



# MEMORANDUM

**To:** City Council  
**From:** City Manager  
**Date:** January 26, 2015  
**CC:**

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**Subject:** Seismic Airgun Surveys

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During the December 15, 2014 City Council meeting, the proposed Proclamation Protesting Seismic Airgun Testing Along the Coast of Georgia was discussed by Council. Staff was requested to provide the Council with information in support of testing in order to provide a balance of information. This information packet was developed for your review.

The Bureau of Ocean Energy Management (BOEM) published a final Programmatic Environmental Impact Statement pursuant to the National Environmental Policy Act (NEPA) in February of 2014. This process was used to evaluate the potential environmental effects of proposed geological and geophysical survey activities, including seismic airgun surveys, of the Atlantic Ocean from Delaware to Florida. BOEM issued a formal Record of Decision in July of 2014 that selected an alternative that included the most protection for environmental and cultural resources during survey activities. The Record of Decision establishes the framework of environmental review that all site specific geological and geophysical activities will have to comply with when undergoing the permitting process and survey activities.

Documents that provide concise information regarding the Programmatic Environmental Impact Statement, the Record of Decision and seismic surveys have been collected for your review. The following documents are attached:

- BOEM. *Fact Sheet: Atlantic Geophysical and Geological Surveys Programmatic Environmental Impact Statement.*
- BOEM. *Fact Sheet: Atlantic Geological and Geophysical and Surveys Record of Decision on the Programmatic Environmental Impact Statement.*
- BOEM. *The Science Behind the Decision.*
- API. *Seismic Surveying 101.*
- IAGC. *Seismic Surveys and Protecting the Marine Environment.*
- IAGC. *Seismic Surveys and Fish.*
- IAGC. *Fundamentals of Sound in the Marine Environment.*

Two additional articles, neither in support of or against seismic airgun surveys, published by National Geographic have been included for your review.

- National Geographic. *Study: Planning Can Protect Whales in Seismic Surveys*
- National Geographic. *Atlantic Seismic Tests for Oil: Marine Animals at Risk?*

Additional information may be obtained on the websites listed on the attached Fact Sheet:

- BOEM. *Selected Sound-Related Studies Funded and Co-Funded by BOEM.*

At the February 2, 2015 City Council meeting, Mr. Brydon Ross, Vice president of State Affairs for the Consumer Energy Alliance will be in attendance to make a brief presentation to Council. Mr. Ross will also be able to answer any questions that Council may have regarding geological and geophysical survey activities, including seismic airgun surveys.

### Selected Sound-Related Studies Funded and Co-Funded by BOEM

1. Atlantic Marine Assessment Program for Protected Species  
<http://www.nefsc.noaa.gov/psb/AMAPPS/>
2. Characterization of Underwater Sound Produced by Trailing Suction Hopper Dredges During Sand Mining and Pump-Out Operations  
<http://el.erdc.usace.army.mil/elpubs/pdf/trel14-3.pdf>
3. COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales: Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic  
[http://www.boem.gov/uploadedFiles/BOEM/Environmental\\_Stewardship/Environmental\\_Studies/Alaska\\_Region/Alaska\\_Studies/PS\\_0902a.pdf](http://www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/Alaska_Region/Alaska_Studies/PS_0902a.pdf)
4. Controlled Exposure Experiments with Humpback Whales and Seismic Air Gun Arrays and Testing of Effectiveness of Ramp-Up (Study completion expected 2015)  
[http://www.boem.gov/uploadedFiles/BOEM/Environmental\\_Stewardship/Environmental\\_Studies/National/AustralianHumpbackWhaleProfile.pdf](http://www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/National/AustralianHumpbackWhaleProfile.pdf)
5. Describing Biologically Significant Marine Mammal Behavior  
[http://www.navy.marinespeciesmonitoring.us/files/8713/4629/1074/Marine\\_Mammals\\_Sound\\_Workshop\\_July\\_2010\\_Final\\_Report.pdf](http://www.navy.marinespeciesmonitoring.us/files/8713/4629/1074/Marine_Mammals_Sound_Workshop_July_2010_Final_Report.pdf)
6. Developing Environmental Protocols and Modeling Tools to Support Ocean Renewable Energy and Stewardship  
<http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5208.pdf>
7. Development of Software and Hardware to Acoustically Detect Classify, and Locate Marine Mammals.  
[http://www.boem.gov/uploadedFiles/BOEM/Environmental\\_Stewardship/Environmental\\_Studies/National/NT1108.pdf](http://www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/National/NT1108.pdf)
- 7a. Companion product: Acoustic Metadata Management and Transparent Access to Networked Oceanographic Data Sets (ONR and BOEM reports expected 2014)  
[http://www.boem.gov/uploadedFiles/BOEM/Environmental\\_Stewardship/Environmental\\_Studies/National/NT1108.pdf](http://www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/National/NT1108.pdf). Interim Report: <http://www.onr.navy.mil/reports/FY12/noroch.pdf>.
8. Long Range Effects of Airgun Noise on Marine Mammals: Responses as a Function of Received Sound Level and Distance [http://www.iwcoffice.co.uk/documents/sci\\_com/SC58docs/SC-58-E35.pdf](http://www.iwcoffice.co.uk/documents/sci_com/SC58docs/SC-58-E35.pdf)
9. Effects of Pile Driving Sounds on Non-auditory Tissues of Fish  
<http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5234.pdf>



10. Evaluating Acoustic Technologies to Monitor Aquatic Organisms at Renewable Energy Sites  
<http://www.nopp.org/wp-content/uploads/project-reports-cdrom/reports/12Horne.pdf>
11. Fish Bioacoustics: Sensory Biology, Behavior, and Practical Applications: an International Symposium  
[http://www.researchgate.net/publication/235199428\\_Fish\\_Bioacoustics\\_-\\_Sensory\\_Biology\\_Behavior\\_and\\_Practical\\_Applications\\_-\\_An\\_International\\_Symposium](http://www.researchgate.net/publication/235199428_Fish_Bioacoustics_-_Sensory_Biology_Behavior_and_Practical_Applications_-_An_International_Symposium)
12. Improving Cetacean Electronic Data Loggers: Examination of health effects and long-term impacts of deployments of multiple tag types on blue, humpback, and gray whales in the eastern North Pacific (ONR and BOEM reports expected 2014)  
[http://www.boem.gov/uploadedFiles/BOEM/Environmental\\_Stewardship/Environmental\\_Studies/National/NT1003.pdf](http://www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/National/NT1003.pdf)
13. Opportunistic Study of Hearing in Sea Otters (*Enhydra lutris*): Measurement of Auditory Detection Thresholds for Tonal and Industry Sounds  
<http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5220.pdf>
14. Pressure Wave and Acoustic Properties Generated by the Explosive Removal of Offshore Structures: Potential Effects on Protected Species  
<http://www.boem.gov/GM-13-05/>
15. Seismic Survey Mitigation Measures and Marine Mammal Observer Reports  
<http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5177.pdf>
16. Sperm Whales and their Response to Seismic Exploration in the Gulf of Mexico (SWSS)  
<http://www.data.boem.gov/PI/PDFImages/ESPIS/4/4444.pdf>
17. Sperm Whales and Bottlenose Dolphins in the Gulf of Mexico  
[http://www.boem.gov/uploadedFiles/BOEM/Environmental\\_Stewardship/Environmental\\_Studies/Gulf\\_of\\_Mexico\\_Region/Ongoing\\_Studies/GM-11-03.pdf](http://www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Studies/Gulf_of_Mexico_Region/Ongoing_Studies/GM-11-03.pdf)
18. The Effects of Noise on Aquatic Life, A. N. Popper and A. Hawkins (eds.), Advances in Experimental Medicine and Biology, 730, Digital Object Identifier (DOI) 10.1007/978-1-4419-7311-5\_1, Springer Science + Business Media, LLC 2012. Commercially available online.
19. Underwater Hearing Sensitivity in the Leatherback Sea Turtle (*Dermochelys coriacea*): Assessing the Potential Effect of Anthropogenic Noise  
<http://www.data.boem.gov/PI/PDFImages/ESPIS/5/5279.pdf>



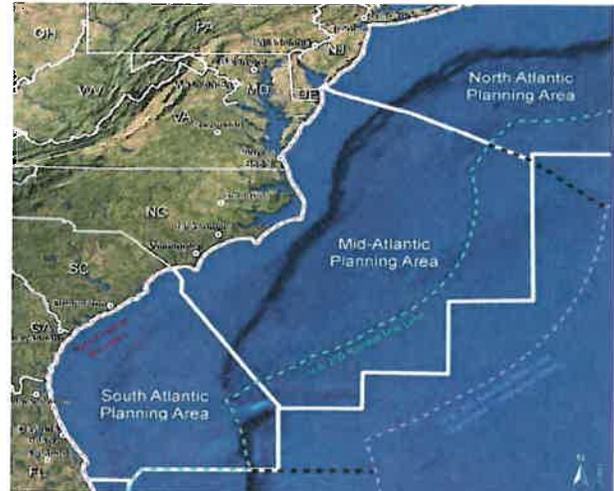
- BOEM -

October 2014

## Atlantic Geophysical and Geological Surveys *Programmatic Environmental Impact Statement*

BOEM, in cooperation with NOAA's National Marine Fisheries Service (NOAA Fisheries), and pursuant to the National Environmental Policy Act (NEPA), has developed a [Programmatic Environmental Impact Statement](#) (PEIS) to evaluate potential environmental effects of proposed geological and geophysical (G&G) survey activities on the Mid- and South Atlantic Outer Continental Shelf (OCS).

G&G surveys use sound waves sent through the ocean floor to map the subsurface. G&G surveys are conducted to: (1) obtain data for hydrocarbon exploration and production; (2) aid in siting renewable energy structures by characterizing the ocean floor; (3) locate potential sand and gravel resources; (4) identify possible seafloor or shallow depth geologic hazards; and (5) locate potential archaeological resources and potential hard bottom habitats that should be avoided.



### Background

From 1966-1988, 2-dimensional (2D) seismic data were acquired in all areas of the Atlantic OCS. This G&G data, acquired over 30 years ago, has been eclipsed by more advanced instrumentation and technology. Newer surveys are needed to make informed decisions regarding whether and where to offer oil and gas leases, engineering decisions regarding the construction of renewable energy projects, and to inform estimates regarding the composition and volume of sand and gravel resources for coastal restoration projects. This information would also be used to ensure the proper use and conservation of OCS energy resources and the receipt of fair market value for any leasing of public lands. Modern 2D and 3D data sets can now be acquired using better acoustic sourcing and longer receiver cables to help define a better stratigraphic framework in areas that may comprise petroleum system elements. These newer data would not just be used by industry for more efficient exploration and development of oil and gas, but also by BOEM to improve national hydrocarbon resource estimates and for other regulatory responsibilities.

Since 1998, BOEM has partnered with academia and other experts to invest more than \$50 million on protected species and noise-related research. The bureau has provided critical studies on marine mammals, such as the sperm whale and seismic impacts, and conducted numerous expert stakeholder workshops to discuss and identify further information needs on acoustic impacts.

### Purpose of the PEIS

The PEIS describes and evaluates the potential environmental impacts of G&G survey activities in Federal waters of the Mid- and South Atlantic OCS and adjacent State waters. It examines G&G survey activities for three

program areas (oil and gas, renewable energy, and marine minerals) for possible activity levels projected between 2012 and 2020. The PEIS also identifies mitigation and monitoring measures to avoid, reduce, or minimize impacts. The goal is to provide factual, reliable, and clear analysis about potential environmental effects of the proposed activities and alternatives. The PEIS also establishes a framework for future NEPA evaluations of site-specific actions, where any new information since publication of the final PEIS will be analyzed and any site-specific mitigation can be applied. BOEM prepared the PEIS for four primary reasons, including:

- (1) Congress directed development of the PEIS through the Conference Report for Department of the Interior, Environment, and Related Agencies Act, 2010;
- (2) There was previously no programmatic NEPA coverage for G&G activities in Atlantic OCS waters;
- (3) BOEM will need similar analyses to comply with various other environmental laws (e.g., a Biological Assessment for consultation under section 7 of the Endangered Species Act, applications for permitting under the Marine Mammal Protection Act, and an Essential Fish Habitat Assessment under the Magnuson-Stevens Fishery Conservation and Management Act);
- (4) BOEM has received several permit requests for seismic air gun surveys in support of oil and gas exploration in these areas, as well as anticipated activity from marine minerals mining; and
- (5) High resolution geophysical surveys and sub-bottom sampling will be necessary to locate shallow hazards, cultural resources, and hard-bottom areas; evaluate installation feasibility; assist in the selection of appropriate foundation system designs; and determine the variability of subsurface sediments for renewable energy facilities.

## **Potential Impacts Identified**

Some marine species rely on sound to communicate and gain information about their environment critical to survival and reproductive success. Human-made sound can affect certain species of marine life in a variety of ways, from minor behavioral modifications to major physiological impacts such as permanent or temporary hearing loss. The potential for impacts is largely tied to the reaction of the individual animal (age, hearing range, prior exposure to sound source), physical environmental factors, and the mitigations put in place to minimize or eliminate the potential for impacts.

The PEIS considers potential impacts on 13 different types of resources (e.g., marine mammals, fish, benthic communities, and cultural resources), as well as cumulative effects from G&G and other human activities in these areas. The PEIS also considers the potential effects from 11 different 'impact producing factors' on these resources. Of these factors, sound from geophysical survey sources presents the highest potential for impacts.

## **Mitigation**

BOEM has worked with NOAA Fisheries and several other agencies to develop a mitigation strategy focused on: (1) avoiding injury from exposure of air gun sound sources to marine animals in close proximity to the source; and (2) reducing the potential for behavioral disruption. The mitigation measures analyzed in the PEIS include limitations on air gun surveys in right whale critical habitat and their migratory corridors during certain times of the year; seismic air gun, electromechanical and borehole operational protocols; vessel speed restrictions and marine trash and debris awareness briefings. Monitoring and reporting requirements are also analyzed. These mitigations and monitoring requirements are covered in detail in the PEIS.

The preferred alternative identified in the PEIS identifies the most aggressive mitigation measures and the strictest safeguards to reduce or eliminate impacts to marine life. Additional mitigation efforts include requirements to avoid vessel strikes, special closure areas to protect the main migratory route for the highly endangered North Atlantic Right Whale, geographic separation of simultaneous seismic airgun surveys, and Passive Acoustic Monitoring (PAM) to supplement visual observers and improve detection of marine mammals prior to and during seismic airgun surveys.

*Last updated: Feb. 25, 2014*

## Atlantic Geological and Geophysical and Surveys *Record of Decision on the Programmatic Environmental Impact Statement*



Time-area closures are required to protect the North Atlantic right whale. Photo: NOAA

BOEM, in cooperation with NOAA's National Marine Fisheries Service (NOAA Fisheries), and pursuant to the National Environmental Policy Act (NEPA), released a final [Programmatic Environmental Impact Statement](#) (PEIS) in February 2014 that evaluated potential environmental effects of proposed geological and geophysical (G&G) survey activities on the Mid- and South Atlantic Outer Continental Shelf (OCS). The PEIS covers an area which extends from the Delaware Bay to just south of Cape Canaveral and from the inner edge of Federal waters along that coastline to 403 miles offshore.

The analysis responds to a 2010 Congressional request to provide a comprehensive review of potential environmental impacts of G&G activities off the Atlantic coast. The NEPA process is an open and public process. During the development of the PEIS, 15 public meetings and two formal public comment periods for the EIS were held, resulting in the receipt of over 120,000 public comments. BOEM considered the public input as well as technical information and selected Alternative B of the PEIS. Alternative B authorizes review of permit applications for G&G activities in all three program areas (oil and gas, renewable energy and marine minerals) and provides the highest practicable level of mitigation measures proposed for airgun acoustic sources and the most reasonable level of mitigation measures for non-airgun sources. A formal [Record of Decision](#) (ROD) was issued by BOEM in July 2014.

The mitigation measures will be incorporated in any surveys authorized. Completion of the PEIS and the release of the ROD do not themselves authorize any specific activities or indicate any decision about future leasing.

Specific mitigation measures in Alternative B include survey protocols such as visual monitoring by trained protected species observers; exclusion zones around vessels; shut-down and ramp-up procedures; passive acoustic monitoring; and time-area closures to protect the North Atlantic right whale and sea turtles.

### Background

Seismic surveys use sound waves which are sent through the ocean floor to map the subsurface. These acoustic surveys are conducted to: (1) obtain data for hydrocarbon exploration and production; (2) aid in siting renewable energy structures by characterizing the ocean floor; (3) locate potential sand and gravel resources; (4) identify possible seafloor or shallow depth geologic hazards; and (5) locate potential archaeological resources and potential hard bottom habitats that should be avoided.

From 1966-1988, 2-dimensional (2D) seismic data were acquired in all areas of the Atlantic OCS. This data, acquired over 30 years ago, has been eclipsed by new acquisition techniques using more advanced instrumentation, computer capacity, and technology. However seismic surveys have not been conducted since the 1980s because of a Federal moratorium on oil and gas activities off the Atlantic coast, which expired in 2008, and because BOEM decided not to begin reviewing permit applications until the PEIS was completed and a decision made on its alternatives.

Newer surveys are needed to make decisions concerning potential oil and gas leases, renewable energy project construction, and the composition and volume of sand and gravel resources for coastal restoration projects. This information would also be used to ensure the proper use and conservation of OCS energy resources and the receipt of fair market value for any leasing of public lands. Modern 2D and 3D acquisition techniques can provide data sets that significantly enhance subsurface imaging, leading to improved oil and gas resource assessments and more informed administration of regulatory responsibilities.



Since 1998, BOEM has partnered with academia and other experts to invest more than \$50 million on protected species and noise-related research. The bureau has provided critical studies on marine mammals, such as evaluation of seismic survey impacts on endangered sperm whales, and BOEM has conducted numerous expert stakeholder workshops to discuss and identify further information needs on acoustic impacts in the ocean.

G&G surveys covered by this decision are not used exclusively for oil and gas exploration. These surveys are also helpful in identifying sand used for restoration of our Nation’s beaches and barrier islands following severe weather events and for protecting coasts and wetlands from erosion. Seismic and geologic coring surveys also provide information that is vital to the siting and development of offshore renewable energy facilities. G&G surveys also help to advance fundamental scientific knowledge and are currently conducted in the Gulf of Mexico and in countries around the world.

Making decisions based on sound science, public input, and the best information available is a critical to environmentally responsible development of the nation’s offshore energy resources. BOEM, by using an adaptive management approach, will consider new scientific information as it becomes available during survey-specific environmental reviews.

### **Process going forward**

The ROD documents the selected alternative and describes mitigation measures that will be incorporated in site-specific G&G permits for any future G&G activities in the Atlantic. BOEM will conduct site-specific environmental reviews for any permit applications. These reviews will include coordination and consultation with federal, state and tribal authorities under a suite of additional statutory requirements. BOEM will also require that operators receive any required authorization from NOAA Fisheries before any final authorization from BOEM is provided. NOAA will not authorize use of G&G surveys unless there is negligible impact and no adverse effects on recruitment or survival of marine mammal species or stocks.

The decision to authorize G& G activities for all three program areas (oil and gas, renewable energy and marine minerals) does not authorize leasing for oil and gas exploration and development in the Atlantic. Those decisions will be addressed through the development of the next Five Year Program for Oil and Gas Leasing. BOEM is at the beginning of the process to develop that program as required by the Outer Continental Shelf Lands Act (OCSLA). The planning process will take two-and-a-half to three years to complete and will offer many opportunities for the public to provide input.

*Updated Aug. 14, 2014*

## The Science Behind the Decision

*Answers to Frequently Asked Questions about the Atlantic Geological and Geophysical Activities Programmatic Environmental Impact Statement (PEIS)*

### **Will air guns used in seismic surveys kill dolphins, whales and sea turtles and ruin coastal communities?**

To date, there has been no documented scientific evidence of noise from air guns used in geological and geophysical (G&G) seismic activities adversely affecting marine animal populations or coastal communities. This technology has been used for more than 30 years around the world. It is still used in U.S. waters off of the Gulf of Mexico with no known detrimental impact to marine animal populations or to commercial fishing.



Bottlenose dolphin from the Atlantic AMAPPS study.

While there is no documented case of a marine mammal or sea turtle being killed by the sound from an air gun, it is possible that at some point where an air gun has been used, an animal could have been injured by getting too close. Make no mistake, airguns are powerful, and protections need to be in place to prevent harm. That is why mitigation measures -- like required distance between surveys and marine mammals and time and area closures for certain species -- are so critical.

### **Is it true that the air guns are 100,000 times louder than a jet, and if so, won't they kill or deafen marine life?**

A large air gun is loud, although it is not 100,000 times louder than a jet. Measured comparably in decibels, an air gun is about as loud as one jet taking off. Scientists who specialize in acoustics confirm that sounds in water and sounds in air that have the same pressures have very different intensities (which is a measure of energy produced by the source) because the density of water is much greater than the density of air, and because the speed of sound in water is much greater than the speed of sound in air. For the same pressure, the higher density and higher speed make sound in water less intense than sound in air.

We do not know what a whale, dolphin, or turtle actually experiences when it hears an air gun. Many marine mammal species -- but not the baleen whales including North Atlantic right whales -- have reduced sensitivity to sound signals that are in the same frequency range as airplanes and air gun arrays. Some whales appear to move away from surveys,

indicating that they probably don't like the noise, but bottlenose dolphins have often been observed swimming toward surveying vessels, and ride bow waves along the vessels.

**Is it true that the government's own scientists expect 100,000 injuries or deaths of marine life if seismic surveys go forward?**

This statement misrepresents the facts. When our scientists began to look at possible impacts of seismic surveys, they first looked at what might happen if no measures were taken to mitigate or avoid possible injury to marine mammals. Next they began to look at what could be done to avoid harm, such as avoiding migration routes and stopping surveys if vessels get close enough to marine mammals to possibly injure their hearing.

After a thorough, public process, the Department selected a preferred alternative that included the most restrictive mitigation measures that would allow surveys to take place. We expect survey operators to comply with our requirements and, if they do, seismic surveys should not cause any deaths or injuries to the hearing of marine mammal or sea turtles.

Another source of confusion is about what a "take" is. As defined by Federal law, a "take" of a marine mammal, unsurprisingly, includes causing its death. However "take" also includes not only injury to hearing but also any disturbance to an animal that may disrupt its behavior. BOEM has published numbers of potential "takes," and the highest numbers are based on potential for behavioral effects, such as temporarily leaving survey areas. These behavioral effects have not been linked to negative impacts on populations. In fact, the same Federal law defining "take" of a marine mammal prohibits all taking unless the NOAA has determined that the taking will have no more than "negligible impact" and no adverse effects on marine mammal species or stocks.

BOEM cannot authorize air gun surveys which "take" marine mammals unless the surveys are also authorized by NOAA and meet this requirement. BOEM also consulted with both NOAA and the U.S. Fish and Wildlife Service under the Endangered Species Act to develop mitigations that would limit any potential impacts to endangered and threatened species, including baleen whales and sea turtles.

**Does this decision mean that the federal government is opening the entire Atlantic coast up for offshore oil and gas drilling?**

The decision to authorize G&G activities for all three program areas (oil and gas, renewable energy and marine minerals) does not authorize leasing for oil and gas exploration and development in the Atlantic. Those decisions will be addressed through the development of the next Five Year Program for oil and gas leasing. BOEM is at the beginning of the process to develop that program pursuant to the Outer Continental Shelf Lands Act. The planning process will take two-and-a-half to three years to complete and will offer many opportunities for the public to provide input.

Completion of the PEIS and BOEM's selection of the strongest environmental alternative and its documentation in the decision (ROD) do not themselves authorize any specific activities. Nor does this make any decision about future leasing.

The bureau's decision requires a set of protective measures that will be used in site-specific permits for any future G&G activities in the Atlantic. BOEM will conduct site-specific environmental reviews for any permit applications. These reviews will include coordination and consultation with federal, state and tribal authorities under a variety of additional statutory requirements. In particular, any "taking" of a marine mammal requires authorization from NOAA, separately from BOEM, and that authorization requires NOAA to find that there is no more than "negligible impact" and no adverse effects on marine mammal species or stocks.



## SEISMIC SURVEYING 101

### WHY ARE SEISMIC SURVEYS NEEDED IN THE ATLANTIC OCS?

The first step in exploring for offshore oil and natural gas resources is often conducted through seismic surveys, which are like ultrasounds of the earth that help scientists “see” below the ocean floor.

- The last surveys of the Atlantic Outer Continental Shelf (OCS) were conducted over 30 years ago. Due to technological advances, the existing estimates of 4.7 billion barrels of oil and 37.5 trillion cubic feet of natural gas are out of date.
- Advances in seismic imaging technology and data processing over the last decade have dramatically improved the industry's ability to locate oil and natural gas offshore.
- Exploration and development activities generally lead to increased resource estimates. For example, in 1987 the Minerals Management Service estimated only 9.57 billion barrels of oil in the Gulf of Mexico. With more recent seismic data acquisition and additional exploratory drilling, that estimate rose in 2011 to 48.4 billion barrels of oil — a fivefold increase.

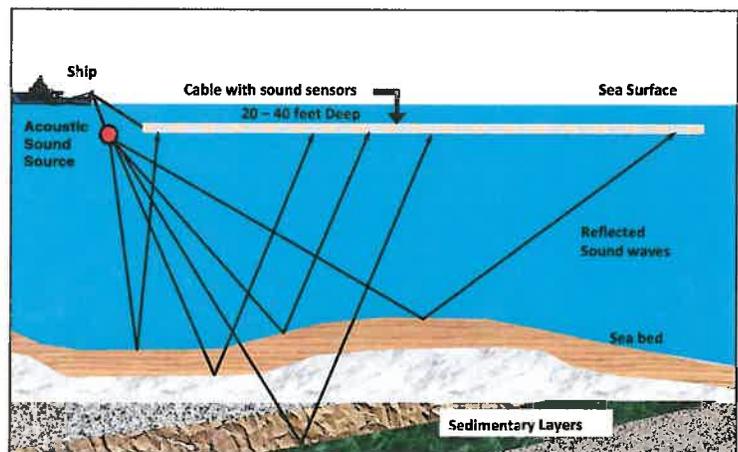
Seismic surveys are a safe and proven technology that help make offshore energy development safer and more efficient.

- Governments and the private sector have used this method of exploration in the U.S. and around the world for over 40 years.
- In addition to the oil and natural gas industry, seismic surveys are commonly used by the U.S. Geological Survey, the National Science Foundation, and the offshore wind industry.
- A rigorous permitting process ensures that seismic surveys are properly managed and conducted so they have minimal impact on the marine environment.

### HOW DO SEISMIC SURVEYS WORK?

Sound waves help scientists map the ocean floor and geology beneath it.

- Surveyors release compressed air into the water to create short duration sound waves that reflect off subsurface rock layers and are “heard” by sensors being towed behind the vessel.
- Scientists analyze the collected data and use it to create maps of geologic structures that could contain energy resources beneath the ocean floor.
- The sound produced during seismic surveys is comparable in magnitude to many naturally occurring and other man-made ocean sound sources, including wind and wave action, rain, lightning strikes, marine life, and shipping.
- Survey operations are normally conducted at a speed of approximately 4.5 to 5 knots (~5.5 mph), with the sound source typically activated at 10-15 second intervals. As a result, the sound does not last long in any one location and is not at full volume 24 hours a day.



To find out more, visit [www.api.org/OCS](http://www.api.org/OCS)

## How do Seismic Surveys Impact Marine Life?

After examining decades of scientific research and real-world experience, federal regulators determined that seismic surveys in the Atlantic OCS will have no measurable impact on fish or marine mammal populations.

- In the words of the federal Bureau of Ocean Energy Management (BOEM), “there has been no documented scientific evidence of noise from air guns used in geological and geophysical (G&G) seismic activities adversely affecting marine animal populations or coastal communities.”
- According to BOEM, seismic surveys in the Atlantic OCS “should not cause any deaths or injuries to the hearing of marine mammal[s] or sea turtles.”
- Dr. William Brown, chief environmental officer for BOEM, told National Geographic that claims to the contrary are “wildly exaggerated and not supported by the evidence.”
- While fish and some whales may swim away from an area and return after the survey vessel has passed, bottlenose dolphins are known to swim toward survey vessels to ride their bow waves.



Despite the already negligible risks, the industry follows standard operating procedures known as “mitigation measures” to provide even more protection for marine life.

- Trained protected species observers (PSOs) are onboard to watch for animals. Operations stop if certain marine animals enter an “exclusion zone” established around the operation and are not restarted until the zone is all-clear for at least 30 minutes.
- When starting a seismic survey, operators use a ramp-up procedure that gradually increases the sound level being produced, allowing animals to leave the area if the sound level becomes uncomfortable.

## WHAT IS THE CURRENT STATE OF SCIENCE AND RESEARCH?

The best science and research indicates that seismic surveys have little-to-no impact on marine wildlife populations.

- Based on both available scientific knowledge and operational experience, there is no evidence to suggest that the sound produced during an oil and gas industry seismic survey has resulted in any physical or auditory injury to a marine mammal.
- Seismic surveys are predominantly low frequency. Not all marine life hears the same frequencies equally well. Just as humans, bats and dogs hear differently, some marine animals hear better at higher frequencies while others hear better at lower frequencies.
- The best available scientific information also indicates that any sound related injury to dolphins occurs at levels higher than the sound generated by a seismic survey.
- Animal strandings can occur for a number of reasons, e.g., sickness, disorientation, natural mortality, extreme weather conditions or injury, but no correlation has been found with seismic surveys.

The industry remains committed to improving the scientific understanding of the impacts of our operations on marine life.

- To provide the utmost safety precautions, seismic surveys in the U.S. Outer Continental Shelf are only conducted with measures in place to protect animals from high sound exposure levels.
- Industry continually monitors the effectiveness of its mitigation strategies and funds research to better understand interactions between offshore operations and marine life, including fish.

To find out more, visit [www.api.org/OCS](http://www.api.org/OCS)

## Seismic Surveys and Protecting the Marine Environment

Seismic surveys are the key tools used in oil and natural gas exploration and the siting of renewable energy facilities. The use of modern seismic technology is similar to ultrasound technology which is commonly used in the medical profession for imaging the human body. Today's advancements in seismic technology, which can pinpoint the most fruitful areas for hydrocarbon potential, have contributed to reducing the overall environmental footprint associated with oil and gas exploration. Seismic technology has also helped to decrease operational and safety risks associated with oil and gas development. Contrary to what has been said, seismic surveying is very well understood and a very safe industry practice.

More than four decades of worldwide seismic surveying and various scientific research indicate that the risk of direct physical injury to marine mammals is extremely low, and currently there is no scientific evidence demonstrating biologically significant negative impacts on marine mammal populations. The seismic industry is committed to conducting its operations in an environmentally responsible manner, including compliance with mitigation and monitoring guidelines and regulations. Industry supports a process of developing and implementing effective mitigation measures that are based on assessing the level of risk or significant impacts on marine animals. Such an approach helps to ensure that the scope of mitigation measures implemented in the field are appropriate to the level of risk and specific to the local population of marine animals.



## Taking Precautions to Protect the Environment

The seismic industry employs a number of measures to ensure that marine life is protected from direct or indirect harm from its operations.

### *Impact Assessments*

Environmental Impact Assessments (EIAs) are an integral part of developing and implementing a seismic survey. Many countries have environmental impact assessment requirements. The assessments include identification of marine species, including protected species, other environmental sensitivities and the human uses of the proposed area of operations. These assessments are conducted during the survey planning stage and evaluate the potential impacts and risks to marine life. The assessments also identify and consider measures to avoid or mitigate such potential impacts and risks. Seismic surveys are generally considered not to be harmful or damaging to the marine environment. Seismic surveys are comparable to many naturally occurring ocean sound sources, are temporary and transitory and the vast majority are conducted at frequencies below the hearing range of many marine species.



*Preparing analysis as part of seismic survey planning*

### *Mitigation and Monitoring*

Mitigation and monitoring must be proportionate to the potential risks identified by an environmental assessment and specific to the local environment and the operation being undertaken. Measures commonly used by the seismic industry include timing seismic surveys to avoid known areas of biological significance, such as whale foraging or breeding areas or avoiding seasonal marine life occurrences such as peak whale and dolphin activity seasons or migration.

Before a seismic operation begins, visual monitoring is undertaken to check for the presence of marine mammals and other marine species within a specified precautionary, or exclusion zone, often using dedicated marine mammal observers (MMOs) or protected species observers (PSOs).



*Protected Species Observer*

Further monitoring may be done using passive acoustic monitoring technology (PAM), which may detect vocalizing marine animals, especially during low visibility and nighttime conditions. In the event marine animals are detected in the exclusion zone, seismic operation will not begin for a certain time period until the marine animal moves away. Similarly, a seismic survey will shut down if the marine animal is observed entering the exclusion zone once operations have begun.

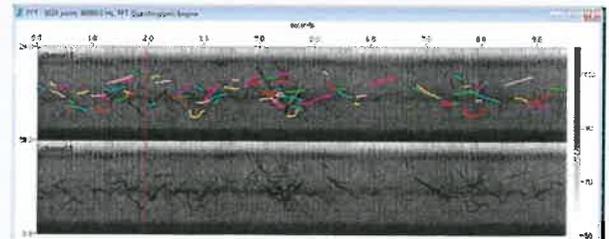


Soft-start or ramping-up procedures are undertaken by seismic vessels as a matter of general operational procedure. Soft starts involve activating a small section of the acoustic sound arrays over a period of time, gradually getting louder until the full acoustic array is operating. This measure also allows a marine animal to swim away before the acoustic source is activated at full strength.

### Environmental Protection Guidelines

Many countries and regional authorities have established guidelines and regulations specific to seismic operations, which are then adapted for the specific location and operation for the permit.

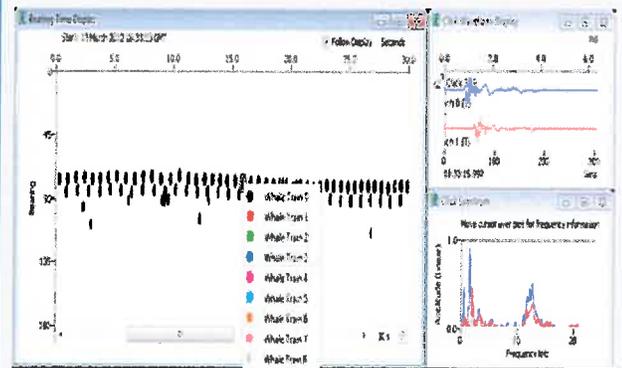
In the absence of regulations or guidelines in a specific area, the industry has committed itself to a set of minimum mitigation measures as outlined in the 2011 International Association of Geophysical Contractors (IAGC) standards document, "Recommended Mitigation Measures for Cetaceans during Geophysical Operations." IAGC has produced additional documents for mitigation and monitoring guidance for seismic operations, "Guidance for Marine Life Visual Observers" and "Guidance on the Use of Towed Passive Acoustic Monitoring during Geophysical Operations."



**Dolphin whistles detected using the PAMGuard whistle and moan detector**

### Contributing to Science

IAGC, together with a number of oil & gas companies, supports research to fill knowledge gaps about the effects of seismic surveys on marine life. This is helping to remove some of the uncertainty about possible effects of seismic surveys. More information on our commitment to science can be found at [www.soundandmarinelife.org](http://www.soundandmarinelife.org).



**Marking up Sperm Whale clicks to localize on the map**

### Additional Resources on Seismic Surveys and Protection of the Marine Environment

1. PAM Guidance: <http://www.iagc.org/articles/new-towed-passive-acoustic-monitoring-guidance-for-geophysical-operations/>.
2. Recommended Mitigation Measures for Cetaceans during Geophysical Operations: <http://www.iagc.org/files/4776/>.
3. Sound and Marine Life Protections: [www.soundandmarinelife.org](http://www.soundandmarinelife.org).
4. PAMGuard: <http://www.pamguard.org/>.
5. Marine Mammal Observer Association: <http://www.mmo-association.org/position-statements/111>.
6. Marine Mammal Observers: <http://www.globalseismicmmo.com/mmo-role/>.
7. OGP/IAGC "Seismic Surveys & Marine Mammals": <http://www.ogp.org.uk/publications/environment-committee/seismic-surveys-and-marine-mammals-joint-ogpiagc-position-paper/>.

### Environmental Stewardship

The geophysical industry takes a great deal of care and consideration of potential impacts to the marine environment. In its efforts to operate in an environmentally responsible manner, the industry implements measures to ensure that marine mammals are further protected from direct or indirect harm from its operations. For more than 40 years, the industry has demonstrated its ability to operate seismic exploration activities in a manner that protects marine life. Various research studies indicate that the risk of direct physical injury to marine mammals is extremely low, and currently there is no scientific evidence demonstrating biologically significant negative impacts on marine mammal populations.

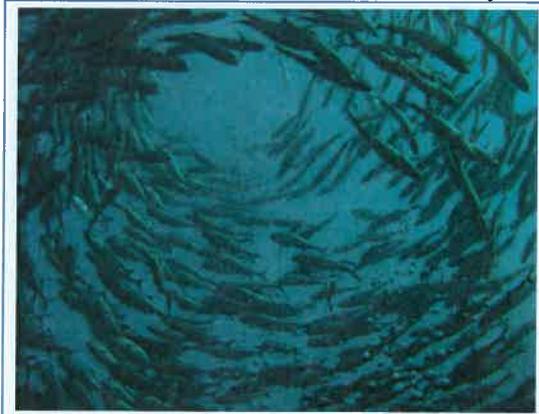
## *Seismic Surveys and Fish*

Marine seismic surveys are the only feasible technology available to accurately image the subsurface before a single well is drilled. Marine seismic surveys predominantly transmit low-frequency sound waves from a source directed downward into the subsurface. The sound waves are reflected from the geological layers in the subsurface, and these reflections are captured by receivers (hydrophones) typically towed just below the surface behind the seismic vessel. The recorded data are processed by computers to produce images of the subsurface.

Marine seismic surveys have been conducted since the 1950's, and experience shows that fisheries and seismic activities can and do coexist. There has been no observation of direct physical injury or death to free-ranging fishes caused by seismic survey activity. Any impacts to fish from seismic surveys are short-term, localized and have not led to significant impacts on a population scale.

### *Are there Physical Impacts to Fish from Seismic Activity?*

There has been no observation of direct physical injury or death to free-ranging fishes caused by seismic survey activity. Seismic vessels move along a survey tract in the water creating a line of seismic impulses. A predominantly low-frequency sound pulse is generated by releasing compressed air into the water as the vessel is moving. As the seismic vessel is in motion, each signal is short in duration, local and transient. Fish may react to these pulses by temporarily swimming away from the seismic air source. When fish move away from a survey vessel they often return after the vessel has passed.



Since typical seismic surveys are a moving sound source, any potential effects on fish are inherently local and short-term. While some studies have shown that various life stages of fish may be physically affected by exposure to seismic surveys, in all of these cases, the fish subjects were very close to the seismic source or subjected to exposures that are virtually impossible to occur in free-ranging fishes.



Fish eggs, larvae and fry do not have the ability to move away from a sound source, and may be injured in the unlikely event they are within a few meters of the seismic source. The impact of this damage, however, is insignificant on a population scale compared to the high natural mortality rate of eggs, larvae and fry.

### *Do Seismic Surveys Affect Fishing?*

Active acoustic sound sources such as seismic surveys may result in fish temporarily moving away from the sound source. There is no conclusive evidence, however, showing long-term or permanent displacement of fish. Because the sound output from a seismic survey is immediate and local, there is no contaminate residue or destruction of habitat.

During seismic surveys, a vessel exclusion zone is maintained around the survey vessel and its towed streamer arrays to avoid interruption of commercial fishing operations, including setting of fishing gear. These exclusion zones are dependent on the type of activity and national and local regulations in the area of operation.

Prior to conducting a seismic survey, operators work cooperatively with local fishing communities and regulatory bodies to avoid sensitive spawning grounds and mitigate any potential economic losses to fisherman. The geophysical industry works with fishermen to define and address potential concerns early in the permitting process.

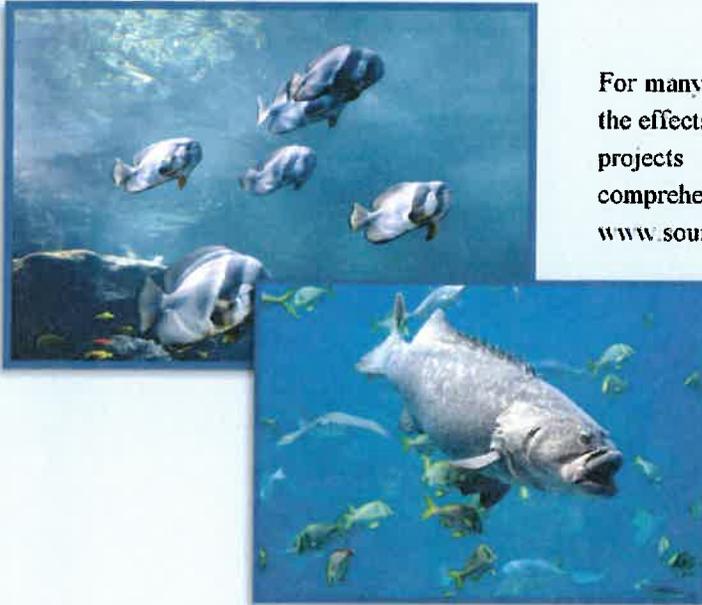
## How do Seismic Activities Compare to Other Sources of Risk to Fish?

Separating the effects of sound from other environmental disturbances can be complex. The impacts of sound on fish stocks must be viewed in a wider context, considering how the effects of sound on populations compare to other natural and human influences on the marine environment. Those influences that are known to threaten marine life, such as overfishing, disease, habitat degradation and pollution, have greater impact from an overall risk perspective.



## What is the Seismic Industry Doing?

For many years, industry has invested in considerable research regarding the effects of seismic surveys on marine animals including fish. Research projects also address gaps in knowledge and assist in a more comprehensive understanding of potential environmental risks (see [www.soundandmarinelife.org](http://www.soundandmarinelife.org)). That investment continues today.



In addition to the research, industry employs various mitigation measures to decrease the potential impact of seismic operations on marine life, including avoidance of important fish spawning grounds and use of soft-start/ramp-up procedure, which is a gradual build-up of the seismic sound source to allow fish to swim away. In the US Gulf of Mexico, where seismic activities routinely occur, \$980 million of seafood is harvested annually, suggesting that commercial fisheries successfully coexist with seismic surveys.

## Additional Resources on Seismic Surveys and Fish

1. Science for Environment Policy, Future Brief: Underwater Noise, European Commission: <http://ec.europa.eu/environment/integration/research/newsalert/pdf/FB7.pdf>.
2. U.S. Department of Commerce, NOAA. Stocks at a Glance – Status of Stocks: [www.nmfs.noaa.gov/stories/2012/05/05\\_14](http://www.nmfs.noaa.gov/stories/2012/05/05_14).
3. Boeger, W.A., Pie, M.R., Ostrensky, A., Cardoso, M.F. The Effect of Exposure to Seismic Prospecting on Coral Reef Fishes. Brazil. J. Oceanogr. 54, 235-239.
4. Marine Pollution Bulletin. 3D Marine Seismic Survey, No Measurable Effects on Species Richness or Abundance of a Coral Reef Associated Fish Community: <http://dx.doi.org/10.1016/j.marpolbul.2013.10.031>.
5. Hassel, A., Knutsen, T., Dalen, J., Skaar, K., Lokkeborg, S., Misund, O.A., Osten, O., Fonn, M., Haugland, E.K. Influence of Seismic Shooting on the Lesser Sand Eel. ICES J. Mar. Sci. 61, 1165-1173.
6. Pena, H., Handegard, N.O. and Ona, E. Feeding Herring Schools Do Not React to Seismic Air Gun Surveys. ICES J. Mar. Sci: <http://icesjms.oxfordjournals.org/content/70/6/1174.short?rss=1>.
7. Saetre, R. and E. Ona. Seismic Investigations and Damages on Fish Eggs and Larvae; An Evaluation of Possible Effects on Stock level. Fisken og Havet:1-17, 1-8.
8. Bureau of Ocean Energy Management. Appendix J, Atlantic G&G PEIS: <http://www.boem.gov/boem-2014-001-v3/>.

## Environmental Stewardship

*The geophysical industry takes a great deal of care and consideration of potential impacts to the marine environment. In its efforts to operate in an environmentally responsible manner, the industry implements measures to ensure that marine mammals are further protected from direct or indirect harm from its operations. For more than 40 years, the industry has demonstrated its ability to operate seismic exploration activities in a manner that protects marine life. Various research studies indicate that the risk of direct physical injury to marine mammals is extremely low, and currently there is no scientific evidence demonstrating biologically significant negative impacts on marine mammal populations.*

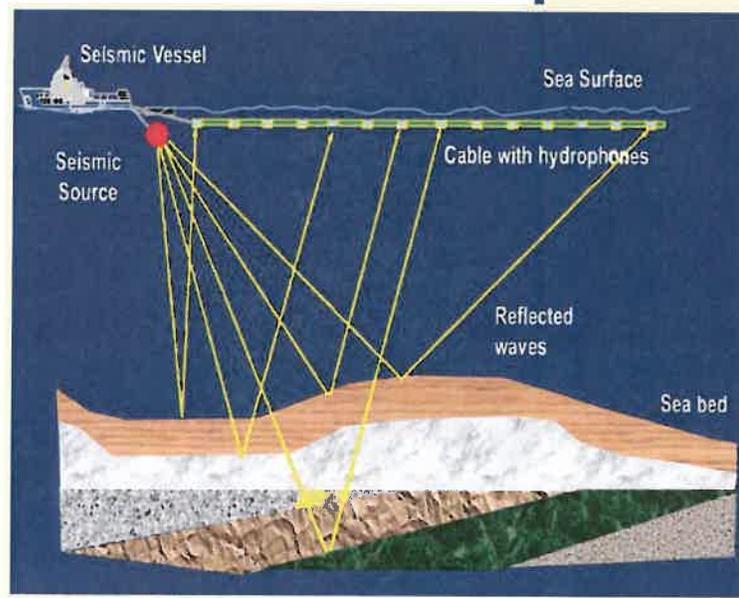
## Fundamentals of Sound in the Marine Environment

### *What Is Sound?*

Sound is a vibration or pressure wave that transmits energy from its source through a medium such as air or water. Sound pressure waves will alternately compress and decompress as they travel away from their source through a medium, such as air or water. The compressions and decompressions associated with sound waves are detected as changes in pressure and are then perceived as sound by a human ear or other acoustic receiver (such as a microphone or hydrophone) that may be in the path. The pressure fluctuations (amplitude or height of the sound pressure wave) determine the loudness. The decibel (dB) system is used to express the relative loudness (amplitude) of sound. The decibel system is logarithmic, which results in an exponential scale being represented as a linear scale, like the Richter scale that expresses the strength of earthquakes. Decibel is not a measuring unit, but a ratio that must be expressed using a reference (benchmark) value (See *Sound in Water in Not the Same as Sound in Air* section). Also, sound pressure levels are not to be confused with sound intensity (power), which is the acoustical energy emitted by a sound source. Sound pressure is what our ears hear and what sound meters measure.

Frequency is another measure of sound. It is the number of pressure waves that pass by a reference point per unit of time and is measured in Hertz (Hz), or cycles per second. To the human ear, an increase in frequency is perceived as a higher pitched sound, while a decrease in frequency is perceived as a lower pitched sound. Humans generally hear sound waves where frequencies are between 20 and 20,000 Hz. Similar to the differences in hearing between humans and bats or dogs, some marine mammals hear well at higher frequencies and relatively poorly at lower frequencies. Others hear better at lower frequencies.

Specific ocean sounds are classified as transient, such as a pulse or as continuous, which is ongoing. Continuous sound can include ambient or background noise. Ambient or background noise is any sound other than the primary sound being monitored.



### *Sound in Water is Not the Same as Sound in Air*

Confusion arises because sound levels given in dB in water are not the same as sound levels given in dB in air. A 150 dB sound in water is not the same as a 150 dB sound in air. This is equivalent to reporting temperature, in which it is important to specify the reference level, as 50 degrees Celsius is not the same as 50 degrees Fahrenheit. When reporting sound levels, it is important to not only specify “dB”, but also the reference level. For sounds in water, the reference level is expressed as “dB re 1 uPa” – the amplitude of a sound wave’s loudness with a pressure of 1 microPascal (uPa).

The reference level for sound in air is “dB re 20 uPa.” The amplitude (loudness) of a sound wave depends not only on the pressure of the wave, but also on the density and sound speed of the medium (air, water) through which the sound is traveling. Because of such environmental differences, 62 dB must be subtracted from any sound measurement under water to make it equal to the same sound level in the air.

Sound travels further in water than it does in air because water is denser. However, in both air and water, the loudness of a sound diminishes as a sound wave radiates from its source. In air, the sound level reduces by 10dB as the distance doubles whereas in water, it reduces by 6 dB for each doubling of the distance. As in air, underwater sound is also subject to additional attenuation as it interacts with obstacles and barriers, water temperature differences, currents, etc. Because sound level in water halves (i.e. 6dB reduction) as the distance doubles, high levels of sound are only experienced very close to the source and the loudness diminishes very quickly close to the source and more slowly away from the source.

## Seismic Surveys and Sound in the Marine Environment

The ocean is filled with sound. Underwater sound is generated by a variety of natural sources such as wind, waves, and marine life as well as underwater volcanoes and earthquakes. There are also man-made (anthropogenic) sounds in the ocean which include shipping, commercial and recreational fishing, pile-driving for marine construction and dredging and military activities.

The geophysical and offshore oil industry relies on transient sound - in the form of seismic surveys - to determine the location of hydrocarbon deposits. Seismic surveys are used to define geological structure below the sea floor by sending low frequency (5 to 200Hz) acoustic sound waves into layers beneath the sea floor and recording the time it takes for each wave to bounce back, while also measuring the amplitude of each returning wave. The sound is transient and temporary. Once the survey is complete, the sound is no longer part of the ambient environment. Transient sounds of this nature also do not accumulate in the marine environment.

The sound produced during seismic surveys is comparable in loudness to many naturally occurring and other man-made sound sources. The seismic surveys are predominantly carried out in a frequency range well below 200 Hz. Approximately 98% of all the acoustic energy in a seismic pulse is within this band.



Type of Sounds	In Air (dB re 20µPa @ 1m)	In Water (dB re 1µPa @ 1m)
Threshold of Hearing	0 dB	62 dB
Whisper at 1 Meter	20 dB	82 dB
Normal Conversation in Restaurant	60 dB	122 dB
Ambient sea noise	--	100 dB
Blue Whale	--	190 dB
Live Rock Music	110 dB	172 dB
Thunderclap or Chainsaw	120 dB	182 dB
Large Ship	--	200 dB
Earthquake	--	210 dB
<b>Seismic Array at 1 Meter</b>	<b>158 - 178 dB</b>	<b>220 - 240 dB</b>
Bottlenose Dolphin	--	225 dB
Sperm Whale Click	--	236 dB
Jet Engine Take-off at 1 Meter	180 dB	242 dB
Volcanic Eruption	--	255 dB
Colliding Iceberg	--	220

### Additional Resources on the Fundamentals of Sound in the Marine Environment

1. Fundamentals of Underwater Sound - OGP: <http://www.ogp.org.uk/pubs/406.pdf>.
2. Discovery of Sound in the Sea: [www.dosits.org](http://www.dosits.org).
3. Seismic and the Marine Environment: [http://www.appea.com.au/wp-content/uploads/2013/05/Seismic\\_and\\_the\\_Marine\\_Environment.pdf](http://www.appea.com.au/wp-content/uploads/2013/05/Seismic_and_the_Marine_Environment.pdf).
4. Seismic Surveys: [www.seismicsurvey.com.au](http://www.seismicsurvey.com.au).

### Environmental Stewardship

The geophysical industry takes a great deal of care and consideration of potential impacts to the marine environment. In its efforts to operate in an environmentally responsible manner, the industry implements measures to ensure that marine mammals are further protected from direct or indirect harm from its operations. For more than 40 years, the industry has demonstrated its ability to operate seismic exploration activities in a manner that protects marine life. Various research studies indicate that the risk of direct physical injury to marine mammals is extremely low, and currently there is no scientific evidence demonstrating biologically significant negative impacts on marine mammal populations.

# Study: Planning Can Protect Whales in Seismic Surveys

*Scientists outline recommendations for protecting whales and other marine animals from loud blasts generated by ocean seismic surveys for oil and gas exploration.*



A new study conducted during seismic surveys near Sakhalin Island offered steps that could be taken to protect western gray whales.

PHOTOGRAPH BY DAVE WELLER, INTERNATIONAL UNION FOR CONSERVATION OF NATURE

Ker Than  
for [National Geographic](#)  
PUBLISHED JANUARY 21, 2014

Whale experts have teamed up with the oil and gas industry to develop a step-by-step guide for reducing the impacts of noise pollution from marine seismic surveys on whales and other marine species.

The paper, published in the current issue of the journal [Aquatic Mammals](#), was the result of a collaboration between scientists with the Switzerland-based International Union for Conservation of Nature (IUCN)'s Western Gray Whale Advisory Panel and the Russian consortium, Sakhalin Energy Investment.

"We wanted to create a go-to document for people who are planning one of these surveys so that they can minimize the risks [to wildlife]," said [Doug Nowacek](#), an oceanographer at Duke University and the paper's lead author.

The energy industry uses [marine seismic surveys](#) to map the seafloor and identify areas of potential interest for oil and gas drilling. To conduct the surveys, ships tow arrays of air guns that repeatedly fire powerful bursts of sound aimed at the ocean bottom. Sensors measure the return echo to reveal details of the seafloor and the underlying geologic structure. (See related, "[Offshore Energy Clash Over Undersea Sound.](#)")

"The air guns' shots are going off every 10 to 15 seconds for days to weeks to months on end," Nowacek said.

Studies have shown that the sound bursts—which can reach 250 decibels, loud enough to be detected 2,500 miles (4,000 kilometers) away—can disturb and even harm marine life. For examples, whales rely on sound for communication, navigation, and foraging, so exposure to loud noise can result in stress and behavior changes, affect foraging and nursing, or cause direct physical damage. [Read also "[Giant Squid Killed by Sound?](#)"]

The new study outlines a series of procedures that Nowacek and his team developed to protect western gray whales during seismic surveys conducted near Sakhalin Island, located on the Russian coast just north of Japan, from 2006 to 2012. The region harbors huge oil and gas reserves, but it is also an important feeding area for the whales, which are listed as critically endangered on the IUCN Red List of Threatened Species. The area is being developed by Sakhalin Energy, which is a consortium that includes the Russian company Gazprom, Royal Dutch Shell,\* and the Japanese companies Mitsui and Mitsubishi.

One of the team's recommendations was for Sakhalin Energy to do as much planning as possible to understand the potential ecological impacts of the seismic surveys in order to mitigate them. Before any ships are even sent out, the authors say, companies should attempt to gather baseline ecological data about a region and learn about what animals might be present during the survey. And whenever possible, the surveys should be conducted when susceptible animals are absent, present in low numbers, or not passing through as part of their migration route. (See related, "[Bubble Curtains: Can They Dampen Offshore Energy Sound for Whales?](#)")

The coauthors also recommend that energy companies conduct real-time acoustic monitoring of the air gun shots to ensure the noise levels match what is predicted by computer models, so that the impact on marine life is not a surprise.

It's also important to set up lines of communication between the survey boats and wildlife observers during surveys so that problems can be addressed quickly, Nowacek said, "so that if anybody sees anything that is listed as a trigger for mitigation"—such as a whale attempting to flee or showing other reactions during a survey—"there's a very direct line for getting that done. That doesn't always exist."

The authors also emphasize the importance of evaluating the effectiveness of monitoring programs and mitigation measures after surveys are completed, and for companies to share what they've learned about how animals are affected. Nowacek said he thinks this could be done without divulging proprietary information about specific techniques.

Carl Gustaf Lundin, director of the global marine and polar program at IUCN, said the tiny population of western gray whales affected by Sakhalin Energy's surveys grew about 3 percent a year, to 140 individuals, during the survey period. That indicates the monitoring and mitigation efforts are working, he said. (See related story: "[Chilean Wind Farm Faces Turbulence Over Whales.](#)")

"It's a good sign . . . but we're not out of the woods yet," Gustaf Lundin said. In particular, he said he worried about the cumulative impact on the whales as more companies begin to explore the region.

[Michael Stocker](#), executive director of [Ocean Conservation Research](#)(OCR), a California-based organization focused on marine noise pollution science and policy, called the new study "exemplary," but he wonders how many companies will spend the time and money that Sakhalin Energy did to work with scientists to investigate their surveys' ecological impacts.

"Right now, as we speak, there are over 50 surveys going on globally," Stocker said. "[Companies] are not going to go through this procedure for all of those."

In the case of Sakhalin Energy, the company was required to conduct a study investigating the risk to western gray whales of its surveys as part of the conditions for securing a large bank loan, according to Nowacek.

New technologies in development—such as ones that use electromagnetic waves in place of acoustic waves—could one day allow companies to gather the same kinds of geological data while being less ecologically disruptive, Nowacek said, but it will still be some time before those techniques can match the efficiency of the air gun approach.

OCR's Stocker said the best way to protect animals from the effects of noise pollution generated by seismic surveys is to eliminate the need for such surveys altogether.

"The types of technology [that are] going to improve this situation are solar panels and [power sources] that get us away from fossil fuel," he said.

*Follow Ker Than on [Twitter](#).*

*\*Shell is sponsor of National Geographic's [Great Energy Challenge](#) initiative. National Geographic maintains autonomy over content.*

Than, Ker. "Study: Planning Can Protect Whales in Seismic Surveys." *National Geographic*. 21 Jan. 2014. Web. 23 Dec. 2014.

<http://news.nationalgeographic.com/news/energy/2014/01/140121-protecting-whales-seismic-energy-surveys-study/>

# Atlantic Seismic Tests for Oil: Marine Animals at Risk?

*U.S. environmental review paves the way for first air-gun surveys in 26 years off the East Coast.*



A North Atlantic right whale crests. Fewer than 500 of the species remain, and the proposed seismic survey area coincides with their main range.

PHOTOGRAPH BY GEORGIA DEPARTMENT OF NATURAL RESOURCES, NOAA

Helen Scales

[National Geographic](#)

PUBLISHED FEBRUARY 28, 2014

The Obama administration has paved the way for the first seismic oil and gas exploration in 26 years off the U.S. Atlantic coast, with an environmental review that concludes the air-gun blasts will have “moderate” impacts on marine mammals and sea turtles.

The [final Environmental Impact Statement \(EIS\)](#), released Thursday by the U.S. Department of Interior’s Bureau of Ocean Energy Management (BOEM), outlines measures for minimizing the impact on wildlife that are especially sensitive to the intense sound impulses used to prospect for energy resources beneath the seafloor. (See related, [“Study: Planning Can Protect Whales in Seismic Surveys.”](#))

The document was three years in the making, and the Obama administration was urged to advance the plan [by Southern governors](#), who say offshore drilling could bring new jobs to their states. But environmental groups argue that proposed mitigation measures will be insufficient to protect the rich sea life in the survey area, a large swath of the Atlantic coast, stretching from Delaware to Florida and encompassing an area twice the size of California.

"Imagine dynamite going off in your living room or in your backyard every ten seconds for days to weeks at a time," said Matthew Huelsenbeck, a marine scientist at Oceana, one of the environmental groups opposing the plan. (See related, "[Offshore Energy Clash Over Undersea Sound.](#)")

The government's estimates of the undiscovered oil and gas resources beneath the U.S. Atlantic outer continental shelf range [from 1.3 to 5.58 billion barrels](#)—a drop in the bucket compared with the Gulf of Mexico's undiscovered stores, which government assessors [estimate at 38.8 to 59.2 billion barrels](#). But energy industry officials say the figures could be understated, because the last energy exploration of the offshore Atlantic occurred in 1988, with equipment that is now outdated. Modern 3-D seismic equipment has uncovered huge oil reservoirs hidden beneath salt deposits in the Gulf of Mexico. The energy industry says similar potential discoveries might lurk in the depths of the Atlantic, but that they could be uncovered only by seismic surveys—towing air guns behind vessels and blasting extremely loud sounds down to the seabed to detect the size and location of hydrocarbon deposits. (See related graphic: "[The Noisy Ocean.](#)")

Drilling in the Atlantic could add "1.3 million barrels equivalent per day to domestic energy production, which is about 70 percent of the current output from the Gulf of Mexico, and raise \$51 billion in new revenue for government," said Erik Milito, director of upstream and industry operations for the American Petroleum Institute (API) at a news conference Thursday after the release of the EIS.

BOEM Director Tommy Beaudreau said in a statement that the agency is "employing a comprehensive adaptive management strategy" that takes into account the fact that scientific knowledge about the Atlantic Ocean is constantly changing and building. "New information and analyses will continue to be developed over time," he said.

"The Department and BOEM have been steadfast in our commitment to balancing the need for understanding offshore energy resources with the protection of the human and marine environment using the best available science as the basis of this environmental review," Beaudreau said.

The EIS concludes that there would be "minor to negligible" impact to most wildlife, with the exception of marine mammals and turtles, for which impact could be "moderate." The review estimates that about 138,000 marine animals could be injured in some way, and perhaps 13.6 million could have their migration, feeding, or other behavioral patterns disrupted by the seismic surveys. (Read also "[Giant Squid Killed by Sound?](#)")

Here is a rundown of the main Atlantic ocean species likely to be affected:

#### North Atlantic Right Whales

Hunted almost to extinction partly because their docile nature and habit of swimming near the surface made them easy targets and the "right" whales to hunt, the North Atlantic right whales have recovered only marginally even though they have been protected from commercial hunting by international agreement since 1986.

Fewer than 500 of these whales are alive today, and the proposed region for air-gun surveys coincides with the main range of the remnants of the species.

"It's the rarest of the large whales," Huelsenbeck said. "You can consider it the American bison of the sea."

These stocky black whales grow to 40 or 50 feet (12-15 meters) and are easy to spot because of the white patterns on their heads known as callosities made from infestations of whale lice.

To help protect these whales, BOEM proposes that during a key period when larger numbers are present, between November and April, the air-gun surveys would be banned close to the coast. The limitation essentially would put a narrow strip of the survey area off limits during the winter and early spring months, preventing seismic testing up to 20 nautical miles (37 km) from shore.

Environmentalists argue that such measures are unlikely to offer full protection to the whales because new research shows that they swim much farther offshore. Cornell University researchers placed listening stations off the coast and heard right whale calls at least 65 nautical miles (120 kilometers) out to sea. (See related, "[Bubble Curtains: Can They Dampen Offshore Energy Sound for Whales?](#)")

#### Humpback Whales

Many other large cetaceans live in the proposed survey area, including humpback whales, killer whales, sperm whales, and short-finned pilot whales, which use low frequency sounds in their daily lives in many ways.

"The mid- and south Atlantic is very special," said Huelsenbeck of Oceana. "It's home to an abundance and diversity of marine mammals that's almost unparalleled throughout the world."

The National Marine Fisheries Service (NMFS), a division of NOAA, is in the final stages of a 15-year research program gathering expert advice on how marine mammals are disturbed and damaged by sound.

Last week, a group of more than 100 scientists wrote to Obama urging him not to finalize the EIS until the latest marine mammal acoustic guidance is available. Without the NMFS advice, the EIS will, they said, "be scientifically deficient and quickly outdated." (See related story: "[Chilean Wind Farm Faces Turbulence Over Whales.](#)")

#### Dolphins

Large populations of many smaller cetaceans live in the proposed survey area, including dolphins such as Atlantic spotted, bottlenose, and Risso's dolphins. These animals are especially sensitive to the higher frequency sounds produced when the air guns blast.

"The air guns operate in broadband," said Huelsenbeck, producing a large range of frequencies, both high and low.

The higher pitched sounds don't provide useful information to the surveyors, but they can damage dolphins' hearing and disrupt their behavior. Alternative survey technologies are being developed that are likely to be less harmful. Marine vibroseis, for example, would emit vibrations instead of bursts of intense sound.

In its report, the BOEM states that as marine vibroseis technologies are developed the agency would consider requiring and/or incentivizing their use, but that this would not be a wholesale replacement for air guns.

BOEM also proposes spacing air-gun surveys at least 25 miles (40 kilometers) apart to reduce their cumulative impact.

Huelsenbeck points out that sounds in the ocean can travel much greater distances. The sound of air guns, he said, "can disturb marine mammal behavior over 100 miles [170 kilometers] away."

BOEM's recommendations also will require survey vessels to use passive acoustic monitoring systems to listen for marine mammals' calling in the test areas, although the agency said the approach may not be entirely effective.

"If they detect sensitive marine life in the vicinity, then all operations stop immediately and are restarted only when the area is clear," said API's Milito.

#### Loggerhead Turtles

Florida beaches are home to 90 percent of the world's loggerhead turtle nesting sites. Midway between Jacksonville and Miami, Brevard County alone has about 33,800 nests. Other species of threatened or endangered sea turtle live in the region as well, including hawksbill, Kemp's ridley, and green turtles.

Like the plan to close an area in Virginia to protect the right whale, BOEM proposes cordoning off near-coastal waters off Brevard County during the turtle nesting season. No air-gun surveys would be allowed in the area from May to October.

With chunky heads and heart-shaped shells that can grow to about 3 feet (1 meter), loggerheads are the second largest sea turtles after gigantic leatherbacks. Females spend years roaming the oceans, munching shellfish as they go, before returning to the beach they were born on to lay their own eggs.

Little is known about the impact of noise on turtles but it is likely that juveniles might be especially vulnerable. After they hatch, they swim straight out to sea, through areas where air-gun surveys would still be permitted.

#### Commercial Fish

Air-gun surveys could also scare fish away from commercially important fishing grounds along the coast.

"Seismic testing has disrupted fisheries around the world," said Oceana marine biologist Matthew Huelsenbeck.

Seismic surveying off the southwest coast of Africa in recent years has been linked to the disruption of migrating tuna and consequently a dramatic decline in catches off the coast of Namibia.

Many species fished in the mid- and south Atlantic—including wahoo, swordfish, and billfishes—embark on long-distance migrations. This means that any impacts of air-gun surveys are likely to spread beyond the survey area itself.

BOEM's report offers no measures to specifically deal with the impact on fish species, although it suggests that slowly ramping up sound levels during surveys could be effective.

"The process begins with a soft start, a technique that gradually increases sound levels, allowing animals that may be sensitive to the sound to leave the area," said API's Milito.

But fish eggs and larvae can be killed by intense sound, and the growth of young scallops is also affected.

The final EIS will be available for public comment until April 7. The schedule after that could move quickly.

"We would hope the government could begin approving permits in the coming months," said Milito.

Miliko said that seismic surveys have been conducted safely for decades in the Gulf of Mexico and other areas off the U.S. coast and around the world. "Like all offshore operations, seismic surveys are highly regulated, and surveyors follow strict guidelines to protect marine life," he said.

But environmental groups expect to submit formal objections during the public comment in the weeks ahead. "We don't believe we need to turn the Atlantic into a blast zone to fulfill our energy needs," Huelsenbeck said.

Scales, Helen. "Atlantic Seismic Tests for Oil: Marine Animals at Risk?" *National Geographic*. 28 Feb. 2014. Web. 23 Dec. 2014.

<http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals/>