

A Deaf Whale is A Dead Whale

Seismic Airgun Testing for Oil and Gas
Threatens Marine Life and Coastal Economies



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Acknowledgements

The authors would like to thank the following individuals who helped with this report:
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Dustin Cranor and Michael Jasny



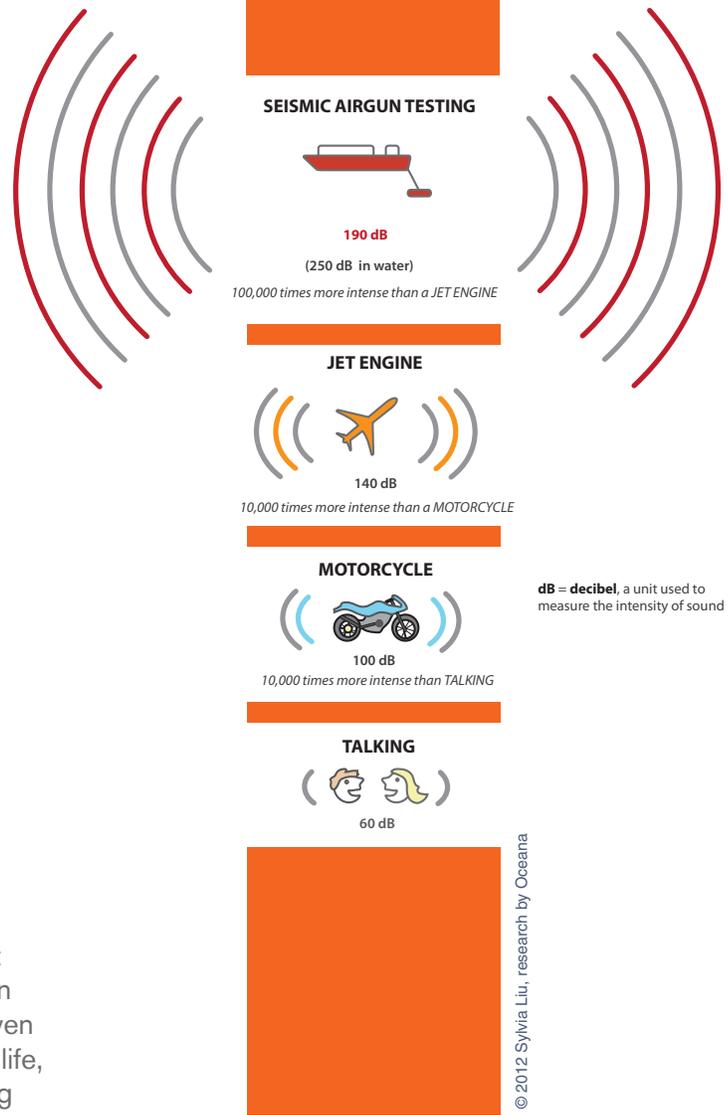
Executive Summary

According to government estimates, 138,500 whales and dolphins will soon be injured and possibly killed along the East Coast if exploration companies are allowed to use dangerous blasts of noise to search for offshore oil and gas.¹ The U.S. Department of the Interior (DOI) is considering allowing geophysical companies, working on behalf of oil and gas companies, to use seismic airguns to search for offshore oil and gas in the Atlantic Ocean, from Delaware to Florida. These airguns use compressed air to generate intense pulses of sound, which are 100,000 times more intense than a jet engine. These loud blasts are used on a recurring basis, going off every ten seconds, for 24 hours a day, often for weeks on end. They are so loud that they penetrate through the ocean, and miles into the seafloor, then bounce back, bringing information to the surface about the location of buried oil and gas deposits.

Airgun blasts harm whales, dolphins, sea turtles and fish. The types of impacts marine mammals may endure include temporary and permanent hearing loss, abandonment of habitat, disruption of mating and feeding, beach strandings and even death. Seismic airguns could devastate marine life, and harm fisheries and coastal economies along the Atlantic coast.

Seismic testing in the Atlantic would also be the first major step toward offshore drilling, which further harms the marine environment through leaks, oil spills, habitat destruction and greenhouse gas emissions.

This seismic testing, and all of the consequences that may ensue, are unnecessary because there cannot be any drilling in the Atlantic for at least the next five years, and oil and gas companies already own undeveloped leases on millions of acres of federal lands and waters.



Findings

This report analyzes the environmental and societal impacts of the proposed seismic testing program for the Atlantic Coast and has the following findings, which are discussed in more detail in the report.

- Airguns would be permitted in federal waters from Delaware to Florida in an area twice the size of California (330,032 square miles)² for at least eight years.
- Airgun use would cause:

- ◆ *138,500 injuries to whales and dolphins³ and 13.5 million disturbances to vital behaviors in marine mammals such as breathing, feeding, mating and communicating,⁴*
- ◆ *Injuries to nine critically endangered North Atlantic right whales and disruption of their critical habitat, when only roughly 500 right whales remain,⁵*
- ◆ *Widespread displacement of whales,^{6,7}*
- ◆ *Disruption of loggerhead sea turtles as they head to nesting beaches that are soon to be designated as critical habitats,⁸*
- ◆ *Death of fish eggs and larvae,^{9,10,11} and*
- ◆ *Potential disruption of fish migration and spawning.¹²*

- Airguns would be used near abundant fishing grounds, marine protected areas, national marine sanctuaries, critical habitats for endangered species, underwater canyons, migration routes for whales and dolphins, sea turtle nesting sites and essential fish habitats.
- Recent mass mortality events in Madagascar¹³ and Peru¹⁴ following seismic surveys may provide an indication of the worst case scenario for ocean life.
- The proposed use of seismic airguns and future offshore drilling along the East Coast threatens commercial and recreational fisheries, tourism and recreation. Commercial and recreational fishing off the mid- and south Atlantic generates \$11.8 billion and supports 222,000 jobs.¹⁵
- Over 500,000 marine tourism and recreation jobs are located within the blast zone.¹⁶

Recommendations

Seismic airguns pose unnecessary risks to marine mammals, sea turtles, fish and other ocean wildlife. The cumulative effects of seismic blasts repeated over large areas will disrupt critical activities and injure and kill many marine animals, including endangered species. Based on the threats of airguns to marine life and ocean resources, Oceana makes the following recommendations:

Reject Airguns

The Obama administration should deny all current proposals that incorporate airgun use and phase out the use of airguns in U.S. waters. If seismic surveying does occur, the following measures must be taken to minimize impacts on marine life:



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Make Seismic Data Public

DOI should make all seismic data publically available to reduce the redundancy in seismic surveys and allow the public to be more engaged in decision-making regarding offshore drilling.

Require Alternative Technologies for Seismic Testing

If seismic testing is going to occur, DOI should require it be done using the least harmful technology available. Marine vibroseis could completely alleviate the need for airguns in three to five years. However, marine vibroseis is not a panacea and the best option continues to be a flat rejection of such activities.

Designate “No Activity Zones”

DOI should permanently close large areas to seismic surveying and drilling to protect vulnerable habitats and species. “No activity zones” must be large enough to create a buffer area between the airgun source and the protected area because airgun noise can disturb marine life from hundreds to thousands of miles away.

Support Renewable Energy

The Obama administration should shift its attention to developing clean renewable energy which, unlike offshore oil and gas, will never run out.

Renewable energy will help bolster energy independence while also reducing greenhouse gas emissions, which are causing climate change and ocean acidification, two of the most significant threats to ocean life.

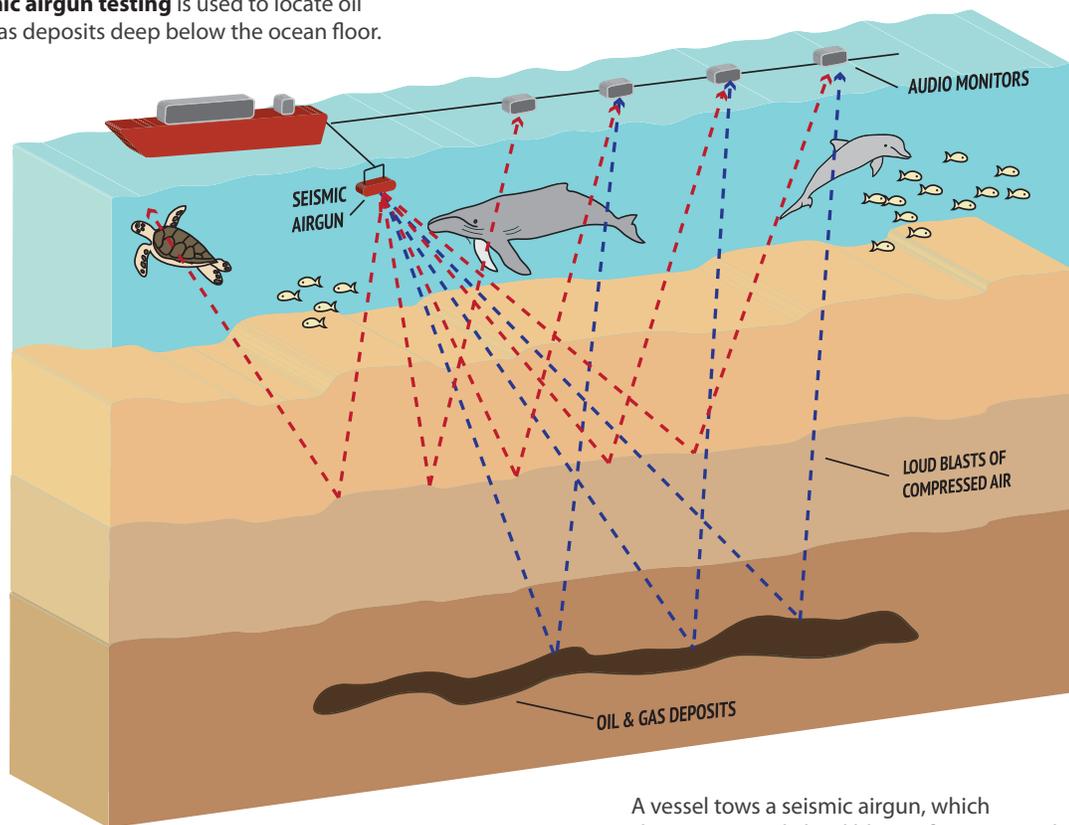


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Seismic Airgun Overview

Hundreds of thousands of marine mammals, as well as sea turtles, fish and other marine life, will be injured and possibly even killed unnecessarily if the Obama administration allows seismic airgun testing to go forward in the Atlantic Ocean. The U.S. Department of the Interior is considering allowing geophysical companies to search for oil and gas with seismic airguns off the East Coast from Delaware to Florida. This threat to whales, dolphins, sea turtles and fish is unnecessary in part because there can be no drilling in the Atlantic for at least the next five years based on current rules. Even without those rules for drilling in the Atlantic, seismic testing represents a continued investment in fossil fuels, a climate change driver, which we should be moving away from, rather than expanding. Developing the last drops of offshore oil is not a sufficient justification for the damaging effects of this proposed testing.

Seismic airgun testing is used to locate oil and gas deposits deep below the ocean floor.



A vessel tows a seismic airgun, which shoots extremely loud blasts of compressed air through the ocean and miles under the seafloor, **every ten seconds, 24 hours a day, for days to weeks on end.**

The seismic airguns would be towed behind ships and would shoot loud blasts that travel through the water and miles into the seabed. These blasts bounce back to the surface carrying with them information on oil and gas deposits. Airguns use compressed air to make intense pulses of sound, 100,000 times more intense than a jet engine, every ten seconds, 24 hours a day, for days to weeks on end. Testing in the Atlantic would last at least eight years, possibly more, creating massive and long-term acoustic pollution with severe impacts on marine life, including many endangered and threatened species. Harm to marine life can include temporary and permanent hearing loss, abandonment of habitat, disruption of mating and feeding, beach strandings and even death.

The Blast Zone

The Atlantic coast from Delaware to Florida – extending out to 350 miles¹⁷ offshore – could be opened up to seismic blasts. This is an area of ocean that is twice the size of California or 330,032 square miles.¹⁸ The airgun noise will injure or disturb commercially important fish species and marine mammals that migrate along the entire East Coast.

There would be an enormous amount of seismic activity in the mid- and south Atlantic with a vast environmental footprint. Two types of seismic surveys would be used. Two-dimensional surveys provide basic information about oil and gas deposits, and the newer three-dimensional surveys use arrays of dozens of airguns towed at various angles to create a higher resolution map. Both types of surveys are harmful for marine life.

More than 25,000 shots from airguns would be fired during a seismic survey lasting 10 days.²¹ The number of surveys could increase over time as geophysical companies will conduct more surveys if drilling becomes more likely. In that case, companies will send ships back again and again to certain areas of interest.

The blast zone includes abundant fishing grounds, marine protected areas, national marine sanctuaries, critical habitats for endangered species, underwater canyons, migration routes for whales and dolphins, sea turtle nesting sites and essential fish habitats. It is extremely difficult to avoid harming sensitive habitats and species since the sound from airgun surveys can travel for hundreds to thousands of miles.

Geophysical companies often test the same areas multiple times because they are hired by different oil and gas companies, and the data collected during each survey is considered proprietary information. This redundancy in surveying unnecessarily heightens the environmental impacts.

PROPOSED AREA

Seismic airgun testing is being considered from **Delaware to Florida**, but its impacts would be felt along the entire East Coast.



Blast zone is twice the size of California

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Seismic airgun blasts cause bubbles to rise to the surface.

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Marine Life Impacts

Airgun blasts are so loud and constant that they can cause a variety of impacts on marine mammals, sea turtles, fish and other marine life – including widespread displacement, disruption of vital behaviors such as foraging and breeding, and even injuries and death.²²



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Approximately 39 humpback whales would be injured by seismic airgun testing in the Atlantic.

For marine mammals that are more sensitive to sound and depend greatly on their hearing, such as whales and dolphins, the airgun noise can be a severe threat. Airguns shoot low and high frequency sound, both of which can be harmful. The low frequency sound can travel thousands of miles away from the airgun source, interrupting whale calls and altering their behavior even at great distances. This is especially of concern for endangered baleen whales, such as the North Atlantic right whale, humpback whale, blue whale and fin whale. Fin and humpback whales in a 100,000 square mile area stopped singing in the North Atlantic because of such noise, and bowhead whales have abandoned their habitat because of it in Alaska.²³ Scaring whales away from important habitats can prevent them from feeding, migrating or reproducing for days to weeks at a time and these reoccurring disturbances could affect their survival and the health of their populations.

Some of the sound emitted by airguns is in the high frequency range; this type of sound is not useful for collecting data on oil and gas reserves and is considered waste sound, but it can still be very harmful for marine life. High frequency sound from seismic surveys can be detrimental to a number of toothed whales and dolphins, and can startle the animals causing them to stop important activities or flee from important habitats.²⁴ Marine mammals can also suffer from decompression sickness due to rapid ascents toward the surface. This is a deadly condition

often referred to as the bends in SCUBA divers.²⁵ The airgun noise can also disorient animals and scare them into shallower waters and bays where they can become stranded.

Sea turtles are impacted by airguns at every stage in life from hatchlings to adults, but they are thought to be most vulnerable while they are young.²⁶ One of the greatest concerns is disruption to nesting females as they head to beaches to lay their eggs. Sea turtle behavior is most altered by seismic sounds at low frequencies, like those emitted by airguns.²⁷ Airgun sounds can startle them and cause them to be unable to detect sounds that are necessary for important activities. All species of sea turtles are listed as endangered or threatened in U.S. waters and they could be seriously harmed by seismic surveys or future oil and gas drilling.

Airgun surveys can also kill fish eggs and larvae²⁸ and displace adult fish from their habitats.²⁹ Airgun noise can disrupt important behaviors in fish like foraging,³⁰ mask biologically significant sounds or prevent reproduction by causing hearing loss.³¹ Low-frequency sound has been shown to disrupt chorusing, or singing, in black drum fish, a behavior essential to breeding.³² These seismic surveys can also impact spawning and migration of fish species, which can limit their population size and their recoveries when overfished; however, more information is needed in this area.

In one case, catch rates of cod and haddock declined by 40 to 80 percent for at least five days over thousands of square miles after seismic testing occurred nearby.³³ Losses in catch rates after seismic surveys led fishermen in Norway to seek compensation in 2008.³⁴ Seismic testing is also being blamed for a dramatic reduction in the offshore tuna fishery in Namibia in 2012 and 2013, where it may have disrupted the migration of tuna, cutting the total catch in Namibian waters in half and causing their worst fishing season on record.³⁵

Shellfish, like crabs, oysters, scallops and lobsters, may also be impacted by airguns, but questions remain. In 2010, 80 percent (24,000 tons) of scallops were lost following intensive seismic surveys in Australia.³⁶ A three-year study into the role of seismic testing on this decline has already begun.

Serious concerns remain about how airguns affect fish and shellfish, including effects on migration, spawning and survival, which can translate into financial losses for the local fisheries that depend on them.



Sea turtles would be disrupted on their way to nesting beaches.

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Unsolved Mysteries

Recent studies have revealed that seismic airguns degrade underwater acoustic environments and cause widespread disruptions to marine mammals and other marine life.³⁷ The blasts may cause population-level consequences for whales and dolphins by driving them away from preferred habitats and interrupting their most important behaviors.³⁸ For example, seismic surveys are implicated in the loss of marine mammal diversity off the coast of Brazil.³⁹

Another major concern is the chance of mass mortality events following seismic surveys for oil and gas. There have been many documented cases of marine mammals dying in large numbers after underwater sound events, but the link between seismic surveys for oil and gas with mass mortality events is often elusive. Although impacts are hard to identify and very few dead marine mammals are ever discovered – perhaps as few as 2 percent⁴⁰ – some mass mortality events following seismic testing have raised alarms about how deadly these tests may be.



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Dead Melon-Headed Whales in Madagascar

In 2008 in Madagascar, dozens of melon-headed whales washed up dead following offshore seismic testing by Exxon Mobil.⁴¹ Melon-headed whales are a mid-water species that is believed to be sensitive to sound. The people of Madagascar had never before seen this species, and beaching events of melon-headed whales in this region are rare. An investigation was conducted into the link between the noise source and the stranding incident, and the results will be an important indicator of worst case scenarios following seismic testing.



Melon-headed whales and other marine mammals can be killed by sound.

Dead Dolphins and Porpoises in Peru

In 2012 in Peru, roughly 900 long-beaked common dolphins and black porpoises washed up dead along a desolate stretch of beach. Seismic surveying had been permitted offshore during the timeframe that the animals started washing up dead. Although the cause of death is unclear, necropsies of the dolphins showed some signs that seismic testing may be blamed. These signs included blood coming from their middle ears, fractures in their periotic ear bones, gas in their solid internal organs and severe acute pulmonary emphysema, which could have been caused by decompression sickness from a rapid ascent to the surface after being startled.⁴²

Similar mass mortality events could occur on the Atlantic coast following the proposed testing, should it go forward.

Marine Life Victims

The government's draft Environmental Impact Statement (EIS) included predictions of dire consequences for marine mammals in the Atlantic from seismic airgun surveys. The EIS, which likely underestimates the cumulative impacts since it is using outdated science, predicts 138,500 injuries to marine mammals and 13.5 million disturbances to vital behaviors like foraging, communicating and mating.⁴³

Although it is difficult to determine how many animals will be killed by seismic airguns, there are serious threats to the health and survival of a variety of species ranging from small fish eggs to large whales.

According to the EIS, the number of 'injuries' listed below for each species represents the number of times that those animals will experience "serious behavioral, physiological, and hearing effects."⁴⁴ Serious effects to hearing can kill whales and dolphins that depend on their ability to hear in order to feed, navigate, reproduce and care for their young. The 'disturbances' represent the number of times that important behaviors will be interrupted, including disruptions in "migration, breathing, nursing, breeding, feeding or sheltering."⁴⁵

Baleen Whales



*Blue Whale

Injuries: **14**
Disturbances: **1,432**



*Humpback Whale

Injuries: **39**
Disturbances: **3,826**



*North Atlantic Right Whale

Injuries: **9**
Disturbances: **1,816**

The North Atlantic right whale is one of the rarest and most endangered species on the planet. It was almost hunted to extinction back in the eighteenth century, and there are only about 500 individuals left in the population. Harming even one of the remaining reproductive-age females can have serious consequences on its recovery. Its migratory route and only known calving ground off Georgia and northern Florida are threatened by proposed seismic testing.



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Toothed Whales and Dolphins



Short-Beaked Common Dolphin

Injuries: **22,809**
Disturbances: **2,235,585**



Short-Finned Pilot Whale

Injuries: **17,038**
Disturbances: **1,669,956**



Risso's Dolphin

Injuries: **11,358**
Disturbances: **1,113,281**



Killer Whale

Injuries: **12**
Disturbances: **1,255**



*Sperm Whale

Injuries: **975**
Disturbances: **95,940**



Striped Dolphin

Injuries: **13,657**
Disturbances: **1,338,571**



Atlantic Spotted Dolphin

Injuries: **20,641**
Disturbances: **2,023,058**



Bottlenose Dolphin

Injuries: **42,648**
Disturbances: **4,180,015**

*Species with a star are listed as endangered or threatened under the Endangered Species Act.

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Sea Turtles



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Marine mammals are not the only animals that will be harmed by seismic airguns; sea turtles are also threatened by these sounds. All sea turtle species in the U.S. are threatened or endangered. The seismic blast zone in the Atlantic overlaps with populations of sea turtles, including green, leatherback, loggerhead, hawksbill and Kemp's Ridley, and contains thousands of nesting locations of particular importance to loggerheads. Since the East Coast has some of the most important nesting beaches for loggerheads,⁴⁶ minimizing disturbances to these nesting locations is paramount for the global conservation of this species. DOI's analysis of the impacts in the Atlantic observes that "Potential impacts could include auditory injuries or behavioral avoidance that interferes with nesting activities."⁴⁷ The recovery plan for the Northwest Atlantic population of loggerhead sea turtles notes that oil and gas activities, including seismic surveying, threaten these populations.⁴⁸

Ninety percent of all loggerhead nesting occurs in Florida, and specifically Brevard County, Florida represents vital loggerhead nesting habitat that must be protected from airguns and offshore oil and gas drilling. Sea turtles nest in many additional locations where seismic airguns could be permitted in Georgia, South Carolina, North Carolina and other parts of Florida:



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Kemp's Ridley hatchling

Sea Turtle Nests

Brevard County, Florida: 33,800 loggerhead.⁴⁹

Volusia County, Florida: 1,865 loggerhead.⁵⁰

Georgia: 1,761 loggerhead.⁵¹

South Carolina: 4,018 loggerhead, 3 green and 4 leatherback.⁵²

North Carolina: 948 loggerhead, 16 green and 1 Kemp's Ridley.⁵³

Loggerhead nesting is already declining in North Carolina, South Carolina, Georgia and southeast Florida.⁵⁴ Nesting females and hatchlings could be disturbed or injured by the proposed seismic activities, so it is critical to loggerhead recovery to protect females heading to and from their nesting beaches and to protect hatchlings that enter the coastal zone. The National Oceanic and Atmospheric Administration (NOAA) is designating critical habitat for loggerheads, which would likely overlap with the proposed seismic tests.⁵⁵ Given the global significance of the region for loggerheads and other sea turtles, seismic airgun use should not be permitted.

State Level Impacts

Opening up new areas in the Atlantic to harmful seismic airguns and offshore drilling is unnecessary and puts coastal economies and jobs at risk. Commercial and recreational fishing in the mid- and southeast Atlantic, where seismic airgun testing is being proposed, generates \$11.8 billion annually and supports 222,000 jobs.⁵⁶ Several ports within the proposed area for seismic airgun testing have among the highest commercial fishing revenues in the United States. Seismic airgun testing could impact 108 fishing communities along the coast from Delaware to Florida.⁵⁷

Jobs and Revenue in Fisheries, Tourism and Recreation at Risk from Seismic Airguns and Offshore Drilling

State	Fisheries, Aquaculture & Seafood Markets GDP	Tourism & Recreation GDP	Tourism & Recreation Jobs	Recreational Fishing Jobs	Commercial Fishing Jobs
Delaware	\$14,222,630	\$492,990,932	13,408	1,270	407
Maryland	\$116,071,142	\$2,630,675,068	59,641	5,714	14,778
Virginia	\$573,719,022	\$1,962,257,873	85,514	5,167	19,064
North Carolina	\$156,743,452	\$982,666,376	30,380	17,221	8,479
South Carolina	\$10,604,779	\$2,401,134,933	55,485	5,035	1,169
Georgia	\$69,138,081	\$522,716,897	13,927	1,613	7,390
Florida	\$284,717,845	\$15,185,649,774	293,385	27,445	64,744

(Source: Compiled by Oceana from NOAA National Marine Fisheries Service data)

The proposed use of seismic airguns in the Atlantic Ocean threatens fisheries and local communities. Airgun noise can displace commercially valuable species of fish across vast areas and decrease catch rates for coastal fisheries. For example, in one study, catch rates for cod and haddock went down by 40 to 80 percent surrounding the use of a single airgun array for at least five days.⁵⁸ Fishermen in Norway recognized the impacts of the testing and requested compensation for losses to their catch rates following the process.⁵⁹

The use of seismic airguns is also the first major step toward dangerous offshore oil and gas drilling, which brings great risks in the form of accidents and oil spills. Offshore drilling, the same practice that brought us the Deepwater Horizon oil disaster in the Gulf of Mexico, was the largest and costliest environmental disaster in our country's history. The accident took 11 rig worker's lives, threatened public health and killed thousands of dolphins, birds, sea turtles, fish and other marine life. The spill has also had significant economic consequences, especially for fisheries.



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Seismic airgun testing is the first step toward dangerous offshore drilling, the same practice that brought us the Deepwater Horizon oil spill.

At the height of the spill, over one-third of federal waters in the Gulf were closed to commercial and recreational fishing, covering an area about the size of Minnesota.⁶⁰ The closure affected 22 percent of the annual U.S. commercial catch in the Gulf of Mexico and caused a loss of at least \$247 million in revenue.⁶¹ Fishing-dependent industries could lose \$8.7 billion and 22,000 jobs over the next seven years due to the Deepwater Horizon spill.⁶²

Seismic airguns and future offshore drilling could harm jobs and gross domestic product (GDP) in coastal tourism, recreation, and commercial and recreational fishing. Below is a state-by-state look at some of the jobs and revenues that could be put at risk in the proposed blast zone from Delaware to Florida.

Delaware

Each of Delaware's counties has considerable coastline. The GDP from Delaware's living resources, which includes fishing, hatcheries, aquaculture, seafood processing and seafood markets, is valued at over \$14 million.⁶³ GDP from ocean-based tourism and recreation in the state totals nearly \$500 million.⁶⁴

Delaware jobs that could be impacted by airguns or drilling:

13,408 jobs in ocean-based tourism and recreation⁶⁵

1,270 jobs in recreational fishing⁶⁶

407 jobs in commercial fishing⁶⁷

From fishing, tourism and recreation, there are a total of 15,085 jobs in Delaware that are directly dependent on the resources threatened by seismic airguns, and countless others that are indirectly dependent on those resources.

Delaware generates millions of dollars in commercial fishing from blue crab, oysters, finfishes, eel and whelk.

Maryland

Maryland is famous for its blue crabs and is a state that depends on the ocean. Sixteen of its 23 counties border tidal water, for a total of 4,431 miles. The GDP from Maryland's living resources, which includes fishing, hatcheries, aquaculture, seafood processing and seafood markets, is valued at over \$116 million.⁶⁸ GDP from ocean-based tourism and recreation in the state totals nearly \$2.6 billion.⁶⁹

Maryland jobs that could be impacted by airguns or drilling:

59,641 jobs in ocean-based tourism and recreation⁷⁰

5,714 jobs in recreational fishing⁷¹

14,778 jobs in commercial fishing⁷²

From fishing, tourism and recreation, there are a total of 80,133 jobs in Maryland that are directly dependent on the resources threatened by seismic airguns, and countless others that are indirectly dependent on those resources.

Maryland generates millions of dollars in commercial fishing from blue crab, striped bass, menhaden and oysters.

Virginia

From the Eastern Shore to Virginia Beach, to the ports of Hampton and Norfolk, Virginia has over 3,000 miles of coastline and is home to thousands who make their living on the shore. The GDP from Virginia's living resources, which includes fishing, hatcheries, aquaculture, seafood processing and seafood markets, is valued at over \$574 million.⁷³ GDP from ocean-based tourism and recreation in the state totals nearly \$1.96 billion.⁷⁴

Virginia jobs that could be impacted by airguns or drilling:

85,514 jobs in ocean-based tourism and recreation⁷⁵

5,167 jobs in recreational fishing⁷⁶

19,064 jobs in commercial fishing⁷⁷

From fishing, tourism and recreation, there are a total of 109,745 jobs in Virginia that are directly dependent on the resources threatened by seismic airguns, and countless others that are indirectly dependent on those resources.

Virginia generates millions of dollars in commercial fishing from menhaden, scallops, blue crabs, croaker and flounder.

North Carolina

The Outer Banks, a long, narrow strip of barrier islands, cover nearly the entirety of North Carolina's coast. The state's abundant ocean resources are a major tourist attraction. The GDP from North Carolina's living resources, which includes fishing, hatcheries, aquaculture, seafood processing and seafood markets, is valued at nearly \$157 million.⁷⁸ GDP from ocean-based tourism and recreation in the state totals nearly \$983 million.⁷⁹

North Carolina jobs that could be impacted by airguns or drilling:

30,380 jobs in ocean-based tourism and recreation⁸⁰

17,221 jobs in recreational fishing

8,479 jobs in commercial fishing⁸¹

From fishing, tourism and recreation, there are a total of 56,080 jobs in North Carolina that are directly dependent on the resources threatened by seismic airguns, and countless others that are indirectly dependent on those resources.

North Carolina generates millions of dollars in commercial fishing from blue crab, shrimp, flounder, croaker and bluefish.

South Carolina

South Carolina's white sandy beaches and coastal towns are critical for the state's economy, recreation and culture. The GDP from South Carolina's living resources, which includes fishing, hatcheries, aquaculture, seafood processing and seafood markets, is valued at over \$10 billion.⁸² GDP from ocean-based tourism and recreation in the state totals nearly \$2.4 billion.⁸³

South Carolina jobs that could be impacted by airguns or drilling:

55,485 jobs in ocean-based tourism and recreation⁸⁴

5,035 jobs in recreational fishing⁸⁵

1,169 jobs in commercial fishing⁸⁶

From fishing, tourism and recreation, there are a total of 61,689 jobs in South Carolina that are directly dependent on the resources threatened by seismic airguns, and countless others that are indirectly dependent on those resources.

South Carolina generates millions of dollars in commercial fishing from blue crab, shrimp, swordfish and snapper.

Georgia

Georgia has a beautiful coast, spanning over 100 miles, that supports a thriving commercial fishing industry, as well as whale and dolphin watching, resorts and recreational fishing, all large players in Georgia's economy. The GDP from Georgia's living resources, which includes fishing, hatcheries, aquaculture, seafood processing and seafood markets, is valued at over \$69 million.⁸⁷ GDP from ocean-based tourism and recreation in the state totals nearly \$523 million.⁸⁸

Georgia jobs that could be impacted by airguns or drilling:

13,927 jobs in ocean-based tourism and recreation⁸⁹

1,613 jobs in recreational fishing⁹⁰

7,390 jobs in commercial fishing⁹¹

From fishing, tourism and recreation, there are a total of 22,930 jobs in Georgia that are directly dependent on the resources threatened by seismic airguns, and countless others that are indirectly dependent on those resources.

Georgia generates millions of dollars in commercial fishing, namely from blue crab, shrimp, various finfishes and clams.

Georgia also serves as critical habitat for North Atlantic right whales, one of the most endangered species on the planet. Approximately 500 North Atlantic right whales remain and they give birth in an area just offshore of southern Georgia.



Seismic airguns and oil spills threaten commercial and recreational fishing.

Florida

Florida has more coastline than any other state in the continental U.S., and its beaches and marine resources support prosperous coastal economies. The GDP from Florida's living resources, which includes fishing, hatcheries, aquaculture, seafood processing and seafood markets, is valued at over \$284 million.⁹² GDP from ocean-based tourism and recreation in the state totals nearly \$15 billion.⁹³

Florida jobs that could be impacted by airguns or drilling:

293,385 jobs in ocean-based tourism and recreation⁹⁴

27,445 jobs in recreational fishing⁹⁵

64,744 jobs in commercial fishing⁹⁶

From fishing, tourism and recreation, there are a total of 385,574 jobs in Florida that are directly dependent on the resources threatened by seismic airguns, and countless others that are indirectly dependent on those resources.

Florida generates millions of dollars in commercial fishing, namely from shrimp, mackerel, blue crab and swordfish.

Florida also serves as critical habitat for North Atlantic right whales, one of the most endangered species on the planet. Approximately 500 North Atlantic right whales remain and they give birth in an area just offshore of northeastern Florida.

Northeast Fisheries

In addition to Atlantic Coast fisheries, migratory fish species that pass through the blast zone could also be harmed by seismic airguns. Some highly migratory species that travel through the mid- and south Atlantic like wahoo, tunas, swordfish and billfishes⁹⁷ are important to the fisheries economies of the Northeast, including New England. Harm to migrating fish from seismic airguns could have effects on distant fisheries.

Recommendations

Seismic airguns pose unnecessary risks to marine mammals, sea turtles, fish and other ocean wildlife. The cumulative effects of seismic blasts repeated over large areas will disrupt critical activities and injure and kill many marine animals, including endangered species. Based on the threats of airguns to marine life and ocean resources Oceana makes the following recommendations:

Reject Airguns: The use of seismic airguns poses unavoidable and unacceptable impacts to marine life, including injuries or disturbances to protected and endangered species of marine mammals, sea turtles and fish. Due to the severity of acoustic harm caused by airguns, they should be phased out of use in U.S. waters, and all current proposals that incorporate the use of airguns should be denied.

Rejecting the use of seismic airguns and stopping the expansion of offshore drilling are a primary means of protecting marine life. But if seismic surveying does occur, the following steps should be taken to reduce impacts to marine life:

Make Seismic Data Publicly Available: DOI should make all information gathered during seismic surveying publicly available, and access to this information should not be restricted from a Freedom of Information Act (FOIA) request. This would reduce the redundancy in seismic surveys and allow the public to be more engaged in decision-making regarding offshore drilling.

Require Alternative Technologies for Seismic Surveys: DOI should require less harmful alternative technologies to airguns, such as marine vibroseis. Marine vibroseis, which creates sound through vibrations, can reduce the loudest peak noise that is generated during surveying and eliminate high frequency 'waste sound', which can help protect some marine mammals.⁹⁸ Although more field tests are needed, it would likely have some environmental benefits over airguns. Commercial testing of marine vibroseis is being conducted in 2013, and could completely phase out airguns in three to five years in U.S. waters with the appropriate policies in place. Marine vibroseis is not a panacea that will entirely eliminate harmful impacts from seismic surveying, but it should be considered as a viable alternative to airguns.

Create Large "No Activity Zones" for Sensitive Habitats and Species: DOI should never permit seismic surveys within or near the following areas: endangered species' critical habitat, areas with high densities of marine mammals, national marine sanctuaries, marine protected areas, coral communities and sensitive benthic habitats, important fishing grounds and fish spawning areas. Closing large areas permanently to seismic surveying and drilling is one of the most effective ways to protect vulnerable habitats and species. "No activity zones" must be large enough to create a buffer area between the air gun source and the protected area because airgun noise can disturb marine life from hundreds to thousands of miles away.

Support Renewable Energy like Offshore Wind: The Obama administration should shift its attention to developing clean renewable energy which, unlike offshore oil and gas, will never run out. Offshore wind could provide at least three times as many jobs as offshore oil and gas in the Atlantic, and could create enough electricity to power millions more homes with clean energy.⁹⁹ The permitting process for offshore wind in the region is much further along than oil and gas, and state and federal officials should continue to push for expansion of this growing clean energy source to help us transition from fossil fuels. Unlike offshore oil and gas drilling, offshore wind energy avoids the environmental threats of seismic airguns, oil spills and greenhouse gas emissions.

References

- 1 Bureau of Ocean Energy Management (BOEM). (2012). Atlantic OCS Proposed Geological and Geophysical Activities Mid and South Atlantic Planning Areas Draft Programmatic Environmental Impact Statement (DPEIS), Vol II Figures, Tables and Appendices. Table 4-10. pg. 101. Annual Level A Takes Estimates from Seismic Airgun Sources Using 180-dB Criteria for Marine Mammal Species during the Project Period (2012-2020). (Note: 138,500 injuries number from the sum of Level A takes from 2012-2020).
- 2 BOEM. (2012). Atlantic OCS Proposed Geological and Geophysical Activities Mid and South Atlantic Planning Areas Draft Programmatic Environmental Impact Statement (DPEIS), Vol I. Chapters 1-8. Section 4.2 Alternative A – The Proposed Action. pg. 177.
- 3 BOEM. (2012). Atlantic OCS Proposed Geological and Geophysical Activities Mid and South Atlantic Planning Areas Draft Programmatic Environmental Impact Statement (DPEIS), Vol II. Figures, Tables and Appendices. Annual Level A Takes Estimates from Seismic Airgun Sources Using 180-dB Criteria for Marine Mammal Species during the Project Period (2012-2020). Table 4-10. pg. 101. (Note: 138,500 injuries from the sum of Level A takes from 2012-2020).
- 4 BOEM. (2012). Atlantic OCS Proposed Geological and Geophysical Activities Mid and South Atlantic Planning Areas Draft Programmatic Environmental Impact Statement (DPEIS), Vol II. Figures, Tables and Appendices. Annual Level B Takes Estimates from Seismic Airgun Sources Using 160-dB Criteria for Marine Mammal Species during the Project Period (2012-2020). Table 4-11. pg. 102. (Note: 13.5 million disturbances from the sum of Level B takes from 2012-2020).
- 5 BOEM. (2012). Atlantic OCS Proposed Geological and Geophysical Activities Mid and South Atlantic Planning Areas Draft Programmatic Environmental Impact Statement (DPEIS), Vol II. Figures, Tables and Appendices. Annual Level A Takes Estimates from Seismic Airgun Sources Using 180-dB Criteria for Marine Mammal Species during the Project Period (2012-2020). Table 4-10. pg. 101. (Note: Nine injuries is the sum of Level A takes for right whales from 2012-2020).
- 6,7 Weller, D. W., A. Burdin, A.L. Bradford, G.A. Tsiudlko, Y.V. Ivashchenko. (2003). "Gray whales off Sakhalin Island, Russia: June-September 2001: A joint U.S. – Russia scientific investigation." U.S. Department of the Interior, Paper 134. see also, Clark, C.W. and G.C. Gagnon. 2006. Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales. International Whaling Commission SC58/E9.
- 8 BOEM DPEIS. VOL I. Types of Impacts on Sea Turtles. 4-79. pg. 248. see also, Nunny, R., E. Graham, and S. Bass. (2008). Do sea turtles use acoustic cues when nesting? NOAA Tech. Mem. NMFS SEFSC No. 582:83. Available at: <http://www.nmfs.noaa.gov/pr/pdfs/species/turtlesymposium2005.pdf>.
- 9,10,11 Booman, C., Dalen, J., Leivestad, H., Levsen, A., van der Meeren, T., and Toklum, K., Effector av luftkanonskyting på egg, larver og yngel. (1996). Effects from airgun shooting on eggs, larvae, and fry, Fisken og Havet 3:1-83. see also, Dalen, J., and Knutsen, G.M., (1987). Scaring effects on fish and harmful effects on eggs, larvae and fry by offshore seismic explorations, Merklinger, H.M., Progress in Underwater Acoustics, 93-102. see also, Banner, A., and Hyatt, M., (1973). Effects of noise on eggs and larvae of two estuarine fishes, Transactions of the American Fisheries Society 1:134-36 L.P.
- 12 Slotte, A., Hansen, K., Dalen, J. (2004). Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fisheries Research, 67, 2. pp. 143-150.
- 13 Hogg, J. "Whales stranded off Madagascar" BBC News, Antananarivo. 9 June 2008. <http://news.bbc.co.uk/2/hi/africa/7443559.stm>
- 14 Jolly, D. Interview with Dr. Yaipen-Llanos. "Expert Links Dolphin Deaths to Sonar Testing." New York Times Green Blog, 28 May 2012. <http://green.blogs.nytimes.com/2012/05/28/expert-links-dolphin-deaths-to-sonar-testing/>
- 15 Commercial Fishing Data: National Marine Fisheries Service, Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at:http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html.
Recreational Fishing Data: National Marine Fisheries Service, Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at: http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html
- 16 NOAA Coastal Services. Economics: National Ocean Watch. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- 17 BOEM DPEIS. pg. viii
- 18 Id. BOEM DPEIS, pg. viii
- 19 Note: Assuming vessel speeds of 4.5 knots.
- 20 Note: Using percentage of 3D surveys in the Arctic
- 21 Lincoln, D. (2002). Sense and Nonsense – the environmental impacts of exploration on marine organisms offshore Cape Breton. Sierra Club.
- 22 Hildebrand, J.A. (2007). Impacts of anthropogenic sound, in Reynolds, J.E. III, Perrin, W.F., Reeves, R.R., Montgomery, S., and Ragen, T.J. (eds), Marine Mammal Research: Conservation beyond Crisis. See also; Weilgart, L., (2007). The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology 85: 1091-1116
- 23 Clark, C.W., and Gagnon, G.C. (2006). Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales (IWC Sci. Comm. Doc. IWC/SC/58/E9). see also; MacLeod, K., Simmonds, M.P., and Murray, E., (2006). Abundance of fin (Balaenoptera physalus) and sei whales (B. borealis) amid oil exploration and development off northwest Scotland, Journal of Cetacean Research and Management 8: 247-254.
- 24 Southall, B., et al. (2007). Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(4):411-521. http://www.thecre.com/pdf/Aquatic%20Mammals%2033%204_FINAL1.pdf
- 25 Jepson, P.D. et al. (2003). Gas bubble lesions in stranded cetaceans. Nature, 425 pp. 575-576.
- 26 Piniak, W.E.D., Mann, D.A., Eckert, S.A., and Harms, C.A., (2012). Amphibious hearing in sea turtles, in Popper, A.N., and Hawkins, A., eds., The Effects of Noise on Aquatic Life at 83-88.
- 27 Id.
- 28 Booman, C., Dalen, J., Leivestad, H., Levsen, A., van der Meeren, T., and Toklum, K., Effector av luftkanonskyting på egg, larver og yngel (Effects from airgun shooting on eggs, larvae, and fry), Fisken og Havet 3:1-83 (1996) (Norwegian with English summary); Dalen, J., and Knutsen, G.M., (1987). Scaring effects on fish and harmful effects on eggs, larvae and fry by offshore seismic explorations, in Merklinger, H.M., Progress in Underwater Acoustics 93-102 see also: Banner, A., and Hyatt, M., (1973). Effects of noise on eggs and larvae of two estuarine fishes, Transactions of the American Fisheries Society 1:134-36. see also: L.P. Kostyuchenko, (1973). Effect of elastic waves generated in marine seismic prospecting on fish eggs on the Black Sea, Hydrobiology Journal 9:45-48.
- 29 Slotte, A., Hansen, K., Dalen, J. (2004). Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fisheries Research, 67, 2. pp. 143-150.
- 30 Purser, J., and Radford, A.N. (2011). Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (*Gasterosteus aculeatus*), PLoS One, DOI: 10.1371/journal.pone.0017478
- 31 McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J. and McCabe, K., (2000). Marine seismic surveys: analysis and propagation of air-gun signals, and effects of air-gun exposure on humpback whales, sea turtles, fishes, and squid (report by Curtin U. of Technology). see also: McCauley, R., Fewtrell, J., and Popper, A.N. (2002). High intensity anthropogenic sound damages fish ears, Journal of the Acoustical Society of America 113: 638-642. see also: Scholik, A.R., and Yan, H.Y., (2002). Effects of boat engine noise on the auditory sensitivity of the fathead minnow, *Pimephales promelas*, Environmental Biology of Fishes 63: 203-209.
- 32 Locascio, J.V. and Mann, D. A. (2011). Localization and source level estimates of black drum (*Pogonias cromis*) calls. J. Acoust. Soc. Am. 130, 4 (1868-1879).
- 33 Engås, A., Løkkeborg, S., Ona, E., and Soldal, A.V. (1996) Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*), Canadian Journal of Fisheries and Aquatic Sciences 53: 2238-2249. see also Skalski, J.R., Pearson, W.H., and Malme, C.I. (1992). Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes spp.*), Canadian Journal of Fisheries and Aquatic Sciences 49: 1357-1365.

- ³⁴ The Fisheries Secretariat. "We won't go seismic, Norwegian fishers say." 4 June 2010. <http://www.fishsec.org/2010/04/06/we-won%E2%80%99t-go-seismic-norwegian-fishers-say/>
- ³⁵ The Namibian. Oil search threatens tuna industry. 19 March 2013. <http://www.namibian.com.na/news/full-story/archive/2013/march/article/oil-search-threatens-tuna-industry/>
- ³⁶ Briscoe, T. "Seismic scallop study." ABC Rural. 31 October 2012. <http://www.abc.net.au/rural/tas/content/2012/10/s3622688.htm>
- ³⁷ Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., van Parijs, S., Frankel, A., and Ponirakis, D., (2009). Acoustic masking in marine ecosystems as a function of anthropogenic sound sources (IWC Sci. Comm. Doc. SC/61/E10).
- ³⁸ Mayo, C.S., Page, M., Osterberg, D., and Pershing, A. (2008). On the path to starvation: The effects of anthropogenic noise on right whale foraging success. North Atlantic Right Whale Consortium: Abstracts of the Annual Meeting.
- ³⁹ Parente, C.L., Pauline de Araújo, J., and Elisabeth de Araújo, M. (2007). Diversity of cetaceans as tool in monitoring environmental impacts of seismic surveys. *Biota Neotropica* 7(1)
- ⁴⁰ Williams, R., Gero, S., Bejder, L., Calambokidis, J., Kraus, S., Lusseau, D., Read, A., and J. Robbins. (2011). Underestimating the damage: interpreting cetacean carcass recoveries in the context of the Deepwater Horizon/BP incident. *Conservation Letters*, DOI:10.1111/j.1755-263x.2011.00168x.
- ⁴¹ BBC News. "Whales stranded off Madagascar." 9 June 2008. Available at: <http://news.bbc.co.uk/2/hi/africa/7443559.stm>
- ⁴² Jolly, D. Interview with Dr. Yaipen-Llanos. "Expert Links Dolphin Deaths to Sonar Testing." New York Times Green Blog, 28 May 2012. <http://green.blogs.nytimes.com/2012/05/28/expert-links-dolphin-deaths-to-sonar-testing/>
- ⁴³ In this report 'injury' and 'disturbance' are defined by Level A and Level B harassment under the Marine Mammal Protection Act (MMPA). The MMPA defines harassment as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment), or disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). The National Marine Fisheries Service (NMFS) criteria for Level A harassment for impulsive sounds are 180 dB re 1 μ Pa for cetaceans. The NMFS criteria for Level B harassment are 160 dB re 1 μ Pa for pulsed sounds (e.g., airgun pulses).
- ⁴⁴ BOEM DPEIS, 4-50
- ⁴⁵ BOEM DPEIS, pg. xii
- ⁴⁶ FWS and NMFS. (2008). Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*) Second Revision available at www.nmfs.noaa.gov/pr/pdfs/recovery/turtle_loggerhead_atlantic.pdf.
- ⁴⁷ BOEM DPEIS, 2-17.
- ⁴⁸ Id.
- ⁴⁹ Florida Fish and Wildlife Conservation Commission, Loggerhead Nesting in Florida. (2013). <http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead/>
- ⁵⁰ FWC/FWRI Statewide Nesting Beach Survey Program Database as of 8 Feb. 2012, Loggerhead Nesting Data 2007-2011, available at <http://myfwc.com/media/2078432/LoggerheadNestingData.pdf>.
- ⁵¹ Georgia Department of Natural Resources. Sea Turtle Conservation and Research, available at <http://www.georgiawildlife.com/node/1804> (accessed May 2012).
- ⁵² South Carolina Department of Natural Resources, SC Marine Turtle Conservation Program, available at <http://www.dnr.sc.gov/seaturtle/> (accessed May 2012).
- ⁵³ North Carolina Wildlife Commission, Sea Turtle Nest Monitoring System: North Carolina loggerhead, available at <http://www.seaturtle.org/nestdb/index.shtml?view=1&year=2011>.
- ⁵⁴ NMFS, Loggerhead Sea Turtle (*Caretta caretta*), available at: <http://www.nmfs.noaa.gov/pr/species/turtles/loggerhead.htm> (accessed May 2012).
- ⁵⁵ 76 Fed. Reg. 58868 (Sept. 22, 2011).
- ⁵⁶ Commercial Fishing Data: National Marine Fisheries Service, Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at: http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html. BOEM DPEIS, pg. xix
- ⁵⁷ Recreational Fishing Data: National Marine Fisheries Service, Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at: http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html
- ⁵⁸ Engås, A., Løkkeborg, S., Ona, E., and Soldal, A.V., (1996) Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*), *Canadian Journal of Fisheries and Aquatic Sciences* 53: 2238-2249. see also Skalski, J.R., Pearson, W.H., and Malme, C.I. (1992). Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp.), *Canadian Journal of Fisheries and Aquatic Sciences* 49: 1357-1365.
- ⁵⁹ The Fisheries Secretariat. We won't go seismic, Norwegian fishers say. 4 June 2010. <http://www.fishsec.org/2010/04/06/we-won%E2%80%99t-go-seismic-norwegian-fishers-say/>
- ⁶⁰ "FB10-055. BP Oil Spill: NOAA Modifies Commercial and Recreational Fishing Closure in the Oil-Affected Portions of the Gulf of Mexico." NOAA. 21 June 2010.
- ⁶¹ McCrear-Strub, A. et al. (2011) Potential impact of the Deepwater Horizon oil spill on commercial fisheries in the Gulf of Mexico. *Fisheries*, 36(7), 334.
- ⁶² Sumaila, U.R., A. Cisneros-Montemayor, A. Dyck, L. Huang, W.W.L. Cheung, J. Jacquet K. Kleisner V. Lam, A. McCrear-Strub, W. Swartz, R. Watson, D. Zeller and D., Pauly. (2012). Impact of the Deepwater Horizon oil spill on the Economics of U.S. Gulf fisheries. *Can. J. Fish Aquat. Sci.* 69: 499-510.
- ⁶³ National Oceanic and Atmospheric Administration (NOAA) Coastal Services. Economics: National Ocean Watch. Delaware (ENOW), Living Resources. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁶⁴ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). Delaware, Tourism and Recreation. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁶⁵ Id.
- ⁶⁶ National Marine Fisheries Service (NMFS), Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at: http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html
- ⁶⁷ Id.
- ⁶⁸ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). Maryland, Living Resources. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁶⁹ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). Maryland, Tourism and Recreation. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁷⁰ Id.
- ⁷¹ National Marine Fisheries Service, Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at: http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html.
- ⁷² Id.
- ⁷³ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). Virginia, Living Resources. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁷⁴ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). Virginia, Tourism and Recreation. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁷⁵ Id.
- ⁷⁶ National Marine Fisheries Service, Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at: http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html.
- ⁷⁷ Id.
- ⁷⁸ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). North Carolina, Living Resources. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁷⁹ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). North Carolina, Tourism and Recreation. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>



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- ⁸⁰ Id.
- ⁸¹ National Marine Fisheries Service, Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at: http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html.
- ⁸² NOAA Coastal Services. Economics: National Ocean Watch (ENOW). South Carolina, Living Resources. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁸³ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). South Carolina, Tourism and Recreation. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁸⁴ Id.
- ⁸⁵ National Marine Fisheries Service, Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at: http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html.
- ⁸⁶ Id.
- ⁸⁷ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). Georgia, Living Resources. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁸⁸ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). Georgia, Tourism and Recreation. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁸⁹ Id.
- ⁹⁰ National Marine Fisheries Service, Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at: http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html.
- ⁹¹ Id.
- ⁹² NOAA Coastal Services. Economics: National Ocean Watch (ENOW). Florida, Living Resources. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁹³ NOAA Coastal Services. Economics: National Ocean Watch (ENOW). Florida, Tourism and Recreation. Accessed March 2013. <http://www.csc.noaa.gov/ENOWDataWizard/#>
- ⁹⁴ Id.
- ⁹⁵ National Marine Fisheries Service, Fisheries Economics of the United States 2009; Economics and Sociocultural Status and Trends, NOAA Technical Memorandum NMFS-F/SPO-109, January, 2012. Available at: http://www.st.nmfs.noaa.gov/st5/publication/fisheries_economics_2009.html.
- ⁹⁶ Id.
- ⁹⁷ BOEM DPEIS, 4-115
- ⁹⁸ LGL Ltd. & Marine Acoustics Inc. Environmental Assessment of Marine Vibroseis. April 2011. Prepared for Joint Industry Programme, E&P Sound and Marine Life, International Association of Oil & Gas Producers. Available at: <http://www.soundandmarinelife.org/Site/Products/EA%20of%20MarVibr-LGL&MAI-20Apr%2711%28final%29.pdf>
- ⁹⁹ Mahan, S. Pearlman, I. Savitz, J. "Untapped Wealth: Offshore Wind Can Deliver Cleaner, More Affordable Energy and More Jobs than Offshore Drilling." Oceana, September 2010. http://oceana.org/sites/default/files/reports/Offshore_Wind_Report_-_Final_1.pdf



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