

*Office of the Governor
State of North Carolina*

*Roy Cooper
Governor*



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July 21, 2017

Mr. Wilbur L. Ross, Jr., Secretary
U.S. Department of Commerce
1401 Constitution Ave., NW
Washington, D.C. 20230

Ms. Jolie Harrison, Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

Dear Secretary Ross and Ms. Harrison:

The North Carolina Department of Environmental Quality submits the attached comments and requests that you deny applications for authorization to incidentally harass marine mammals off North Carolina's coast.

On July 20, 2017, I announced my strong opposition to oil and gas drilling and exploration off the coast of North Carolina. Seismic testing and offshore drilling threaten our coastal economy and environment, yet offer little economic benefit to North Carolina. North Carolina has over 300 miles of coastline and coastal tourism generates \$3 billion annually, supporting more than 30,000 jobs in the eastern part of the state. Commercial fishing brings in another \$95 million every year. We cannot afford to endanger the natural resources that serve as the foundation of our tourism industry and coastal economy.

As the attached comments explain, geophysical and geological surveying pose a significant threat to marine mammals off our shores. Opening North Carolina's coast to offshore drilling is a bad deal for our state. Accordingly, I ask that you respect the wishes of North Carolina and deny the incidental harassment authorization applications.

Very truly yours,

A handwritten signature in black ink, appearing to read "Roy Cooper".

Roy Cooper



ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

July 21, 2017

Jolie Harrison
Chief, Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910

Dear Ms. Harrison:

I am writing on behalf of the State of North Carolina in response to the June 6, 2017, National Marine Fisheries Service (NMFS) Federal Register notice (82 Fed. Reg. 107) of five proposed incidental harassment authorizations (IHAs) pursuant to the Marine Mammal Protection Act (MMPA). If finalized, the IHAs would allow geophysical and geological survey activity in the Atlantic Ocean off North Carolina's coast that would harm marine mammals. The surveys would harass the diverse assemblage of marine mammals in the highly productive ecosystem created by the confluence of the Gulf Stream and Labrador Currents along North Carolina's coast, resulting in takings of more than a small number of mammals and that will have a more-than-negligible impact on these species. The disruption of North Carolina's critical marine resources by seismic surveying and offshore drilling represent a critical threat to North Carolina's coastal communities and economy. For this reason, North Carolina Governor Roy Cooper announced on Thursday, July 20, 2017, our state's strong opposition to seismic testing and offshore drilling along our coast.

Seismic testing and offshore drilling offer little economic benefit to North Carolina, yet threaten our coastal economy. North Carolina's coastal economy depends upon tourism and commercial fishing, both of which would be threatened by offshore drilling and exploration. North Carolina has over 300 miles of coast line and coastal tourism generates \$3 billion annually, supporting more than 30,000 jobs in the eastern part of the state. Commercial fishing brings in another \$95 million every year. There is no 100% safe offshore drilling method, and the risk of catastrophic oil spill will always be part of the equation. Offshore drilling comes with massive risk to North Carolina's economy and environment but virtually no potential economic benefit. Bottom line: Opening North Carolina's coast to offshore drilling is a bad deal for our state.

In addition, the IHAs if authorized will become part of a faulty permitting process that deprives North Carolina of its normal consistency review for seismic activities. In particular, the Bureau of Ocean and Energy Management (BOEM) re-started the seismic survey permitting process by resurrecting denied permits. It is also trying to bind North Carolina to consistency determinations made in 2015 when such determinations expire after one year. Such irregularities should invalidate the seismic survey process and avoid the need to issue IHAs altogether. Assuming, *arguendo*, that BOEM has the authority to continue review of a permit previously denied, we ask that you deny the IHA requests.

Under the Marine Mammal Protection Act, the NMFS may only allow the incidental taking of small numbers of marine mammals if the impact of those takings will have a negligible impact on marine mammals. Our review of the proposed IHAs and relevant scientific literature indicate that geological and geophysical surveying in the Mid-Atlantic region will have more than a negligible impact on marine mammals. In our view, the conclusion in the proposed IHAs that impacts on marine mammals will be negligible is due to a failure to sufficiently account for key findings in relevant scientific literature. First, the proposed IHAs insufficiently address key scientific studies and therefore ultimately undercount the number of marine mammal takes that would result from seismic testing. Second, the proposed IHAs overstate the effectiveness of putative mitigation measures and fail to adequately address key scientific findings. In light of the potential harms to marine mammals indicated by the peer-reviewed scientific literature, I respectfully request that you deny the requests for incidental harassment authorizations off the shore of North Carolina.

BOEM's Seismic Survey Permit Process is Faulty

The seismic survey permit applications that necessitate the IHAs were denied by BOEM in January 2017. The BOEM Director directed the denial in order to avoid the possibility of any level of environmental impact from airgun surveys and because there was no immediate need to acquire the Atlantic data. Factors in the Director's decision that seismic airgun activities was unnecessary were:

- "The Secretary decided to remove the Atlantic planning areas from any leasing in the 2017-2022 Five Year Program and there is no immediate need for new G&G data from seismic airgun surveys to inform pending decisions;
- The G&G data to be acquired could become outdated if the Atlantic is offered for oil and gas leasing activities too far into the future, as is the case now with the G&G data currently available;
- Developments in technology might allow for the use of lower impact airguns or other seismic instruments that do not have the potential for the level of impacts on the environment from currently proposed airgun surveys; and
- Although the mitigation measures included in the Atlantic G&G PEIS may be adequate for purposes of minimizing the level of impacts that airguns could cause on the environment (e.g., [North Atlantic Right Whale (NARW)] and other species), there is no certainty that in all cases those mitigation measures will avoid all potential impacts. Allowing the possibility of high intensity impacts from airguns, even if only possible in a nominal number of instances, is unnecessary given the lack of immediate need for acquiring O&G G&G data at this time."

Rather than allow the appeal process to continue to its regular conclusion, BOEM interrupted the appeal process and returned the applications to ongoing review. Specifically, in May 2017, BOEM took a series of actions to resurrect the denied permits, actions that violate controlling law. First, the Acting Director, Walter Cruickshank, issued a memorandum rescinding the January 2017 memoranda that denied the permit applications. The Acting Director then informed the Regional Director of the Gulf of Mexico Region of his decision to request that the Interior Board of Land Appeals remand to BOEM the appealed denials. The Acting Director also directed the Regional Director to rescind the denial of permit applications and resume evaluations. Within a week, the Regional Director rescinded the denials and directed staff to resume evaluations.

Some of those permit applications had received from North Carolina conditional consistency determinations that expressed serious concerns to the impact of marine resources. North Carolina issued those conditional consistency determinations in 2015. Rather than continue with stale

determinations, new BOEM permit applications are needed along with new consistency reviews. However, because of the denials, then resurrections, BOEM insists that the applications are still valid and North Carolina is bound to consistency determinations it made two years ago.

Because of the irregularities in the seismic survey permitting process, North Carolina's marine resources including its marine mammals are not adequately protected. North Carolina therefore requests that NMFS deny the IHA's as based on faulty predicate information and process.

Background

Marine Mammals are a critical marine resource in the coastal and offshore waters of North Carolina

North Carolina has a higher diversity of marine mammals than anywhere along the east coast of the United States or the Gulf of Mexico (Byrd et al. 2014, Roberts et al. 2016). This is particularly true in the area off Cape Hatteras where the Gulf Stream and Labrador Currents meet. This high diversity is reflected in the variety of marine mammals stranded along North Carolina's coast, more than many coastlines around the world (Byrd et al. 2014). Another reflection of diversity is the types of whales in North Carolina's offshore waters: six species of baleen whales and twenty-four species of toothed whales, four of which are beaked whales. (Cox et al. 2006). Because of this unique marine mammal diversity off the North Carolina coast, we have strong concerns about the impacts of seismic testing on marine mammals.

The offshore waters of North Carolina are biologically important areas for endangered North Atlantic right whales (*Eubalaena glacialis*), which migrate and calve within the proposed seismic exploration area (LaBrecque et al. 2015, Roberts et al. 2016). LaBrecque et al. (2015) defined a Biologically Important Area for North Atlantic right whale calving from the coast to the 25m depth contour from Cape Canaveral, Florida to Cape Lookout, North Carolina. Additionally, Roberts et al. (2016) found a moderate density of minke whales (*Balaenoptera acutorostrata*) south of Cape Hatteras in winter months and North Atlantic right whales in high density in near-shore calving grounds, including state waters of North Carolina south of Cape Fear. North Atlantic right whales are of particular concern as there are fewer than 500 individuals remaining in the North Atlantic, so that any impacts from seismic surveys will likely be more than negligible. Humpback whales (*Megaptera novaeangliae*) are also frequently seen in both North Carolina state waters and offshore waters in all months of the year (Swingle et al. 1999, Barco et al. 2002).

Multiple stocks of bottlenose dolphins (*Tursiops truncatus*) inhabit North Carolina estuarine, neritic, and offshore waters (Hayes et al. 2016; Roberts et al. 2016). There is one offshore bottlenose dolphin stock that is typically found 34 km offshore (Torres et al. 2003) but recently has been found as close as 7.3 km from shore and in depths of 13 m (Hayes et al. 2016). In addition to this offshore stock, there are two North Carolina estuarine stocks and two coastal migratory stocks. The northern migratory (coastal) bottlenose dolphins are known to range at least 7.5 km offshore north of Cape Hatteras. In the summer months, these bottlenose dolphins move from inshore waters to the mid- to outer-shelf, where harbor porpoises (*Phocoena phocoena*) and white-sided dolphins (*Lagenorhynchus acutus*) are found in the cooler months. South of Cape Hatteras, coastal bottlenose dolphins are present on the shelf and in the estuarine waters. Near the shelf break, an offshore ecotype of bottlenose dolphins is present (Roberts et al. 2016). Atlantic spotted dolphins (*Stenella frontalis*) are also common in state and federal waters offshore of North Carolina (Roberts et al. 2016).

With the presence of so many marine mammals, North Carolina regulates and participates in various efforts to protect them as an integral part of our coastal ecosystem. For example, North Carolina participates in the Bottlenose Dolphin Take Reduction Team, and North Carolina state waters are regulated under the Take Reduction Plan for the Bottlenose Dolphin. The North Carolina Division of Marine Fisheries, North Carolina Wildlife Resources Commission, North Carolina State University, University of North Carolina at Wilmington, and the North Carolina Maritime Museum are also part of the Marine Mammal Stranding Network, which responds to marine mammal strandings on our coast. Seismic surveys that harass marine mammals along our shore directly undermine state efforts to protect and foster the growth of our marine mammal populations.

The IHA “negligible impact” standard

Sections 101(a)(5)(A) and (D) of the Marine Mammal Protection Act, 16 U.S.C. 1361 *et seq.*, direct the Secretary of Commerce to allow the incidental taking of small numbers of marine mammals by U.S. citizens that engage in a specified activity within a specified geographical region. An authorization for incidental takings shall be granted only if NMFS finds that the taking will have a negligible impact on the species or stock(s). NMFS has defined “negligible impact” as “an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival,” 50 CFR 216.103.

Our review of relevant scientific literature indicates that geological and geophysical surveying in the Mid-Atlantic region will have more than a negligible impact on marine mammals. As explained below, scientific literature indicates surveying will lead to a significant number of marine mammal takes and that proposed mitigation measures are unable to ensure a negligible impact on marine mammals.

Seismic Surveying Impacts on Marine Mammals Will Be More Than Negligible

The scientific literature indicates that the effects of seismic surveying on marine mammals will be more than negligible. As explained below, marine mammals are reasonably likely to suffer impacts in many forms: depleted food sources, communication disruption, behavioral disturbance, masking, death, and strandings. The proposed IHAs fail to adequately account for and address current scientific understanding of these impacts. In addition, the IHAs do not adequately consider the correct thresholds for marine mammal response, the impacts long-distances from the surveying, and the cumulative impacts on marine mammals of conducting multiple seismic surveying operations at once.

Zooplankton Depletion

The proposed IHA failed to adequately address evidence that seismic activity can significantly impact the food systems of marine mammals. McCauley et al., 2017, found a median 64% decrease in abundance between exposed and control tows for all taxa of zooplankton after exposure to seismic airguns tows. Zooplankton are an important part of the food web, and the main food source for many species of fish and baleen whales.

Communication Disruption

The proposed IHA failed to adequately address evidence that seismic activity is reasonably likely to disrupt communication by marine mammals. The continuous, overlapping airgun blasts used in seismic testing would overwhelm, distort, and disrupt the normal sound communication occurring within the ocean and along North Carolina’s coast. Marine mammals use sound and hearing as their primary methods of communicating and understanding their environment (Frankel 2002). They use sound to locate prey, communicate with other mammals, reproduce, and avoid predators.

Seismic blasts from airguns produce approximately 250-260 dB of sound; a jet engine, by contrast, produces approximately 140 dB of sound. Because water transmits sound much more effectively than air, the seismic blasts proposed are louder than normal background levels of sound and will disrupt the normal behavior of ocean animals.

One study, Shannon et al. (2015), analyzed more than 20 years of peer-reviewed studies and found that wildlife, including a range of marine mammals, are negatively affected by human-produced noise. The analysis showed that adverse effects include changing foraging patterns and predator avoidance, silencing and changing vocal behaviors, and displacement.

Behavioral Disturbance

The proposed IHAs failed to adequately address evidence that seismic activity is likely to cause behavioral disturbances, especially due to the cumulative impact of multiple surveys. Marine mammals respond to seismic survey activities by leaving the area (Weilgart 2013). Bowhead whales avoided seismic airguns by a distance of 20 km (Richardson et al. 1999). Cerchio et al. (2014) found that humpback whales (*Megaptera novaeangliae*) stopped vocalizing or moved to other areas when seismic surveys were in close proximity, with implied potential effects on mating behavior and success. Castellote et al. (2012) showed that fin whales (*Balaenoptera physalus*) modified vocalizations under increased background noise conditions, and when seismic airgun activity occurred, the whales left the area for extended periods of time. The metabolic costs of these behavioral changes are unknown, however the results show that anthropogenic sound can affect and chronically increase energetic costs of life functions (Castellote 2012). Robertson et al. 2016 found that bowhead whales exhibited behavioral changes (reduced their calling rates) when the cumulative sound exposure levels rose above 160 db. Southall et al. (2007) found that bowhead whales exhibited significant behavioral disturbances when exposed to seismic pulses at 120 dB, and other low-frequency cetaceans showed behavioral changes at ~150 dB.

Responses of marine mammals to seismic survey noise can differ according to species, area, context, or age class (Weilgart 2013). Pirotta et al. (2014) found that porpoises exposed to moderate levels of seismic airgun noise reduced their buzzing noises and increased buzzes with increased distance from the source vessel. Sperm whales in the Gulf of Mexico did not change behavior or direction of movement with the introduction of seismic testing, but foraging behavior was affected, as was seen by decreases in pitch rate and buzzes (Miller et al. 2009). Buzzes are part of the whale's echolocation system and occur when the whales are attempting to capture prey.

Masking

The proposed IHAs failed to adequately address evidence that seismic activity masks whale sounds essential to feeding, breeding, and other biological activities. "Masking" takes place when the perception of one sound is affected by the presence of another, and it can occur at received levels that are just above the ambient noise level. Nieuirk (2012) found that when several seismic surveys were recorded simultaneously, whale sounds were masked and the airgun noise became the prominent part of background noise levels. For species, whose hearing thresholds are close to the natural background levels (Clark et al. 2009), any change in the background noise from anthropogenic sources can potentially lead to masking. Seismic surveys have been demonstrated to mask frequencies used by whales and many species of fish at hundreds and thousands of miles from the source. Stress hormones were measured in North Atlantic right whales and were found to be significantly lower in the absence of ship noise (Rolland et al. 2012). Prolonged elevated levels of stress hormones can affect behavior, lead to disease, and compromise reproductive capabilities (Romero & Butler 2007).

Death and Strandings

The proposed IHA failed to adequately address evidence that seismic activity is likely to lead to whale deaths and strandings. Seismic airguns have been implicated as a probable cause of whale strandings and deaths, especially in beaked whales (Hildebrand 2005). In 2002, researchers discovered two freshly dead Cuvier's beaked whales in the Gulf of California and found that a research vessel had been conducting seismic surveys approximately 22 km offshore at the time of stranding (Taylor et al. 2004, Cox et al. 2006). Even when impacts are fatal, there is a chance not all cetacean mortalities are discovered.

Incorrect Threshold for Response to Seismic

The impact threshold that is used by BOEM in its Environmental Impact Statement is that marine mammals do not respond to impulse sounds at levels below 160 dB. Studies demonstrate that multiple types of marine mammals respond to sound impulses below 160 dB. The literature states that baleen whales respond to seismic impulses that are less than 160 dB and exhibit behavioral responses at approximately 120 dB (Blackwell et al. 2015). Toothed whales also respond to seismic impulses that are less than 160 dB. In sperm whales, exposure to seismic surveys has been associated with substantial decline in hunting noises (buzzes) at received levels of 135 dB- 147 dB (Miller et al. 2009). Miller et al. (2005) found that sound impulses at 130 dB affect beluga whales, evidenced by findings of an absence of whales in the Arctic within 12 miles of a seismic survey and an unusually high density of beluga whales at distances of 12-20 miles from the surveys at levels of 130 dB (Miller et al. 2005). Thus, the estimates of marine mammal impacts from Atlantic seismic surveys could substantially exceed the number calculated in the BOEM's current impact assessment using a 160 dB response threshold.

Distance of Seismic Sounds and Cumulative Effects

The proposed IHAs failed to adequately address evidence that seismic sounds travel long distances and that show significant marine mammal impacts from cumulative exposure to seismic activity. The Bureau of Ocean and Energy Management's own documentation identifies significant harm to marine mammals. Specifically, BOEM's Final Programmatic Environmental Impact Statement (PEIS) for Atlantic Proposed Geological and Geophysical Activities for the Mid-Atlantic and South Atlantic Planning Areas estimates that a significant number of adverse impacts and takes of multiple species of whales and dolphins are reasonably foreseeable. The harm comes from seismic blasts from airguns towed behind seismic survey vessels that produce approximately 250-260 dB of sound. Madsen et al. (2006) found that sound traveled up to 12 km from the seismic vessel as determined from acoustic tags on sperm whales in the Gulf of Mexico. Nieukirk et al. (2012), analyzed ten years of recordings from the Mid-Atlantic Ridge and found that seismic sounds were heard at distances of 2,500 miles from the source and were present 80-95% of the days each month for 12 consecutive months in some locations.

The seismic testing at issue in the IHAs would entail the continuous, overlapping firing of seismic airguns along the east coast from the New Jersey border to the central Florida coast. BOEM's PEIS describes a total of 616,174 km of survey effort over seven years. Each survey would discharge its airguns every 10-12 seconds and would operate almost 24 hours per day. This constant repeated exposure to seismic blast from survey vessels up and down the east coast indicates that marine mammals off the North Carolina coast will experience continuous and cumulative impacts far beyond those acknowledged or addressed in the IHAs.

The IHAs fail to address additional studies about cumulative impacts of seismic sounds on marine mammals. Cumulative impacts are especially important off the North Carolina coast because five companies have applied for seismic testing permits. If all permits are approved, their testing

schedules would overlap and expose marine mammals to ongoing simultaneous impacts from multiple seismic surveying expeditions up and down the east coast.

Proposed Mitigation Measures Insufficient

The proposed IHAs failed to address scientific studies that show the limits of mitigation measures and consequently failed to require mitigation measures that would ensure seismic surveying only has a negligible impact on marine mammals. Weilgart (2013) concluded that current mitigation measures to protect whales from high noise exposures are inadequate. One of the proposed mitigation measures is onboard vessel observers during daylight hours. However, surveys will be conducted at night (24 hours a day). In addition, only the area within 500 m of a seismic survey vessel is directly observed, yet noise levels can travel greater distances and surveys will be conducted at night. For example, Madsen et al. (2006) found that sound traveled up to 12 km from the seismic vessel as determined from acoustic tags on sperm whales in the Gulf of Mexico. In addition, these visual surveys are likely ineffective due to other factors such as sea state, experience of the observer, and the diving and surfacing behavior of different whales (Cox et al. 2006, Nowacek et al. 2013, Schorr et al. 2014). Gordon et al. (2004) suggest that the most immediate and effective method to reduce impacts to marine mammals from seismic surveys is to minimize the total number of surveys by encouraging companies to share the results of past and future surveys.

The proposed IHAs fail to adequately address significant research published after the five separate requests for authorization to take marine mammals incidental to geophysical surveys in the Atlantic Ocean were originally proposed. Best practices since have been documented by Nowacek and Southall (2016). In his testimony to Congress on July, 14, 2015, Dr. Douglas Nowacek of Duke University recommended additional mitigation measures prior to commencement of new seismic surveys in the Atlantic region. Dr. Nowacek explained recently developed animal density and distribution models that identify the area off Cape Hatteras as having the greatest marine mammal biodiversity of any area off the entire east coast of the United States. Yet this area falls within the survey area of all the seismic applications that BOEM has received. In addition, new technologies exists, such as controlled source electromagnetic vibroseis, that could reduce environmental impacts (Duncan *et al.* 2017).

Conclusions

Marine mammals are an important component of North Carolina's coastal ecosystem. Due to the converging Labrador Current and Gulf Stream currents off our coast, North Carolina is a unique biogeographic convergence zone where the southern limit of temperate species and the northern limit of tropical species overlap. North Carolina's marine mammal diversity is unique along the Atlantic Coast and one of the highest in the world. Significant impacts to marine mammals are likely to occur from single seismic surveys, yet the proposed IHAs would further endanger marine mammals through cumulative impacts of numerous surveys by different companies within the same oceanic subregions. If finalized, the IHAs would allow geophysical and geological survey activities that would significantly harass the large, diverse assemblage of marine mammals along the North Carolina coast, resulting in takings of more than a small number of mammals and that will have a more-than-negligible impact on these species.

Based on the research and environmental concerns outline above, I request that you deny all requests for incidental harassment authorizations to conduct geological and geophysical surveys off the North Carolina coast.

Sincerely,

A handwritten signature in cursive script that reads "Michael S. Regan".

Michael S. Regan
Secretary

Cc: Dr. Kenneth Taylor, State Geologist
Braxton Davis, Director of Division of Coastal Management and Division of Marine Fisheries

Literature Cited

- Barco, S., W. A. McLellan, J. M. Allen, R. A. Asmutis, R. Mallon-Day, E. M. Meagher, D. Ap. Pabst, J. Robbins, R. E. Seton, W. M. Swingle, M. T. Weinrich, P. J. Clapham. 2002. Population identity of humpback whales (*Megaptera novaeangliae*) in the waters of the US mid-Atlantic states. *J Cetacean Research Management* 4:2:135-141.
- Byrd, B., A. Hohn, G. Lovewell, K. Altman, S. Barco, C. Harms, W. McLellan, K. T. Moore, P. Rosel, and V. Thayer. 2014. Strandings as indicators of marine biodiversity and human interaction in North Carolina. *Fisheries Bulletin* 112: 1-23. doi. 10.7755/FB.112.1.1
- Castellote, M., C. W. Clark, and M. O. Lammers. 2012. Acoustic and behavioral changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. *Biological Conservation* 147:1, 115-122. <http://doi.org/10.1016/j.biocon.2011.12.021>
- Cerchio, S., S. Strindberg, T. Collins, C. Bennett, and H. Rosenbaum 2014. Seismic surveys negatively affect humpback whale singing activity off northern Angola. *Plos One*, 9:3 e8646f4. <http://doi.org/10.1371/journal.pone.0086464>
- Clark, C. W., W. T. Ellison, B. L. Southall, L. Hatch, S. M. van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking marine ecosystems: intuitions, analysis, and implication. *Marine Ecology Progress Series*, 395:201-222.
- Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fernández, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. Ketten, C. D. MacLeod, P. Miller, S. Moore, D. C. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead, L. Benner, L. 2006. Understanding the impacts of anthropogenic sounds on beaked whales. *J. of Cetacean Research Management*. 7(3): 177-187.
- Duncan A. J, L. S. Weilgart, R. Leaper, M. Jasny, S. Livermore 2017. A modelling comparison between received sound levels produced by a marine Vibroseis array and those from an airgun array for some typical seismic survey scenarios. *Marine Pollution Bulletin*, 119:1. 277-288.
- Frankel, A. S. 2002. Sound Production. In: *The Encyclopedia of Marine Mammals*, Eds. W. F. Perrin, B. Würsig, J. G. M. Thewissen, Academic Press, San Diego. Pp. 1126-1138
- Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M. P. Simmonds, R. Swift, D. Thompson. 2004. A Review of the Effects of Seismic Surveys on Marine Mammals. *Marine Technology Society Journal*, 37(4): 16-34. doi:10.4031/002533203787536998
- Hayes, S. A., Josephson, E., Maze-Foley, K., and Rosel, P. E. (eds.). 2016. US Atlantic and Gulf of Mexico. *Marine Mammal Stock Assessments-2015*. NOAA Technical Memorandum NMFS NE-241.
- Hildebrand, J. A. 2005. Impacts of anthropogenic sound. In: Reynolds, J. E. et al. (eds.) *Marine mammal research: conservation beyond crisis*. The Johns Hopkins University Press, Baltimore, MD, 101-124.
- LaBrecque, E., C. Curtice, J. Harrison, S. M. Van Parijs, and P. N. Halpin. 2015. Biologically important areas for cetaceans within U.S. waters- East Coast Region. *Aquatic Mammals* 4(1), 17-29. doi:10.1578/AM.41.1.2015.17

McCauley, R. D., R. D. Day, K. M. Swadling, Q.P. Fitzgibbon, R. A. Watson, and J. M. Semmens. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. *Nature Ecology & Evolution* 1, 0195. Doi: 10.1038/s41559-017-0195.

Madsen, P.T., M. Johnson, P. J. O. Miller, N. Aguilar Soto, J. Lynch, and P. Tyack. 2006. Quantitative measures of air-gun pulses recorded on sperm whales (*Physeter macrocephalus*) using acoustic tags during controlled exposure experiments. *The Journal of the Acoustic Society of America* 120: 2366-2379. Doi:10.1121/1.2229287

Miller, P. J. O., Johnson, M. P., Madsen, P.T., Biassoni, N. Quero, M. & Tyack, P.L. 2009. Using at-sea experiments to study the effects of airguns on the foraging behavior of sperm whales in the Gulf of Mexico. *Deep Sea Research I*, 56, 1156-1181.

Nieukirk, S. L., Mellinger, D.K., Moore, S. E., Klinck, K., Dziak, R. P. & Goslin, J. 2012. Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999-2009. *Journal of the Acoustic Society of America*, 131(2), 1102.

Nowacek, D. P., K. Bröker, G. Donovan, G. Gailey, R. Racca, R. R. Reeves, A.I. Vedenev, D.W. Weller, B.L. Southall. 2013. Responsible Practices for Minimizing and Monitoring Environmental Impacts of Marine Seismic Surveys with an Emphasis on Marine Mammals. *Aquatic Mammals*, 39(4), 356-377, doi:10.1578/AM.39.4.2013.356

Nowacek, D.P., and B. L. Southall 2016 Effective Planning Strategies for Managing Environmental Risk Associated with Geophysical and Other Imaging Surveys. Gland, Switzerland: IUCN. 42pp. doi:10.2305/IUCN.CH.2016.07en

Pirotta, E., Brooks, K.L., Graham, I. M., Thompson, P.M., 2014. Variation in harbor porpoise activity in response to seismic survey noise. *Biol.Lett.* 10: 20131090. <http://doi.org/10.1098/rsbl.2013.356>

Richardson, W. J., Miller, G. W., & Greene, C. J. 1999. Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea. *Journal of the Acoustical Society of America*, 106, 2281.

Robertson, F. C., W. R. Koski, and A. W. Trites. 2016. Behavioral responses affect distribution analyses of bowhead whales in the vicinity of seismic operations. *Marine Ecology Progress Series* 549:243-262. Doi. 10.3354/meps11665

Roberts, J. J., B.D. Best, L. Mannocci, E. Fujioka, P. N. Halpin, D. L. Palka, L. P. Garrison, K.D. Mullin, T. V. N. Cole, C. B. Khan, W. A. McLellan, D. A. Pabst, and G. G. Lockhart. 2016. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. *Scientific Reports*, 6, 22615. Doi:10.1038/srep22615.

Rolland, R.M., Parks, S. E., Hunt, K.E., Castellote, M., Corkeron, P.J., Nowacek, D. P., Wasser, S.K., Kraus, S. D. 2012. Evidence that ship noise increases stress in right whales. *Proceedings of the Royal Society B*. 279, 2363-2368.

Romero, M. L. and L.K. Butler. 2007. Endocrinology of stress. *International Journal of Comparative Psychology*, 20 (2) 89-95.

Schorr, G. S., E.A. Falcone, D. J. Moretti, and R. D. Andrews 2014. First Long-Term Behavioral Records from Cuvier's Beaked Whales (*Ziphius cavirostris*) Reveal Record-Breaking Dives. PLoS ONE 9(3): e92633. doi:10.1371/journal.pone.0092633

Shannon, G., McKenna, M. F., Angeloni, L. M., Crooks, K. R., Fristrup, K. M., Brown, E., Warner, K. A., Nelson, M. D., White, C., Briggs, J., McFarland, S., & Wittemyer, G. 2015. A synthesis of two decades of research documenting the effects of noise on wildlife. *Biological Reviews*, n/a-n/a. <http://doi.org/10.1111/brv.12207>

Southall, B., A. E. Bowles, W. T. Ellison, J. J. Finneran, ...P. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals* 3: 411-509.

Swingle, W. M., S. G. Barco, T. D. Pitchford, W. A. McLellan, and D. A. Pabst. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. *Marine Mammal Science* 9(3):309-315.

Taylor, B., Barlow, J., Pitman, R., Ballance, L., Klinger, T., DeMaster, D., Hildebrand, J., Urban, J., Palacios, D., and Mead, J. 2004. A call for research to assess risk of acoustic impact on beaked whale populations. Paper SC/56/E36 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy. 4 pp.

Torres, L. G., P. E. Rosel, C. D'Agrosa, and A. J. Read. 2003. Improving management of overlapping bottlenose dolphin ecotypes through spatial analysis and genetics. *Marine Mammal Science* 19(3):502-514.

Weilgart, L. 2013 A Review of the Impacts of Seismic Airgun Surveys on Marine Life. Submitted to the CBD Expert Workshop on Underwater Noise and its Impacts on Marine and Coastal Biodiversity, 25-27. Available at <http://www.cbd.int/doc/?meeting=MCBEM-2014-01>

Zimmer, W. M. X. 2011. *Passive acoustic monitoring of cetaceans*. Cambridge, UK: Cambridge University Press. <http://dx.doi.org/10.1017/CB09780511977107>.