

## Spring 2014, Topic 3 --

**Does the Value of Offshore Seismic Testing Warrant Its Use in NC?**

BIOL 5680/CRM 7011 Current Topics in Coastal Biology

Instructor: Dr. R.A. Rulifson

Author	Page
Adme, Zaneta	1
Bailey, Taylor (10, 5)	4
Burch, Amber (15, 0)	7
Byrd, Cory (14, 1)	11
Foote, Dustin (10, 5)	14
Green, Olivia (10, 5)	18
Jones, Andrew (10, 5)	21
Quarles, Haley (10,5)	24
Rose, Meganne (14, 1)	27
Sassano, Nina (10, 5)	30
Sharp, Amanda (10, 5)	33
Summerlin, Brandi (10, 5)	37
Tobin, Travis (13, 2)	40
Vu, Adrian (11, 4)	40
Ward, Takeisha (10, 2)	46
Wells, Brenna (12, 3))	48

**Zaneta Adme**

Scales, H. 2014. Atlantic Seismic Tests for Oil: Marine Animals at Risk? National Geographic. Available:

<http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals/>. Accessed: 03/23/2014.

This article reviews an Environmental Impact Statement produced by BOEM which assesses whether seismic testing will have an adverse effect on marine life. The article reviews the sequence of events that have led up to the possibility of seismic testing in the Atlantic. The article also seeks out the opinion of various marine scientists on seismic testing all of which say the testing will be detrimental to marine life. The article outlines

the major species that the EIS says will be moderately harmed which include North Atlantic right whales, humpback whales, dolphins, loggerhead turtles, and some commercial fish species.

Bureau of Ocean Energy Management. 2012. Atlantic Geological and Geophysical (G&G) Activities Programmatic Environmental Impact Statement (PEIS). Available: <http://www.boem.gov/Atlantic-G-G-PEIS/>. Accessed: 03/23/2014.

This is the Bureau of Ocean Energy Management's page for all information related to the production of the EIS for seismic testing in the Atlantic. It not only has links to information for the final draft of the EIS but all preliminary information including the draft EIS, applications received for seismic testing activities, and an EIS schedule.

Greenpeace. 2014. Available: <http://www.greenpeace.org/usa/en/campaigns/oceans/Seismic-Testing-Sonar-Testing/>. Accessed: 03/23/2014.

This is Greenpeace's sight signaling their opposition to the Obama Administration's interest in seismic testing in the Atlantic. Greenpeace believes that the airgun blasts used in seismic testing will be harmful to whales, dolphins, sea turtles, and fish. They also outline the particular impacts of seismic testing on sealife which include hearing loss, loss of habitat, disruptions in spawning, beach strandings, and death. Greenpeace is using this site to gather support for their measures to prevent seismic testing in the Atlantic.

Queram, K. E. 2014. East Coast seismic testing gets endorsement. Sun Journal. Available: <http://www.newbernsj.com/news/local/east-coast-seismic-testing-gets-endorsement-1.289068>. Accessed: 03/23/2014.

This newspaper article reports on BOEM's endorsement of seismic testing in the Atlantic. The article states that endorsement was given in the EIS but does actually permit testing. The author states that the secretary of the Interior has not issued a final decision on the issue but the report is the first step to allowing oil and gas drilling in the Atlantic. The author also speaks with other stakeholders in the issue including conservations that completely oppose seismic testing to local officials that both support and oppose seismic testing.

E360 Digest. 2013. U.S. offshore seismic testing threatens many marine species, study says. Available: [http://e360.yale.edu/digest/us\\_offshore\\_seismic\\_testing\\_threatens\\_many\\_marine\\_species\\_study\\_says/3818/](http://e360.yale.edu/digest/us_offshore_seismic_testing_threatens_many_marine_species_study_says/3818/). Accessed: 03/23/2014.

This article reviews an analysis on seismic testing for the exploration of oil and gas in the Atlantic by the conservation group Oceana. The study says seismic testing could injure or kill nearly 140,000 marine animals, from tiny fish eggs to large whales, annually. The study describes that air gun blasts from seismic testing 100,000 more powerful than a jet engine which could disturb habitats for sealife.

Seismic Airgun Testing. 2012. Oceana. Available: <http://oceana.org/en/our-work/climate-energy/seismic-airgun-testing/overview>. Accessed: 03/23/2014.

This is Oceana's webpage for information related to seismic air gun testing. Oceana is the largest international organization focused solely on ocean conservation. The webpage has

several different sections related to seismic testing which include and overview of the use of seismic airguns and the legislative history of the issue, Oceana's position on the issue, and literature and news on the issue. Oceana seeks to halt the use of seismic airguns and also halt the expansion of offshore drilling into the Atlantic.

Bryce, E. 2012. New York Times. Will seismic blasts upend Atlantic marine life?  
Available: [http://green.blogs.nytimes.com/2012/10/11/will-seismic-blasts-upend-atlantic-marine-life/?\\_php=true&\\_type=blogs&\\_r=0](http://green.blogs.nytimes.com/2012/10/11/will-seismic-blasts-upend-atlantic-marine-life/?_php=true&_type=blogs&_r=0) Accessed: 03/23/2014.

This article attempts to gauge the attitudes of different stakeholders' interested in the debate on seismic test in in the Atlantic. The reporting in the article contends that both environmental and commercial fishing groups both oppose plans to allow seismic testing and plan to protest any finding that advances seismic testing. Both groups site the disruption to the lives of marine mammals and commercial fishes as their main point of opposition.

Daraskevich, J. The Florida Times Union. Seismic testing bad for marine life.  
Available: <http://jacksonville.com/news/crime/2014-02-28/story/sufrider-foundation-seismic-testing-bad-marine-life#ixzz2wv9POTZu> Accessed: 03/23/2014.

The author interviews the Surfrider Foundation to assess their view on seismic testing. The Foundation opposes all seismic testing in the ocean. The Ocean Program Manager for the Surfrider Foundation believes that the only option that makes sense for the marine environment is the option to forbid seismic testing in the Atlantic. They also believe that seismic testing is a deterrent for tourist believing that the disruptions in the life of marine animals will have a detrimental on the economy of coastal cities and towns.

\*Andriguetto-Filho, J. M., Ostrensky, A., Pie, M. R., Silva, U. A., & Boeger, W. A. (2005). Evaluating the impact of seismic prospecting on artisanal shrimp fisheries. *Continental Shelf Research*, 25(14), 1720-1727.

This article examines the use of seismic air guns on shellfish resources. The authors use this study to explicitly assess the effect of seismic methods on shrimp. They measured the yields of bottom trawls for Southern white shrimp, Southern brown shrimp, and the Atlantic. They measured these yields before and after a synchronized air gun blast. The authors find that there was no significant negative impact on these certain species. The authors feel that this suggests that shrimp stock may be resilient to the effects of seismic air gun testing.

\*Wardle, C. S., Carter, T. J., Urquhart, G. G., Johnstone, A. D. F., Ziolkowski, A. M., Hampson, G., & Mackie, D. (2001). Effects of seismic air guns on marine fish. *Continental Shelf Research*, 21(8), 1005-1027.

The authors of this experiment were concerned about the effect of air gun blast on marine fish living on reefs. They collected data on fish and invertebrates before and after synchronized air gun blasts. The authors find that if the air gun was not visible to the fish, most of the fish were only slightly bothered by the air gun blast and actually continued what they were doing before the gun blast. Those fish that could see the explosion turned away and fled the location. They found that the day-to-day behavior of the fish was not altered.

\*Parsons, E. C. M., Dolman, S. J., Jasny, M., Rose, N. A., Simmonds, M. P., & Wright, A. J. (2009). A critique of the UK's JNCC seismic survey guidelines for minimising acoustic disturbance to marine mammals: Best practise?. *Marine Pollution Bulletin*, 58(5), 643-651.

This paper is used to review the Joint Nature Conservation Committee, the United Kingdom's conservation agency, guidelines on ways to minimize acoustic disturbances of marine mammals by seismic air gun testing. These were the first national guidelines developed in the world on the mitigation of noise pollution during seismic testing and have become the standard for most other guidelines on the subject. The authors believe that the guidelines lack scientific basis or proven effectiveness. They also site other problems with the guidelines including difficulty in monitoring certain species, limitations in monitoring and lack of baseline data.

\*Compton, R., Goodwin, L., Handy, R., & Abbott, V. (2008). A critical examination of worldwide guidelines for minimising the disturbance to marine mammals during seismic surveys. *Marine Policy*, 32(3), 255-262.

This article reviews the seismic testing guidelines from different countries including the USA, Canada, Brazil, the United Kingdom. This paper describes the differences and similarities of mitigation measures currently in place, and identifies the deficiencies within them. The authors believe an international standard should be produced with a need for more accurate data. The authors also believe that there should be a greater collaboration between academic institutions and governments on this issue.

\*Dolman, S. J., Weir, C. R., & Jasny, M. (2009). Comparative review of marine mammal guidance implemented during naval exercises. *Marine pollution bulletin*, 58(4), 465-477.

There are three main methods used in the mitigation of impacts on marine mammals due to seismic and sonar exploration in the ocean. They are planning for certain times of the year when marine mammals could be most affected, implementation of a graduated sound level scheme, and monitoring animals to create and exclusion zone around the source of the sound. This article reviews the effectiveness of these measures. The authors also make suggestions on a minimum worldwide standard regarding mitigation during seismic testing.

### **Taylor Bailey**

Bryce, E. 10/11/12. Will Seismic Testing Uphend Atlantic Marine Life?. *New York Times*. <http://green.blogs.nytimes.com/2012/10/11/will-seismic-blasts-upend-atlantic-marine-life/?action=click&module=Search&region=searchResults%230&version=&url=http%3A%2F%2Fquery.nytimes.com%2Fsearch%2Fsitesearch%2F%3Faction%3Dclick%26region%3DMasthead%26pgtype%3DHomepage%26module%3DSearchSubmit%26contentCollection%3DHomepage%26t%3Dqry600%23%2Fseismic+testing> Accessed: 03/18/14.

This article touches on how seismic testing will affect marine life along the Atlantic coast. Seismic testing is expected to occur from Delaware to Florida. This area is home to several endangered species and seismic testing has been related to negative effects on marine mammals due to loud sound levels. Some argue it is even linked to beached whales. The Bureau of Ocean Energy Management has received over 29,000 petitions to

stop seismic testing along the Atlantic coast. If not stopped, seismic testing is expected to hurt both marine mammals and the fishing industry.

Bureau of Ocean Energy Management. No Date. Atlantic Geological and Geophysical (G&G) Activities Programmatic Environmental Impact Statement (PEIS)

<http://www.boem.gov/Atlantic-G-G-PEIS/> Accessed: 03/24/14

This article describes the purpose of seismic testing. It addresses the importance of using seismic testing to study locations and the extent of oils and natural gases in these locations. By partaking in seismic testing states can make better informed business decisions regarding energy sources. This website also includes a picture depicting the area along the Atlantic coast that will be impacted by seismic testing.

\*Chapman, G., J. Richards, and L. Loflin. May 1998. Achieving cost savings through collaborative seismic testing. *Nuclear Engineering and Design*. 181(1-3):235-246.

This article discusses how seismic testing went from being costly to cost saving. Seismic Qualification Reporting and Testing Standardization (SQRSTS) is a program developed to organize and cost efficiently promote seismic testing. The primary data library for this program is held in Charlotte, North Carolina. SQRSTS invests in utility sponsors in order to promote cost efficiency.

Cockerham, S. No Date. Decision Near on Seismic Testing off Carolinas, Va. Coast. Newspaper. Accessed: January 2014.

This article describes the seismic testing that is expected to occur off the coast of the Carolinas and Virginia. It is estimated that there is roughly 3.3 billion barrels of oil and 31.28 trillion cubic feet of natural gas. Although these numbers sound enticing the article also addresses the harmful effects that seismic testing is known to have on marine mammals.

\*Compton, R., L. Goodwin, R. Handy, and V. Abbott. May 2008. A critical examination of worldwide guidelines for minimizing the disturbance to marine mammals during seismic surveys. *Marine Policy*. 32(3):255-262.

This article discusses the harms of seismic testing on marine animals, specifically mammals. It goes into the current use of seismic testing in various nations and the guidelines that are currently set. It compares and contrasts the similarities and differences among the nations, elaborating on what works and what does not. It makes recommendations regarding standard international guidelines in order to benefit both the geophysical exploration industry and the conservation community.

GreenPeace. 09/11/03. The Dangers of Seismic Testing.

<http://www.greenpeace.org/usa/en/news-and-blogs/news/the-dangers-of-seismic-testing/>

Accessed: 03/20/14.

This article describes what seismic testing is and how it affects marine animals. It elaborates on specific locations of testing in the U.S. and suggests alternatives for the U.S. government to look into. It also lists several negatively impacting facts about seismic testing that pinpoint and give examples of the dangers regarding this issue.

Heimer, T. 04/14/09. The True Cost of Seismic Surveys.

[http://switchboard.nrdc.org/blogs/tkiekow/the\\_true\\_cost\\_of\\_seismic\\_surve.html](http://switchboard.nrdc.org/blogs/tkiekow/the_true_cost_of_seismic_surve.html)

Accessed: 03/23/14.

This website briefly touches on the financial cost of seismic test and then proceeds to elaborate on the cost of life due to seismic testing. It focuses on the harmful effects to marine mammals, especially endangered species. It also makes suggestions regarding regulations and how to proceed in a way that will not negatively impacts wildlife.

Morris, R. 03/03/14. Opinions Split on Offshore Seismic Testing. North Carolina Coastal Federation. <http://nccoast.org/Article.aspx?k=ec1bd237-d802-4f3e-802d-c50ff2cbbc58>

Accessed: 03/23/14.

This article touches on the various opinions regarding seismic testing in North Carolina. Those in favor of it are enthused by the number of jobs projected to be created and the amount of money that the state will bring in each year. However, those opposed worry about the negative effects that seismic testing will have on marine mammals located off the shore of North Carolina.

\*Parsons, E.C.M., S. Dolman, M. Jasny, N. Rose, M. Simmonds, and A. Wright. May 2009. A critique of the UK's JNCC seismic survey guidelines for minimising acoustic disturbance to marine mammals: Best practice?. *Marine Pollution Bulletin*. 58(5):643-651.

This article discusses the techniques used by the United Kingdom during seismic testing. It is regarded as a safer way to complete seismic testing while minimizing the negative effects on marine life. This information can be used to help set guidelines for seismic testing in the United States along the North Carolina coast.

Stephen, R. 1998. Ocean Seismic Network Seafloor Observatories. *Oceanus*. 41(1):33-37.

This article describes the ideas and reasoning behind seismic testing. It elaborates on the process and the location information regarding seismic tested sites in the late 90s. It further discusses the Ocean Seismic Network Pilot Experiment, which was created to make broadband seismic measurement in order to further research by the Global Seismic Network in regards to ocean basins. Along with this it discusses future plans for testing and other projects.

Sturgis, S. 03/03/14. The growing fight against oil and gas exploration off the NC coast. Institute for Southern Studies. <http://www.southernstudies.org/2014/03/the-growing-fight-against-oil-and-gas-exploration-.html> Accessed: 03/24/14

This article addresses Pat McCrory's support for seismic testing off the coast of North Carolina. It also addresses how this could cause more than just problem for marine mammals. Tourism around the coast of North Carolina along with commercial fishing could also face negative effects from seismic testing. Many conservationist and other concerned citizens have wrote letters to President Obama addressing their concerns.

U.S. Energy Information Administration. 02/28/14. Natural Gas Prices.

[http://www.eia.gov/dnav/ng/ng\\_pri\\_sum\\_gv`dcu\\_snc\\_m.htm](http://www.eia.gov/dnav/ng/ng_pri_sum_gv`dcu_snc_m.htm) Accessed: 03/23/13

This website gives the prices for natural gas in North Carolina in 2013. It lists the prices by month and by use. This information can be valuable when discussing the costs of seismic testing in terms of financial price of natural gasses. These numbers can be compared economically versus the cost of life.

U.S. Fish and Wildlife Service. 12/10/13. Endangered and Threatened Species of North Carolina. [http://www.fws.gov/raleigh/es\\_tes.html](http://www.fws.gov/raleigh/es_tes.html) Accessed: 03/18/14.

This website give a brief synopsis of the Endangered Species Act of 1973 and local programs implemented to help protect endangered species. It also list all of North Carolina's threated or endangered animals. This information will be helpful when determining which marine animals are most at risk of endangerment from seismic testing and can be used as a reference for further research into specific species migration and mating patterns.

\*Wardle, C.S., T.J. Carter, G.G. Urquhart, A.D.F. Johnstone, A.M. Ziolkowski, G. Hampson, and D. Mackie. May-June 2001. Effects of seismic air guns on marine fish. *Continental Shelf Research*. 21(8-10):1005-1027.

This article briefly discusses the various types of high energy sound sources used in seismic testing and the negative effects it has had on marine mammals. In this study, researchers focus on the effects of fish. Scientists tagged and group of fish and then monitored these fish in order to test the effects of air guns used in seismic testing. This studied showed that in-shore and reef species often were not concerned with the sounds and continues with their normal routine. However, in open sea experiments, commercial fish often responded directionally based on the sound of the gun fire.

Wines, M. 02/27/14. U.S. Moves Toward Atlantic Oil Exploration, Stirring Debate Over Sea Life. *New York Times*. [http://www.nytimes.com/2014/02/28/us/us-moves-toward-atlantic-oil-exploration-stirring-debate-over-sea-life.html?action=click&module=Search&region=searchResults%230&version=&url=http%3A%2F%2Fquery.nytimes.com%2Fsearch%2Fsite%2F%3Faction%3Dclick%26region%3DMasthead%26pgtype%3DHomepage%26module%3DSearchSubmit%26contentCollection%3DHomepage%26t%3Dqry600%23%2Fseismic+testing&\\_r=0](http://www.nytimes.com/2014/02/28/us/us-moves-toward-atlantic-oil-exploration-stirring-debate-over-sea-life.html?action=click&module=Search&region=searchResults%230&version=&url=http%3A%2F%2Fquery.nytimes.com%2Fsearch%2Fsite%2F%3Faction%3Dclick%26region%3DMasthead%26pgtype%3DHomepage%26module%3DSearchSubmit%26contentCollection%3DHomepage%26t%3Dqry600%23%2Fseismic+testing&_r=0) Accessed: 03/18/14

This article describes the conflict over seismic testing. Although supporters argue that seismic testing is beneficial because it will create jobs and generate revenue, those opposed argue that the effect on marine animals outweighs this. Seismic testing will affect ocean life along the entire Atlantic coast. Several endangered species live along this area and will be most affected. This article explores both sides of these two arguments.

### **Amber Burch**

\*Alemagi, D. September 2007. The oil industry along the Atlantic coast of Cameroon: assessing impacts and possible solutions. *Resources Policy* 32: 135-145. Available from: <http://www.sciencedirect.com.jproxy.lib.ecu.edu/science/article/pii/S0301420707000578>. Accessed: 03/20/2014.

This study looks at how the oil industry has affected the coast of Cameroon in the Atlantic in relation to environmental impacts. Although the oil industry has provided Cameroonians with income and made significant contributions to the national government in revenue and foreign exchange earnings, it has also increased pollution in the coastal ecosystems.

Bryce, E. October 11, 2012. Will Seismic Blasts Upend Atlantic Marine Life. The New York Times. Available from: [http://green.blogs.nytimes.com/2012/10/11/will-seismic-blasts-upend-atlantic-marine-life/?\\_php=true&\\_type=blogs&action=click&module=Search&region=searchResults%230&version=&url=http%3A%2F%2Fquery.nytimes.com%2Fsearch%2Fsite%2F%3Dfaction%3Dclick%26region%3DMasthead%26pgtype%3Dhomepage%26module%3DsearchSubmit%26contentCollection%3Dhomepage%26t%3Dqry90%23%2Fseismic+testing+north+carolina&\\_r=0](http://green.blogs.nytimes.com/2012/10/11/will-seismic-blasts-upend-atlantic-marine-life/?_php=true&_type=blogs&action=click&module=Search&region=searchResults%230&version=&url=http%3A%2F%2Fquery.nytimes.com%2Fsearch%2Fsite%2F%3Dfaction%3Dclick%26region%3DMasthead%26pgtype%3Dhomepage%26module%3DsearchSubmit%26contentCollection%3Dhomepage%26t%3Dqry90%23%2Fseismic+testing+north+carolina&_r=0). Accessed: 03/23/2014.

This article from the New York Times discusses why environmental and fishing groups are opposed to offshore testing because of seismic blasts. It is stated that if the Bureau of Ocean Energy Management determines that the risks to wildlife are too great, the testing will not be carried out.

Butler, D. January 15, 2014. Ottawa commissions study to find out what impact seismic testing for oil and natural gas has on endangered species. The Vancouver Sun. Available from: <http://www.vancouversun.com/technology/Whale+Music/9389017/story.html>. Accessed: 03/20/2014.

This article discusses the potential impacts of seismic testing from oil companies of the coast of Nova Scotia. It mentions that the federal Department of Fisheries and Oceans plans to find more information on the effects seismic surveys have on endangered whale populations.

\*Cicin-Sain, B. and A. Tiddens. 1989. Private and public approaches to solving oil/fishing conflicts offshore California. *Managing Marine Conflicts* 12: 233-251. Available from: <http://www.sciencedirect.com.jproxy.lib.ecu.edu/science/article/pii/0951831289900052?via=ihub>. Accessed: 03/20/2014

This study looks at the impacts of oil operations on the commercial fishing industry in the south-central coast of California.

\*Handegard, N.O., T.V. Tronstad, and J.M. Hovem. June 5, 2013. Evaluating the effect of seismic surveys on fish—the efficacy of different exposure metrics to explain disturbance. *Canadian Journal of Fisheries and Aquatic Sciences* 70: 1271-1277. Available from: <http://www.nrcresearchpress.com.jproxy.lib.ecu.edu/doi/abs/10.1139/cjfas-2012-0465#.Uy8KXyiWW0s>. Accessed: 03/23/2014.

This study was made to assess the potential disturbance affects on fish that are caused by seismic air-gun surveys by using different metrics to characterize the exposures from these surveys. The different metrics include the number of emissions by area and time and also the accumulated sound exposure levels.

Lee, D.S. March 15, 2014. Oil exploration off NC coast would present a whale of a problem. NewsObserver.com. Available from: <http://www.newsobserver.com/2014/03/15/3702364/oil-exploration-off-nc-coast-would.html>. Accessed: 03/20/2014.

This article discusses how important hearing is for whales and porpoises and how seismic testing will ultimately affect these marine mammals. It mentions that the speed of sound is four times greater in water than in air, which is how whales communicate to other whales for locate food. With seismic testing, their hearing could be impaired or even entirely lost, which will cause these mammals to be unable to maintain their current social cues for survival.

\*Liu, H., Y. Hu, Y. Yanxin, L. Wang, S. Tong, and H. Ma. September 2013. Shallow water body data processing based on the seismic oceanography. Journal of Ocean University of China 12: 319-326. Available from: <http://link.springer.com.jproxy.lib.ecu.edu/article/10.1007%2Fs11802-013-2100-5>. Accessed: 03/20/2014.

This study shows a new approach to improving ways to suppress the noise that is caused by shallow sea water disturbance. According to this study, this particular study has the potential value to applications such as 3D sea water monitoring, engineering evaluation, geological disaster assessment and environmental assessment.

Longstreet, A. March 2, 2014. Seismic Blasts in Atlantic Ocean Threaten 138,000 Marine Animals. Liberty Voice. Available from: <http://guardianlv.com/2014/03/seismic-blasts-in-atlantic-ocean-threaten-138000-marine-animals/>. Accessed: 03/20/2014.

These articles bring to surface that with seismic blasts and oil drilling in the Atlantic Ocean, 138,000 marine animals will be threatened. It says that the Atlantic oil drilling is to being in 2017 after it has already been delayed since 2011. Biologists say that migration and feeding patterns of over 13.6 million animals could be compromised and the intensity of the seismic blasts could cause hearing impairments to marine life.

Morris, R. March 1, 2014. Opinions still split after study on offshore seismic testing. The Outer Banks Voice. Available from: <http://outerbanksvoice.com/2014/03/01/mccrory-praises-disputed-review-on-offshore-energy-testing/>. Accessed: 03/20/2014.

This article discusses the new environmental review. It says that a NC State University study estimates that exploring energy off the coast would make 1,122 jobs and \$181 million every year for the state during the first 7 years. Although it is reference that the seismic gun blasts will be “disruptive, destructive and directly threaten the survival of marine creatures”, McCrory says that the study also include safeguards for marine life.

National Geographic. No Date. Drifting in Static. NationalGeographic.com Available from: <http://ngm.nationalgeographic.com/2011/01/big-idea/noisy-ocean>. Accessed: 03/20/2014.

This article discusses how man-made noises drown out the sounds that marine animals use to find food, mates, avoid predators, and communicate in general with one another. Navy vessels are one threat to marine life by testing submarine-hunting sonar systems, but oil company ships that use air guns to fire continuously can be heard under water from hundreds of miles away.

Oceana. No Date. Seismic Airgun Testing: Overview. Oceana.com. Available from: <http://oceana.org/en/our-work/climate-energy/seismic-airgun-testing/overview>. Accessed: 03/23/2014.

This overview of seismic airgun testing on Oceana’s website gives detail on what seismic airguns are, and also the problems that they tend to cause for marine life. Not only does airgun blasts damage the hearing of whales, but they also kill fish eggs and larvae, and scare away fish from important habitats.

\*Popper, A.N., J. Fewtrell, M.E. Smith, and R.D. McCauley. December 1, 2003. Anthropogenic sound: effects on the behavior and physiology of fishes. Marine Technology Society Journal 37: 35-40. Available from: <http://www.ingentaconnect.com.jproxy.lib.ecu.edu/content/mts/mts/2003/00000037/00000004/art00004>. Accessed: 03/20/2014.

This study looks at how anthropogenic sounds in the ocean not only affect the hearing of marine mammals, but the hearing receptors of fishes and marine invertebrates as well.

Scales, H. February 28, 2014. Atlantic Seismic Tests for Oil: Marine Animals at Risk. National Geographic. Available from: <http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals/>. Accessed: 03/20/2014.

This article discusses the final Environmental Impact Statement by the U.S. Department of Interior’s Bureau of Ocean Energy Management and how it outlines the measures to minimize the impact on wildlife from intense sound impulses.

Than, K. May 3, 2011. Giant Squid Killed by Sound. National Geographic. Available from: <http://news.nationalgeographic.com/news/2011/05/110503-giant-squid-octopus-sonar-acoustic-tests-science-whales-sound/>. Accessed: 03/20/2014.

This article discusses a study that shows that sounds from human activities can affect squid and other cephalopods—not just marine mammals. This was determined by studying the remains of a giant squid that was found off of Spain soon after ships had used air guns.

Than, K. January 21, 2014. Study: Planning Can Protect Whales in Seismic Surveys. National Geographic. Available from: <http://news.nationalgeographic.com/news/energy/2014/01/140121-protecting-whales-seismic-energy-surveys-study/>. Accessed: 03/20/2014.

This article discusses a new study that could be a go-to document for people who do seismic surveys so they can minimize the risks to wildlife by oceanographer, Doug Nowacek at Duke.

### **Cory Byrd**

Alaska Marine Conservation Council. No date. Impacts of Seismic Surveys on Marine Mammals and Fish. Available: [http://www.akmarine.org/our-work/protect-bristol-bay/Impacts\\_of\\_Seismic\\_Surveys\\_AMCC.pdf](http://www.akmarine.org/our-work/protect-bristol-bay/Impacts_of_Seismic_Surveys_AMCC.pdf) Accessed: (3/24/2014).

This is information pdf file by the Alaska Marine Conservation Council that helps outline what seismic surveys are, the impacts they can have on marine mammals and fish. It also talks about how seismic surveys impact fishing and shows the reduction of fish catches by using a chart.

Australian Government, Department of the Environment. No date. Sonar and Seismic Impacts. Available: <http://www.environment.gov.au/node/18410> Accessed: (3/24/2014).

This website by the Department of the Environment of Australia talks about all the different kinds of sonar that can be used. It talks about the three different types of military sonar, and the differences of passive sonar and active sonar. The end of the web page talks about seismic surveys and has a pdf file about the seismic guidelines that are required for offshore seismic exploration.

\*Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M.P., Swift, R., & Thompson, D. 2003. A Review of the Effects of Seismic Surveys on Marine Mammals. Marine Technology Society. 37(4): 16-34.

This is a review that highlights significant gaps in our knowledge of the effects of seismic air gun noise on marine mammals. This article outlines and investigates the characteristics of the seismic signal at different ranges and depths and at higher frequencies. Because of the insufficient amount of data it is believed that these seismic surveys can be associated with many biological factors including physical/physiological effects, behavioral disruption, and indirect effects

associated with altered prey availability. This article addresses all of those through extensive testing.

\*Hirst, A.N., & RodHouse, P.G. 2000. Impacts of geophysical seismic surveying on fishing success. *Reviews in Fish Biology and Fisheries*. 10(1): 113-118.

In the review the author's goal is to review the close range effects on airgun surveys to the success rate of a catch. The author also talks about how different factors can have different effects of the catch success rate. This review concentrates on fish that swim in the water column, also crustacean and mollusks.

Lee, D.S. March 15, 2014. Oil Exploration off Coast Would Present a Whale of a Problem. NCspin.com. Available: <http://www.ncspin.com/2014/03/17/oil-exploration-off-nc-coast-would-present-a-whale-of-a-problem/> Accessed: (3/24/2014).

This is an article addressing the problem that offshore seismic testing would have on 26 species of marine mammals. These species include whales, porpoises, and dolphins, which use the waters off of North Carolina as breeding grounds, migration pathways, and homes in local habitats.

\*McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., & McCabe, K. 2000. Marine Seismic Surveys- A Study of Environmental Implications. *APPEA Journal*. 40, 692-708.

This article is about a study done of Australia to help understand the characterization of airgun signals and model airgun array sources, and developed an 'exposure model' to predict the scale of potential biological effects for a given seismic survey over its duration. They also set out to make observations of humpback whales traversing a 3D seismic survey, and carry out experiments on the approaching humpback whales with a single air gun. They also carried out experiments on sea turtles, fishes, and squid.

Murawski, J. Nov. 18, 2013. Seismic Testing to get Underway in Lee County as Energy Developers Assess NC's Shale Gas Potential. Newsobserver.com. Available: <http://www.newsobserver.com/2013/11/18/3385057/seismic-testing-to-get-underway.html> Accessed: (3/24/2014).

This article talks about how North Carolina is a low priority which means that North Carolina only has a small amount of natural gas offshore. Then it gives a section of how they would have to go about finding the old and removing it from the ground.

\*Parry, G.D., & Gason, A. 2006. The Effect of Seismic Surveys on Catch Rates of Rock Lobsters in Western Victoria, Australia. *Fisheries Research*. 79(3): 272-284.

This study was done to show the effects of seismic discharges on rock lobsters was investigated through statistical analysis of the coincidence between seismic surveys and changes in commercial catch rates in western Victoria between 1978 and 2004. This was done in 12 depth-stratified regions, the number of acoustic pulses during a seismic survey were calculated and then they would examine the number of rock lobster caught that year.

\*Popper, A.N., Smith, M.E., Cott, P.A., Hanna, B.W., MacGillivray, A.O., Austin, M.E., & Mann, D.A. 2005. Effects of Exposure to Seismic Airgun Use on Hearing of Three Fish Species. *The Journal of the Acoustical Society of America*. 117(6): 3958-3971.

This study was done on the harmful effects of seismic airguns on three species of fish in Mackenzie River Delta. The three fish the study was on were the northern pike (*Esox Lucius*), broad whitefish (*Coregonus nasus*), and lake chub (*Couesius plumbeus*). Fish were placed in cages in the 1.9 m of water and exposed to five or 20 airgun shots, while controls were placed in the same cage but without airgun exposure. The fish were then examined using the auditory brainstem response (ABR) to see the effects on both the exposed and controlled fish.

Queram, K.E. March 9, 2014. East Coast Seismic Testing gets Endorsement. *Starnewsonline.com*. Available:

<http://www.starnewsonline.com/article/20140309/ARTICLES/140309722?p=1&tc=pg>  
Accessed (3/24/2014).

This news article talks about what exactly seismic testing is, it also talks about how North Carolina is approving to allow seismic testing in the Atlantic. It also talks about how the people of the coast of North Carolina are opposing this.

Shutak, M. March 21, 2014. N.C. Panel Looks at Revenue. *Carteret County News-Times* online. Available: [http://www.carolinacoastonline.com/news\\_times/article\\_f26d3306-b107-11e3-8e6c-001a4bcf887a.html](http://www.carolinacoastonline.com/news_times/article_f26d3306-b107-11e3-8e6c-001a4bcf887a.html) Accessed: (3/24/2014).

This news article talks about how the N.C. Energy Policy Council wants to make sure that if offshore seismic exploration finds oil or gas off North Carolina's coast, the current administration wants to ensure there's revenue sharing with coastal communities. This article also talks about how governor Pat McCrory's administration will make sure coastal communities will get their fair share of potential revenue from offshore energy.

\*Slotte, A., Hansen, K., Dalen, J., & Ona, E. 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): 143-150.

This article was written from research done in April 1999, where scientists tested the possible influence of this seismic activity on pelagic fish (herring, blue whiting and mesopelagic species) by the use of two different methods. The first tests was to see the distribution and abundance within the seismic area and the surrounding waters up to 30–50 km away and were mapped acoustically three times. Secondly, the acoustic abundance was recorded directly prior to and after shooting along some of the seismic transects.

\*Stoneley, R. 1995. *An Introduction to Petroleum Exploration for Non-Geologists*. Oxford University Press, Oxford, United Kingdom. Print.

This book outlines key topics dealing with the occurrence of petroleum, exploration methods to find petroleum, an outline of reservoir geology, and a case study showing an example of all these methods used in the North Sea. This book is straight forward and would be helpful with the introduction of the white paper.

Talton, T. 1/21/2014. Testing for Offshore Drilling Sets Off Debate. NCCoast.org. Available: <http://www.nccoast.org/m/article.aspx?k=e47a2c31-a84b-4f13-a877-77ffa7ebe5f3> Accessed: (3/24/2014).

This is an article online that addresses where and what methods could be used to do the seismic testing of the coast of North Carolina. The author also outlines the potential acoustic effects on the wildlife and states that most of the effects to marine mammals “are expected to be avoided by mitigation.” Then next sections talks about the economic benefit of offshore drilling in the Atlantic could generate upwards of 280000 jobs and contribute up to \$23.5 billion towards the U.S. economy each year. The last section she talks about the controversy in Kure Beach which has the locals to Kure Beach’s opinions and thoughts.

U.S. Department of the Interior, Bureau of Ocean Energy Management. 2012. Atlantic OCS, Proposed Geological and Geophysical Activities, Mid- Atlantic and South Atlantic Planning Areas: Biological Assessment. Available: [http://www.boem.gov/uploadedFiles/BOEM/Oil\\_and\\_Gas\\_Energy\\_Program/GOMR/Biological\\_Assessment\\_finalforwebposting\\_wcover\\_5-24-12.pdf](http://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/GOMR/Biological_Assessment_finalforwebposting_wcover_5-24-12.pdf) Accessed (3/24/2014).

This is the Bureau of Ocean Energy Managements biological assessment for seismic testing to look for offshore oil. This pdf file outlines every species, habitat and side effect that could happen while testing for offshore oil. It also outlines the vessel travel and noise and trash, debris, and effects of an accidental oil spill.

### **Dustin Foote**

Boniti, L. 03/04/2014. Seismic Testing May Soon Happen off of NC Coasts. TWC News. <http://triadnc.twcnews.com/content/news/705340/seismic-testing-may-soon-happen-off-of-nc-coasts#sthash.yVcVSYis.dpuf>. Accessed 03/20/14

North Carolina is requested more information after the US Department of the Interior pushed for some seismic testing to map potential oil and natural gas fields on the Atlantic coast. North Carolina lawmakers are concerned about environmental effects of sound pollution on marine wildlife. A compact is being considered to unite states across the Atlantic in an effort to work with the federal government on developing a coast wide agreement on offshore testing.

\*Dutta, N., and D. Schlumberger. 2009. Exploration for gas hydrates in marine environment using seismic inversion and rock physic principles. *The Leading Edge* 2009: 792-802.

Seismic testing is carried out to look for oil and gas reserves under the ocean floor. This paper scientifically discusses how seismic testing works, going into detail how the images are composed from seismic data. This particular paper is examining gas hydrates by remote sending tools such as seismic testing and EM. While this is a different energy source then discussed in class, the methods they discuss are pertinent.

\*Goldbogen, J. A., B. Southall, S. L. DeRuiter, J. Calambokidis, A. S. Friedlaender, E. L. Hazen, E. A. Falcone, G. S. Schorr, A. Douglas, D. J. Moretti, C. Kyburg, M. F. McKenna, and P. L. Tyack. 2013. Blue whales respond to simulated mid-frequency military sonar. *Proceedings of the Royal Society* 280: 2-8.

Sonar has been associated with toothed whale strandings, but baleen whale species and the consequences are not understood. This study used tagged blue whales to examine the 1-10kHz sonar. The researchers found that even with these low frequencies, the sound significantly affected whale behavior primarily deep feeding and movement away from the sound source.

\*Hastie, G. D., C. Donovan, T. Gotz, and V. M. Janik. 2014. Behavioral responses by grey seals (*Halichoerus grypus*) to high frequency sonar. *Marine Pollution Bulletin* 79: 205-210.

Many marine mammals use sound to navigate, hunt, and communicate and people fear that high frequency sonar will disrupt these activities. This study looked at seal activity during 200 and 375 kHz. Both frequencies significantly changed seal behavior, with the higher frequencies causing seals to leave the water.

Kuhl, J. 02/07/14. Bubble Curtains: Can They Dampen Offshore Energy Sound for Whales? *National Geographic*.  
<http://news.nationalgeographic.com/news/energy/2012/02/120207-bubble-curtains-to-protect-whales/>. Accessed 03/20/14

Coastal oil and wind power companies are looking into a means of lessening the impact of sound on marine mammals known as bubble curtains. This technique proved successful in underwater bridge building, energy firms are testing the benefits of surrounding their operations with walls of bubbles that dampen the noise waves. However, the sound created by seismic testing is an even, constant noise, different from the staccato bursts emitted by driving piles. Construction projects are usually stationary as well, allowing for bubble curtains to be put up around the exterior. Dragging bubble curtains behind seismic testing ships would prove challenging.

\*Kumar, A., J. Nissen, J. Bell, and M. Shoemaker. 2012. Using Passive Acoustics to Monitor the Presence of Marine Mammals During Naval Exercises. *Advances in Experimental Medicine and Biology* 730: 641-643.

Seismic testing is sometimes discussed along side naval sonar ranges, with both having suspected harmful effects on marine life. In this study, The US Navy collected data on the presence of marine mammals in during a Navy exercises involving sonar. Five bottom-mounted passive acoustic recorders were set up in

Onslow Bay and recorded both pilot and sperm whales. This study could be important in monitoring for marine life prior to seismic testing, a safety method that many are arguing for.

McCrorry, P. 02/28/14. Governor Pat McCrorry Applauds Movement Toward Offshore Seismic Testing for Oil and Gas. Governor Pat McCrorry: Ethics and Accountability. <http://www.governor.state.nc.us/newsroom/press-releases/20140228/governor-pat-mccrorry-applauds-movement-toward-offshore-seismic#sthash.QraiUtT3.dpuf>. Accessed 03/20/14

Governor McCrorry is for seismic testing off of the coast of North Carolina. “We have the technology and the environmental expertise to responsibly explore the oil, gas and wind resources off our coast.” His sources estimate over 1,122 jobs and \$181 million in annual income for the state during the first seven years of production. Over 30 years his sources calculated \$1.9 billion in annual income during which 16,910 jobs would be created. Some environmental restrictions such as a pause in testing during whale migrations could be implemented to minimize the impact of seismic testing on marine life.

Murawski, J. 11/18/2013. Seismic testing to get underway in Lee County as energy developers assess NC’s shale gas potential. News and Observer.com. <http://www.newsobserver.com/2013/11/18/3385057/seismic-testing-to-get-underway.html#storylink=cpy>. Accessed 03/20/2014

Seismic testing is not always carried out but companies that develop the resource. In this article from the News and Observer, companies who performed inland seismic testing end up not developing North Carolina’s derricks and wellheads but instead plan on selling their seismic data to the highest bidder in the oil-and-gas industry. Despite having known geology that is not conducive to oil and gas, NC has decided to test for inland oil reserves.

Queram, K. 01/27/14. Kure Beach mayor sees backlash for seismic testing support. Star News Online, Wilmington. <http://www.starnewsonline.com/article/20140127/ARTICLES/140129695>. Accessed 03/20/14

The federal Bureau of Ocean Energy Management held public hearings on seismic testing in Wilmington last year, but never released an environmental impact statement. Kure Beach mayor’s letter of support for testing was pushed by the Energy Forum, a lobbying group backed by the American Petroleum Institute. In a January hearing, Kure Beach showed publicly they do not support their Mayor’s decision. The Mayor said he signed the letter to generate revenue for the town and provide beach nourishment.

Queram, K. 02/28/14. Carolina Beach officials united in opposition of seismic testing. Star News Online, Wilmington.

<http://www.starnewsonline.com/article/20140228/ARTICLES/140229615>. Accessed 03/20/14

Carolina Beach officials are in opposition of the Obama Administration's endorsement of opening the Atlantic Coast to seismic testing, noting that it would require oil and gas companies to follow environmental standards to protect marine life. The frequency, volume, areas for seismic testing, and the potential threat to marine life are all key issues for the opposition. The endangered North Atlantic Right Whale is also of concern, as the Atlantic coast is an important migratory route.

\*Robinson, P., P. D. Theobald, and P. A. Lepper. No Date. The noise radiated by marine piling for the construction of offshore wind farms. Loughborough University Press. Accessed 03/20/14

Marine piling is another source of sound pollution that is common in the construction of offshore wind farms and oilrigs. The construction consists of steel piles driven into the ocean floor by hydraulic hammers. Each pile needs to be hit hundreds of times and is a source of high-amplitude repetitive sounds. This study exams methods for measuring the sound produced by marine piling.

Scales, H. 02/28/14. Atlantic Seismic Tests for Oil: Marine Animals at Risk? National Geographic.

<http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals/>. Accessed 03/20/14

The EIS predicts that there would be minor to negligible impact on most wildlife, with the exception of moderate impacts on marine mammals and turtles. The review estimates that about 138,000 marine animals could be injured in some way, and 13.6 million could have their migration, feeding, or other behavioral patterns disrupted by the seismic surveys. Species of concern are the Right Whale, Humpback Whale, Loggerhead Turtle, Commercial fish populations, and dolphins. In an effort to work with environmental groups, testers are proposing seasonal timelines of when testing can and cannot be done to reduce impacts on these species.

\*Sebastianutto, L., M. Picciulin, M. Costantini, and E. A. Ferrero. 04/19/14. How boat noise affects an ecologically crucial behavior: the case of territoriality in *Gobius cruentatus* (Gobiidae). *Environ Biology Fish* 92: 207-215.

Seismic testing is type of underwater sound pollution that has unknown effects on fish species. In this study, the effect of boat noise on goby territoriality is studied. Sound production is important for territorial defense in gobies. The study found that boat noise diminished the ability of the resident gobies to maintain territories and disrupted their breeding. Seismic testing produces louder sounds that could further disrupt gobies and lead to territory abandonment.

Talton, T. 01/21/14. Testing for Offshore Drilling Sets Off Debate. North Carolina Coastal Federation. <http://www.nccoast.org/m/article.aspx?k=e47a2c31-a84b-4f13-a877-77ffa7ebe5f3>. Accessed 03/20/14

December 2013, Kure Beach Mayor Dean Lambeth signed a letter approving seismic testing for oil and gas off the North Carolina coast. Environmental groups and pro-testing groups have met to discuss the pros and cons because of the mayors endorsement. According to a December 2013 report by the American Petroleum Institute, offshore oil and natural gas development in the Atlantic could generate upwards of 280,000 jobs and generate \$23.5 billion. Environmental groups are concerned about the effect seismic testing has on marine wildlife.

The Associated Press. 03/01/14. Carolina Beach Town Council approves resolution opposing seismic testing off the NC coast. The Republic, Indian. <http://www.therepublic.com/w/NC--Seismic-Testing>. Accessed 03/20/14

The Carolina Beach Town Council voted no to seismic testing for oil and gas after the federal Bureau of Ocean Energy and Management endorsed testing. The bureau said they would require oil and gas companies to follow strict environmental laws. Conservationists are concerned that the air guns creating sound waves will disrupt migrating and resident North Atlantic right whales, loggerhead sea turtles and other species.

### **Olivia Green**

Carnevale, C. February 19, 2014. Local Business Owners Say Offshore Drilling is bad for Business. Cleanenergy.org. <http://blog.cleanenergy.org/2014/02/19/local-biz-owners-say-offshore-drilling-is-bad-for-business/>. Accessed 3/22/14.

The coastal business owners in coastal North Carolina made themselves heard in a letter to be Obama administration, after McCrory's push for opening the Atlantic coast to offshore oil and energy exploration. The letter states that the 25,000 jobs and \$2 billion dollars from tourism and recreation, and the \$336 million brought in by the commercial fisherman depend heavily on a healthy offshore environment. "As coastal business owners, we believe that the governors push for offshore exploration is misguided and presents significant risks to our economy.

\*Erbe, C. April 2002. Underwater noise of whale-watching boats and potential effects on killer whales (*Orkinus Orca*), based on an acoustic impact model. Marine Mammal Science. Volume 18: pg 394-418. Accessed 3/23/14.

A software sound propagation and impact assessment model was applied to estimate zones around whale-watching boats where boat noise was audible to killer whales, where it interfered with their communication, where it caused behavioral avoidance, and where it possibly caused hearing loss.

Huelsenbeck, M. & C. Wood. April 2013. A Deaf Whale is a Dead Whale: Seismic Airgun Testing for Oil and Gas Threatens Marine Life and Coastal Economics. Seismic Air Gun Testing Report: Oceana.  
[http://fish101.community.uaf.edu/files/2013/05/Seismic\\_Airgun\\_Testing\\_Report\\_FINAL.pdf](http://fish101.community.uaf.edu/files/2013/05/Seismic_Airgun_Testing_Report_FINAL.pdf). Accessed 3/22/14.

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.

Lee, D. March 15, 2014. Oil exploration off NC coast would present a whale of a problem. NC SPIN. <http://www.ncspin.com/2014/03/17/oil-exploration-off-nc-coast-would-present-a-whale-of-a-problem/>. Accessed 3/23/14.

The government has stated that the exploration will be conducted in regions that the sea mammals do not usually reside. However since noise can travel much faster in water than in air, and even the lowest frequencies can be detected underwater several hundred miles away, it doesn't matter where they do it, it will cause harm to the 26 species of whales that reside in North Carolina. Several of those species are listed as endangered species.

McCrorry, P. February 28, 2014. Governor Pat McCrorry Applauds Movement Toward Offshore Seismic Testing for Oil and Gas.  
<http://www.governor.state.nc.us/newsroom/press-releases/20140228/governor-pat-mccrorry-applauds-movement-toward-offshore-seismic>. Accessed 3/22/14.

Governor Pat McCrorry, chair of the Outer Continental Shelf (OCS) Governors Coalition, issued the following statement after the U.S. department of interior released its review that could allow seismic testing firms to submit permit applications to the department to map the potential oil and natural gas fields in the mid-south Atlantic: "this decision is the right step toward more jobs for North Carolina, particularly in our rural areas near the coast. We have the technology and the environmental expertise to responsibly explore the oil, gas and wind resources off of our coast. It's time that the states be allowed to get off the sidelines and start producing jobs and energy for our economy." In 2013, Dr. Mike Walden of NC State estimated that offshore exploration could produce 1,122 jobs and \$181 million in annual income for the state during the first seven years of production.

\*Popper, A. January 9, 2011. Effects of Anthropogenic Sounds on Fishes. Fisheries. Volume 28: pgs 24-31. Accessed 3/23/14.

There is increasing concern regarding the effect of human-generated (anthropogenic) sounds on marine organisms. While most concern is focused on marine mammals, many

of the lower frequency (under 1,000 Hz) sounds are also likely to affect fish. Limited data suggest that short- or long-term exposure to loud sounds may alter behavior, and also result in temporary or permanent loss of hearing.

McLamb, E. September 6, 2011. Fossil Fuels vs Renewable Energy Resources. Ecology.com. <http://www.ecology.com/2011/09/06/fossil-fuels-vs-renewable-energy-resources/>. Accessed 3/23/14.

We currently use a non-renewable source for fuel. Perhaps it's time to invest more research in solar energy. Solar energy is a renewable source. It's already being used today for energy to fun heating systems and other things.

Murawski, J. October 9, 2013. Opening Atlantic Ocean to offshore drilling likely. Both Obama's and Romney's policies move option closer. <http://www.trianglejobs.com/2012/10/02/4244/opening-atlantic-ocean-to-offshore.html>. Accessed 3/23/14.

The issue of whether or not to drill offshore for gas exploration off the coast of North Carolina has boiled down to a political issue. People need to understand the environmental implications that will take place. North Carolina is heavily dependent on tourism. The promise for jobs from the exploration is a hollow one.

Talton, T. No Date. Testing for Offshore Drilling Sets Off Debate. <http://www.nccoast.org/Article.aspx?k=e47a2c31-a84b-4f13-a877-77ffa7ebe5f3>. Accessed 3/23/14.

These tests, environmentalists say, produce high-frequency sounds that harm marine mammals and interfere with the habits of fish populations crucial to the commercial fishing industry. Groups including the Surfrider Foundation and Oceana, the world's largest international ocean conservation organization, are petitioning the government against allowing the tests. Both organizations also oppose offshore drilling.

The Outer Banks Chapter of the Surfrider Foundation. No Date. No Offshore Drilling off NC. [http://outerbanks.surfrider.org/?page\\_id=85](http://outerbanks.surfrider.org/?page_id=85). Accessed 3/23/14.

The Outer Banks Chapter of the Surfrider Foundation is opposed to any offshore oil or gas exploration or drilling along the North Carolina Coast, because they state that it is a waste of capital, short sighted in scope and an open invitation for environmental catastrophe to begin search for a nonrenewable source.

\*Watkins, W. August 26, 2006. Whale Reactions to Human Activities in Cape Cod Waters. Marine Mammal Science. Volume 2: pgs 251-252. Accessed 3/23/14.

A review of our whale observations of more than 25 years indicated that each of the species commonly observed within 35 km of Cape Cod reacted differently to stimuli from human activities, and that these responses have gradually changed with time. Over the years of exposure to ships. Most have become completely uninterested.

\*Weilgart, L.S. 2007. A Brief Review of Known Effects of Noise on Marine Mammals. International Journal of Comparative Psychology. Volume 20: pgs 159-168. Accessed 3/23/14.

Observed reactions to noise in marine mammals could theoretically result in impacts such as decreased foraging efficiency, higher energetic demands, less group cohesion, higher predation, decreased reproduction, and thus seriously impact the population.

Alternatively, they may be harmless. However, noise is thought to contribute to at least some species' declines or lack of recovery (Southern resident killer whales (*Orcinus orca*), western gray whales (*Eschrichtius robustus*) off Sakhalin).

\*Weilgart, L. December 6, 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. *Canadian Journal of Zoology*. Volume 85: pgs 1091-1116. Accessed 3/23/14.

Fish show permanent and temporary hearing loss, reduced catch rates, stress, and behavioral reactions to noise. Management implications of noise impacts include difficulties in establishing “safe” exposure levels, reducing noise levels and distancing the noise from biologically important areas.

Wilttrout, K. May 15, 2005. Sonar’s effect on sea mammals may jeopardize offshore testing. *The Virginian Pilot*.

<http://news.google.com/newspapers?nid=1454&dat=20050515&id=7b1jAAAIBAJ&sjid=6R8EAAAIBAJ&pg=5044,3897352>. Accessed 3/22/14.

Four months prior to the publication of this article, 30 whales washed up onshore dead, after a sonar testing. This caused concern, even though it cannot be proven that the sonar testing is what caused the deaths. The Navy has agreed to hinder testing, or move it to a different location if marine mammals are spotted within a certain distance, however studies are showing that even in the lowest frequencies, the mammals are effected both physically and behaviorally. The sonar testing is necessary for the protection of our coast however, seeing that other countries have developed submarines which are inaudible.

\*Wursig, B., C. R. Greene., & T.A. Jefferson. February 2000. Development of an air bubble curtain to reduce underwater noise of percussive piling. *Marine Environmental Research*. Volume 49: pgs 79-93. Accessed 3/23/14.

A study was done with a bubble curtain to reduce noise pollution. It did not stop all the noise, and there were still behavioral disturbances seen in the surrounding mammals. Because the bubble curtain effectively lowered sound levels within 1 km of the activity, the experiment and its application during construction represented a success, and this measure should be considered for other appropriate areas with high industrial noises and resident or migrating sound-sensitive animals.

### **Andrew Jones**

Alaska Marine Conservation Council. No date. Impacts of Seismic Surveys on Marine Mammals and Fish. *Akmarine.org*. (Accessed 3/22/2014).

This is a useful report of what seismic testing is and how it impacts aquatic life. I included it in the bibliography because it was one of the few I found that talked about the impacts on not only mammals but also fish. It talks about how there have been significant reductions in fish catches in areas where seismic testing has been done. There is also a

useful table that displays what fish have been affected, how loud the testing was, and the reduced catch percentage.

Colman, Z. February 27, 2014. Obama administration takes step toward allowing Atlantic Ocean Drilling. Washington Examiner. <http://washingtonexaminer.com/obama-administration-takes-step-toward-allowing-atlantic-ocean-drilling/article/2544819>. (Accessed 3/20/2014).

The US interior department believes that seismic testing off the Atlantic Coast would not significantly harm aquatic life, contrary to what many environmentalists and scientific studies believe. This is the first precursor to offshore drilling. Tests by the interior's Bureau of Ocean Energy Management agreed that it may affect some marine life but those affects would only be "minor" and fish might see "moderate" levels of disruption. This drilling is not supposed to take place until 2017. One advocate against this testing made a good point that the government's assessments have shown that thousands of animals will be affected and the possibility of oil disaster will only hurt coastal economies.

Doyle, A. January 20, 2014. New guidelines seek to curb risk to whales from seismic tests. Reuters. <http://in.reuters.com/article/2014/01/20/us-seismic-idINBREA0J0K720140120>. (Accessed 3/22/2014).

There are already some restrictions on seismic testing in the Pacific Ocean to protect endangered whale species, the IUCN (international union for conservation of nature) believes these safeguards can act as a model for similar restrictions. Seismic testing bounces sound waves into the sea floor to try and detect oil and gas deposits. These blasts can be as loud as 250 decibels and can sometimes be heard 2500 miles away. The belief is that this testing may not directly harm whales but it will cause them to migrate from their normal feeding grounds. These new guidelines in the Pacific require extensive study of the marine wildlife in testing areas to determine where the best place to test would be. The IUCN believes that these guidelines should be implemented worldwide.

Greenpeace. No Date. Seismic and Sonar Testing. Greenpeace USA. <http://www.greenpeace.org/usa/en/campaigns/oceans/Seismic-Testing-Sonar-Testing/>. (Accessed 3/24/14)

Not only do marine mammals face threat from international whalers and habitat loss, they also face the domestic threat related to harmful seismic testing. Today seismic testing is allowed with very little restriction, in order to find gas and oil deposits on the sea floor. The government estimates that 138,500 whales and dolphins will soon be injured or killed along the US east coast if these practices continue. Soon these tests will begin from Delaware to Florida. The blasts go off every ten seconds, 24 hours a day. This website provides an excellent image that could be used in the white paper.

Holleran, C. September 20, 2012. Seismic Testing Threatens Aquatic Wildlife In The Pacific Ocean. Greenpeace. <http://greenpeaceblogs.org/2012/09/20/seismic-testing-threatens-aquatic-wildlife-in-the-pacific-ocean/>. (Accessed 3/24/2014).

Conner Holleran is an environmentalist who works for Greenpeace who is trying to raise awareness of the harmful effects of seismic testing in oceans. He states how marine mammals communicate primarily by the transfer of sound waves and how these animals

are extremely sensitive to sound. He may be a little extreme but he says that seismic blasts can cause dolphins eyes to bleed and sometimes burst and also that the sounds confuse and rupture the ear drums of marine mammals.

Huelsenbeck, M, Wood, C. 2013. A Deaf Whale is A Dead Whale. Oceana.

This article starts out by stating the deafening effects of seismic testing and how seismic testing is about to begin all along the eastern coast of the United States. The article states that the government expects 138,500 whales and dolphins will soon be negatively affected by these tests. Some of these effects may be permanent hearing loss, abandonment of habitat, disruption of mating and feeding, beach stranding, and death. It is also stated that seismic testing is the first step to major offshore drilling which will further harm marine life. This paper goes on to discuss recommendations of how to stop or regulate this testing, unsolved mysteries of stranding that is likely due to testing, what animals will be affected most, and a number of useful figures for this class.

\*Madsen, P. T., Mohl, B., Nielsen, B. K., & Wahlberg, M. (2002). Male sperm whale behavior during exposures to distant seismic survey pulses. *Aquatic Mammals*, 28(3), 231-240.

This study describes the behavior of adult male sperm whales during exposure to pulses from seismic air guns. For five hours a large aperture array recorded both air gun blasts as well as sperm whale clicks. After the study was completed it was concluded that the pulses had little to no effect on sperm whale behavior as most of the whales stayed in the area for at least 13 days. It was also observed that the whales continues to feed and communicate as if there were no pulses at all. This study could be useful for those debating FOR seismic testing.

Mellor, C. January 16, 2014. Seismic testing, whales targeted. Herald News.  
<http://thechronicleherald.ca/novascotia/1180170-seismic-testing-whales-targeted>.  
(Accessed 3/24/14).

The United States government is looking into the behavior of endangered whales before and after seismic air gun testing, off Nova Scotia. A number of endangered marine mammals frequent the waters off Nova Scotia including North Atlantic right whales and northern bottlenose whales. It is known that seismic testing may affect these species but how is not well understood. Increased interest in oil and gas in the area has led to the permission of seismic testing in this area but because it is a biological hotspot there has also been funding to study how these species will be affected. If these studies are successful, testing may cease.

National Aquarium. October 14, 2013. Conservation Update: Seismic Airgun Testing.  
National Aquarium.  
<http://nationalaquarium.wordpress.com/2013/10/14/conservation-update-seismic-airgun-testing/>. (Accessed 3/24/14).

The Mid-Atlantic has never been an area for offshore oil drilling, but the government's desire to be less dependent of foreign oil may soon cause this to change. In 2010 it was proposed that testing should take place in the Mid-Atlantic to determine how much oil was really out there. The oil spill incident in the Gulf of Mexico later that year led to this exploration being pushed back until 2017 (when everyone had hopefully forgotten about

the incident). The testing that will be used is called seismic air gun testing and many believe that it will be harmful to all aquatic life. Seismic air gun testing send loud blasts of noise into the sea floor. These blast are believed to be capable of deafening marine life and sometime even killing marine mammals and fish.

\*Popper, A. N., Smith, M. E., Cott, P. A., Hanna, B. W., MacGillivray, A. O., Austin, M. E., & Mann, D. A. (2005). Effects of exposure to seismic airgun use on hearing of three fish species. *The Journal of the Acoustical Society of America*, 117(6), 3958-3971.

This paper details a study done to determine how seismic testing affect three river delta species of fish in the Mackenzie River Delta. The three fish are the northern pike, broad whitefish, and Lake Chub. This was a controlled experiment. Fish were placed in cages in water 2m deep and were exposed to either 5 or 20 blasts form the air gun. The control group received no blasts. Post-blasts none of the fish appeared to have any physical harm done to them. Further study and autopsy on the Broad Whitefish also showed no significant difference. The northern pike showed decrease in hearing threshold but fully recovered to normal within 24 hours. Similarly, in the lake Chub immediate hearing loss was apparent but they seemed to recover to normal within 18 hours.

Scott, K.P. February 3, 2014. United States Considerers Seismic Testing in Atlantic. Martindale.org. [http://www.martindale.com/energy-law/article\\_Jones-Walker-LLP\\_2069570.htm](http://www.martindale.com/energy-law/article_Jones-Walker-LLP_2069570.htm). (Accessed 2/20/2014)

Currently the Atlantic seaboard of the United States is an untapped hydrocarbon resource. Meaning that there has been no oil exploration or drilling in this area. This is about to change. The US government estimated that there are over 3.3 billion gallons of oil in this area that it wants to get its hands on. The first step to obtaining this oil is conducting seismic tests to determine if there are oil or gas deposits below the sea floor. Environmental groups are against this testing because they believe it may harm aquatic life, though it seems president Obama will soon pass the legislation and allow seismic testing.

Sharp, M. L., & Environmental, T. (2011). *A Review of Effects of Seismic Testing on Marine Fish and Fisheries as Applied to the DCP 3-D Seismic Project*. Pacific Gas and Electric Co.

PG&E is proposing seismic testing to search for gas and oil deposits in the Diablo Canyon area off the central Pacific Coast. This paper is a study done by PG&E that discusses the potential environmental impacts of this testing. The study found that seismic testing can result in the direct mortality of fish in their early life stages but more frequently results is changes in fish behavior. It has also been recorded that seismic testing significantly reduces fish catches in the time following seismic testing. The most serious injuries to aquatic life occur within 1.5 miles of the test but life can be affected up to 1000 miles away.

Sneed, D. November 10, 2012. Seismic tests off Diablo Canyon could harm divers. *The Tribune*. <http://www.sanluisobispo.com/2012/11/10/2291933/seismic-tests-off-diablo-canyon.html>. (Accessed 3/22/2014).

I found this article interesting because it was the only one that discussed the possible impacts of seismic testing on humans, in this case scuba divers. PG&E believes that anyone submerged in the area where tests are being done for more than 15 minutes could be harmed. The human threshold for sound is 154 decibels and the tests are going to emit 250 decibel blasts every 15 seconds, for 9 days. These blasts could cause the instantaneous compression of bodily gasses causing potential damage to the lungs, intestines, and heart.

Spina, J. No Date. Limit Damaging Seismic Testing in the Atlantic. Forcechange.com. <http://forcechange.com/64133/limit-damaging-seismic-testing-in-the-atlantic/>. (Accessed 3/24/14)

This website is the proposal for a petition against seismic air gun testing. The first paragraph describes exactly what seismic testing is and how the government has estimated that it will harm over 130,000 marine mammals alone, not including fish. Spina stated that these blasts can cause aquatic life to abandon habitats, disrupt mating and feeding, and cause death, especially in fish eggs and larvae. Air guns also drastically affect the fishing industry too, after seismic tests catch rates of cod declined 80 in an area within 1000 miles of the testing. The original petition letter is also included on the webpage.

Troyan, M.O. February 28, 2014. Rules set for oil testing in Atlantic Ocean. Greenvilleonline. [http://www.greenvilleonline.com/article/20140228/NEWS07/302280057/Rules-set-oil-testing-Atlantic-Ocean?nclick\\_check=1](http://www.greenvilleonline.com/article/20140228/NEWS07/302280057/Rules-set-oil-testing-Atlantic-Ocean?nclick_check=1). (Accessed 3/22/2014).

This article is from February 2014 and talks about how Obama has just released a report that details how seismic testing companies should protect wildlife if they want to start seismic testing. It states that this does not directly allow for drilling and testing but it is the beginning of what is to come. The report was over 800 pages long.

### **Haley Quarles**

Associated Press. 3/1/2014. Carolina Beach Town Council approves resolution opposing seismic testing off the NC coast. The republic. <http://www.therepublic.com/w/NC--Seismic-Testing>. Accessed 3/24/2014.

StarNews of Wilmington that the council approved the resolution against seismic testing. The federal Bureau of Ocean Energy Management is endorsing the testing but stated that oil and gas companies would have to follow strict environmental standards in order to protect marine mammals.

Boniti L. 3/04/2014. Seismic testing may soon happen off of NC coasts. TWC News. <http://triadnc.twcnews.com/content/news/705340/seismic-testing-may-soon-happen-off-of-nc-coasts>. Accessed 3/24/2024.

The Office of the Governor to the Joint Legislative Commission of Energy Policy expressed that North Carolina's coasts could soon see seismic testing. Under Senate Bill 76, the governor was encouraged to make a compact with south- Virginia and South

Carolina for seismic testing. It is also stated in this article that "Even if testing does begin, it would still be several years before any sort of drilling could be considered".

\*Castellote M. 2007. General Review of Protocols and Guidelines for Minimizing Acoustic Disturbance to Marine Mammals from Seismic Surveys. *Journal of International Wildlife Law and Policy* 10: 273-288.

This article gives a summary of the guidelines established to minimize acoustic disturbance to marine mammals during seismic testing. Some of these guidelines include the ramp up approach, safety zones, and acoustic monitoring.

\*Chapman G, Richards J, and Loflin L. 5/1998. Achieving cost saving through collaborative seismic testing. *Journal of Nuclear Engineering and Design* 181:253-246.

The prices and costs of seismic tests are discussed in this article. These costs include dealing with test failures and lack of understanding of the testing process. SQRSTS is a partnership of 22 utilities that provide funding and leadership to help reduce the price of testing.

*Environment* 360. 4/16/2013. U.S. offshore seismic testing threatens many marine species, study says. Yale.

[http://e360.yale.edu/digest/us\\_offshore\\_seismic\\_testing\\_threatens\\_many\\_marine\\_species\\_study\\_says/3818/](http://e360.yale.edu/digest/us_offshore_seismic_testing_threatens_many_marine_species_study_says/3818/). Accessed 3/24/2014.

It is estimated that around one hundred and forty thousand marine animals could be affected by seismic testing along the East Coast. Seismic testing could affect fish eggs to large whales and also could disturb breathing, feeding, and mating habits. This came from the U.S Interior Department's Bureau of Ocean Energy Management. Oil industries reference research that states seismic testing is unlikely threatening to marine mammals.

\*Kausel, E. 5/1998. New Seismic Testing Method. 1:Fundamental Concepts. *Journal of Engineering Mechanics* 124: 565-570.

In this article a new type of hybrid testing method is explained. This method is done by separating the ground motion components into two parts, the first stimulation is accomplished with a shaking table and the second is done with actuators acting directly into the structure.

\*Lacroix D. L., Lanctot R. B., Reed J. A., and McDonald T. L. 2013. Effect of underwater seismic surveys on molting male Long-tailed Ducks in the Beaufort Sea, Alaska. *Journal of Zoology* 81: 1862- 1875.

Between ten and thirty thousand ducks were studied to see the effect of seismic testing on their diving behavior. The results showed a decrease in the population during the testing. This study recommends further research to fully understand this topic.

Morris R. 3/3/2014. Opinions Split on Offshore Seismic Testing. NC coast.

<http://www.nccoast.org/Article.aspx?k=ec1bd237-d802-4f3e-802d-c50ff2cbbc58>. Accessed 3/24/2014.

N.C. State University conducted a study to estimate the costs involved with energy exploration off the coast and found it would produce one thousand one hundred and twelve jobs and one hundred and eighty one million dollars for the state in the first

seven years. This statement was released from Governor McCrory's office. On the opposite side, an environmental group warned that the airguns used for seismic testing could potentially harm the fish for commercial fishing groups which will take a toll on the state's economics.

Murawsk J. 11/13/2014. Seismic testing to get underway in Lee County as energy developers assess NC's shale gas potential. News Observer.

<http://www.newsobserver.com/2013/11/18/3385057/seismic-testing-to-get-underway.html>. Accessed 3/24/2014.

According to the chairman of the N.C. Mining and Energy Commission, James Womack, "The seismic testing will mark the beginning of a sequence of exploratory steps that could lead to the first five wells producing shale gas by 2015" Lee County is preparing to take ultrasound images of Lee County to better determine the possibility for fracking. Womack predicted that NC could have as many as 140 natural gas wells by 2018. Lee, Moore and Chatham counties are believed to have the most gas in NC which puts the state at low priority for natural gas.

Oceana. No date. Seismic Airgun Testing: Overview. Oceana. <http://oceana.org/en/our-work/climate-energy/seismic-airgun-testing/overview>. Accessed 3/24/2014.

Airguns are towed behind ships and emit loud blasts of compressed air through the water to the seabed and reflect back to determine if buried oil and gas deposits are beneath the ocean floor. These airblasts can harm marine mammals, sea turtles, and fish with affects such as hearing loss and even death. It can also kill fish eggs and larvae and scare fish away from their habitats. Cod and haddock catch rates declined by forty to eighty percent following seismic surveys.

Queram K. E. 2/28/2014. Carolina Beach officials united in opposition of seismic testing. Star news online.

<http://www.starnewsonline.com/article/20140228/ARTICLES/140229615?p=1&tc=pg>. Accessed 3/24/2014.

Carolina Beach passes and unanimous decision against seismic testing off the NC Coast at a meeting held Friday February twenty eighth. Carolina Beach does not support the frequency, volume, and the areas for seismic testing nor do they support the potential threat to marine mammals. The Obama Administration showed interest in seismic testing on off the Atlantic Coast although the endangered North Atlantic right whale resides in the Atlantic Coast. This has been a point conservationists have used in their favor for this debate.

\*Reeves R. R., Ljungblas D. K., and Clarke J. T. 10/27/2009. Bowhead Whales and acoustic seismic surveys in the Beaufort Sea. Journal of Polar Record 22:271-280.

A survey conducted in 1982 studied the effects on migrating Bowhead whales. It was conducted on the Alaskan coast and the disturbance, behavior and numbers of whales were studied while seismic tests were conducted.

Scales H. 2/28/2014. Atlantic Seismic Tests for Oil: Marine Animals at Risk?. National Geographic. <http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals/>. Accessed 3/24/2014.

This article first discusses what seismic testing is and relates it to “dynamite going off in your living room or in your backyard every ten seconds for days to weeks at a time”. The different types of marine mammals that seismic testing affects such as the endangered North Atlantic right whale, humpback whales, dolphins, loggerhead turtles, and commercial fish is discussed. Techniques that could possibly lessen the damage to these marine mammals are also mentioned in this article.

Syner J. 2/27/2014. Review Clears Path for Seismic Tests of U.S. Atlantic Oil. Bloomberg. <http://www.bloomberg.com/news/2014-02-27/review-clears-path-for-seismic-tests-of-u-s-atlantic-oil.html>. Accessed 3/24/2014.

Measures can be taken to minimize the harmful effects on marine wildlife such as pausing testing when marine wildlife is in the testing area. In the mid and south Atlantic outer continental shelf there are at least three billion barrels of oil, half of this is the amount the United States consumes in a year. Airguns are explained in this article and long term strategies are also discussed.

Talton T. 1/21/2014. Testing for Offshore Drilling Sets Off Debate. NC coast. <http://www.nccoast.org/m/article.aspx?k=e47a2c31-a84b-4f13-a877-77ffa7ebe5f3>. Accessed 3/24/2014.

Kure Beach Mayor Dean Lambeth is endorsing seismic testing off the coast of North Carolina and signed a letter for his approval in December 2013. The last time seismic testing was conducted was over thirty years ago. An industry lobbying group says "with today's technology, they can get a more accurate picture of what lies beneath the seabed". Seismic testing can be conducted with airgun surveys and high resolution geophysical surveys; both produce sound detectable to marine mammals. According to the American Petroleum Institute, offshore oil development in the Atlantic could produce two hundred eighty thousand jobs and contribute twenty three and a half billion dollars to the United States economy. Most of this would come from the East Coast.

### **Meganne Rose**

Balk, L. Hylland, K. Hansson, T. Berntssen, M.H.G. Beyer, J; et al. 05/2011. Biomarkers in Natural Fish Populations Indicate Adverse Biological Effects of Offshore Oil Production. E19735(6.5)

This Journal Entry goes into the direct impacts that offshore drilling and seismic testing has on the naturally occurring species in the sites where drilling and seismic testing currently occur. Fish exposure to Polycyclic Aromatic Hydrocarbons and their inevitable uptake ends with a dramatic decrease in fish population as the fish die due to the chemical changes happening as a direct result of the chemical releases from the drilling.

Benn, A.R. Weaver, P.P. Billet, D.S.M. Hove, S.V. Murdock, A.P; et al. 09/2010. Human Activities on the Deep Seafloor in the North East Atlantic: An Assessment of Spatial Extent. E12730(5.9)

This paper shows the direct impact of human activity on the deep ocean floor. The North Atlantic Ocean area was chosen specifically because the largest influence of human impact has been on that part of the deep ocean floor. While this document is split into five areas of impact: submarine communication cables, marine scientific research, oil and gas industry, bottom trawling and the historical dumping of radioactive waste, munitions and chemical weapons, there is much information on the oil and gas industry impact of drilling and seismic testing to be found from this source.

Cockerham, S. 02/27/2014. Interior Department favors controversial seismic tests for Atlantic Ocean oil. McClatchyDC.com 219596.

<http://www.mcclatchydc.com/2014/02/27/219596/interior-department-favors-controversial.html>. Accessed: 03/23/2014.

States that the estimates of the oil and gas lying in the Atlantic seabed at approximately 3.3 billion barrels of oil are from the 70s and 80s, not giving a true measure of the oil remaining there. Many parts of the Atlantic Seabed will be left untouched to maintain the natural migration habitat of such species as whales, turtles, and dolphins.

Greenpeace, USA. No Date. Seismic and Sonar Testing. Campaigns. Oceans.

<http://www.greenpeace.org/usa/en/campaigns/oceans/Seismic-Testing-Sonar-Testing>.

Accessed: 03/22/2014.

Indicates number of threatened whales and dolphins to be threatened by the seismic testing off the shore of North Carolina to be 138,500. This number is without the added deaths if drilling is allowed to occur. Impacts to marine mammals include hearing loss, habitat abandonment, mating disruption, and beaching.

\*Jones, D.O.B. Cruz-Motta, J.J. Bone, D. Kaariainen, J.I. 03/2012. Effects of oil drilling activity on the deep water megabenthos of the Orinoco Fan, Venezuela. Marine Biological Association of the United Kingdom. Journal of the Marine Biological Association of the United Kingdom. 92.2:245-253.

Based on data collected from Venezuela, this article shows the direct impact of oil drilling and exploration on the megabenthos in the surrounding area. Benthic communities are crucially important as they contain much diversity and provide a large portion of the energy given to higher trophic levels. These communities often contain the bivalves, decomposers, and are the food source for many individuals in higher trophic levels. By limiting the growth and development of benthic communities, the growth and development of the fish species that rely on them will be threatened.

\*Konyukhov, A.I. 12/03/2008. Structure and Geological History of Sedimentary Petroliferous Basins in the North Atlantic. Lithology and Mineral Resources. 44(3): 229-244.

This article from Lithology and Mineral Resources details the sedimentary history of the North Atlantic and the formation of the oil reserves. It goes into the process of drilling and seismic testing and how it has an influence on the basin itself as a

whole. Konyukhov also describes in much detail the thick sedimentary cover of the oil source and the natural layering of the different rock types and oil and how the layers are changed and disturbed via drilling and seismic testing.

\*Konyukhov, A.I. 03/19/2012. Oil Source Rocks at the Mesozoic and Cenozoic Continental Margins: Communication 1. Oil Source Rocks at Continental Margins in the Triassic-Jurassic and Neocomian- Aptian. *Lithology and Mineral Resources*. 47(5):401-418.

Details the importance of the continued use of Atlantic Gas Reserves, and why they are some of the most plentiful reserves in the world, capable of maintaining our current use for many, many years. Explains why the Atlantic Ocean geologically has so much oil wealth to offer.

Mundy, A. 02/27/2014. Interior Department Endorses Seismic Testing for Oil and Gas Off Atlantic Coast. *Wall Street Journal*.  
<http://online.wsj.com/news/articles/SB10001424052702304071004579409621926543690>  
. Accessed: 03/24/2014.

This article from the Wall Street Journal offers a more positive outlook on the drilling set to occur off of the coast of North Carolina. Shows the balancing of the need of oil and the concern for the conservation of marine life.

\*Netto, S.A. Fonseca, G. Gallucci, F. 06/04/2010. Effects of drill cuttings discharge on meiofauna communities of a shelf break site in the southwest Atlantic. *Environmental Monitoring and Assessment*. 167(1-4):49-63.

These three authors explain the environmental side effects of oil drilling that directly impact the meiofauna and cause a cascade into other types of biota. Nematodes and copepods are directly examined, with varying results. In testing sites copepods flourished, and nematodes were depleted. This direct change in meiofauna diversity has a drastic impact on the larger biota that predate on these species. This can result in higher competitive forces, creating less diversity as some species that are not adequately fed start to become endangered.

Oceana.org. No Date. Seismic Airgun Testing: Overview. *Climate Energy*.  
<http://oceana.org/en/our-work/climate-energy/seismic-airgun-testing/overview>. Accessed: 03/23/2014.

This provides an overview of the seismic testing process for deepwater oil. It also outlines the hazards of the process on the environment.

Scales, H. 02/28/2014. Atlantic Seismic Tests for Oil: Marine Animals at Risk? *National Geographic*. Energy. 140228.  
<http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals>. Accessed: 03/22/2014.

This popular magazine article goes into the potential risk to the North Atlantic Right Whale as a species if Seismic testing along the coast of North Carolina is to continue. It states that the 'moderate' effects that are expected to occur on specific species like the native turtles and whales, will be much more than moderate, and

have an extremely large ripple effect on many species as a result, endangering and possibly causing the extinction of several species.

Sharpless, A. 11/13/2013. Don't Ignore the Science. Seismic Testing. <http://oceana.org/en/category/blog-free-tags/seismic-testing>. Accessed: 03/21/2014.

Refers to a report from the International Whaling Commission, states a firm connection between the sonar mapping air gun method of seismic testing used by oil and gas companies to locate deepwater pools of oil under sediment, and the deaths of many marine animals. These noises purportedly drove dolphins, whales, and turtles to shallow waters where they attempted to beach themselves to escape the noise disturbance.

Troyan, M.O. 02/28/2014. Rules set for oil testing in Atlantic Ocean. 302280023. <http://www.greenvilleonline.com/article/20140228/NEWS/302280023/Rules-set-oil-testing-Atlantic-Ocean>. Accessed: 03/24/2014.

This article states that although the Obama Administration has so far approved the seismic testing in mainly North Carolina waters, strict rules are set in place to protect the habitats, migratory patterns, and marine life found in the Atlantic Ocean. Oil drilling and seismic testing will not be allowed to occur within these safe zones.

\*Wagner, C.G. (March-April, 2000) Deepwater oil; The Final Frontier? The Futurist. 34(2):16.

Cynthia Wagner talks about the last push for the future of oil on this planet. Saying that most land based and coastal based options for oil exploration and extraction have been exhausted, she goes into the most natural last step: deepwater oil. This scientific journal entry talks about the push for deepwater oil exploration in the gulf and in the Atlantic ocean, also begging the question, what is next after we exhaust this option?

Weilgart, L. 03/2010. Alternative Technologies to Seismic Airgun Surveys for Oil and Gas Exploration and their Potential for Reducing Impacts on Marine Mammals. Okeanos Foundation.org. <http://www.okeanos-foundation.org/assets/Uploads/Airgun.pdf>. Accessed: 03/22/2014.

Details methods of reducing damage to the marine ecosystems while still allowing for oil exploration. Such options include reducing amplitude, reducing airgun volume, reducing the duration of surveys, and lowering frequency bandwidth. All of these options even individually would drastically change the impact that seismic testing has on the surrounding aquatic life.

Nina Sassano

\*Bailey, H., B. Senior, D. Simmons, J. Rusin, G. Picken, P. M. Thompson. 2010. Assessing underwater noise levels during pile driving at an offshore windfarm and its potential effects on marine mammals. Marine Pollution Bulletin. 60:6, 888-897.

This report provides empirical data for the impacts of two 5 MW wind turbines installed off NE Scotland on nearby populations of bottlenose dolphins. Results show that auditory injury on the dolphins would only have occurred within 100m of the pile driving, and behavioral disturbance would have occurred within 50km of noise disturbances.

\*Brette, F., B. Machado, C. Cros, J. Incardona, N. Scholz, B. Block. 2014. Crude oil impairs cardiac excitation-contraction coupling in fish. *Science*. 343:6172, 772-776.

Brette et al. investigated the harmful impacts of crude oil on larval fish populations. Although this does not directly relate to seismic testing, it is an example of the harmful effects oil has on the ecosystem. If the government decides to move forward with seismic testing in the Atlantic, it is for the purpose of drilling for oil, which this article shows that oil has direct negative impacts on the development and reproduction of marine vertebrate species.

\*Buckstaff, K. R. S. Wells, J. G. Gannon, et al. 2013. Responses of bottlenose dolphins (*Tursiops truncatus*) to construction and demolition of coastal marine structures. *Aquatic Animals*. 39:2, 174-186.

This study examined the impacts of underwater construction on bottlenose dolphins in Sarasota Bay, Florida. Dolphin abundance increased during the construction of a large bridge, which implemented the use of near surface and sub surface explosions during construction. This study shows that near-surface above water explosions create more of a noise disturbance than sub surface explosions, and cause dolphins to group together and change their headings. This is important since these explosions will be necessary in the implementation and construction of new oilrigs along the Atlantic coast.

Covi, M., E. Devon, D. Swain, S. Watkins-Kenney. 2008. Noise in the ocean: A review of the issues, science and policy relating to the effects of noise on marine life. East Carolina University, Coastal Resource Management CRM 6100. Available: <http://www.ecu.edu/org/tcs/Docs/CRM61002008.pdf>

This paper was written to describe and review the impacts of sound on marine life, and how it impacts humans living along the coastal Atlantic. It also discusses human-caused sound mitigation, and how NOAA has been working to evaluate the views of stakeholders, policy makers, and government agencies and determine the best recommendations for the future of seismic testing.

Crow, S., A. Sharpless. 2013. A win for whales: seismic airgun testing decision delayed. Huffington Post Green. Available: [http://www.huffingtonpost.com/sheryl-crow/whales-seismic-testing\\_b\\_3975608.html](http://www.huffingtonpost.com/sheryl-crow/whales-seismic-testing_b_3975608.html)

This article provides a general overview of the technique involved with seismic testing using air guns, as well as the range of impacts associated with the testing. The air gun is towed behind a boat, and sends air pulses into the ground to search for subterranean oil. This air pulse harms local fauna, including feeding, calving and breeding habits of many marine creatures, as well as disturbing the echolocation of marine mammals. This article also briefly discusses the political debate associated with allowing seismic testing off the coast of the Atlantic seaboard, indicating that policy makers have postponed any testing for the near future.

\*Di Iorio, L., C. W. Clark. 2010. Exposure to seismic survey alters blue whale acoustic communication. *Biology Letters*. 6:3, 334-335.

This study found that blue whales (*Balaenoptera musculus*) altered their behavior through the duration of seismic testing. During the times with additional soundwaves, blue whales called on each other more frequently, especially during social encounters and feeding. The authors believe that this response can be attributed to “elevated ambient noise from seismic survey operations”.

Jolly, D. 2012. Expert links dolphin deaths to sonar testing. *The New York Times*. Available: [http://green.blogs.nytimes.com/2012/05/28/expert-links-dolphin-deaths-to-sonar-testing/?\\_php=true&\\_type=blogs&\\_r=0](http://green.blogs.nytimes.com/2012/05/28/expert-links-dolphin-deaths-to-sonar-testing/?_php=true&_type=blogs&_r=0)

Over 400 dolphins were recently found washed up on the shores of Peru, and scientists are linking this death to seismic testing. Although the sound waves produced by seismic testing did not appear to interfere with the echolocation of the dolphins, necropsies showed that the dolphins were bleeding in their middle ears, suffered fractures in their ears, and showed symptoms of the bends, all of which could have been caused by acoustic trauma.

Kurh, E. 2014. To drill or not to drill- debate over offshore testing and drilling in the Atlantic. *Time*. Available: <http://time.com/3249/to-drill-or-not-to-drill-debate-over-offshore-testing-and-drilling-in-the-atlantic/>

Nearly half of what the US uses in oil consumption could potentially be lying beneath the ocean floor along the Atlantic seaboard. This article explains to the layman exactly what is happening with the debate regarding seismic testing along the Atlantic coast. As of 1982, the government has had a ban on seismic testing in the Atlantic Ocean.

Kurwicky, H. 2014. Conservationists, capitalists battle over seismic testing. *WWAY News Channel 3, North Carolina*. Available: <http://www.wwaytv3.com/2014/01/27/conservationists-capitalists-battle-over-seismic-testing>

This article is a review of a recent town hall debate in Kure Beach, North Carolina. Present at the meeting were both conservationists and people who believed that locating oil off the coast of NC will do nothing but good for the economics of NC coastal communities. The mayor of Kure Beach submitted a letter of approval for seismic testing without the approval of the members of the community, and it has caused a lot of controversy. Members of Oceana protested the town meeting, citing that seismic testing off the coast of Peru has led to the beach stranding of bottlenose dolphins. Not much was resolved at this town hall meeting.

\*Nieukirk, S. L., K. M. Stafford, D. K. Mellinger, et al. 2004. Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean. *Journal of the Acoustical Society of America*. 115:4, 1832-1843.

Hydrophones were deployed along the mid-Atlantic ridge (35-15 degrees N, 50-33 degrees W), and data was recorded for two years (1999-2001). Data retrieved showed four different sounds detected, all of biological origin (whales). This study is important because it determines the different frequencies observed and the types of whales communicating along the Atlantic coast.

Scales, H. 2014. Atlantic Seismic Tests for Oil: Marine Animals at Risk? US Environmental review paves the way for first air-gun surveys in 26 years off the East Coast. National Geographic Daily News. Available: <http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals/>

This article provides an overview of the history and current debate regarding seismic testing for oilrig development along the Atlantic Coast. The debate lies between the Obama administration and southern governors and officials who believe that these oil rigs will provide new job opportunities to their residents. Building oilrigs off the Atlantic Coast could output nearly 70% of the oil produced currently by the Gulf of Mexico. This article also outlines specific impacts that seismic testing will have on right whales, sperm whales and commercial game fish, which are all important ecologically within the Atlantic coastal region.

Sharp, M. L. 2011. A review of effects of seismic testing on marine fish and fisheries as applied to the DCPD 3-D seismic project. Prepared by Tenera Environmental for Pacific Gas and Electric Company. Available: [http://www.pge.com/includes/docs/pdfs/shared/edusafety/systemworks/dcpp/effects\\_of\\_seismic\\_testing\\_on\\_marine\\_fish\\_and\\_fisheries.pdf](http://www.pge.com/includes/docs/pdfs/shared/edusafety/systemworks/dcpp/effects_of_seismic_testing_on_marine_fish_and_fisheries.pdf)

This report was prepared to analyze and outline the impacts of seismic testing on marine fish and fisheries, specifically for the DCPD 3-D Seismic Project conducted by Pacific Gas and Electric Company. It determines the potential short and long term effects on fish and fish catches in California. This shows the impacts on fish at all life stages, including juveniles and adults. It provides scientific data to support the findings.

\*Smit, H. 1997. Investment Analysis of offshore concessions in the Netherlands. Journal of the Financial Management Association. 26:2, 5-17.

This paper provides an economic and environmental impact assessment of the development of an oil field concession on the Dutch Continental Shelf. It weighs the economic value of exploration drillings as well as the construction of new oil rigs along the continental shelf.

Stocker, M. 2001. Fish, Mollusks and other Sea Animals' use of Sound, and the impact of Anthropogenic Noise in the Marine Acoustic Environment. Michael Stocker Associates. Available: <http://www.msa-design.com/FishEars.html>

This article provides an assemblage of data between 1950-2000 to show the different organisms and their use of acoustic sounds. It describes the sound mechanisms in whales, teleosts, and invertebrates. It also describes sources of anthropogenic noise and their historical impacts on these species.

\*Wardle, C. S., T. J. Carter, G. G. Urquhart, A. D. F. Johnstone, A. M. Ziolkowski, G. Hampson, D. Mackie. 2001. Effects of seismic air guns on marine fish. Continental Shelf Research. 21: 8-10, 1005-1027.

This study tested the impact of a G. gun (Seismic Systems Inc and Sodera), which represents a gun now commonly used by survey companies in arrays and clusters for survey work. Using tagged fish on a reef, impacts of the gun's sound were observed. Positions of the fish were continuously updated using an array of seven hydrophones. A

variety of species of fish were chosen for the study. The gun was fired from multiple locations in the water level. Results determined that the sound of the G. guns had little to no effect on the everyday behavior of the resident fish and invertebrates.

### **Amanda Sharp**

Anonymous. No Date. Endangered and Threatened species of North Carolina. U.S. Fish & Wildlife Service. [http://www.fws.gov/raleigh/es\\_tes.html](http://www.fws.gov/raleigh/es_tes.html) . Accessed: 3/18/2014.

The U.S. Fish & Wildlife Service website provides an explanation of The Endangered Species Act of 1973 and a list of all the plants and animals that are either considered threatened for endangered in North Carolina. The marine mammals that are considered as endangered in North Carolina include the Fin Whale, the Humpback Whale, the Right Whale, the Sei Whale, the Sperm Whale, and the West Indian Manatee. The marine reptiles that are considered threatened in North Carolina are the Green Sea Turtle and the Loggerhead Sea Turtle. The marine reptiles that are considered endangered include the Hawksbill Sea Turtle, the Kemp's Ridley Sea Turtle, and the Leatherback Sea Turtle. The website also provides a list of endangered and threatened fishes, mussels, and snails.

Anonymous. No Date. Seismic Airgun Testing: Overview. Oceana. <http://oceana.org/en/our-work/climate-energy/seismic-airgun-testing/overview?gclid=COW5grHqnL0CFW1nOgodHOQAYw> . Accessed: 3/18/2014.

The Oceana website provides an overview of seismic testing and information on what Oceana is doing to prevent seismic testing. The reason seismic airguns are used is because they find oil and gas deep within the ocean floor. These airguns are so loud that they often disturb, injure or kill marine life. They are also harmful to commercial fisheries and they disrupt the coastal economies. The blast are repeated every 10 to 15 seconds for 24 hours a day and can last up to weeks at a time. They are 100,000 times more intense than a jet engine. It is estimated that the seismic testing that has been proposed off of the East Coast will injure 138,500 whales and dolphins and disturb many more.

Associated Press. January 28, 2014. Kure Beach, N.C., mayor criticized for seismic testing. Pilotonline.com. <http://hamptonroads.com/2014/01/kure-beach-nc-mayor-criticized-seismic-testing> . Accessed: 3/18/2014.

The Mayor Dean Lambeth signed a letter written by America's Energy Forum, which is a lobbying group that is backed by the American Petroleum institute. The signing of this letter left hundreds of residents at a beach town located in southeastern North Carolina upset. A proposal is being considered by the federal Bureau of Ocean Energy Management, which states that air guns will be used in order to determine whether oil and gas deposits exists underneath the ocean floor off of the Atlantic. The conservationists worry that the testing will disrupt migrating North Atlantic right whales and loggerhead sea turtles, as well as other species. The Mayor's reasoning behind signing the letter was to bring revenue into the town; however, revenue would not occur unless drilling actually happened.

Boniti, Loretta. March 3, 2014. Seismic testing may soon happen off of the NC coasts. Time Warner Cable News. <http://triadnc.twcnews.com/content/news/705340/seismic-testing-may-soon-happen-off-of-nc-coasts> . Accessed: 3/18/2014.

This short article written by Loretta Boniti suggests that Donald R. van der Vaart, who is DENR's Energy Policy Director, believes North Carolina is finally taking a positive step, which has been made possible by the Department of the Interior in order to start developing the offshore resources. An announcement that came from the US Department of the Interior said that some seismic testing could happen under certain circumstances in the mid and south Atlantic in order to map potential oil and natural gas. The law makers of North Carolina want more details especially on the impact that may occur to the marine animal's health in safety. The article also states that if testing does begin it would be years before any sort of drilling occurred.

\*Castellote, Manuel. 2007. General Review of Protocols and Guidelines for Minimizing Acoustic Disturbance to Marine Mammals from Seismic Surveys. *Journal of International Wildlife Law & Policy* 10: 273-288.

This article outlines the current protocols as well as guidelines that are in place by many countries to minimize acoustic disturbance to marine mammals from seismic surveys. The most common measures are listed and described in the article. It also includes the more relevant protocols and problems issues that are faced with seismic surveys.

\*Handegard, N. O., T. V. Tronstad, J. M. Hovem. 2013. Evaluating the effect of seismic surveys on fish- the efficacy of different exposure metrics to explain disturbance. *Can. J. Fish. Aquat. Sci.* 70: 1271-1277.

This article shows the disturbances effects that may be potential on fish from seismic air-gun surveys. This article includes characterized exposures for such surveys, which includes the number of emissions by area and time and metrics based on accumulated sound and exposure levels. It was concluded that simple sound models should be avoided and that sound energy disturbance effects should be interpreted with caution.

\*Hudson, J. H., E. A. Shinn, D. M. Robbin. 1982. Effects of Offshore Oil Drilling on Philippine Reef Corals. *Bulletin of Marine Science* 32: 890-908.

This article includes the research that was conducted around an offshore drilling site. This is an area with extensive live-coral bottom off of the northwest Palawan Island in the Philippines. It was examined 15 months after well completion in order to determine the effects of drilling on coral growth and survival. It was concluded that there was a 70% to 90% reduction in foliose, branching, and plate like corals.

Kurwicky, Holden. January 28, 2014. Conservationists, capitalists battle over seismic testing. WWAY 3 abc NewsChannel. <http://www.wwaytv3.com/2014/01/27/conservationists-capitalists-battle-over-seismic-testing> . Accessed: 3/18/2014.

During a Kure Beach Town Council Meeting Clarke Slaymaker was quoted saying "I'm very concerned with the preservation of our oceans, its marine life, and our beaches." The conservationists and capitalists debated the pros and cons of seismic testing off of the North Carolina coast which will ultimately give oil companies an idea of the amount of oil and natural gas that is located off of the coast. Albert Eckel stated that this was a

conversation about the ability to create jobs and revenue as well as understand the resources that are out there. Many of the Kure beach residents are angry about the Mayor of Kure Beach supporting seismic testing without considering the citizen's input.

Levin, Alan. June 6, 2010. Oil spills escalated in this decade. USA Today.

[http://usatoday30.usatoday.com/news/nation/2010-06-07-oil-spill-mess\\_N.htm?csp=34news](http://usatoday30.usatoday.com/news/nation/2010-06-07-oil-spill-mess_N.htm?csp=34news) . Accessed: 3/18/2014.

This article written in 2010 by Alan Levin talks about how the number of spills from offshore oil rigs and pipelines have more than quadrupled within the last decade in U.S. waters. This is believed to have been a warning for the massive leak that occurred in the Gulf of Mexico. From the year 2005 through 2009 the average spills was 22 a year. The company with the most spills from the year 2000 through 2009 was BP, millions of gallons of oil has leaked into the Gulf. These spills should have been a red flag to the industry that they need to tighten safety practices and that the federal regulations needed to improve.

Morris, Rob. March 3, 2014. Opinions Split on Offshore Seismic Testing. North Carolina Coastal Federation.

<http://www.nccoast.org/Article.aspx?k=ec1bd237-d802-4f3e-802d-c50ff2cbcb58> . Accessed: 3/18/2014.

This article written by Rob Morris discusses Governor Pat McCrory's stance on seismic testing and other methods to look for oil as well as natural gas under the ocean floor off of North Carolina's coast. A study conducted at North Carolina State University suggest that the energy exploration off of the coast would produce 1,122 jobs and \$181 million annually for the state. The article includes information from an environmental group that warns the damage that seismic air guns may cause to marine life. It is stated in the article that "It's disruptive, destructive, and directly threatens the survival of marine creatures like dolphins, whales, and turtles."

Murawski, John. November 18, 2013. Seismic testing to get underway in Lee County as energy developers assess NC's shale gas potential. Newsobserver.com.

<http://www.newsobserver.com/2013/11/18/3385057/seismic-testing-to-get-underway.html>. Accessed: 3/18/2014.

It is estimated that the seismic testing off of North Carolina's coast will be the beginning of a sequence of exploratory steps that may lead to the first five wells producing shale gas by the year 2015. This article states that North Carolina is thought to have a relatively small region with potential for natural gas. The area with gas-rich zones is thought to be located in Lee, Moore, and Chatham counties. There is a low market price for natural gas in North Carolina due to the absence of gas lines and other infrastructure placing the state low on the energy industry's priority list. The article also states what the seismic test results will conclude, the data could indicate the presence of energy fluids such as gas or oil.

Queram, Kate E. February 28, 2014. Carolina Beach officials united in opposition of seismic testing. StarNews Online.

<http://www.starnewsonline.com/article/20140228/ARTICLES/140229615> . Accessed 3/18/2014.

The Town Council of Carolina Beach held a meeting where a resolution was unanimously passed opposing seismic testing off of the coast of North Carolina. This occurred a day after a federal agency endorsed the process along the eastern seaboard. The town of Carolina Beach does not support the current proposals to conduct seismic testing off of the North Carolina coast due to the potential threat to marine life. The Obama Administration expressed interest in seismic testing off of the Atlantic coast. This process uses air guns to determine whether oil and gas deposits are beneath the ocean floor. Compacted air is shot to the bottom of the ocean, creating a sound wave that reflects geological formations. These blasts occur every 15 minutes and may cause harm and confuse migrating endangered marine animals.

Scales, Helen. February 28, 2014. 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. National Geographic.

<http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals/> . Accessed: 3/18/2014.

This article written for the National Geographic by Helen Scales provides detailed information on the species that may be negatively affected by seismic testing that may occur off of North Carolina's Coast. It is estimated that fewer than 500 North Atlantic Right Whales are alive today. It was proposed by the BOEM, in order to protect these whales during a key period when larger numbers are present, which is between November and April that the air-gun surveys be banned close to the coast. The National Marine Fisheries Service is in the final stages of a 15 year long research program that is gathering advice on how marine mammals are disturbed and damaged by sound. A group of more than 100 scientist wrote to President Obama encouraging him to wait until the latest marine mammal acoustic guidance was available.

Stephen, R. A. 1998. Ocean seismic network seafloor observatories. *Oceanus* 41.1: 33-37.

This article outlines and discusses the challenges that may occur with seismic imaging and establishing a seafloor seismic observatory are examined. By the end of 1997 there were 105 seismic stations on continents and islands around the world, which is part of the US sponsored Global Seismic Network. These seismic stations are used to find out information about the sea floor. The three major challenges when it comes to establishing seismic stations is installing the sensor to obtaining quality of land, providing power, and then retrieving the data.

\*Wood, L.C., S. Treitel. 1975. Seismic signal processing. *Proceedings of the IEEE* 63: 649-661.

This article is about the digital revolution seismic prospecting for oil and gas as undergone during the past decade. The seismic reflection is normally weak and must be strengthened by the use of signal summing procedures. The exploration for oil and gas occurs in offshore areas where a water layer mask reflections from below and the technology discussed in this article shows how seismic testing has become more reliable.

**Brandi Summerlin**

Bartel, B. February 28, 2014. U.S. regulators say seismic testing can be done safely. The Virginian-Pilot. <http://hamptonroads.com/2014/02/us-regulators-say-seismic-testing-can-be-done-safely>. Accessed 03/21/14.

This article, which was published recently, discusses the idea of seismic testing and offshore drilling and the various impacts that will be seen. Like many of the other articles, this article says that there are ways to find the oil and gas deposits without injuring or bringing any harm to the marine mammals. The Federal Bureau of Ocean Energy Management is the main group responsible for coming up with an environmental plan or statement that best protects the marine life during these periods of seismic testing. The article addresses some possible restrictions that need to be put into place before seismic testing or any kind of offshore drilling begins.

Cockerham, S. February 27, 2014. Interior Department favors controversial seismic tests for Atlantic Ocean oil. McClatchy Washington Bureau. <http://www.mcclatchydc.com/2014/02/27/219596/interior-department-favors-controversial.html>. Accessed 03/21/14.

The above article begins by talking about the controversial issue surrounding seismic testing along the Carolinas, Virginia, and potentially down to Florida area. One of the biggest concerns is our marine life and how this will affect the whales, dolphins, sea turtles and various families of fish. From this article we find out that it has been decades since we have obtained data from these regions in regard to oil and gas deposits. That is one of the reasons why some parties are pushing very heavily for seismic testing, the decade old data is far past its expiration date and it is, in their opinion, time to learn more. However, the opposing party, the environmentalist, has some issues with this idea and they are voiced in this article.

Firestone, J. and C. Jarvis. May 22, 2007. Response and Responsibility: Regulating Noise Pollution in the Marine Environment. Journal of International Wildlife Law & Policy 2007:109-152.

The article listed above begins by discussing how even though there are natural contributors such as wind and waves that contribute to noise levels in the ocean, it is becoming even more increasingly dangerous for our marine life since commercial shipping, resource extraction activities, and military-related activities are on the rise. While various proposals in regard to sonar testing have been mentioned, others fear for the safety of North Carolina's coastal wildlife such as the endangered whales and the sea turtles that are negatively affected by all the noise pollution. The international law, which regulates the amount of noise or sound in the marine environment, is mentioned in this article.

Huelsenbeck, M., and C. Wood. April 2013. A deaf whale is a dead whale: Seismic airgun testing for oil and gas threatens marine life and coastal economies. Oceana.org. [http://oceana.org/sites/default/files/reports/Seismic\\_Airgun\\_Testing\\_Report\\_FINAL.pdf](http://oceana.org/sites/default/files/reports/Seismic_Airgun_Testing_Report_FINAL.pdf). Accessed 03/23/14.

The PDF file above provides a lot of really good information in regard to seismic testing and how powerful these types of test are and what the direct impacts are on the sea life. One of the things from the article that really stood out to me was the fact that this airgun

that they want to use for seismic testing transmits a pulse/sound through the water that is roughly 100,000 more intense than a jet engine! The file goes on to give findings associated with these airguns and gives some recommendations.

Kumagai, J. April 2006. Drowning in Sound. *Spectrum*, IEEE 2006:54–60.

The primary literature article listed above is a good resource for individuals against seismic testing. The article actually gives a great example of a case that took place back in 2005. According to the article in 2005 more than thirty-four whales ran themselves into the sand on shore. The problem here once again linked back to sonar testing; in this case it was military sonar. This case really caught the attention of others and drew scrutiny to the issue of noise in our oceans. According to most whale experts sonar does not only deafen whales but in many cases kills them and these are just one of few species being negatively affected by the powerful and harmful nature of sonar surveys.

O'Neil, L. January 28, 2010. Seismic Shoot is Key to Opening Atlantic. *The Oil Daily* 2010:60(19).

The primary literature article listed above begins by talking about how President Obama and his administration staff are looking into the possibility of using seismic shoot surveys off the Atlantic Coast to look for valuable oil and gas deposits. The Interior department is a strong advocate surrounding this, should we allow or should we not allow seismic testing off the coast. The article tells us that through these seismic surveys, sound waves will be sent through the water and to the bottom of the ocean floor and this will help aid in the finding of hydrocarbons. It is said that by using a certain scientific approach seismic surveying can be done without harming the marine life, an issue that the environmentalist are very much concerned about.

O'Rourke, D., and S. Connolly. 2003. Just Oil? The Distribution of Environmental and Social Impacts of Oil Production and Consumption. *Annual Reviews*, Inc. 2003:587-617.

The review listed about is a compilation of previous data that is analyzed to observe the type of impacts that oil extraction, transport, refining, and consumption has on various sectors of society; such as, socioeconomic impacts, environmental impacts, biological impacts, etc... We are told that oil can have both positive and negative impacts and costs so it is important to strategically look at both sides of the issue and weigh the pros and cons.

Queram, K. February 28, 2014. Carolina Beach officials united in opposition of seismic testing. *StarNews Online*.

<http://www.starnewsonline.com/article/20140228/ARTICLES/140229615?p=2&tc=pg>.

Accessed 03/20/14.

The article above talks about one of the groups in opposition of seismic testing along the coast of North Carolina; this group is The Carolina Beach Town Council. In the article we learn that the Obama administration has a strong interest in allowing seismic testing in this region in order to search for oil or gas deposits. Many environmentalist hate the idea of seismic testing, however, the Bureau of Ocean Energy Management has come up with a strict environmental plan and feel confident in moving forward with the idea. In the article, we see that The Carolina Beach Town Council held a meeting in which they discussed the issue and later addressed it publicly.

Queram, K. March 10, 2014. East Coast seismic testing gets endorsement. Newbernsj.com. <http://www.newbernsj.com/news/local/east-coast-seismic-testing-gets-endorsement-1.289068>.

This very recent publication addresses the report put out by the Federal Bureau of Ocean Energy Management and how, while passing bills and setting everything into place is typically a long process, things are in motion. While the Kure beach mayor supports the process, many of the residents do not. The article goes on to talk about other beach towns that have voiced their opinion on the matter but it is unknown whether their opinion will hold as much weight as an official council statement.

Scales, H. February 28, 2014. Atlantic Seismic Tests for Oil: Marine Animals at Risk? National Geographic. <http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals/>. Accessed 03/22/14.

This article, published by in National Geographic, catches the readers eye by placing a large picture of a North Atlantic right whale in the article and stating that fewer than 500 of these species remain and the projected region for seismic surveys coincide with their main range. As mentioned in many other articles, there are lots of groups surrounding this controversy. One of the groups opposing seismic testing is Oceana. In this article we find out that according to the Environmental Impact Statement, written by the Federal Bureau of Ocean Energy Management, most wildlife will receive “minor to negligible” impact with the exception of marine mammals and turtles, for which the impact could be classified as “moderate.” The article goes into more detail about the various marine life in danger such as, dolphins, North Atlantic right whales, loggerhead sea turtles, etc...

Schoof, R. February 24, 2014. McCrory, other governors press for seismic testing off coastlines. NewsObserver.com. <http://www.newsobserver.com/2014/02/24/3650834/mccrory-other-governors-press.html>. Accessed 03/22/14.

This article discusses the various states and their governors that are pushing for seismic testing. Also, in this article the idea of creating jobs through this oil and gas extraction initiative is mentioned. One interesting concept that is mentioned in this article is something that state governors came up with. If any gas or oil deposits are found off the coast of their states in the federal waters then they want a system in which revenue is shared.

Shutak, M. March 24, 2013. N.C. Energy panel looks at revenue. Carteret News-Times. [http://www.carolinacoastonline.com/news\\_times/article\\_f26d3306-b107-11e3-8e6c-001a4bcf887a.html](http://www.carolinacoastonline.com/news_times/article_f26d3306-b107-11e3-8e6c-001a4bcf887a.html). Accessed 03/21/14.

This article expands off of the previously aforementioned article found above. Governor Pat McCrory want to ensure that coastal communities get a share of any potential revenue from any offshore energy that is found. Geologists feel that some areas off the coast hold a high significance because of high probability the oil or biogenic gas will be found there. This article would be good for individuals who want to learn more about the various parties affiliated with this controversial issue.

Smith, J. March 19, 2014. Energy Council rep. calls on N.C. to split future offshore oil money with coastal counties. WECT. <http://www.wect.com/story/25019542/energy->

[council-rep-calls-on-nc-to-split-future-offshore-oil-money-with-coastal-counties.](#)

Accessed 03/21/14.

One of the big topics related to seismic testing and offshore drilling is the idea of sharing revenue. According to this article there are roughly 20 coastal communities that would make use of the shared revenue. Some proposed examples of how to spend the acquired revenue include using it for beach renourishment, wetlands restoration, or other needs. The article tells us that other states such as Texas and Louisiana already set aside a large portion of their federal oil royalties for coastal communities and believes that N.C. legislature should agree to give half of any offshore revenue to their coastal counties. According to the article, state members have already began talking of revenue sharing for onshore gas, so hopefully that will lead to the topic of offshore revenue.

Troyan, M. February 28, 2014. Rules set for oil testing in Atlantic Ocean. GreenvilleOnline.com.

<http://www.greenvilleonline.com/article/20140228/NEWS07/302280057/Rules-set-oil-testing-Atlantic-Ocean>. Accessed 03/22/14.

The article above begins by talking about the Federal Bureau of Ocean Energy Management and their recently released 800 page environmental impact statement (EIS). While the EIS does not grant testing permits it opens up the path for processing applications from various companies that wish to survey what's below the ocean floor. For Representative Duncan he feels that we are moving forward with this process and it will lead us closer to energy independence as well as provide numerous new job opportunities. One part of the EIS states that additional technology would be used to detect when marine mammals come close during the survey; this is done to ensure their safety and protection. According to the article, an estimated nine companies have already put in 13 permit requests seeking to perform airgun surveys in the Atlantic region.

Weilgart, L.S. November 1, 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. *Canadian Journal of Zoology* 2007:1091-1116.

While this article is titled "The impacts of anthropogenic ocean noise on cetaceans and implications for management" I choose to include it in the annotated bibliography because it also mentions other marine life that is affected by seismic testing, such as beaked whales. The article goes on to talk about various stranding incidents and how the mortality rates are affected by naval maneuvers involving tactical sonars or seismic surveys. Sound waves have a huge impact not only on marine animals hearing but they could lead to increased stress levels, abandonment of important habitats, and "masking" of natural sounds.

Weir1, C.R. and S.J. Dolman. April 18, 2007. Comparative Review of the Regional Marine Mammal Mitigation Guidelines Implemented During Industrial Seismic Surveys, and Guidance Towards a Worldwide Standard. *Journal of International Wildlife Law & Policy* 2007:1-27.

This comparative review would have to be my favorite source out of all the primary literature sources listed in this annotated bibliography. The review tells us, not only seismic testing negatively affect marine mammals but it is also talks about the high

amplitude sounds associated with these airguns (tools used in seismic testing). These high frequency sounds can cause physical injury, indirect physical damage, physiological effects, and various forms of behavioral effects (such as feeding and mating). The review also talks about what has been done in some places to mitigate the impact that these surveys have on our marine life.

### **Travis Tobin**

Burns, M. April 15, 2013. Economist: Energy Exploration in NC has Benefits, Costs. WRAL. Available: <http://www.wral.com/economist-energy-exploration-in-nc-has-benefits-costs/12342043/>. Accessed 3/24/14.

Great article explaining both the costs and benefits of energy exploration in North Carolina including offshore oil drilling. Author mentions that there are both benefits and costs and that both should be researched and considered. Also includes more estimates on the economic impact to the state.

Carteret County News-Times. December 27<sup>th</sup>, 2013. Advocates push for offshore drilling. Carteret County News-Times. Available: [http://www.carolinacoastonline.com/news\\_times/article\\_74ef48de-6f07-11e3-af19-001a4bcf887a.html](http://www.carolinacoastonline.com/news_times/article_74ef48de-6f07-11e3-af19-001a4bcf887a.html). Accessed 3/24/14.

This article puts down all the positives that the government officials are trying to display about offshore drilling in the Atlantic. It says that with the amount of oil that is projected to be out there, its not even worth it. It is also brought up about how long it will take to actually start drilling and how much work it will be. It talks about the entire infrastructure that will have to be built. It is mentioned that it could be a decade or two before any oil could be tapped once they got started.

Cockerham, S. January 10<sup>th</sup>, 2014. Should we blast Atlantic with air guns to map oil drilling potential? McClatchyDC. Available: <http://www.mcclatchydc.com/2014/01/10/214159/should-we-blast-atlantic-with.html>. Accessed 3/24/14.

This article comes from Washington and gives a government perspective of the debate to search for offshore oil in the Atlantic Ocean. It mentions that the federal government has estimated that there are 3.3 billion barrels of oil and 31.28 trillion cubic feet of natural gas along the Atlantic seabed. Those estimates are 30-40 years old. This provides a need for more testing to be done.

Cummings, J., and N. Brandon. June 2004. SONIC IMPACT: A Precautionary Assessment of Noise Pollution From Oceanic Seismic Surveys. Greenpeace.

This writing describes how seismic testing is done as well as great photographs that show the process. It shows different sounds that are comparable to the sounds that the air guns make underwater during a survey. It describes many different effects on marine life including physiological effects, as well as behavioral changes. It includes ethical considerations to the problem as well as calls for action on how to help create a solution.

Dalesio, E. December 23<sup>rd</sup>, 2013. Advocates push for new Atlantic offshore drilling. Associated Press. Available: <http://finance.yahoo.com/news/advocates-push-atlantic-offshore-drilling-172831233.html>. Accessed: 3/24/14.

This article describes this situation as a “trade-off between financial gain and environmental costs.” It goes into detail about both the financial gains that could be in play for North Carolina and also the environmental costs that could also happen. Also mentioned is the fact that this area has not been tested for oil in 30-40 years and that there is potential to be much more than expected in the Atlantic.

Huelsenbeck, M., and C. Wood. April 2013. A Deaf Whale is A Dead Whale, Seismic Airgun Testing for Oil and Gas Threatens Marine Life and Coastal Economies. OCEANA.

This report shows the potential environmental and economical effects on seismic testing off the east coast. It shows great figures on the blast zone and how large it will be along the coast. It goes over different species that will be affected and how they have already been impacted.

Miller, T. January 23<sup>rd</sup>, 2013. Why the Federation Is Opposed to Drilling off N.C. North Carolina Coastal Federation. Available: <http://www.nccoast.org/Blog-Post.aspx?k=7966dc36-bd8e-477c-be47-1ffb362eb626>. Accessed 3/24/14

This article is one huge argument against offshore drilling in North Carolina. It is very detailed with a lot of good points. The author also states points for drilling in North Carolina and what kind of economic impact it could have on the state. He talks about wanting to keep our coast spectacular like it always has been.

Morris, R. March 3<sup>rd</sup>, 2014. Opinions Split on Offshore Seismic Testing. North Carolina Coastal Federation. Available:

<http://www.nccoast.org/Article.aspx?k=ec1bd237-d802-4f3e-802d-c50ff2cbcb58>.  
Accessed 3/23/14.

This article mentions governor McCrory's decision to welcome the idea of testing for offshore oil in North Carolina. Talks about the jobs it would provide as well as revenue for the state. Also mentions concerns from environmental groups on the effect on marine life.

Murawski, J. October 9<sup>th</sup>, 2013. Opening Atlantic Ocean to offshore drilling likely. News and Observer. Available: <http://www.trianglejobs.com/2012/10/02/4244/opening-atlantic-ocean-to-offshore.html>. Accessed 3/24/14.

This article speaks about the push for offshore drilling off of North Carolina and how the idea is becoming closer to reality. It mentions the potential revenue for the state to be between \$66 million and \$400 million a year. It notes that offshore seismic testing could bring 6,700 jobs to North Carolina.

Penn Energy Editorial Staff. December 9<sup>th</sup>, 2013. Offshore oil drilling would bring 55,000 jobs to NC economy. Penn Energy. Available: <http://www.pennenergy.com/articles/pennenergy/2013/12/offshore-oil-drilling-would-bring-55-000-jobs-to-nc-economy.html>. Accessed: 3/24/14.

This is a short article that provides good information on the potential economic impact of offshore drilling in North Carolina. It provides eye-opening numbers as to what could be in store for the state. \$885 million in annual royalties between 2017-2035 and 55,000 jobs for the state by 2035 is part of what it mentions.

Peterson, D. February, 2004. Seismic Survey Operations: Impacts on Fish, Fisheries, Fishers and Aquaculture. British Columbia Seafood Alliance.

This article answers many questions about seismic testing. It provides information on how it is done and its different effects on the marine environment. It answers the questions about the economical side of it with how jobs will be effected. It specifically talks about the noise that is involved with testing, and the effects on fishing.

Popper, A., M. Smith, P. Cott, B. Hanna, A. MacGillivray, M. Austin, and D. Mann. March 16<sup>th</sup>, 2005. Effects of exposure to seismic airgun use on hearing of three fish species.

This was an experiment done on three species of fish to find the effects on fish hearing from air gun blasts used in seismic testing. The three species they used were the lake chub, northern pike, and broad whitefish. Their results were very interesting and find that the effects on fish hearing had a direct correlation with the fish's hearing sensitivity.

Simmonds, M., S. Dolman, and L. Weilgart. 2004. *Oceans of Noise*. Whale and Dolphin Conservation Society.

This is a report done by the Whale and Dolphin Conservation Society on specific effects of noise to different whale and dolphin species. It goes through many different types of marine noise that disturb marine life, with seismic testing being one of them. It describes the use of sound by whales and dolphins and how these loud noises in their environments are a problem.

Sturgis, S. March 4, 2014. The growing fight against oil and gas exploration off the NC coast. Facing South. Available: <http://www.southernstudies.org/2014/03/the-growing-fight-against-oil-and-gas-exploration-.html>. Accessed 3/24/14.

This article shows the opposition that governor McCrory is facing with his support of offshore seismic testing off the coast of NC. Coastal communities are not happy with his decision and strongly disagree with him. This article gives specific meetings that coastal communities are having and how worried they are about the potential impact of this decision.

Talton, T. January 21<sup>st</sup>, 2014. Testing for Offshore Drilling Sets off Debate. North Carolina Coastal Federation. Available: <http://www.nccoast.org/m/article.aspx?k=e47a2c31-a84b-4f13-a877-77ffa7ebe5f3>. Accessed 3/23/13.

This article describes both sides of the topic. It explains the process of testing for offshore oil and mentions the effect it has on marine life. It talks about how valuable this could be to North Carolina and how much revenue it could bring into the state. The author mentions it could be worth billions to North Carolina.

### **Adrian Vu**

\*Akamatsu, T., Y. Hatakeyama, and N. Takatsu. 1993. Effects of Pulse Sounds on Escape Behavior of False Killer Whales. *Nippon Suisan Gakkaishi*. 59(8): 1297-1303.

This article talks about an experiment that was done where the behavior of two false whales was observed in response to different underwater sounds. The whales were kept in an enclosed area and were exposed to fifteen different kinds of sounds and was subjected to sixty eight experiments. The behavior of the whales were recorded and classified as “effective,” “somewhat effective,” and “not effective.”

\*Bowles, A. E., M. Smultea, B. Wursig, D. P. DeMaster, D. Palka. 1994. Relative abundance and behavior of marine mammals exposed to transmissions from the Heard Island Feasibility Test. *Acoustical Society of America*. 96(4): 2469-2484

This article focuses on the Heard Island Feasibility Test and how this test would affect marine mammals. Researchers monitored these marine mammal’s behavior visually and acoustically in a 70x70 km square transmission site.

Foley, J. A. April 17, 2013. Dolphins and Whales at risk from Offshore Seismic Testing in Atlantic Ocean, Group Warns. *Nature World News*.  
<http://www.natureworldnews.com/articles/1434/20130417/dolphins-whales-risk-offshore-seismic-testing-atlantic-ocean-group-warns.htm> Accessed March 24, 2014.

This article talks about the risks of offshore seismic testing and the impact it has on marine life specifically dolphins and whales. The article goes into detail about the harm that seismic testing does as well as the estimated injuries and possible fatalities of dolphins and whales.

\*Gausland, I. 2000. Impact of seismic surveys on marine life. *The Leading Edge*. 19(8): 903-905.

This article focuses on seismic testing and the impact of seismic testing on marine life and as well the environmental impact. The article mentions the different sound levels and how the sound level affects behavior and marine life. The goal of this article is clear up the confusion over sound-levels and the misunderstanding of the nature of seismic signals.

Litvak, A. March 21, 2014. Seismic tests before drilling cause Pa. disputes. *The Post-Gazette*. <http://www.sfgate.com/business/energy/article/Seismic-tests-before-drilling-cause-Pa-disputes-5339865.php> Accessed March 24, 2014.

This article talks about how seismic testing in Pennsylvania has stirred up controversy. This article also talks about the specific problems with the drilling as well as the seismic testing and whether or not the pros outweigh the cons.

Mundy, A. February 27, 2014. Interior Department Endorses Seismic Testing for Oil and Gas Off Atlantic Coast. The Wall Street Journal. <http://online.wsj.com/news/articles/SB10001424052702304071004579409621926543690> Accessed March 24, 2014.

This article talks about the Interior Department endorsing seismic testing in the Atlantic, which will be the first step towards oil and gas drilling. The article goes into details about the environmental impacts and how measures will be taken in order to minimize these impacts.

Oceana. No Date. Seismic Airgun Testing: Overview. Oceana. <http://oceana.org/en/our-work/climate-energy/seismic-airgun-testing/overview> Accessed March 24, 2014.

This article gives a brief description as to what an airgun is. It also talks about the uses of the airgun and the environmental impact the airgun has especially on marine life such as whales, dolphins and more. The article touches on how the use of the seismic airgun will also lead to offshore drilling which is harmful for the environment.

\*OSAPR Commission. 2009. Overview of the impacts of anthropogenic underwater sound in the marine environment. Biodiversity Series. The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”).

This document gives an overview of underwater sounds. The document then goes into detail about the impacts of the sound on marine life, effects on those marine life, how shipping affects marine life, the use of sonar and its effects on marine life, and seismic surveys and how that affects marine life.

Queram, K. E. March 10, 2014. East Coast seismic testing gets endorsement. Halifax Media Services. <http://www.newbernsj.com/news/local/east-coast-seismic-testing-gets-endorsement-1.289068> Accessed March 24, 2014.

This article talks about how seismic testing is getting closer to being a reality on the East Coast. Seismic testing has been recently endorsed by the Federal Bureau of Ocean Energy Management. An environmental impact statement was released

on February 27, 2014 and has guidelines, however it is believed to be a step closer towards allowing oil and gas drilling.

Queram, K. E. February 28, 2014. Carolina Beach officials united in opposition of seismic testing. Star News Online.

<http://www.starnewsonline.com/article/20140228/ARTICLES/140229615?tc=ar>

Accessed March 24, 2014.

This article focuses on the side that is against seismic testing. The article talks about the negative impacts of seismic testing and reasons why seismic testing shouldn't take place.

\*Richardson, W.J. and B. Wursig. 1997. Influences of man-made noise and other human actions on cetacean behaviour. *Marine and Freshwater Behaviour and Physiology*. 29(1-4): 183-209.

This article is about how man-made sounds effect cetaceans. The article summarizes the observed reactions of cetaceans to noise and from other man-made sounds such as boats, marine industrial activities, seismic exploration, and more. The hearing thresholds are also specified for certain species and are variable even among the same species.

Scales, H. February 28, 2014. Atlantic Seismic Tests for Oil: Marine Animals at Risk?. National Geographic. <http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals/> Accessed March 23, 2014.

This article gives a brief description of the governments plan to continue to use seismic testing to test for oil and the steps that the U.S. Department of Interior's Bureau of Ocean Energy Management (BOEM) are taking to make sure the seismic testing will only have "moderate impacts on marine mammals and sea turtles. The article also highlights certain species and ways to minimize impact on these species by proposing alternatives.

Schoof, R. February 24, 2014. McCrory, other governors press for seismic testing off coastlines. News and Observer.

<http://www.newsobserver.com/2014/02/24/3650834/mccrory-other-governors-press.html>

Accessed March 24, 2014.

This article highlights how Governor Pat McCrory and the governors of Virginia, Mississippi and Alabama are pressing for seismic testing for oil and gas off the

coast. The article also touches on considerations and ways to implement their plan with minimal negative environmental impact.

Snyder, J. February 27, 2014. Review Clears Path for Seismic Tests of U.S. Atlantic Oil. Bloomberg. <http://www.bloomberg.com/news/2014-02-27/review-clears-path-for-seismic-tests-of-u-s-atlantic-oil.html> Accessed March 24, 2014.

This article talks about how seismic measuring of oil and gas off the Atlantic coast can be done safely under certain conditions. The article focuses on ways to proceed with seismic testing with minimal environmental impact, long-term strategy, and how production will rise.

Talton, T. January 21, 2014. Testing for Offshore Drilling Sets Off Debate. North Carolina Coastal Federation. <http://www.nccoast.org/m/article.aspx?k=e47a2c31-a84b-4f13-a877-77ffa7ebe5f3> Accessed March 22, 2014.

This article talks about the controversy over whether or not offshore drilling should be allowed or not. Both sides are still waiting for BOEM to release its final environmental impact statement on seismic surveying and the affects it could have on marine life. The primary problem is the that sound created from the survey will negatively impact marine life.

### **Takeisha Ward**

Bernstein, L. 02/27/2014. Washington Post. U.S. rules would allow ‘seismic air guns’ in search for offshore oil, gas. [http://www.washingtonpost.com/national/health-science/us-rules-would-allow-seismic-air-guns-in-search-for-offshore-oil-gas/2014/02/27/68533a0c-9ffb-11e3-a050-dc3322a94fa7\\_story.html](http://www.washingtonpost.com/national/health-science/us-rules-would-allow-seismic-air-guns-in-search-for-offshore-oil-gas/2014/02/27/68533a0c-9ffb-11e3-a050-dc3322a94fa7_story.html). Accessed 03/23/2014.

This source tells us that the federal government has proposed rules that would allow the use of “seismic air guns” and other methods of exploring the ocean floor off a huge part of the southeastern U.S. for the first time in decades. It tells us also that nine companies have applied for permits to use the loud devices to determine how much fossil fuel lies beneath the water in a 330,000 square-miles area from Delaware Bay to south of Cape Canaveral

Boniti, Loretta. 03/04/2014. Time Warner Cable News. Seismic testing may soon happen off of NC coast. <http://triadnc.twcnews.com/content/news/705340/seismic-testing-may-soon-happen-off-of-nc-coasts> . Accessed 03/23/2014.

This source tells us that North Carolina’s coast could soon see seismic testing. A New Hanover County republican wanted to know the options for doing seismic

testing in a safe way. It also tells us that under a law passed last year, Senate Bill 76, the governor was encouraged to create a three state compact on offshore energy. That compact would consist of our neighbors to the north and south Virginia and South Carolina. However, this compact is on the back burner.

Bonni, William and Woolard, George. March. AAPG Datapages/Archives. Subsurface Geology of North Carolina-South Carolina Coastal Plain from Seismic Data. Vol 44, Iss 3. <http://archives.datapages.com/data/bulletns/1957-60/data/pg/0044/0003/0250/0298.htm>. Accessed 03/23/2014.

This source tells us of sixty new seismic-refraction measurements on the Coastal Plain of NC and SC that were made to fill gaps in existing well and geophysical data, and to make a more comprehensive study of the structure of the Coastal Plain floor. Seismic velocities were observed and conclusions were made based off the observations.

Dalen, J. and Knutsen, G. 1987. Progress in Underwater Acoustics. Scaring Effects in Fish and Harmful Effects on Eggs, Larvae and Fry by Offshore Seismic Explorations. pp 93-102. [http://link.springer.com/chapter/10.1007/978-1-4613-1871-2\\_12](http://link.springer.com/chapter/10.1007/978-1-4613-1871-2_12). Accessed 03/23/2014.

This source tells us of research that took place in the North Sea during June, 1984. The observed behavioral patterns of the fish along the course lines of the seismic vessel immediately before and just after air gun shooting, and the changes proved that the fish were affected. Changes in fish distribution were seen one week after shooting, and compared to that of right before.

Greenpeace. No Date. Seismic and Sonar Testing. <http://www.greenpeace.org/usa/en/campaigns/oceans/Seismic-Testing-Sonar-Testing/>. Accessed 03/23/2014.

This source informs us of the impacts of seismic testing. It tells us that according to the government, 138,500 whales and dolphins will soon be injured and possibly killed along the East Coast if exploration companies are allowed to use seismic testing offshore. It says that the air-guns use compressed air to generate intense pulses of sounds, which are 100,000 times more intense than a jet engine. These blast are used on a recurring basis, going off every ten seconds, for 24 hours a day, often for weeks at a time.

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M. Simmonds, R. Swift, D. Thompson. 12/01/2003. Marine Technology Society Journal. A Review of the Effects of Seismic Surveys on Marine Mammals. Vol. 37, Iss 4. <http://www.ingentaconnect.com/content/mts/mts/2003/00000037/00000004/art00003>. Accessed 03/23/2014.

This source highlights significant gaps in our knowledge of the effects of seismic air gun noise on marine mammals. Potential biological effects include physical/physiological effects, behavioral disruption, and indirect effects associated with altered prey availability. Direct information on the extent to which seismic pulses could damage hearing is difficult to obtain. Consequently, the true impacts on hearing are poorly known.

Killough, W. 01/29/2014. Island Gazette. Kure Beach Council Hears Citizen Input On Seismic Air-gun Testing. <http://islandgazette.net/news-server5/index.php/news/local-and-state-news/local/21360-kure-beach-council-hears-citizen-input-on-seismic-air-gun-testing>. Accessed 03/23/2014.

This source tells us of how approximately 300 people rallied at Kure Beach Town Hall on January 27<sup>th</sup> to voice their opposition to Mayo Dean Lambeth signing a letter in December 2013 supporting seismic air-gun testing for off shore oil and natural gas exploration. They were angry they had no chance to voice concerns on the issue prior to the Mayor signing the letter. It also explains certain specifics of the letter.

McCauley, R., J. Fewtrell, A. Popper. 01/08/2003. The Journal of the Acoustical Society of America. High intensity anthropogenic sound damages fish ears. Vol 113, issue 1. <http://scitation.aip.org/content/asa/journal/jasa/113/1/10.1121/1.1527962>. Accessed 03/23/2014.

This source tells us about the marine petroleum exploration and how it involves the repetitive use of high-energy noise sources, air guns, which produce short, sharp, low-frequency sound. It also shows us that the ears of fish exposed to an operating air-gun sustained extensive damage to their senses, with no evidence of repair or replacement.

Morris, R. 03/03/2014. North Carolina Coastal Federation. Opinions Split on Offshore Seismic Testing. <http://www.nccoast.org/Article.aspx?k=ec1bd237-d802-4f3e-802d-c50ff2cbcb58> . Accessed 03/23/2014.

This source tells about Gov. Pat McCrory welcoming a new federal environmental review that sets broad standards for companies to use seismic testing and other methods to look for oil and natural gas under the ocean floor. It also tells us that a N.C. State University study estimates that exploration off the coast would produce 1,122 jobs and \$181 million annually for the state during its first seven years. It also tells us how one environmental group, Oceana, warns that seismic air guns will damage marine life, and therefore lead to bigger losses in commercial and recreational fishing industries.

PilotOnline.com. 01/28/2014. Kure Beach, N.C., mayor criticized for seismic testing. <http://hamptonroads.com/2014/01/kure-beach-nc-mayor-criticized-seismic-testing>. Accessed 03/23/2014.

This source tells us that hundreds of people at a beach town in southeastern North Carolina are upset with the mayor's decision to support seismic testing for oil and gas off the coast. Mayor Dean Lambeth signed a letter last month written by America's Energy Forum, which is a lobbying group backed by the American Petroleum Institute. Conservationists worry that the testing would disrupt migrating North Atlantic right whales, loggerhead sea turtles and other species.

Popper, A., M. Smith, P. Cott, B. Hanna, A. MacGillvray, M. Austin, D. Mann. 05/31/2005. The Journal of the Acoustical Society of America. Effects of exposure to seismic airgun use on hearing of three fish species. Vol 117, Iss 6.

<http://scitation.aip.org/content/asa/journal/jasa/117/6/10.1121/1.1904386> . Accessed 03/23/2014.

This source tells us about the amounts of acoustic energy produced by seismic air guns that have the potential to affect marine life. The study investigates the effects of exposure to a 730in air gun array on hearing of three fish species. They placed the species in cages and conducted a controlled experiment.

Talton, Trista. 01/21/2014. North Carolina Coastal Federation. Testing for Offshore Drilling Sets Off Debate. <http://www.nccoast.org/m/article.aspx?k=e47a2c31-a84b-4f13-a877-77ffa7ebe5f3>. Accessed 03/23/2014.

This source tells us of the controversy going on because of the N.C. beach town mayor that has supported the petroleum industry's push for seismic testing off the Atlantic coast. It also tells us of the negative effects that the air gun and non-air gun surveying might have on marine mammals and fish in the Atlantic. Along with that, it tells us that offshore oil and natural gas development in the Atlantic could generate upwards of 280,000 jobs and contribute up to \$23.5 billion to the U.S. economy each year.

The Republic. 03/01/2014. Carolina Beach Town Council approves resolution opposing seismic testing off the NC coast. <http://www.therepublic.com/w/NC--Seismic-Testing>. Accessed 03/23/2014.

This source tells us that the Carolina Beach Town Council said No to seismic testing for oil and gas off the North Carolina coast. The council approved the resolution unanimously Friday, the day after a federal agency endorsed the process along the eastern seaboard. The federal Bureau of Ocean Energy Management endorsed the testing on Thursday, pointing out that it would require oil and gas companies to adhere to strict environmental standards to protect marine life.

Townsend, S. No Date. Shale Advice. Seismic testing damage. <http://www.shleadvice.com/1417/hopewell-resident-says-seismic-testing-damaged-his-home/>. Accessed 03/23/2014

This source tells of a Hopewell Township resident that experience house damage due to seismic activity. Water was coming out of his water line, there was a big crack in his driveway, and his garage floor was cracked on the side. On top of that, damage from seismic testing was not covered under his homeowner's policy.

W. Alexis. 03/09.2014. Wisegeek. What is Seismic Testing? <http://www.wisegeek.com/what-is-seismic-testing.htm>. Accessed 03/23/2014.

This source tells us a little about what seismic testing and it's uses. It tells us history about seismic testing, including that of when it was developed and its use to detect patterns that indicate impending earthquakes. It explains how later seismic testing became popular because it was discovered to be able to measure the presence of petroleum and natural gas in seas and oceans as well.

**Brenna Wells**

\*Andre, M., P. E. Nachtigall. 2007. Electrophysiological Measurements of Hearing in Marine Mammals. *Aquatic Mammals* 33: 1-5. Available: <http://search.proquest.com.jproxy.lib.ecu.edu/docview/197736156>. Accessed 03/22/14.

This journal article talks about at what levels the different marine mammals hear. It also talks about the different types of noises they can hear, amplitude vs clicking sounds. Things such as beluga whales, dolphins, elephant seals, and manatees are looked at.

\*Carls, M. G., S. D. Rice, J. E. Hose. 2010. Sensitivity of fish embryos to weathered crude oil: Part I. Low-level exposure during incubation causes malformations, genetic damage, and mortality in larval pacific herring (*Clupea pallasii*). *Environmental Toxicology and Chemistry* 18: 481-493. Available: <http://onlinelibrary.wiley.com/doi/10.1002/etc.5620180317/full>. Accessed 03/22/14.

This study is done on Pacific herring eggs that were exposed to seismic testing levels. The eggs suffered malformations, genetic damage, mortality, decreased size, and inhibited swimming. The oil that leaked into the water also effected the overall pH of the water which effects marine life in a different way than the sound produced from the testing.

\*Govoni, J. J., M. A. West, L. R. Settle, R. T. Lynch, M. D. Greene. 2008. Effects of Underwater Explosions on Larval Fish: Implications for a Coastal Engineering Project. *Journal of Coastal Research* 24: 228-233. Available: <http://www.jcronline.org/doi/abs/10.2112/05-0518.1>. Accessed 03/24/14.

The impacts of underwater explosions are usually focused on adult fish, turtles, and marine mammals. This study focuses on the impacts the explosions have on fish larvae and juveniles. About 2-3% of fish larvae in a system can be seriously injured or killed, this is unlikely to have a sufficient affect of fish populations at this level.

Greenpeace. No date. Seismic Testing. Greenpeace USA. Available: <http://www.greenpeace.org/usa/en/campaigns/oceans/Seismic-Testing-Sonar-Testing/>. Accessed 03/19/14.

U.S. Department of the Interior (DOI) is considering letting 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. The airguns are 100,000 times more intense than a jet engine. Impacts on marine mammals include: temporary or permanent hearing loss, abandonment of habitat, disruption to mating and feeding, and beach stranding and death. Pacific Coast Greenpeace just won a battle in favor of marine life when California Coastal Commission denied a seismic testing application from the energy company PG&E, the same opportunity will soon be happening on the East Coast.

Heulsenbeck, M., C. Wood. 2013. A Deaf Whale is a Dead Whale. Oceana. Available: [http://americadelsur.oceana.org/sites/default/files/reports/Seismic\\_Airgun\\_Testing\\_Report\\_FINAL.pdf](http://americadelsur.oceana.org/sites/default/files/reports/Seismic_Airgun_Testing_Report_FINAL.pdf). Accessed 03/22/14.

The government estimates that 138,500 whales and dolphins will be injured or killed if seismic testing is started on the East Coast. The sounds made by the air guns are 100,000 times more intense than a jet engine, 250 dB in water. The testing is just the first step towards drilling, which is harmful because of leaks, spills, habitat destruction and greenhouse gas emissions.

Killough III, W. 2014. Kure Beach Council Set to Discuss Seismic Testing on Jan. 27<sup>th</sup>. Island Gazette. Available: <http://www.islandgazette.net/news-server5/index.php/news/local-and-state-news/local/21194-kure-beach-council-set-to-discuss-seismic-testing-on-jan-27th>. Accessed 03/24/14.

Mayor Dean Lambeth sent a letter supporting seismic testing and off shore drilling for oil and gas and it has upset citizens and environmental groups. Oceana has contacted the mayor saying they do not support his decision. His letter stated that he thinks it will create more jobs, and help the economy, especially the coastal communities.

\*Mann, D. A., D. E. Colbert, J. C. Gaspard, B. M. Casper, M. L. H. Cook, R. L. Reep, G. B. Bauer. 2005. Temporal Resolution of the Florida Manatee (*Trichechus manatus latirostris*) Auditory System. *Journal of Comparative Physiology* 191: 903-908. Available: <http://search.proquest.com.jproxy.lib.ecu.edu/docview/17258750/99023DD6A69C49F2PQ/1?accountid=10639>. Accessed 03/22/14.

Auditory responses of Florida manatees were measured in response to amplitude modulated tones. The animals are most sensitive to anything above 150 Hz AM rates. When some testing is done and the numbers are underestimated it is probably due to the electrodes being located several centimeters from the brain.

\*Prakash, A., B. G. Samanta, N. P. Singh. 2013. Evidence of Gas Hydrate Accumulations and its Resource Estimation in Andaman Deep Water Basin from Seismic and Well Log Data. *Marine Geophysical Research* 34: 1-16. Available: <http://search.proquest.com.jproxy.lib.ecu.edu/docview/1356916691/abstract?accountid=10639>. Accessed 03/22/14.

Both 2D and 3D seismic reflection are used to test for gas hydrate. Gas hydrates show relatively high acoustic velocity and electrical resistivity values compared to unconsolidated water-saturated sediments. 3D seismic testing gives a better estimate for how much gas is available and where it is located in the ground.

Scales, H. 2014. Atlantic Seismic Tests for Oil: Marine Animals at Risk. National Geographic. Available: <http://news.nationalgeographic.com/news/energy/2014/02/140228-atlantic-seismic-whales-mammals/>. Accessed 03/19/14.

Matthew Huelsenbeck, a marine scientist at Oceans, compared seismic testing to “dynamite going off in your living room or backyard every ten seconds for days to weeks at a time.” Helen Scales says that the government estimates that there is 1.3 to 5.58 billion barrels of oil beneath the Atlantic outer continental shelf compared to the estimate of 38.8 to 59.2 billion barrels in the Gulf of Mexico. However, these numbers could be understated because they were calculated with equipment that was used in 1988 and is undated. It is estimated by EIS that 138,000 marine animals could be injured in some way, and 13.6 million could have their migration, feeding, or other behavioral patterns disrupted by the seismic testing. The main Atlantic ocean species likely affected are North Atlantic Right Whales, Humpback Whales, Dolphins, Loggerhead Turtles, and Commercial Fish.

Shutak, M. 2014. N.C. Energy Panel Looks at Revenue. Carteret County News-Times. Available: [http://www.carolinacoastonline.com/news\\_times/article\\_f26d3306-b107-11e3-8e6c-001a4bcf887a.html](http://www.carolinacoastonline.com/news_times/article_f26d3306-b107-11e3-8e6c-001a4bcf887a.html). Accessed 03/24/14.

Drilling will only happen if there is enough oil to make it profitable for the state of North Carolina. There are fossil fuels out there, but they are not sure how much is actually available. The BP spill scared the N.C. Coastal Resources Commission, knowing there could be damage to the coastal communities.

Stauffer, P. 2014. Atlantic Ocean to Become a Blast Zone? Seismic Testing for Oil and Gas Nears Approval. Surfrider Foundation. Available: <http://www.surfrider.org/coastal-blog/entry/atlantic-ocean-to-become-blast-zone-seismic-testing-for-oil-gas-nears-appro>. Accessed 03/24/14.

The federal government is moving toward the plan to test for oil and gas off the East Coast. There has been an intense debate over this topic for a year and the majority of citizens are opposed to this proposal. Surfrider Foundation responded to the proposal by stating that seismic airgun testing would cause catastrophic damage to the marine ecosystem.

Talton, T. 2014. Testing for Offshore Drilling Sets Off Debate. North Carolina Coastal Federation. Available: <http://www.nccoast.org/m/article.aspx?k=e47a2c31-a84b-4f13-a877-77ffa7ebe5f3>. Accessed 03/19/14.

Trista Talton goes into detail about what seismic testing is and how it is done. There are also different ways of going about testing, using the airguns interferes with the sonar of marine mammals, but there's ways of doing the tests with different wave frequencies that don't interfere with the mammals. Money

generated from seismic testing can help pay for beach re-nourishment projects Dean Lambeth said. Applicants must receive authorization under the Marine Mammal Protection Act and from the National Marine Fisheries Service before they can start the testing. If the government allows testing in the Atlantic, drilling could start as early as 2009.

UPI. 2014. Seismic Testing to Atlantic oil and gas. United Press International. Available: [http://www.upi.com/Business\\_News/Energy-Resources/2014/02/28/Seismic-testing-for-Atlantic-oil-and-gas/UPI-97661393610463/](http://www.upi.com/Business_News/Energy-Resources/2014/02/28/Seismic-testing-for-Atlantic-oil-and-gas/UPI-97661393610463/). Accessed 03/19/14.

The U.S. Interior Department's Bureau of Ocean Energy Management says that they do not authorize any geological or geophysical testing, but they are establishing a framework for additional mandatory environmental reviews for applications to do testing. Oceana says seismic airguns are loud enough to kill small animals like fish eggs and larvae and can disrupt behavior of large animals up to 100 miles away.

Queram, K. E. 2014. East Coast Seismic Testing Gets Endorsement. Star News Online. Available: <http://www.starnewsline.com/article/20140309/ARTICLES/140309722>. Accessed 03/24/14.

The Federal Bureau of Ocean Energy Management released an endorsement of Feb 27 wanting to move forward with seismic testing. The endorsement does not give permission, as there still is an approval process, but it's a step towards drilling in North Carolina.

Queram, K. E. 2014. Kure Beach mayor sees backlash for seismic testing support. Star News Online. Available: <http://www.starnewsline.com/article/20140127/ARTICLES/140129695?p=2&tc=pg>. Accessed 03/19/14.

Kate Queram talks about the hundreds of people that attended a town meeting regarding Myor Dean Lambeth's decision to sign a letter endorsing seismic testing off the NC coast. The public says that they feel they were not represented by their mayor in this decision. The mayor invited Brady Bradshaw, campaign coordinator for Echo Friendly Action, to speak and he outlined the potential environmental consequences for seismic testing, particularly the disruption to the migration of the North Atlantic right whales, loggerhead sea turtles and other species, including red drum.