

[https://web.archive.org/web/20130510001433/http://www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/whalehome.htm](https://web.archive.org/web/20130510001433/http%3A//www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/whalehome.htm)

Last updated 2013

INTRODUCTION

The North Atlantic right whale is one of the most endangered species in the world. Two major causes of death for endangered North Atlantic right whales are ship collisions and entanglements in fishing gear. To reduce the number of human-induced injuries to right whales, the Endangered Species Act requires that an Early Warning System be developed which would alert mariners to the presence of right whales to diminish the number of collisions with ships. This act also requires Maine fishermen to modify their fishing gear in areas where whales are common to help reduce right whale entanglements.

In this WebQuest, students are part of a team of specialists trying to devise a method to reduce whale mortality caused by either entanglement or ship collisions. The team studies the feeding behavior, migration patterns and geographical distribution of Northern right whales. One member of the team will research the sensory biology of whales to determine how they "see" and "hear" in their environment. Another specialist will examine current research and technology involving sonar and echolocation. Specific issues associated with whale entanglements and collisions will also be explored.

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| **Background Information** |

The [Gulf of Maine](https://web.archive.org/web/20150304045547/http%3A/www.gomoos.org/aboutgulfme/) is one of the world's most diverse and biologically productive marine habitats. The landward edge of the Gulf of Maine runs from Nova Scotia, Canada, to Cape Cod, Massachusetts. Over 2,000 species of plants and animals can be found within this marine environment. Every spring, rivers carry melting snow to the Gulf of Maine. This makes the water colder, less salty, and more productive than other parts of the Atlantic Ocean. The strong ocean currents also bring nutrients and food to the plants and animals that live here.

The Gulf of Maine is home to a variety of [large whale species](https://web.archive.org/web/20150304045547/http%3A/www.whalecenter.org/species.htm) including [humpback whales](https://web.archive.org/web/20150304045547/http%3A/www.acsonline.org/factpack/humpback.htm) (*Megaptera novaeangliae*), [finback whales](https://web.archive.org/web/20150304045547/http%3A/www.acsonline.org/factpack/finwhl.htm) (*Balaenoptera physalus*), [minke whales](https://web.archive.org/web/20150304045547/http%3A/www.acsonline.org/factpack/MinkeWhale.htm) (*Balaenoptera acutorostrata*), [sei whales](https://web.archive.org/web/20150304045547/http%3A/www.acsonline.org/factpack/SeiBrydesWhales.htm) (*Balaenoptera borealis*) and [right whales](https://web.archive.org/web/20150304045547/http%3A/www.acsonline.org/factpack/RightWhale.htm) (*Eubalaena glacialis*). All of these are baleen whales, which feed on the abundant supply of plankton found in the Gulf of Maine. Approximately 3,500 of these individuals migrate into the Gulf of Maine each summer. During the winter months these baleen whales return to warmer waters where they breed and calve.

Right whales have a worldwide distribution but contain three distinct small populations in the North Atlantic, North Pacific and southern oceans. Although there are three distinct populations, there are only two species of right whales: northern right whales, which have populations in the North Atlantic and North Pacific, and the southern right whale, which is only found in the southern hemisphere. Both northern right whale populations are in danger of becoming extinct. The North Atlantic right whale population, numbering only 300 individuals, is one of the most endangered species in the world. The southern population of right whales is approximately ten times larger (3,000 - 4,000) than the population of the northern species and has only increased in size in the last 15 years.

The North Atlantic right whale, *Eubalaena glacialis*, is a slow moving, surface-feeding animal that was hunted in the early 20th century to near extinction. This species was targeted by whalers because they were easy to capture and floated to the surface when killed, thus they were the "right" whale to be hunted. In addition, right whales yielded a tremendous amount of oil, meat, and whalebone. Despite a total ban on hunting right whales since the 1930's, populations of this species have not shown signs of increasing.

Current threats to right whales include collisions with ships, entanglement with fishing gear, habitat destruction, and changes in food availability due to climate fluctuations (Fujiwara & Caswell, 2001). Ship collisions kill more right whales than any other documented cause of mortality. The right whale is particularly susceptible to ship strikes because of its habit of resting near the surface, its slow-moving pace as well as its surface courtship and skim-feeding behavior. Often, the whales are not killed outright but are fatally injured by propeller blades, and eventually die because of injury or loss of function. After ship-strikes, entanglement in fishing gear is the leading cause of known mortality in the endangered North Atlantic right whale population. More than 60% of North Atlantic right whales have scars from entanglement in fishing gear such as lobster pots and sink gillnets (Waring et al., 1999). Obviously both causes of mortality need to be reduced in order for the population to recover. If we could prevent only two deaths of female right whales per year, the population level would increase (Fujiwara & Caswell, 2001).

Strong currents combined with large tidal fluxes in the Gulf of Maine cause significant challenges to offshore lobstermen. To avoid large gear losses, lobstermen not only weigh down their traps with cinder blocks, steel bars and bricks but they also link several lobster traps together with rope. This allows them to find their gear more easily, because if they find one buoy it will lead them to several more. The ropes, called ground lines or tailer ropes, are often made of polypropylene, which floats. These ropes tend to arc or loop upwards towards the surface. When large, baleen whales feed they swim with their mouths open and often accidentally catch the fishing line in their mouths. As the whales twist and turn, trying to disentangle themselves they often make matters worse and cause the rope to cut into their skin; sometimes it goes clear down to the bone.

In a world where sight is limited, many marine animals rely on sound to accomplish many tasks. For cetaceans, such as whales, hearing is arguably their most important sensory system. Whales and dolphins have three times more neurons devoted to hearing than any other animal. For these organisms, sound is a key element for survival and hearing is a key component of communication, mate selection, and predator avoidance. Sounds are also produced during feeding and to help navigate underwater.

There are two ways that sound is used: passively and actively. In passive acoustics, the animal makes no sound of its own but instead listens and interprets the sounds made in the environment. In active acoustics when sound is used actively it is first created by a source and then received by a "listener" which could be another whale or technology. Some active acoustic systems have separate sources and receivers (e.g., underwater telephones). Other active acoustic systems (sonar/echolocation) emit a sound which bounces off an object and returns to the receiver. By analyzing the return signal, information about the object such as its size, shape, orientation, direction, speed and composition can be obtained. The distance that whales can "hear" in the environment is much greater than the distance that they can "see".

The North Atlantic right whale is one of the most endangered species in the world. Two major causes of death for endangered North Atlantic right whales are ship collisions and entanglements in fishing gear. To reduce the number of human-induced injuries to right whales, the Endangered Species Act requires that an Early Warning System be developed which would alert mariners to the presence of right whales to diminish the number of collisions with ships. This act also requires Maine fishermen to modify their fishing gear in areas where whales are common to help reduce right whale entanglements.

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| TASKSection 7 of the [Endangered Species Act](https://web.archive.org/web/20130509223144/http%3A/endangered.fws.gov/) requires a reduction in the number of human-induced injuries to right whales. It also requires that an Early Warning System be developed which would alert mariners to the presence of right whales to diminish the number of collisions with ships. This act also requires Maine fishermen to modify their fishing gear in areas where whales are common as part of an overall management plan for the reduction of right whale entanglements.You are part of a team of specialists whose mission is to aid right whale conservation efforts by devising a method to reduce whale mortality from either entanglement or ship collisions. Your team will explore the feeding behavior, migration patterns and geographical distribution of Northern right whales. In addition, one member of the team will research the sensory biology of whales to determine how they "see" and "hear" in their environment. Another specialist will examine current research and technology involving sonar and echolocation. Specific issues associated with whale entanglements and collisions will also be explored.Based on what you learn about the sensory biology of right whales your team will devise innovative technology that will reduce whale mortalities and potentially save this species from extinction. You have been asked by a national funding agency to travel to Washington, D.C. to present your idea to a panel of governmental scientists. Several teams of specialists are competing for limited funding. The team with the most innovative and feasible idea will have their project funded. The funding agency requires a short, written proposal (1-2 pages) and a PowerPoint presentation.Good luck!PROCESSEach student will become an "expert" on one of the topics below by visiting the informational websites associated with the topic they select. Be sure to take notes and record the source (citation) of your information as you research your topic.After completing this task you will reassemble as a group and share what you have learned with your teammates. Your task (as a group) is to develop either a technological method of right whale detection for ships or a fishing gear modification based on the knowledge you have gained about the whale's sensory system. After you have developed your new technology you will need to write a short proposal (1-2 pages) and create a presentation to secure Agency funding**Task #1:** Prior to selecting an individual topic, you should read the following two articles. The Oceanus written by article Michael Moore at the Woods Hole Oceanographic Institute outlines the issues associated with the endangered right whale. The American Scientist article provides backgound information on how marine mammals perceive sound and it discusses current research into using bioacoustics to protect endangered manatees from boat collisions.[Moore, M. 2004. Whither the North Atlantic Right Whale? Oceanus 43: 1-5.](https://web.archive.org/web/20130509221742/http%3A/www.whoi.edu/oceanus/viewArticle.do?id=2482&archives=true&sortBy=printed)[Gerstein, E.R. 2002. Manatees, Bioacoustics and Boats. American Scientist 90:154-163.](https://web.archive.org/web/20130509221742/http%3A/www.americanscientist.org/template/AssetDetail/assetid/14703?fulltext=true)If this link is not working, try accessing the article from the archives using the author index. Or, teachers can contact American Scientist directly to request permission to use the article in their classes. **Task #2:**Each student in your group should select one of the following research topics:[(1) biology of right whales including feeding behavior, migration patterns, and geographical distribution](https://web.archive.org/web/20130509221742/http%3A/www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/Links1.htm)[(2) sensory biology in marine mammals including how whales "see" and "hear" in their environment](https://web.archive.org/web/20130509221742/http%3A/www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/Links2.htm)[(3) current technology based on sonar/echolocation](https://web.archive.org/web/20130509221742/http%3A/www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/Links3.htm)[(4) issues associated with whale entanglements or ship strikes](https://web.archive.org/web/20130509221742/http%3A/www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/Links4.htm) Clip Art of a Clipboard  Click on the topic you have selected and it will bring you to another web page with a list of web links that are specific to your research area. Read through the web pages and **take notes**on pertinent information. Be sure to also write down which web page the information came from.  **Task #3:** After conducting web-based research on your topic, all members of your group will need to get together to discuss what you have learned. Each student should provide a short, verbal report of their findings. Clip Art of a brainstorm**Task #4:** As a group you will need to do some brainstorming to come up with an innovative solution to reducing right whale entanglements or collisions. After you have developed a good idea, discuss it with your teacher to make sure that it is feasible and then write a brief proposal of your idea. The proposal should be no longer than 2 pages and should include important background information as well as how you intend to help reduce right whale mortalities. Clip Art of slide projector and screen**Task #5:** As a group you will need to put together a PowerPoint presentation. The presentation should include information from each of the research areas and should outline your innovative idea. You will be competing against other teams of research specialists who have come together to try and solve the plight of the right whale. The substance and quality of your presentation will no doubt have an impact on who will receive funding for their project.The following is a grading rubric to show you how you will be graded on this WebQuest. Each person will receive an individual evaluation based on their group contribution and their individual contribution.Note: You can either print this webpage or download the [evaluation rubric](https://web.archive.org/web/20130509215043/http%3A/www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/Images/Rubric.pdf)as a pdf file.**Evaluation Rubric**

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| **CATEGORY** | **Beginning****0** | **Developing****1** | **Accomplished****2** | **Exemplary****3** | **Score & Comments** |
| **Group Grade** |
| Subject Knowledge | Subject knowledge is not evident. Information is confusing, incorrect or flawed. | Some subject knowledge is evident. Some information is confusing, incorrect or flawed. | Subject knowledge is evident in much of the product. Information is clear, appropriate, and correct. | Subject knowledge is evident throughout (more than required). All information is clear, appropriate, and correct. |   |
| Organization of Presentation and Written Proposal | The presentation and proposal were not turned in or show lack of planning and no logical sequence of information. | The presentation and proposal are of poor quality and show minimal planning; contains a somewhat logical sequence of information. | The ideas presented in the presentation and the written proposal are accurate and understandable; both show adequate planning. | The ideas presented in both the presentation and written proposal show detailed planning and are presented accurately and effectively. |   |
| Delivery | No audience eye contact; very poor vocal inflection; shows lack of rehearsal. | Very little eye contact; somewhat lacking in vocal inflection; shows some organization and evidence of rehearsal. | Good eye contact; projects voice clearly and loudly; shows good organization, obviously rehearsed. | Excellent eye contact; excellent use of voice (loud, clear, animated, varied pitch); talk is very professional and is clearly polished. |   |
| Mechanics | Product has four or more spelling errors and/or grammatical errors. | Product has three or more misspellings and/or grammatical errors. | Product has fewer than two misspellings and/or grammatical errors. | Product has no misspellings or grammatical errors. |   |
| **Individual Grade** |
| Use of Internet Research Opportunity | Time on Internet was spent on task some of the time. Internet citations were incomplete. Very little or no research was done. | Time on Internet was spent on task. Some research was done by visiting one or two of the provided websites, but did not contribute any informatin of value. | Internet time was used well, made extensive notes about websites that were useful, and located a few new resources in addition to those that were provided. | Used Internet time exceptionally well, thoroughly evaluated every website that was provided, and located several new resources in addition to those provided. |   |
| Participation and Collaboration | Inadequate participation exhibited and little collaborative effort reflected in project. Frequently off task in the classroom and required reminders from teacher or group to help with project. | Adequate evidence of participation and some collaborative efforts reflected in project. Usually on task but occasionally distracted or was unhelpful to others. | Strong evidence of participation and good collaborative efforts reflected on project. Always on task and usually helpful to others. | Excellent evidence of participation and excellent collaborative efforts reflected in project. Always on task and helpful to others. Added many ideas and initiated project work. |   |

CONCLUSIONNow that you have presented your project idea to the panel of governmental scientists at the national funding agency you can sit back and relax and await their decision. You will be notified as to which project will be funded in three to four months.The process that you just went through is a shortened version of what research scientists go through each time they develop and present a new project proposal to a funding agency. This WebQuest also introduced you to the role of acoustic cues in ocean ecology and how mammals in the marine environment perceive their surroundings. Your team was presented with a real life problem and asked to provide a real solution. The feasibility of using acoustic warning devices as technological tools to prevent right whale fishing gear entanglements and ship strikes in the Gulf of Maine remains to be seen. The ideas that you generated in this exercise are cutting-edge research into the conservation of Northern right whales.If you are interested in pursuing the topic of marine conservation check out the following links:[Ocean Conservancy](https://web.archive.org/web/20130509222133/http%3A/www.oceanconservancy.org/site/PageServer?pagename=home)[Marine Conservation Biology Institute](https://web.archive.org/web/20130509222133/http%3A/www.mcbi.org/)[National Coalition for Marine Conservation](https://web.archive.org/web/20130509222133/http%3A/www.savethefish.org/)[Whale Center of New England](https://web.archive.org/web/20130509222133/http%3A/www.whalecenter.org/adopt.htm)[Whale Adoption Project](https://web.archive.org/web/20130509222133/http%3A/whales.org/)[International Wildlife Coalition](https://web.archive.org/web/20130509222133/http%3A/www.iwc.org/)[Center for Coastal Studies](https://web.archive.org/web/20130509222133/http%3A/www.coastalstudies.org/)[Ocean Life Institute - Woods Hole Oceanographic Institute](https://web.archive.org/web/20130509222133/http%3A/www.whoi.edu/institutes/oli/index.htm) TEACHER RESOURCES* [Background information for teachers](https://web.archive.org/web/20130510005746/http%3A/www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/Teacher%20Page.htm#background)
* [Additional resources (books and articles)](https://web.archive.org/web/20130510005746/http%3A/www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/Teacher%20Page.htm#resources)
* [Maine State Learning Results Content Standards and Essential Skills](https://web.archive.org/web/20130510005746/http%3A/www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/Teacher%20Page.htm#MSLR)

This lesson was developed to introduce high school students (grades 9-12) to the topic of sensory perception in the marine environment. The WebQuest introduces the role of acoustic cues in ocean ecology and challenges students to determine if acoustic warning devices are useful tools to prevent right whale fishing gear entanglements and ship strikes in the Gulf of Maine.This WebQuest is designed to be used after an initial introduction by the teacher to the issues associated with right whale mortalities in the Gulf of Maine. Teachers should also discuss the broad topic of sensory biology and how animals in the marine environment perceive their surroundings. After this brief introduction, the teacher should only act as a facilitator during the rest of the process. This WebQuest will take about 3 classes to complete the research aspect and another 2-3 classes to produce the written proposal and the PowerPoint presentation. In the student section of the WebQuest, teachers can find a detailed description of what is required by all students ([Process](https://web.archive.org/web/20130510005746/http%3A/www.umaine.edu/marine/people/sites/slindsay/LindsayLab/Whaleweb/Process.htm)). Groups of 4 students can be chosen by the students or by the teacher. All students are required to produce written notes and to participate in the group activities.Teachers may have to adapt the process depending on the types and quantity of technology at their school. We have provided a number of useful websites but students may wish to search for more. Thus, both teachers and students should be familiar with Internet searches. Each individual (if possible) or group should have access to a computer for both their initial information gathering as well as for the development of their proposal and presentation. If computer access is limited, the WebQuest can be completed using traditional library book searches. Presentations do not have to be done in PowerPoint but can be in the form of overheads or posters.We believe that this WebQuest provides an alternative to the more traditional method of classroom instruction - lecturing and note taking. This inquiry-based activity allows students to take an active role in problem solving and development of a feasible solution. By performing this task, students will be working together in groups, thus developing group participation skills. In addition, the students will be dealing with a real life, current environmental issue. This activity will allow them to learn about the plight of the right whales as well as create real solutions to real problems.

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| Clip Art of stacked books**Additional Resources** |

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| **Maine State Learning Results****Secondary Grades** |

This WebQuest was written to meet the following Maine State Learning Standards for grades 9 thru 12. Completing this WebQuest will help students develop content area knowledge in ecology and essential skills in inquiry and problem solving, scientific reasoning and scientific communication.**Content Standard*****B.******Ecology****- Students will understand how living things depend on one another and on non-living aspects of the environment.*4. Analyze the impact of human and other activities on the type and pace of change in ecosystems.**Essential Skills*****J. Inquiry and Problem Solving****- Students will apply inquiry and problem-solving approaches in science and technology.*3. Demonstrate the ability to use scientific inquiry and technological method with short term and long-term investigations, recognizing that there is more than one way to solve a problem. Demonstrate knowledge of when to try different strategies.***K. Scientific Reasoning****- Students will learn to formulate and justify ideas and to make informed decisions.*6. Analyze situations where more than one logical conclusion can be drawn.***L. Communication****- Students will communicate effectively in the application of science and technology.*2. Use journals and self-assessment to describe and analyze scientific and technological experiences and to reflect on problem-solving processes.3. Make and use appropriate symbols, pictures, diagrams, scale drawings, and models to represent and simplify real-life situations and to solve problems.7. Use computers to organize data, generate models, and do research for problem solving.***M. Implications of Science and Technology****- Students will understand the historical, social, economic, environmental, and ethical implications of science and technology.*2. Demonstrate the importance of resource management, controlling environmental impacts, and maintaining natural ecosystems.4. Analyze the impacts of various scientific and technological developments.CREDITSThis WebQuest was designed as an educational outreach project for a National Science Foundation, Division of Ocean Sciences grant titled, "Linking bioturbation and sensory biology: Chemoreception mechanisms in deposit-feeding polychaetes" ([S. Lindsay](https://web.archive.org/web/20130509222544/http%3A/www.umaine.edu/marine/people/sites/slindsay/LindsayLab/index.htm) and [P. Rawson](https://web.archive.org/web/20130509222544/http%3A/www.marine.maine.edu/~rawsonp/rawsonlab/home.htm), Grant No. OCE 0221229).Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. |