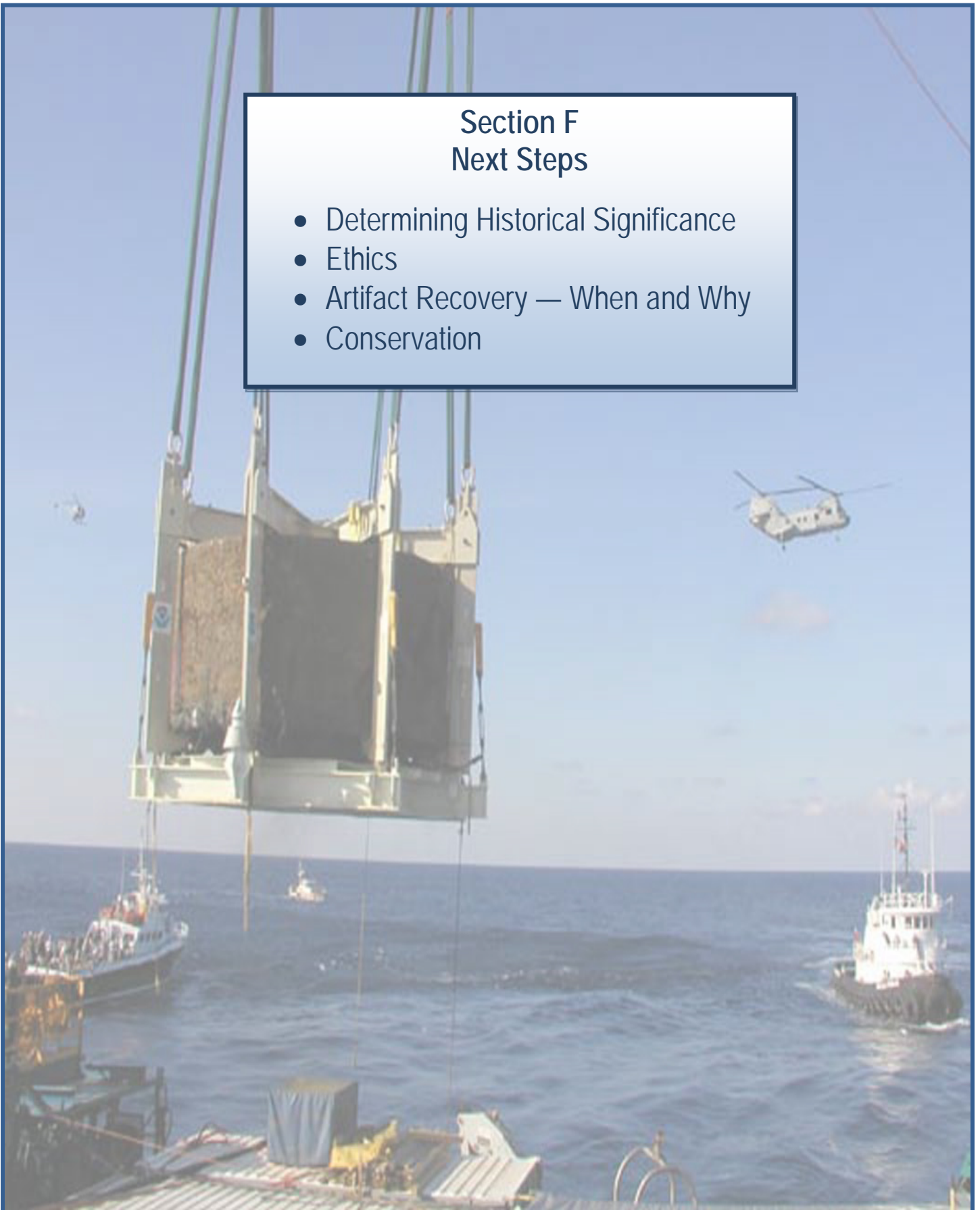# Shipwreck Mapping Log Sheet

1 square = 2 inches

Starboard Side

Section F
Next Steps

- Determining Historical Significance
- Ethics
- Artifact Recovery — When and Why
- Conservation

Historically Significant

Section of the armor belt, USS *Monitor*
Photo: NOAA, *Monitor* Collection

Grade Level

6-12

Timeframe

1-2 hours

Materials

- Computer with Internet access or
- Printed resources for students to use in researching the National Register

Activity Summary

In this lesson, students will explore the National Register of Historic Places focusing on the nomination process of vessels. Students learn the complex process of determining if a vessel is historically significant.

Learning Objectives

- To identify various criteria required for a vessel to be classified as historically significant
- To use knowledge learned and construct a fictitious nomination for the National Register.
- To analyze nominations based on criteria learned.

Vocabulary

See Vocabulary Box

National Standards:

NCSS:II; NCSS.HT.1 and 3; CCS.ELA.LIT.RI.4; NCTE:1, 5, 7 and 8; OL6.7

Background

For potentially thousands of years, water crafts have connected our continent to the rest of the world. Vessels crossing the Atlantic Ocean, Caribbean, Pacific Ocean, and our inland waters made beneficial contributions to settlement, development of trade, exploration, national defense and territorial expansion. Unfortunately, much of this maritime tradition and ships have been lost, wrecked or have been scrapped by shipbreakers.

To recognize the importance of these maritime cultural resources that helped to develop our nation and to encourage their preservation, Congress expanded the National Register of Historic Places in 1966 to include vessels, as well as building and structures, such as canal, drydocks, shipyards and lighthouses that have survived the test of time.

The National Register of Historic Places is an important tool for maritime preservation. As a first step in the preservation of historic vessels, the National Register offers consistent criteria to evaluate a vessel's significance and integrity. The National Register is also the best means to define categories and establish priorities. Moreover, a list provides incentive for maritime preservation by recognizing resources that are worthy of preservation. A list also provides a measure of protection for the resource through recognition.

Activity Overview

In this activity, students will explore the nomination process for shipwrecks to the National Register of Historic Places in order to understand the criteria required for a shipwreck to be considered historically significant. Students will then create a fictitious shipwreck and "nominate" it for consideration. They will exchange their nominations and use a criterion score sheet to score the nomination form they exchanged.

Disclaimer: This activity, including the nomination form and score sheet, in no way represents the actual process for nomination and awarding of a listing within the National Register. The activity is designed purely for educational purposes to help students understand that there are standard criteria and the process is rigorous and complex.

Objectives

- To comprehend the requirements for a shipwreck to be considered historically significant.
- To familiarize students with the National Register of Historic Places and that maritime cultural resources are included in it.
- To demonstrate knowledge of some of the criteria required for nomination of a shipwreck to the National Register.
- To critique a fictitious nomination then demonstrates knowledge.

Teacher Preparations and Implementation

1. Familiarize yourself with the website listed on the *Class Activity* page.
2. Bookmark the page for the students or create a Livebinder. For more information on Livebinders visit
   http://www.livebinders.com/welcome/education
3. Print copies of the *Class Activity* pages.
4. Lead the students in a discussion asking the inquiry question: "Should all shipwrecks be protected by law?"
5. Have students begin the activity by researching the answers to the questions on the Class Activity page.
6. Lead a discussion on what they learned about the nomination process and its complexity. Why is there a need for standard criteria? What constitutes "historically significant?" Why should the nomination be created by a person knowledgeable in maritime studies?
7. Divide the students into pairs or teams and have each create a fictitious shipwreck that they want to nominate to the Federal Register.
8. Optional: Before filling out the form, have the students write a short story about their ship, including any facts that might be significant in the nomination process.
9. Have students complete the fictitious nomination form for their shipwreck.
10. Once all teams have completed the assignment, have them exchange with another team and score. If time allows, have them repeat the process with one or more nominations.
11. As a class, discuss the nominations and scores and determine if any shipwreck should be nominated. If each nomination was scored more than once, average the scores.

Resources
Websites

National Park Service — Nominating Historic Vessels
Complete instructions and criteria for nominating vessels to the National Register of Historic Places. Be sure to click through all four pages.
http://www.nps.gov/nr/publications/bulletins/nrb20/vsintro.htm

National Register Bulletin — How to Complete the National Register Registration Form
Complete instructions and criteria for nomination to the National Register of Historic Places.
http://www.nps.gov/nr/publications/bulletins/nrb16a/index.htm

National Register — Facebook Page
The Register may be a bit difficult to navigate, but its Facebook page is easy and has some interesting posts that are fun and educational.
https://www.facebook.com/NationalRegisterNPS

National Park Service — Teaching with Historic Places
Lesson plans for a variety of topics featuring historic places in the U.S.
http://www.nps.gov/nr/twhp/index.htm

Vocabulary

INTEGRITY – The condition of being unified, unimpaired, or sound in construction.

NATIONAL REGISTER – National Register of Historic Places maintained by the Secretary of the (Department of the) Interior

The USS *Monitor* was originally listed in the Federal Register of Historic Places on October 11, 1974, just prior to the shipwreck being designated the nation's first national marine sanctuary. The document to the left was prepared on February 4, 1986, requesting that the vessel receive a higher designation as a Historic Landmark. Image: NOAA, *Monitor* Collection

Name: _____   Date: _____

A Story of a Shipwreck
Class Activity

Background

For potentially thousands of years, water crafts have connected our continent to the rest of the world. Vessels crossing the Atlantic Ocean, Caribbean, Pacific Ocean, and our inland waters made beneficial contributions to settlement, development of trade, exploration, national defense, and territorial expansion. Unfortunately, much of this maritime tradition and ships have gone to watery graves or have been scrapped by shipbreakers.

To recognize the importance of these maritime cultural resources that helped to develop our nation and to encourage their preservation, Congress expanded the National Register of Historic Places in 1966 to include vessels, as well as building and structures, such as canal, drydocks, shipyards, and lighthouses that have survived the test of time. However, the National Register could be more fully utilized to nominate maritime resources, particularly historic vessels.

The National Register of Historic Places is an important tool for maritime preservation. As a first step in the preservation of historic vessels, the National Register offers consistent criteria to evaluate a vessel's significance and integrity. The National Register is also the best means to define categories and establish priorities. Moreover, a list provides incentive for maritime preservation by recognizing resources that are worthy of preservation. A list also provides a measure of protection for the resource, and it can be a source of funding when money is available.

In the following activities, you will explore what makes a shipwreck historically significant and the nomination process for the Federal Register of Historic Places.

Activity A: Exploring the National Register's Criteria for Nominating Historic Vessels

1. Go to "Nominating Historic Vessels" at http://www.nps.gov/nr/publications/bulletins/nrb20/vs1.HTM and answer the following questions.

2. What are the five basic types of historic vessels which may be eligible for listing in the National Register?

3. Who does the National Register recommend to prepare nominations for historic vessels and shipwrecks?

4. What three criteria are used in determining the significance of a historic vessel?

5. Scroll down to "Historic Contexts." What is a vessel's significance based on?

6. Scroll down to "Significance." What criteria determine if a vessel is eligible for the National Register? Does it need to meet all of them?

7. Scroll down to "Integrity." What are the seven aspects or qualities that the National Register uses to recognize a property's integrity?

8. Scroll down to "Field Work, Research, and Documentation Techniques." What is the recommended process for field examination of a vessel?

Activity B—To Nominate or Not to Nominate

1. In your group, use the criteria outlined below to create a nomination of a fictitious shipwreck.
2. After filling in all the required information, exchange forms with another group. Use the rating sheet to determine if the shipwreck should be nominated for the National Register of Historic Places based on these criteria. Be prepared to justify and defend your answer. *Disclaimer: This activity is for educational purposes to help students understand the complex process of determining if a shipwreck is historically significant. It does not in any way represent the actual method used by the National Register to determine if a shipwreck is historically significant for listing.*

National Register of Historic Places Form

NAME
Historic
_____

And/Or Common

LOCATION
Street and Number
_____

City, Town   Congressional District
State   County

CLASSIFICATION

Category	Ownership	Status	Present Use	
___Site	___Public	___Occupied	___Commercial	___Museum
___Object	___Private	___Unoccupied	___Educational	___Park
___Building	___Both	___Work in Progress	___Government	___Military
			___Industrial	___Commercial
Accessible			___Transportation	___Other
___Yes, Restricted				
___Yes, Unrestricted				
___ No				

DESCRIPTION
Describe the present and original (if known) physical appearance. (Use additional sheets if needed.)

SIGNIFICANCE

Period

___Prehistoric
___1400-1499
___1500-1599
___1600-1699
___1700-1799
___1800-1899
___1900-present

Areas of Significance – Check and Justify Below

___Archaeology Prehistoric	___Community Planning	___Landscape Architecture
___Archeology Historic	___Conservation	___Military
___Architecture	___Economics	___Music
___Commerce	___Engineering	___Politics Government
___Exploration /Settlement	___Transportation	___Science
___Industry	___Invention	___Other (specify)

_____

Specific dates   Builder/Architect

Statement of Significance (Use additional sheets if needed.)

FORM PREPARED BY

Name/Title_____ Date:_____

Organization_____

Street and Number_____

City or Town_____

Scoring Sheet for National Register Nomination*

Disclaimer: This score sheet was created for the sole purpose of this educational activity. It does not in any way represent the actual method used by the National Register to determine if a shipwreck is historically significant for listing.

Use this sheet to score your fictitious shipwreck against each of the criteria listed below. Assign a number value between 1 and 10 for each criterion. Visit the site for more information on each criterio:
http://www.nps.gov/nr/publications/bulletins/nrb20/vs1.htm

SCORE:

1) _____Is one of the five basic types of historic vessels which may be eligible for listing in the National Register
  ___Floating Historic Vessel   ___Dry-berthed Historic Vessel   ___Small Craft
  ___Hulks   ___Shipwrecks

2) _____Does the vessel retain integrity of location, design, setting, materials, workmanship, feeling, and association? Base your total score on the following factors:
  _____Is the vessel the sole, best or a good representation of a specific vessel type?
  _____Is the vessel associated with a significant designer or builder?
  _____Was it involved in important maritime trade, naval, recreational, government, or commercial activities?

3) _____Was the vessel significant in American history, architecture, archaeology, engineering, or culture? The vessel must meet one or more of the four National Register criteria:
  ___A. Be associated with events that have made a significant contribution to the broad patterns of our history; or
  ___B. Be associated with the lives of persons significant in our past; or
  ___C. Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possesses high artistic values, or that represents a significant and distinguishable entity whose components may lack individual distinction; or
  ___D. Have yielded, or may be likely to yield, information important in prehistory or history.

4) _____ Did a person qualified and knowledgeable in maritime studies prepare the form?

5) _____ Was the form well written and legible?

_____ Total Score (maximum 50 points)

Comments by Scorers (Positive and Constructive)

Ethically Speaking
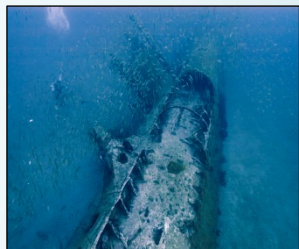
Military craft, such as the U-*352* off Beaufort, N.C., are protected by the Sunken Military Craft Act.
Photo: NOAA, Monitor NMS

Grade Level

6-12

Timeframe

1-2 hours

Materials

Computer with Internet access or printed resources

Activity Summary

Students answer an overarching question: Do divers have the right to take artifacts from shipwrecks? They will explore how and why military craft are protected and engage in a Socratic Seminar.

Learning Objectives

- To understand that shipwrecks offer a window into the past and should not be disturbed.
- To learn about the Sunken Military Craft Act and other protections for cultural resources.
- To debate using a Socratic Seminar.

Vocabulary

See Vocabulary Box

National Standards:

NCSS:II, III, V, VI and IX; CCSS:ELS.LIT.RI.4; CCSS:ELS.LIT.SL.1-6; NCTE:1, 3, 7 and 8;OL.6 and 7

Background

Shipwrecks can be found in deep water, near shore and sometimes even on the beach. The idea of finding a shipwreck is exciting and mysterious because shipwrecks are vessels of untold stories that connect us to the ocean and our maritime past. Unlocking the secrets a shipwreck holds may be difficult, but that only fuels our imagination and curiosity to learn more.

Shipwrecks are intriguing for many different reasons. To scuba divers, they are part of an underwater world of wonder that offers divers a look at things not seen on land. To marine biologists and fishermen, they are an oasis of life that teams with an overwhelming amount of variety. To maritime archaeologists, they are windows into our past. And to local coastal communities, shipwrecks provide economic support through maritime heritage tourism.

Shipwrecks are exciting, but they are also a finite resource. And because they are nonrenewable, it is important to protect them, especially those that are significant to our nation's history. There are a variety of laws and regulations in place for the protection of shipwrecks, but they do not apply to all shipwrecks. Therefore, while visitation and enjoyment of cultural resources is encouraged in most cases, the removal of artifacts is not widely accepted and, in some cases, it is even illegal. Therefore, it is always a good idea to know the rules before you visit a shipwreck!

Activity Overview

Students will come to understand the importance of historically significant shipwrecks to our maritime heritage. They will learn that these cultural resources are non-renewable and that in order to preserve them for future generations, divers must maintain high ethical standards in their practices, even when shipwrecks are not protected by law. They will also explore the Sunken Military Craft Act that protects all foreign and domestic military shipwrecks and learn how formal agreements with other governments help to protect our nation's history.

Objectives

Students will understand that divers need to establish and consistently adhere to a code of ethics in order to preserve historically significant shipwrecks. They will explore the laws and agreements that protect military craft around the world.

Techer Preparations and Implementation

1. Review the websites and activity pages.
2. Bookmark any website(s) to be used or create a Livebinder for students. For more information on Livebinders, visit http://www.livebinders.com/.
3. Determine if students will work individually or in groups.
4. Print the *Class Activity* pages.
5. If Internet is not available, print copies of the CSS *Alabama* Wreck Protection Agreement and the Sunken Military Craft Act (see websites on Class Activity pages).
6. Lead a discussion with the class asking the overarching question: "Do divers have the right to take artifacts from all shipwrecks?" Have students explain the reason for their positions. Positions might include a diver's inherent right to take artifacts, or a legal right, or both.
7. Have students read the background information for the *Class Activity*.
8. **Activity A**: Have students go to the Navy's site for the CSS *Alabama* Protection Agreement or give them a printed copy of the agreement. Let students explore the site to answer the questions.
9. **Activity B**: Have students go to the Sunken Military Craft Act or give them a printed copy of the act. Let students explore the site to answer the questions.
10. **Activity C**: Wrap-up by asking students the overarching question again. Who changed his/her position? Why? Have students choose a side and debate the issues in a Socratic Seminar.
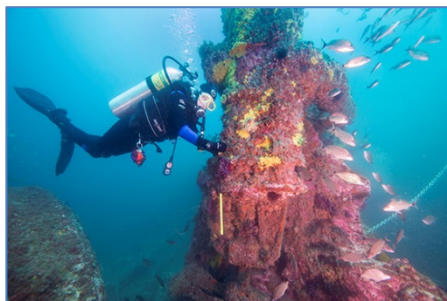
Resources
Websites

Sunken Military Craft Act
Visit this site to view the regulations that govern sunken military craft.
http://www.history.navy.mil/research/underwater-archaeology/sunken-military-craft-act/smca.html

NOAA diver, documents the *Caribsea* shipwreck located off North Carolina's coast. Photo: NOAA

Historic Preservation Policy Regarding U.S. Navy Sunken Military Craft
Common questions about submerged military craft federal laws and regulations.
http://www.history.navy.mil/research/underwater-archaeology/policy-and-resource-management/sunken-military-craft-act.html

American Battle Monuments Commission — The Battle of the Atlantic Interactive Timeline
Excellent site that offers a well done interactive site/map with a wealth of information on WWII and the Battle of the Atlantic. Do not overlook the timeline at the bottom and after watching the video segment for each time period, be sure to check out the "briefings" for each, as there is a plethora of information given.
http://www.abmc.gov/sites/default/files/interactive/interactive_files/BOTA_Web/index.html

U.S. Navy — Historic Preservation Policy Regarding US Navy Sunken Military Craft
A list of common questions about submerged military craft.
http://www.history.navy.mil/research/underwater-archaeology/sunken-military-craft-act/ua-preservation-policy.html

Monitor National Marine Sanctuary
Download a copy of the Underwater Cultural Heritage Law Study that provides an analysis of existing laws that protect U.S. underwater cultural heritage sites, the gaps in protection and recommended legislative changes.
http://monitor.noaa.gov/publications/welcome.html

The National Paideia Center — Socratic Seminar
Visit this site for an overview and step-by-step directions for conducting a Socratic Seminar, including a scoring rubric.
https://www.nwabr.org/sites/default/files/SocSem.pdf

Vocabulary

ETHICS – Moral principles that govern a person's or group's behavior

SOCRATIC SEMINAR – A collaborative, intellectual dialogue facilitated with open-ended questions about a text

SUNKEN MILITARY CRAFT ACT – Enacted in 2004 to preserve and protect all sunken military craft, both foreign and domestic, from unauthorized disturbances within U.S. waters.

Name: _____   Date: _____

Ethically Speaking
Class Activity

Background

Shipwrecks can be found in deep water, near shore and sometimes even on the beach. The idea of finding a shipwreck is exciting and mysterious because shipwrecks are vessels of untold stories that connect us to the ocean and our maritime past. Unlocking the secrets a shipwreck holds may be difficult, but that only fuels our imagination and curiosity to learn more.

Shipwrecks are intriguing for many different reasons. To scuba divers, they are part of an underwater world of wonder that offers divers a firsthand look at things not seen on land. To marine biologists and fishermen, they are an oasis of life that team with an overwhelming amount of variety. To maritime archaeologists, they are windows into our past. And to local coastal communities, shipwrecks provide economic support through maritime heritage tourism.

The presence of shipwrecks also provides economic support to coastal communities through maritime tourism. For example, shipwrecks can serve as a diving or fishing location for chartered vessels. Shipwrecks along the beach also offer those who do not dive or fish an opportunity to experience a wreck from shore. As all these people visit the community, they stay in hotels, eat in restaurants, visit local museums, and buy souvenirs or groceries from local stores, to name only a few. Ultimately, visitors can provide a large source of income to communities.

When a new ship is discovered, it is quite exciting, but often there is conflict over what to do with the new shipwreck. Most people not only want to do what is ethical to protect shipwrecks for archaeological or historical purposes, but also to ensure that its remains can be seen by many people for future generations. Hurricanes, storms, currents and water take a huge toll on a shipwreck, but divers can also do damage both intentionally and unintentionally. There are some divers who intentionally remove artifacts for financial gain, which often destroys the shipwreck. In other instances, a diver that is perhaps not aware of the importance of leaving a shipwreck *in situ* might take a piece of a ship or an artifact home. Never intending to do any harm, they just may not realize that a shipwreck is a finite resource and cannot be replenished. If every diver took a piece of a shipwreck with them each time they dove, over time, there would not be much left. Therefore, it is important to educate divers "to take only pictures and leave only bubbles," so that future generations will have an opportunity to experience and explore these resources as well.

Being ethical when diving, understanding the importance of leaving a shipwreck *in situ*, is a must. However, in the past not everyone thought that way. In 1987, Congress passed the *Abandoned Shipwrecks Act*. The act was passed due to the severe damage of about 3,000 historic wrecks in the Great Lakes and other coastal areas. The ships had been salvaged and in some cases ruined by treasure hunters in the 1970s. The law provides that any wreck that lies embedded in a state's submerged lands (lands lying below the high tide line or high water mark) is property of that state and subject to the state's jurisdiction if the wreck is determined abandoned.

For other shipwrecks there are additional laws and regulations that protect them. For example, some shipwrecks are protected by the *Sunken Military Craft Act of 2004*. This act protects all military vessels (foreign and domestic) and their associated contents. While people can enjoy and visit these cultural resources, the removal of artifacts is strictly prohibited. Also, some shipwrecks may belong to a foreign government, such as the German U-boats off North Carolina's coast. Just as we would want citizens in foreign countries to respect and preserve our military vessels off their shores, we want to demonstrate that same level of respect. Another consideration is that many of the military vessels had losses of life, so they are also considered war graves. Therefore, it is not only important to learn what is ethically correct when diving on shipwrecks, as we want to honor and respect the men who died, but also know the law. Remember that "ethics" is what you SHOULD do and "law" is what you CAN do!

In this activity, you will explore a few of the laws that protect some of our most historically significant shipwrecks.

Activity A: How Old is too Old?

The Civil War occurred over 150 years ago, but many of the ships, that fought during the war and sank, continue to live on as shipwrecks. These shipwreck sites offer valuable information to maritime archaeologists and are protected under the *Sunken Military Craft Act.* However, what happens when a Confederate ship is sunk off the coast of another country? Does the U.S. maintain ownership? Can the United States just give that ownership to another country or organization?

Explore answers to these questions and more by going to **Navy History and Heritage Command** to read about the CSS *Alabama* Wreck Protection Agreement.

http://www.history.navy.mil/research/underwater-archaeology/policy-and-resource-management/agreements/css-alabama-wreck-protection-agreement.html

1. This agreement was made between _____ and _____

2. CSS *Alabama* is a former Confederate ship sunk by the USS *Kearsarge* on June 19, 1864. Where did the ship sink?

3. Who is the rightful owner of the *Alabama*? Why? When was rightful ownership recognized and by whom?

4. Who found the CSS *Alabama*?

5. What is the purpose of the "Association?" Whose laws do they operate under?

6. Why do you think it was important for the U.S. Navy to enter into this agreement with the French government?

Painting of CSS A*labama*. Painting: U.S. Navy's Naval Historical Center

Activity B: Why Protect Military Craft?

Even before the United States entered World War II, a battle raged between Germany and Allied forces for the waters of the Atlantic Ocean. When the United States entered the war on December 1941, East Coast shipping lanes became key targets for German U-boats. Heavy losses of merchant and Allied ships occurred, especially along the North Carolina coast in an area known as "Torpedo Alley." Today, the area is littered with over 60 WWII shipwrecks, including four German U-boats. These sunken warships (naval auxiliary or other vessels owned or operated by a government on military non-commercial service when it sank) are protected by the Sunken Military Craft Act (SMCA). Enacted in October 2004, the SMCA applies to all U.S. sunken military craft that rest in U.S. waters. International collaboration and reciprocity are essential to preserve these craft through joint research efforts, the application of legal mandate, and enforcement for violations.

Visit the **Naval History and Heritage Command's** site at:
http://www.history.navy.mil/research/underwater-archaeology/sunken-military-craft-act.html

1. Who retains ownership of all military craft? Is there a time limit on ownership?

2. How many Navy ships and aircraft wrecks does the Naval History and Heritage Command's Underwater Archaeology Branch manage?

3. What does the permitting program allow? Do you need a permit to fish or dive recreationally if you do not intend to disturb the wreck?

In the left navigation bar, click on "SMCA" under "Sunken Military Craft Act."

4. Read Sec. 1402. Prohibitions (a) and write in your own words what you think it is saying.

5. Read Sec. 1403. Permits (a). For what reasons may a permit be issued?

6. Read *Sec. 1404. Penalties (b)*. What is the penalty for violating the SMCA?

7. Read *Sec. 1407*. Encouragement of Agreements with Foreign Countries. Explain why you think the U.S. should enter into agreements with foreign governments.

8. Do you think that the SMCA is beneficial and should be kept in place? Why or why not?

Activity C: The Great Debate

Background

Socratic seminars were named for one of the most interesting and influential thinkers of the fifth century, Socrates. Socrates was born around 470 BCE, in Athens, Greece. His *Socratic Method* laid the groundwork for Western systems of logic and philosophy. He believed in the power of asking questions and encouraged inquiry and discussion. Although Socrates left no written legacy of his own, we know a lot about him and his philosophy through the writings of his students, such as Plato and Xenophon.

A Socratic seminar is a formal discussion in which a leader asks open-ended questions. Throughout the discussion, students listen to the answers and comments of others and think critically for themselves in order to offer their own thoughts and responses.

During the discussion some basic rules should be followed:

- Be courteous at all times
- Listen while others are talking
- Support all comments with evidence from the source
- Avoid raising your hand to talk – instead jump in at an appropriate time
- When disagreeing with a previous comment, disagree with the idea rather than attack the person
- Address the group when talking, not the teacher

You are responsible for:

- Asking questions
- Asking for clarification
- Being courteous and respectful
- Pausing and thinking before responding
- Give your opinions clearly
- Make judgments that you can defend with facts and evidence
- Explain how you derived any inferences
- Listening patiently as peers share their ideas
- Listening critically to others' opinions and taking issue with any inaccuracies or illogical reasoning
- Move the seminar forward to new concepts
- Listen to a peer's entire position before responding
- Exhibit mature behavior
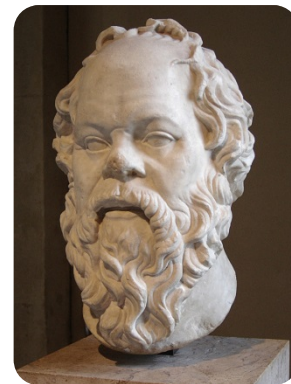
Bust of Socrates. Photo: Eric Gaba—Wikimedia Commons user. Sting

Discuss: Do divers have the right to take artifacts from shipwrecks?

The Art of Artifacts

Government issued pocket comb found in the USS *Monitor*'s turret. Photo: NOAA, *Monitor* Collection

Grade Level

6-12

Timeframe

2-4 hours

Materials

- Variety of objects to represent artifacts (see *Teacher Preparation and Implementation*)
- Variety of broken objects and a basket for each group (see *Teacher Preparation and Implementation* for Activity C)

Activity Summary

This lesson engages students to explore the recovery of artifacts and recognize the importance of skilled archaeologists in any recovery efforts.

Learning Objectives

- To understand that artifacts should only be removed by trained archaeologists
- To experience the difficulty in identifying unfamiliar artifacts and to make inferences.
- To discover the difficulty in piecing together artifacts

Vocabulary

See Vocabulary Box

National Standards:

NCTE:1; NCSS:HT.1, 2, 3, 4 and 5; CCSS:ELA.LIT.RH.7; OL.6 and 7

Background

Shipwrecks are remnants of human history. The suddenness with which a ship often sinks creates an "accidental" moment in time and is the perfect place for archaeologists to study the past and what to expect over time. However, a shipwreck is more than just a collection of objects lying on the seabed. Specifically, they offer a wealth of information that represent the human activities and cultural and social systems of their time. For example, they can tell us what items were considered essential for survival on a ship; give us a look at a cross-section of social classes by the different quarters (living spaces) onboard; tell us how ships were constructed; teach about ship life; help to understand the trade of goods; and through the personal belongings of the crew and passengers, give us glimpses into the lives of the people who sailed on the ship. Sometimes, something as seemingly insignificant as a small stamp or mark on an artifact can even provide valuable, previously unknown information. Therefore, a shipwreck's treasure is not its cargo, but rather the infinite amount of information that can be learned about our past.

Although legend and lore often provide us with stories of shipwrecks full of treasure, every shipwreck, even those without "treasure," provide archaeologists with a special bounty: information. For instance, the position of the wreck, distribution of wreckage and/or other items, rate of deterioration, and much more help archaeologists tell a ship's complete story. Therefore, it is important to preserve a shipwreck *in situ* (in its original place), so that it can be studied as a whole. Removal of artifacts from a site destroys the archeological context. If artifacts are removed, it should be done with archaeologists that have been trained to keep an accurate record of the artifacts through notes, photographs, site plans, and other documents. However, no matter how well archaeologists collect data, once artifacts are removed, the site will never be intact and whole again.

The raising of a shipwreck and the removal of artifacts is often debated. For most shipwrecks, archaeologists agree they should be studied *in situ.* However, a water environment, especially salt water, can have devastating effects on a shipwreck. Specifically, salty water, hurricanes, storms, and human activities can all cause a shipwreck to deteriorate. Therefore, in a few instances, when a shipwreck is nationally and historically significant, such as the USS *Monitor,* a decision is made to recover some or all of the ship's artifacts.

Any recovery of artifacts must be carefully planned as it is imperative that they be immediately conserved. Conversely, without conservation, most artifacts will perish and all historical data lost. Organic material can crumble within a few hours after it dries; iron may last a few days or months, but will eventually fall apart; and glass and pottery will slowly become hard, opaque or crystalline. Therefore, is it is imperative that all factors be considered before recovering artifacts. Some factors considered include the location for conservation and display after artifacts are preserved; the amount of money available to conserve the artifacts; and the reason to conserve an artifact.

Activity Overview

Students conduct four different activities to better understand the important role artifacts play in the story of the shipwreck. They will analyze and interpret "artifacts," and discover the difficulty often encountered when trying to put together pieces of artifacts. Through these activities, students will not only understand the difficulty in identifying artifacts, but also learn how artifacts teach us much about a society's culture.

Objective

To understand that artifacts should only be removed by trained archaeologist. To experience the difficulty in identifying unknown artifacts. To make inferences about the uses of unfamiliar tools. To discover the difficulty in piecing together artifacts.

Teacher Preparations and Implementation

1. Review the activities and resources.
2. Determine group size.
3. Make copies of *Class Activity* pages.
1. Before beginning *Activities A-C*, read and discuss the opening background information. Answer discussion questions. Make sure that students clearly understand that removal of artifacts from a shipwreck should only be done by highly skilled archaeologists and for a valid reason.
2. **Activity A**
   a. Collect a variety of discarded empty containers, such as soda cans, cereal boxes, or frozen food boxes so that each student/group has at least one. The containers are "artifacts."
   b. Have students follow directions to analyze their artifact
3. **Activity B**
   a. Collect several unique kitchen/garden tools or other unusual objects, such as a cherry pitter or garlic press that students might not readily recognize. Provide one for each group.
   b. Using a tag, label each item with a number. On an index card, record the number of the artifact, what it actually is, and the purpose of the object. Save the cards until the conclusion of the activity.
4. **Activity C**
   a. Purchase or acquire, from places such as thrift stores, several inexpensive and various shaped ceramic objects. If possible have two objects that are similar.

   b. Carefully break the objects into many pieces and remove several of the pieces from each broken object.
   c. Divide the class into small groups and give each group a basket with most of the pieces from several objects. For more difficulty, divide the broken pieces among all the groups in class.

7. After the students complete all the activities, wrap up with a discussion on what artifacts tell us, why it is important to only remove artifacts for specific reasons, and how difficult it is to analyze and piece them back together.
8. Optional: Have students relay what they have learned by writing a report, creating a video, or posting to a fake social media.

Above: ECU students work to assemble the 6,500-gallon tank to hold the *Queen Anne's Revenge* anchor. Photo: Cliff Hollis, ECU

Bottom: A nail from *Queen Anne's Revenge* awaits transport to the N.C. Maritime Museum in Beaufort. Photo: ECU

Resources

Websites

The Mariners' Museum
Explore the Batten Conservation Laboratory to learn more about the conservation of the USS *Monitor*.
http://www.marinersmuseum.org/uss-monitor-center/

East Carolina University
Read about the recovery of artifacts from Blackbeard's ship, *Queen Anne's Revenge.*
http://www.ecu.edu/cs-admin/news/QARlab.cfm#.VcJStPlVhuA

NOAA's Maritime Heritage Program – Visit the Office of National Marine Sanctuaries to learn how NOAA maritime archaeologists are exploring the ocean.
http://sanctuaries.noaa.gov/maritime/welcome.html

*Titanic***: The Artifact Exhibition**
Visit this site to learn why artifacts have been recovered from the *Titanic.*
http://www.premierexhibitions.com/exhibitions/3/3/titanic-artifact-exhibition/recovery-conservation

Books

Davis, Robert P. *Stobart. The Rediscovery of America's Maritime Heritage.* Dutton, 1985. ISBN-10:0525243623.

Bowens, Amanda (Editor). *Underwater Archaeology: The NAS Guide to Principles and Practice.* Blackwell Publishing (2nd Edition), 2009. ISBN-13: 978-1405175913.

Hume, Ivor Noël. *A Guide to Artifacts of Colonial America.* University of Pennsylvania Press, May 18, 2001. ISBN-13: 978-0812217711.

Levitt, Peggy. *Artifacts and Allegiances: How Museums Put the Nation and the World on Display.* University of California Press, July 7, 2015. ISBN-13: 978-0520286078.

Panchyk, Richard. *Archaeology for Kids: Uncovering the Mysteries of Our Past.* Chicago Review Press, 2001. ISBN: 1556523955.

Sanford, Patricia. *Archaeology for Young Explorers: Uncovering History at Colonial Williamsburg.* Colonial Williamsburg Foundation, 1995. ISBN: 087935089X.

Spirek, James D. and Della A. Scott-Ireton (Editors). *Submerged Cultural Resource Management: Preserving and Interpreting Our Maritime Heritage.* Springer, July 31, 2003. ISBN-13: 978-0306478567.

Smith, Robert H. *Maritime Museum of North America.* C Books, August 6, 2009. ISBN-13: 978-0941786072.

Vocabulary

ARTIFACT – Any object made by humans, typically an item of cultural or historical interest

CONSERVATION – Preservation, repair, and prevention of deterioration of archaeological, historical, and cultural sites and artifacts

CONSERVATOR – A person responsible for the repair and preservation of works of art, building, or other things of cultural or environmental interest

ETHICS – Moral principles that govern a person's or group's behavior

IN SITU – Latin phrase that means in its original place or position

Extensions

Activity A: Create a time capsule by collecting items that represent your culture. Put the items in a coffee can or other container that is waterproof and can be sealed tightly. Record the date the items were collected. You may wish to bury the container and leave it for someone to find in the future or put the can in a safe place to be opened by a future class.

Activity B: Conduct research to find out about primary and secondary sources of information. How do historians use inferences to help them interpret events from the past?

Activity C: Place three animal cookies in a small baggie and gently break them apart. On a flat surface and a paper towel, spread the cookies apart. Try to put the cookies back together again. Students can't eat until they have them together…well at least almost together!

The USS *Monitor*'s turret was raised in 2002. Inside the turret were a plethora of artifacts. Two sets of human remains were also discovered during excavation. Photo: NOAA, *Monitor* Collection

Name: _____   Date: _____

The Art of Artifacts
Class Activity

Background

Shipwrecks are remnants of human history. The suddenness with which a ship often sinks creates an "accidental" time capsule and is the perfect place for archaeologists to study the past and what to expect from the progression of time. However, a shipwreck is more than just a collection of objects lying on the seabed. Specifically, they offer a wealth of information that represents the human activities and cultural and social systems of their time. For example, they can tell us what items were considered essential for survival on a ship; give us a look at a cross-section of social classes by the different quarters (living spaces) onboard; tell us how ships were constructed; teach about ship life; help to understand the trade of goods; and through the personal belongings of the crew and passengers, give us glimpses into the lives of the people that sailed on the ship. Sometimes, something as seemingly insignificant as a small stamp or mark on an artifact can even provide valuable, previously unknown information. Therefore, a shipwreck's treasure is not always its cargo, but rather the infinite amount of information that can be learned about our past.

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The raising of a shipwreck and the removal of artifacts is often debated. For most shipwrecks, archaeologists agree they should be studied *in situ.* However, a water environment, especially salt water, can have devastating effects on a shipwreck. Specifically, salty water, hurricanes, storms, and human activities can all cause a shipwreck to deteriorate quickly over just a few decades. Therefore, in a few instances, when a shipwreck is historically significant, such as the USS *Monitor,* a decision is made to recover some or all of the ship's artifacts.

Any recovery of artifacts must be carefully planned as it is imperative that they be immediately conserved. Conversely, without conservation, most artifacts will perish and all historical data lost. Organic material can crumble within a few hours after it dries; iron may last a few days or months, but will eventually fall apart; and glass and pottery will slowly become hard, opaque, or crystalline. Therefore, is it is imperative that all factors be considered before recovering artifacts. Some factors include the location for conservation and display after artifacts are preserved; the amount of money available to conserve the artifacts; and the reason to conserve artifacts.

Discussion Questions

1. Explain "accidental time capsule."

2. What can artifacts from shipwrecks tell an archaeologist? How?

3. Why is it important to sometimes preserve the shipwreck *in situ*? When might artifacts be recovered?

4. Explain why it is imperative to plan for conservation before recovering artifacts?

In the following three activities, you will learn 1) how archaeologists interpret artifacts; 2) make inferences about unknown artifacts; 3) and the difficulty in piecing together broken or torn artifacts.

Activity A: Analyzing Artifacts

Background

An artifact is an object that is made or used by humans. Archaeologists often study cultures that existed before the written word, so they must try to interpret the artifacts that are left by the people that used them. A shipwreck, for instance, can offer a unique look at the life of the people that sailed on a ship and the culture when the ship sank. These time capsules hold a wealth of information and even their "trash" provides clues of what life was like onboard. Moreover, artifacts that were discarded as trash many years ago are treasures today to archaeologists. Archaeologists carefully examine the objects and analyze them to learn their stories. A simple everyday object may actually tell us more than we think about the people that made and used it. An artifact might even tell us what their lives were like, how they thought, what they valued and how they changed the world in which they lived.

Procedure

1. You are an archaeologist analyzing artifacts that have been recovered from an archaeological site. Select an artifact.
2. Carefully observe the artifact.
3. In your science journal, record your observations and provide as many details as possible about the artifact.
4. Answer the following questions about the artifact and write a sentence to explain its potential culture of origin and/or the values of the culture. For example, a nutritional label on a box might indicate that the culture was concerned about their health.
   a. Is the artifact plain or decorated?
   b. How was it sealed?
   c. Is there any writing on the artifact?
   d. What material is the artifact made of?
   e. Where was the product made?
   f. What other details offer clues?
5. Share and compare your findings and explanations with the other archaeologists in your class.

Discussion

1. Why do archaeologists look at objects that were discarded or thrown away by people?
2. What are some of the things archaeologists can learn about a culture by studying artifacts?

Left: Boot recovered from the USS *Monitor*. Photo: NOAA, *Monitor* Collection

Right: Silver spoon after its removal from USS Monitor's turret. Photo: NOAA, *Monitor* Collection

Activity B: Making Inferences

Background
When artifacts are found and/or recovered they are analyzed, which may prove to be difficult. Unless an artifact is something that was used and documented in history, archaeologists are left to interpret the purpose and use of the artifact based on what they know about the culture and how people might use the same kind of object today. When ancient Egyptian artifacts were first uncovered, the archaeologists had difficulty interpreting the objects and making sense of how they were used. After the discovery and translation of the Rosetta stone, archaeologists were able to interpret Egyptian hieroglyphics (picture writing), which gave them a new and better understanding of Egyptian artifacts.

You and your class are future maritime archaeologists from the twenty-third century that uncover some unique artifacts from the twenty-first century.

Procedure
1. Carefully observe the artifact.
2. In your science journal, draw a picture of the object. Record your observations including as many details as possible.
3. In your group, discuss your observations and based on what you know about life in the twenty-first century; determine a purpose for the object. Come to a consensus on its purpose.
4. In your science journal, explain what the artifact might have been used for and why your group came to that conclusion.
5. As a group, create a short 2-3 minute skit that explains to the other archaeologists in your class the artifact, without naming it, and its use.
6. After all archaeologists have completed their skits, get the card from your teacher that explains what the artifact is and how it was/is actually used.
7. Compare your inferences and conclusions.

Discussion
1. Were you able to identify the purpose of your artifact? Why or why not?
2. Did everyone agree about the purpose of each artifact?   Why or why not?
3. How is this activity similar to what happens when an archaeologist recovers an artifact?

Extensions
1. Read excerpts from historical journals. What clues do the authors leave about the cultures in which they lived? How are journals helpful to archaeologists? What might an archaeologist learn from these kinds of records found at a site?
2. Look at a picture of an old painting. What can you learn about the culture from the painting? Conduct research to find out about ancient artworks that have been found on cave walls or rock cliffs.
3. Visit a museum to look at the artifacts from another culture. Before reading the information cards, predict how the object may have been used; then read about the object in the museum case. Keep track of the number of times you were correct in your predictions.

Look at the photo and identify the four objects recovered from the USS *Monitor*'s turret in 2002. What can be inferred by these objects?

Activity C: Picking Up the Pieces

Background

Once a maritime archaeologist has uncovered artifacts, recorded their location, and documented each piece, the scientific process of archaeology continues. The artifacts are usually brought to a lab where they may be washed, counted, weighed, and catalogued. Next, archaeologists carefully sort the artifacts into groups according to their characteristics. Think of the last time you put a puzzle together. Did you first find all the edge pieces? Or did you find all the ones of the same color? Similarly, an archaeologist sorts the artifacts and any pieces.

All artifacts are unique and offer valuable information; in particular, pottery is an especially important artifact for archaeologists to find. Specifically, pottery does not break down as easily as cloth, and it is often the most abundant artifact found. Another helpful characteristic of pottery is that the method and style for making pottery changes over time and across different cultures. Therefore, pottery can be used to determine the age of the site and its relationship to other cultures.

Procedure
1. Carefully, observe the pieces of artifacts in your group's basket.
2. Come to a consensus in your group about how to best sort the artifacts and then carefully sort them.
3. Once the artifacts are sorted, try to put the pieces together and determine the identity of the artifact.
4. Continue until you have either no more pieces or you can no longer make them fit together.
5. Sometimes broken artifacts can be recovered at different times and/or in different places of a shipwreck. Therefore, be sure to consult with the other groups to see if they have any pieces that are similar to yours.
6. If there is a group that has pieces similar to your artifacts, join them and try to put the artifacts together.
7. As a class, discuss the difficulty of piecing together the artifacts.

Discussion
1. What was the most difficult part about putting the pieces together?
2. In a real archaeological recovery, why might there be missing pieces?
3. Are all artifacts always identified?

Pottery is useful to identify the time period and culture of a shipwreck.

A conservator works to conserve a shoe found inside the USS *Monitor*'s turret. Photo: NOAA, *Monitor* Collection
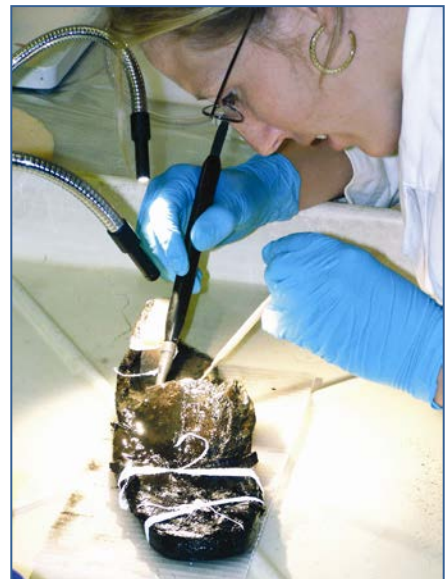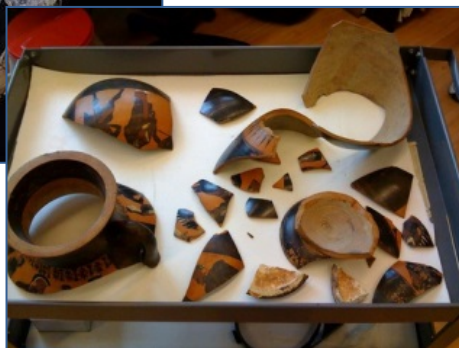
Conservation and Conservators

USS *Monitor*'s turret shortly after recovery, Photo: NOAA, Monitor Collection

Grade Level

6-8; easily adapted for 9-12

Timeframe

1-2 hours

Materials

See *Teacher Preparation and Implementation* for each activity's materials

Activity Summary

This lesson engages students to explore the conservation of artifacts through online learning and experiments.

Learning Objectives

- To understand that artifact conservation is complex and can take years to complete
- To observe the destructive properties of rust
- To discover that modern metals differ from historic metals

Vocabulary

See Vocabulary Box

National Standards:

NCSS:HT.1; CCSS:ELA.LIT.RI.4 and 6; NS:5-8.A, B, E, F and G; NS:9-12.A, B, E, F and G

Background

When planning to recover artifacts from a marine archaeological site, two of the most important items to consider are: 1) how to preserve the artifact and 2) how much it will cost (and who is funding it). Without conservation, most artifacts would perish and all historical information would be lost. Conservation may seem like a straightforward and simple process, but it is very complicated. Conservation is also time consuming and expensive, often costing more than the original recovery of an artifact.

Conservation does not simply involve a single set of procedures; therefore, only highly trained professional conservators should work to conserve artifacts. Moreover, professional conservators are often the first person to see an actual artifact, and for that reason, they are deeply concerned with the integrity of the artifact and the history it represents.

Conservators take on the same responsibilities as an archaeologist, and they also fill the roles of a mender, caretaker and recorder of the artifacts they conserve. They take great care to handle the artifact with respect and ensure that the artifact is conserved correctly. Additionally, conservators are guided by a set of ethical guidelines adopted by the International Institute for Conservation.

When artifacts are recovered from a salt water environment, they must not be allowed to dry. Artifacts absorb salt from the water and over time, these salts become embedded in an artifact, especially in iron objects. The presence of salt can be fatal for an artifact, because as the artifact dries, salt comes out of solution and crystalizes. Salt crystals act as tiny wedges breaking apart an artifact. Therefore, before an artifact can dry, the salt must be removed. The salt removal process varies in length. Many other factors can also affect the length of time it takes to conserve an artifact, such as its size and source material.

Removing salt from objects can take years or even decades, like with the USS *Monitor*'s turret. The process requires that skilled, professional conservators and other support staff are hired. A facility must be acquired and then, there are numerous other costs, such as utilities, supplies, chemicals and more. Therefore, funding is a key component in recovering artifacts from a shipwreck site. If decades are required, as with the *Monitor*, then the amount of funding required can be in the millions of dollars.

Activity Overview

Students explore the conservation of the USS *Monitor*'s turret. Students will also perform two experiments. In the first experiment, they will observe the destructive properties of rust; and in the final activity, they will learn that the composition of metals has changed over time.

Objectives

- To recognize that artifact conservation is a costly and complex process requiring years to complete.
- To observe the destructive properties of rust and to predict how rust forms in different environments.
- To recognize that metal composition has changed over time and to predict the most effective way to clean copper.

Teacher Preparations and Implementation

1. Review the background information, resources and activities.
2. Determine group size for each activity.
3. Bookmark websites for students or create a Livebinder. For more information on Livebinders: http://www.livebinders.com/welcome/education
4. Print copies of the activity pages. If Internet is not available, print website information.
5. Activity B—Materials per Group—Create a set of materials for each group
   a. 5 pieces of steel wool (without soap)
   b. 5 shallow plastic disposable bowls
   c. 4 small clean jars
   d. 15 mL baking soda
   e. 60 mL vinegar
   f. 15 mL salt
   g. 180 mL water
   h. 2 stir sticks
   i. 2 tongue depressors (or tweezers)
   j. 5 paper plates
   k. Safety goggles

6. Activity C—Review acids and bases and how to use a litmus strip. For each group, create a set of materials from the list below
   a. ~8 pennies that are not shiny
   b. 7 small plastic cups
   c. Graduated cylinder or beaker
   d. 30 mL water
   e. 30 mL vinegar
   f. 15mL baking soda mixed in 30 mL water
   g. 30 mL lemon juice
   h. 30 mL liquid hand soap
   i. 15mL salt mixed in 30 mL water
   j. 30 mL ketchup
   k. Tape
   l. Soft paper towels
   m. Seven litmus strips
7. Wrap up the activities with a discussion on the complexity of the conservation of artifacts. Help students to understand that because the process is complex, expensive, and time consuming, most artifacts should be left *in situ* unless they are historically significant in some way that warrants their recovery.

Resources

Website

Monitor National Marine Sanctuary: Preserving a Legacy
An in depth look at the USS *Monitor*'s history, discovery, recovery of artifacts, and present day conservation efforts.
http://monitor.noaa.gov/150th

Vocabulary

ARTIFACT – Any object made by humans, typically an item of cultural or historical interest

CONSERVATION – Preservation, repair, and prevention of deterioration of archaeological, historical, and cultural sites and artifacts

CONSERVATOR – A person responsible for the repair and preservation of works of art, building, or other items of cultural or environmental interest

CORROSION – A chemical action that causes the breakdown of a material, especially metal

IN SITU – Latin phrase that means in its original place or position

IRON – A strong, hard magnetic silvery-gray metal, often used as a material for construction and manufacturing, especially in the form of steel

METAL – A solid material that is typically hard, shiny, malleable, fusible, and ductile, with good electrical and thermal conductivity

RESTORATION – The action of returning something to a former owner, place or condition

RUST – A reddish- or yellowish-brown flaky coating of iron oxide that is formed on iron or steel by oxidation, especially in the presence of moisture

The Mariners' Museum – Explore the USS *Monitor* Center and watch live webcams of the turret and other artifacts undergoing conservation and more. http://www.marinersmuseum.org/uss-monitor-center/uss-monitor-center

Comic Book Periodic Table – Explore the periodic table of elements in a whole new way. Connect each element to a comic book hero who has the same characteristics as the element. http://www.uky.edu/Projects/Chemcomics/

Chemistry for Kids – Explore the structure of molecules and learn how atoms combine to form compounds. http://www.chem4kids.com/files/atom_intro.html

David's Whizzy Periodic Table – This website provides a multimedia crash course on the chemistry behind all materials, and includes the ever popular and very interactive "David's Whizzy Periodic Table." http://www.colorado.edu/physics/2000/periodic_table/index.html

The National WWII Museum – Visit this site to learn more about the techniques and guidelines to preserve artifacts. http://www.nationalww2museum.org/give/donate-an-artifact/preservation-of-artifacts.html

Science Kids: Metals for Kids – Check out the cool topic of metals with a range of free games, experiments, and more. http://www.sciencekids.co.nz/metals.html

Great Schools Science Worksheets – Great teacher resource for metals with printable worksheets. http://www.greatschools.org/worksheets/science/?start=18

Books

Bowens, Amanda (Editor). *Underwater Archaeology: The NAS Guide to Principles and Practice.* Blackwell Publishing (2nd Edition), 2009. ISBN-13: 978-1405175913.

Llewellyn, Claire. *Metal.* Scholastic Library Publishing, 2001, ISBN: 0531148343.

Mebane, Robert C. and Thomas Rybolt. *Metals (Everyday Material Science Experiments).* 21st Century, 1997. ISBN: 0805028420.

Oxlade, Chris. *How We Use Metal.* Raintree, 2004. ISBN: 1410908933.

Sparrow, Giles. *Iron.* Marshall Cavendish, 1999. ISBN: 0761408800.

Zronik, John Paul. *Metals.* Crabtree Publishing Company, 2004. ISBN: 0778714500.

Extensions

1. Learn more about the human remains discovered inside the *Monitor*'s turret and their burial at Arlington National Cemetery. http://monitor.noaa.gov/150th
2. Explore the difference between chemical and physical changes. Create a poster, skit or song that explains the differences.
3. Repeat *Activity B* using pennies, paper-covered metal twist ties, and brass nails. Make a poster to compare and contrast the results. What does this experiment tell you about the corrosion of different metals in the same environments? Use this information to talk about the kinds of buildings that might be built in different climates or which kinds of metals will need the most protection from corrosion.
4. Visit the United States Mint's website http://www.usmint.gov to learn more about the metals that are used in coins.
5. Visit or contact a museum to find out how they clean and restore their paintings or other artifacts. Prepare a report to share with the class.
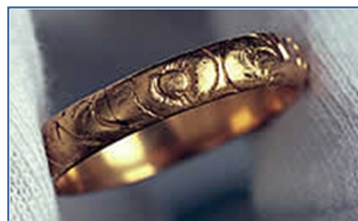
Left: Steam engine register
Center: Ring found with human remains.
Top Right: Alloy spoon found in turret.
All Photos: NOAA, *Monitor* Collection

Name: _____   Date: _____

Conservation and Conservators
Class Activity

Background

When planning to recover artifacts from a marine archaeological site, one of the most important items to consider is how to preserve the artifact. Specifically, without conservation, most artifacts would perish and all historical information would be lost. For many people, conservation seems like a straightforward and simple process, but it is very complicated. Conservation is also time consuming and expensive, often costing more than the original recovery of the artifact.

Conservation does not simply involve a single set of procedure; therefore, only highly trained professional conservators should work to conserve artifacts. Moreover, professional conservators are often the first people to see an actual artifact, and for that reason, they are deeply concerned with the integrity of an artifact and the history it represents. Conservators take on the same responsibilities as an archaeologist, and they also fill the roles of a mender, caretaker and recorder of the artifacts they conserve. They take great care to handle the artifact with respect and ensure that the artifact is conserved correctly. Additionally, conservators are guided by a set of ethical guidelines adopted by the International Institute for Conservation.

When artifacts are recovered from a salt water environment, they must not be allowed to dry. Artifacts absorb salt from the water and over time, these salts become embedded in an artifact, especially in iron objects. The presence of salt can be fatal for an artifact because, as the artifact dries, salt comes out of solution and crystalizes. Salt crystals act as tiny wedges that can break apart an artifact. Therefore, before an artifact can dry, the salt must be removed. The salt removal process varies in length. Many other factors can also affect the length of time it takes to conserve an artifact, such as its size and its source material.

Removing salt from objects can take years or even decades, like with the USS *Monitor*'s turret. The process requires that skilled, professional conservators and other support staff are hired. A facility must be acquired and then, there are numerous additional costs, such as utilities, supplies, chemicals and more. Therefore, funding is a key component to making any decision to recover artifacts from a shipwreck site. If decades are required, as with the *Monitor*, then the amount of funding can be in the millions of dollars.

Getting Started
In this activity, you will explore the conservation process for the USS *Monitor*'s turret, observe the destructive properties of rust and understand that the composition of metals has changed over time.

A look inside the Batten Conservation Lab where artifacts from the USS *Monitor* are being conserved. In the foreground is the steam engine tank and behind it is the turret tank. Photo: NOAA, *Monitor* Collection

Activity A: Exploring the Conservation of the USS *Monitor*'s Turret

In your science journal, answer the following questions using information form The Mariners' Museum's websites listed for each set of questions.

http://www.marinersmuseum.org/uss-monitor-center/conservation-process

1. Where are the USS *Monitor*'s turret, steam engine, condenser, Dahlgren guns and other artifacts being conserved?

2. How many years were these artifacts submerged in the ocean?

3. How many tons of iron artifacts are being conserved at the museum?

4. When the conservation process is completed, where are the artifacts displayed?

5. What is concretion?

http://www.marinersmuseum.org/uss-monitor-center/countering-effects-corrosion

6. What is electrolytic reduction? Explain fully.

7. Why is a negative charge applied to an artifact?

8. When is the solution changed?

9. Why are there bubbles?

The 90,000 gallon tank must be drained in order for conservators to work inside the turret. The process takes about five hours and typically occurs once a year.
Photo: NOAA, Monitor NMS
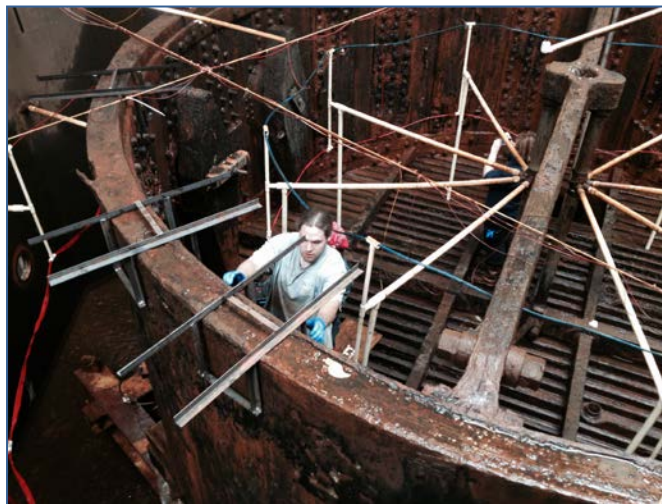
Activity B: Rusting Away

Background

Corrosion is a naturally occurring physical and chemical deterioration, or break down, of a material as it reacts with oxygen and other parts of its environment, such as acids, salts, or moisture. Corrosion takes place slowly over a long period of time. Often, there are no clues to announce that the reaction is taking place until the corrosion is seen. In the United States, corrosion of metals causes more than five billion dollars of damage each year. Different metals corrode in different ways. When iron is exposed to oxygen for an extended period of time, iron oxide (Fe_2O_3), or rust, forms on the surface. Because rust is porous, exposure to oxygen and water in the air continues the corrosion process until the metal breaks down entirely.

When copper is exposed to gases in the air, the product of the corrosion reaction is a green finish that acts much like a coat of paint that prevents the air from further reaching the metal so only the surface of the object corrodes. This green coating is a layer called patina. Corrosion on silver is a dull tarnish that changes the physical appearance of silver. Tarnish can be removed using another chemical reaction with aluminum foil and baking soda.

Scientists and researchers study ways to reverse the problems of corrosion and to prevent corrosion from happening, and conservators work to find ways to slow or stop the corrosion of artifacts.

Procedure

1. Put on your safety goggles.
2. Label each of four bowls:
   a. Water
   b. Salt
   c. Baking soda
   d. Vinegar
3. Pour the vinegar into the bowl labeled "vinegar."
4. Pour 60 mL of water into each of the other three bowls.
5. In the bowl marked "salt," add 15 mL salt to the water and stir until dissolved. Discard stir stick.
6. In the bowl marked "baking soda," add 15 mL baking soda to the water and stir until dissolved. Discard stir stick.
7. Place a piece of steel wool in each bowl.
8. Turn a jar upside down over each piece of steel wool in the bowl to form a sealed environment. See image.
9. Label the last bowl, Control.
10. Put a dry piece of steel wool in the control bowl and leave it uncovered.
11. Place the bowls in a location where they will not be disturbed.
12. Predict what will happen to the steel wool in each of the bowls.
13. Determine which bowl will show the most change. Record your predictions on your *Student Observation Chart*.
14. Over the next four days, while wearing your safety goggles, observe the steel wool. Record your observations on the *Student Observation Chart*.
15. Label five paper plates with the same labels as the bowls.

Above: Conservators place anodes around one of the Monitor's Dahlgren guns. Photo: NOAA, *Monitor* Collection

Above: Conservators work inside the *Monitor*'s turret
Left: Port pump recovered from the USS *Monitor*. Photos: NOAA, *Monitor* Collection

16. On day 5, put on your safety goggles and remove the steel wool from each of the bowls and place them on the corresponding paper plate.
17. Using the tongue depressors (or tweezers if available), pull apart each piece of steel wool.
18. Observe what happens and record your observations.
19. Compare the control sample to the other samples.

Discussion
1. What happened to the steel wool pieces in each of the bowls?
2. Which bowl showed the most change after four days?
3. Why is it important to protect metal surfaces from corrosion?
4. Using what you have learned from your test results, how does iron react in salt water? Fresh water?

Student Observation Chart

Day	Water	Baking Soda	Vinegar	Salt Water	Control
Prediction					
0					
1					
2					
3					
4					

In your science journal, answer the following questions:

1. Which piece of steel wool rusted the fastest?
2. Which piece rusted the most?
3. What happened when you used the tongue depressors to pull apart the steel wool from the four experimental containers?
4. What happened when you tried to pull apart the control piece of steel wool?
5. Explain what this activity taught you about rust.

Extensions
1. Place one of the rusty pieces of steel wool in a glass of cola for one hour. What happens to the rust? Can the metal that was destroyed be replaced?
2. Visit a car dealership or automotive shop that puts protective coatings on the underside of a car. Interview the technician to find out what the coating is made from and why it is used.

Activity C: Changing Metal

Background

Scientists always look for ways to protect metals and prevent corrosion. Because different metals corrode in different ways, scientists can develop new combinations of metals that will resist corrosion and last longer.

Although many common items are made of metals, the composition of the metals used today may be different than in the past. Pennies are a good example of this difference.
- From 1793 to 1837, pennies were made of pure copper.
- From 1837 to 1857, pennies were made of bronze (95% copper and 5% tin and zinc).
- From 1857 to 1864, the penny was 88% copper and 12% nickel, giving the coin a whitish appearance.
- From 1864 to 1962 (except for the year 1943), the penny was again bronze.
- In 1943, copper was needed for use in World War II, so most of the pennies that were minted, or made, were zinc-coated steel coins.
- In 1962, the small amount of tin that was used in earlier pennies was removed, making the metal composition of the one cent piece 95% copper and 5% zinc.
- From mid-1982 to present day, pennies are made with 97.5% zinc and 2.5% copper.

A penny is shiny when it is first made, but exposure to oxygen and dirt cause it to become dull and turn dark brown. Copper oxide forms and coats the penny, much like tarnish on silver. Copper oxide reacts with mild acids. When dipped in an acidic solution the copper oxide dissolves, leaving a bright shiny penny again.

Archaeologists, museum curators, and art restoration technicians all use a variety of cleaning methods to restore artifacts. Scientists have discovered that oxygen atoms react with organic materials causing them to dissolve. Many common laundry and carpet cleaners today use the power of oxygen to boost their cleaning power. People that do metal restoration must consider the time period in which the metal was made because metals were created differently throughout time just like the penny. Concurrently, knowledge of the time period helps archeologists to know how best to clean or restore an item.

Procedure
1. Predict which chemicals will clean the pennies, making them shiny again.
2. Write your predictions in your science journal and explain your predictions.
3. Label each cup: water, vinegar, water and baking soda, lemon juice, soap, saltwater, and ketchup.
4. Using a graduated cylinder or beaker, measure and pour the amounts listed for each cup: 30 mL water, 30 mL vinegar, 15 mL baking soda mixed with 30 mL water, 30 mL lemon juice, 30 mL liquid hand soap, 15 mL salt mixed with 30 mL water, 30 mL ketchup.
5. Place a penny into each cup.
6. Leave the last penny on the table. This penny is your control.
7. Leave the pennies in the cups overnight.
8. Observe the penny the next day and record your observations. What changes did you see?
9. Remove one penny from its solution.
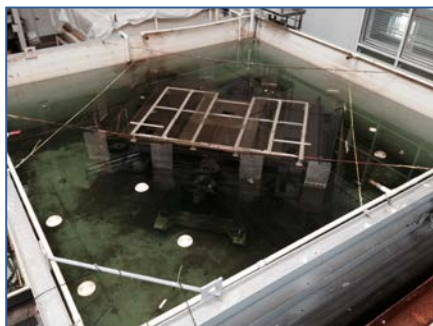
Left: The steam engine in its tank undergoing conservation. Photo: NOAA, Monitor NMS

Right: The steam engine under conservation. Photo: The Mariners' Museum.
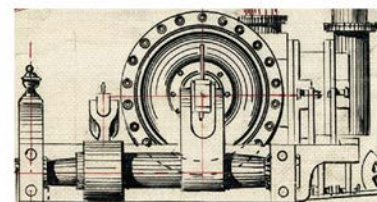
10. Rinse the penny with plain water and dry with a soft paper towel.
11. Observe the penny after it is rinsed and dried. Record your observations.
11. Tape the penny onto the chart in the correct space provided.
12. Repeat with the other pennies, one at a time.
13. Determine which solutions cleaned the pennies best.
14. Test each solution using a litmus paper strip to determine if the solutions were primarily acids or bases.

Discussion
1. What changes did you observe after the pennies had soaked in the solutions overnight?
2. Which solutions were the most effective to clean the pennies?
3. Why do you think rinsing the pennies with water made a difference?
4. Would you achieve the same effect by simply wiping the pennies with a clean paper towel? Why or why not?
5. What conclusions can you draw about the types of substances that would best remove corrosion from a copper surface?

Penny Observation Chart

Solution	Prediction	Results Before Rinsing	Results After Rinsing	pH of Solution (Acid or Base)	Penny (Tape in Box)
Water					
Vinegar					
Water and Baking Soda					
Lemon Juice					
Soap					
Salt Water					
Ketchup					

What do the results tell you?