Request by Lamont-Doherty Earth Observatory for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals during a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Eastern Mediterranean Sea, November–December 2015

submitted by

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to

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SUMMARY

Researchers from Oregon State University, with funding from the United States (U.S.) National Science Foundation (NSF), propose to conduct a high-energy seismic survey on the Research Vessel (R/V) *Marcus G. Langseth* (*Langseth*) in the eastern Mediterranean Sea during November–December 2015. The NSF-owned *Langseth* is operated by Columbia University's Lamont-Doherty Earth Observatory (L-DEO). The proposed seismic survey would use a towed array of 36 airguns with a total discharge volume of ~6600 in^3. The seismic survey would take place within the Exclusive Economic Zone (EEZ) of Greece, including its territorial waters, in water depths ~20–3000+ m. This request is submitted pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371(a)(5).

Numerous species of marine mammals inhabit the eastern Mediterranean Sea. Several of these species are listed as ***Endangered*** under the U.S. Endangered Species Act (ESA): the North Atlantic right, humpback, sei, fin, and sperm whales, and the Mediterranean monk seal. Other marine ESA-listed species that could occur in the area are the ***Endangered*** leatherback and loggerhead sea turtles, Audouin's gull, and slender-billed curlew, and the ***Threatened*** green turtle. The ***Endangered*** scalloped hammerhead shark and the Adriatic and European sturgeons could also occur in or near the survey areas. ESA-listed ***candidate species*** that could occur in the area are the sawback angelshark, smoothback angelshark, angelshark, guitarfish, blackchin guitarfish, and undulate ray.

The items required to be addressed pursuant to 50 C.F.R. § 216.104, "Submission of Requests", are set forth below. They include descriptions of the specific operations to be conducted, the marine mammals occurring in the study areas, proposed measures to mitigate against any potential injurious effects on marine mammals, and a plan to monitor any behavioral effects of the operations on those marine mammals.

I. OPERATIONS TO BE CONDUCTED

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

Overview of the Activity

The proposed study consists of a survey around the island of Santorini (officially known as Thira) in the southern Aegean Sea, between ~36.1–36.8°N and ~24.7–26.1°E, and a transect line that spans across the Hellenic subduction zone which starts in the Aegean Sea at ~36.4°N, 23.9°E and runs to the southwest, ending at ~34.9°N, 22.6°E (Fig. 1). Water depths in the survey areas are ~20–3000+ m. The

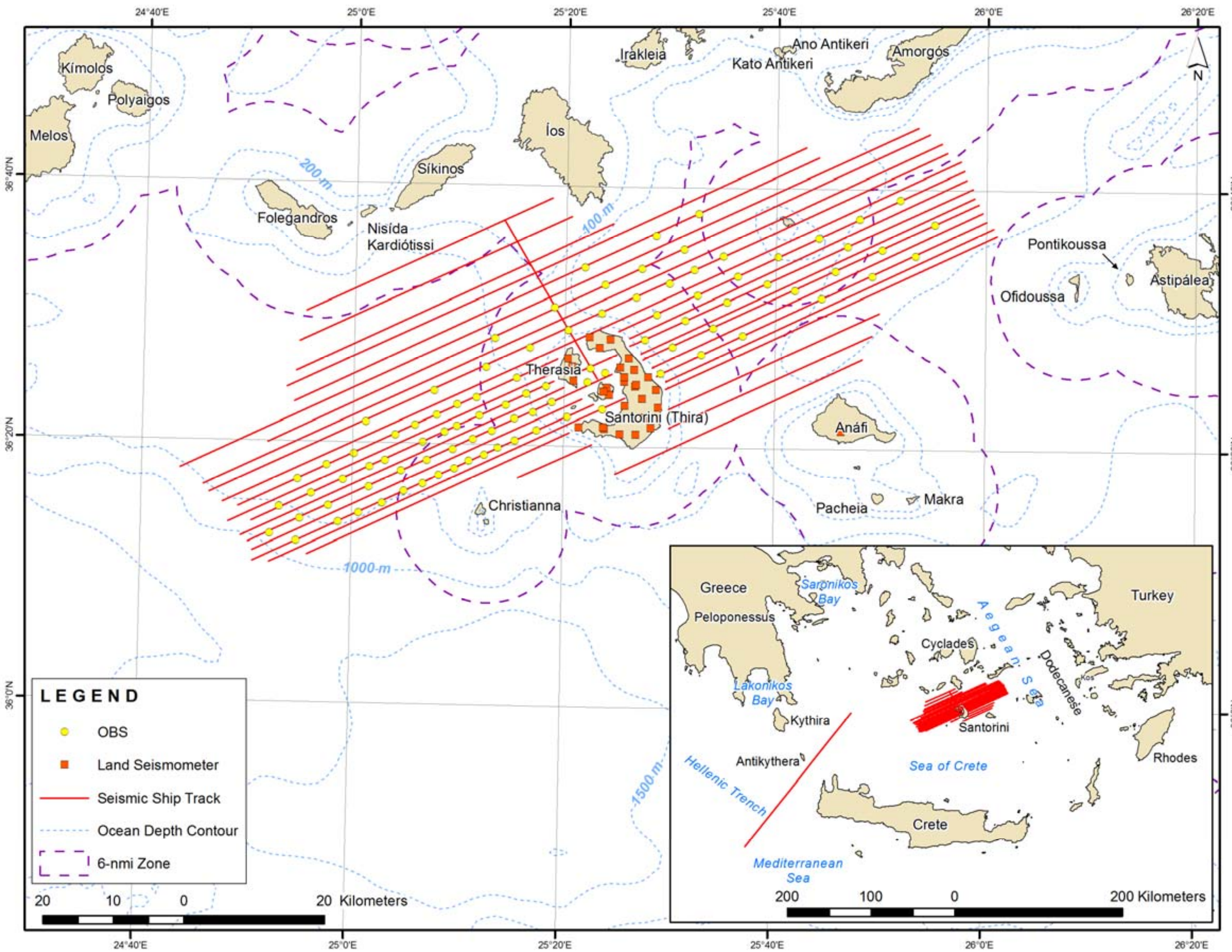


FIGURE 1. Location of the proposed seismic survey in the eastern Mediterranean Sea during November–December 2015. A total of ~2140 km of transect lines would be surveyed. The 6-n.mi. zone of the Greek territorial seas is also shown.

seismic survey would be conducted within the EEZ and territorial waters of Greece. Greece considers its territorial seas to extend out to 6 n.mi. as opposed to the typical 12-n.mi. limit. Just over half of the line km in the Santorini survey area are located within Greek territorial seas; most (92%) of the Hellenic subduction zone transect line is located outside of the territorial seas. The survey is scheduled to occur for ~1 month in November–December 2015; however, there would only be ~16 days of seismic surveying.

The procedures to be used for the survey would be similar to those used during previous seismic surveys by L-DEO and would use conventional seismic methodology. The primary goal of the proposed research is to collect and analyze three dimensional (3-D) marine-land seismic data on and around the island of Santorini to examine the crustal magma plumbing of the Santorini volcanic system. Models of how magma evolution at arc volcanoes generates the dominantly silicic magmas that form the continental crust, and of the dynamics that control magma migration, storage, and eruption, require better physical constraints on the geometry, crystal content, and the nature of interconnections of magmas at all depths throughout the crust. To address these outstanding issues, a high-resolution 3-D seismic refraction survey would be conducted at the active and semi-submerged Santorini Volcano (Fig. 1) that takes advantage of high-density spatial sampling of the seismic wave field and state-of-the-art travel time and waveform inversion methods to provide new insights into the structure of the whole crustal magmatic system and its surroundings.

The results from the proposed study would test the following three hypotheses: (1) Crystallization of mafic melts occurs in shallow crustal magma chambers; (2) Magma evolves continuously as it resides in and moves through multiple levels of magma reservoirs; and (3) Differentiation and/or mixing with melts of surrounding rock occurs almost entirely in the lower crust. To test these hypotheses and achieve the project's goals, the Principal Investigators (PIs) Drs. E. Hooft and D. Toomey (University of Oregon) propose to sample the seismic wave field that propagates throughout the entire crust beneath the volcano by collecting high-density, 3-D marine and land seismic data using the R/V *Marcus G. Langseth* airgun source.

In addition, on behalf of scientists from Ifremer, the French Institute for Exploitation of the Sea, two dimensional (2-D) seismic reflection data would be collected along a single transect line to image in depth the megathrust fault between Peloponnesus and Crete in the Hellenic subduction zone off southwestern Crete. The data would be used to identify the structural markers of the downdip and updip limits of the seismogenic zone and their along-strike variations. The Hellenic subduction zone has the highest rate of seismic activity in Europe; several large magnitude earthquakes have occurred off Peloponnesus in the past.

The Santorini portion of the study involves international collaboration with scientists from Greece. Dr. P. Nomikou (University of Athens) would be on board during the entire seismic survey, and Prof. C. Papazachos (University of Thessaloniki) would be in charge of installation and recovery of land seismometers on Santorini.

The survey would involve one source vessel, the *Langseth*, which is owned by NSF and operated on its behalf by Columbia University's L-DEO. The *Langseth* would deploy an array of 36 airguns as an energy source with a total volume of ~6600 in^3. The receiving system would consist of 93 ocean bottom seismometers (OBSs) and 30 land seismometers for the Santorini survey in the Aegean Sea, and a single 8-km hydrophone streamer for the Hellenic subduction zone transect line that extends from the Aegean Sea to the southwest of Crete. As the airgun array is towed along the survey lines, the seismometers would receive the returning acoustic signals internally for later analysis, and the hydrophone streamer would transfer the data to the on-board processing system.

A total of ~2140 km of transect lines would be surveyed in the eastern Mediterranean Sea (Fig. 1). There could be additional seismic operations in the Santorini survey area in the Aegean Sea associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard. In our calculations (see § VII), 25% has been added for those additional operations. Repeat coverage would not be expected for the Hellenic subduction zone transect line that extends from the Aegean Sea to the southwest of Crete, and therefore no additional coverage was added.

In addition to the operations of the airgun array, a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) would also be operated from the *Langseth* continuously throughout the survey. All planned geophysical data acquisition activity would be conducted by L-DEO with on-board assistance by the scientists who have proposed the study. The vessel would be self-contained, and the crew would live aboard the vessel.

Source Vessel Specifications

The R/V *Marcus G. Langseth* is described in § 2.2.2.1 of the Final Programmatic Environmental Impact Statement (PEIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey (NSF and USGS 2011) and Record of Decision (NSF 2012), referred to herein as the PEIS. The vessel speed during seismic operations would be 4.5 kt (~8.3 km/h).

Airgun Description

During the survey, the *Langseth* full array consisting of four strings with 36 airguns (plus 4 spares) and a total volume of ~6600 in^3, would be used. The airgun arrays are described in § 2.2.3.1 of the PEIS, and the airgun configurations are illustrated in Figures 2-11 to 2-13 of the PEIS. The 4-string array would be towed at a depth of 9 or 12 m; the shot intervals range from 35 to 170 s (~80 to 390 m) for OBS lines and ~22 s (50 m) for multi-channel seismic (MCS) lines with the streamer.

Predicted Sound Levels

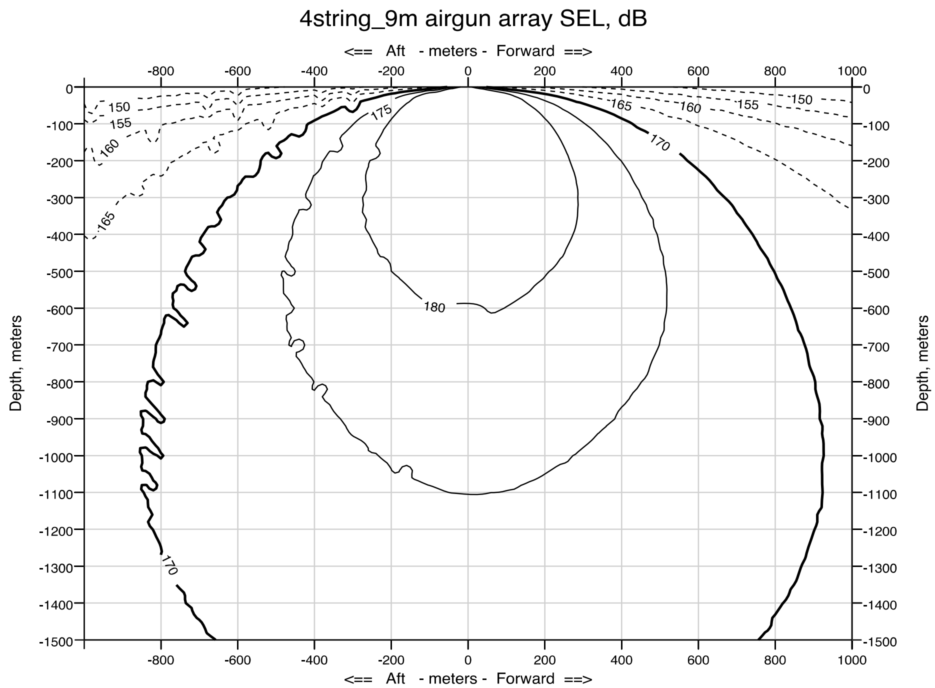
During the planning phase, mitigation zones for the proposed marine seismic survey were calculated based on modeling by L-DEO for both the exclusion and the safety zones. Received sound levels have been predicted by L-DEO's model (Diebold et al. 2010, provided as Appendix H in the PEIS), as a function of distance from the airguns, for the 36-airgun array at any tow depth and for a single 1900LL 40-in^3 airgun, which would be used during power downs. This modeling approach uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). In addition, propagation measurements of pulses from the 36-airgun array at a tow depth of 6 m have been reported in deep water (~1600 m), intermediate water depth on the slope (~600–1100 m), and shallow water (~50 m) in the Gulf of Mexico (GoM) in 2007–2008 (Tolstoy et al. 2009; Diebold et al. 2010).

For deep and intermediate-water cases, the field measurements cannot be used readily to derive mitigation radii, as at those sites the calibration hydrophone was located at a roughly constant depth of 350–500 m, which may not intersect all the sound pressure level (SPL) isopleths at their widest point from the sea surface down to the maximum relevant water depth for marine mammals of ~2000 m. Figures 2 and 3 in Appendix H of the PEIS show how the values along the maximum SPL line that connects the points where the isopleths attain their maximum width (providing the maximum distance associated with each sound level) may differ from values obtained along a constant depth line. At short ranges, where the direct arrivals dominate and the effects of seafloor interactions are minimal, the data recorded at the deep and slope sites are suitable for comparison with modeled levels at the depth of the calibration hydrophone. At longer ranges, the comparison with the mitigation model—constructed from the maximum SPL through the entire water column at varying distances from the airgun array—is the most relevant. The results are summarized below.

In deep and intermediate water depths, comparisons at short ranges between sound levels for direct arrivals recorded by the calibration hydrophone and model results for the same array tow depth are in good agreement (Fig. 12 and 14 in Appendix H of the PEIS). Consequently, isopleths falling within this domain can be predicted reliably by the L-DEO model, although they may be imperfectly sampled by measurements recorded at a single depth. At greater distances, the calibration data show that seafloor-reflected and sub-seafloor-refracted arrivals dominate, whereas the direct arrivals become weak and/or incoherent (Fig. 11, 12, and 16 in Appendix H of the PEIS). Aside from local topography effects, the region around the critical distance (~5 km in Fig. 11 and 12, and ~4 km in Fig. 16 in Appendix H of the PEIS) is where the observed levels rise closest to the mitigation model curve. However, the observed sound levels are found to fall almost entirely below the mitigation model curve (Fig. 11, 12, and 16 in Appendix H of the PEIS). Thus, analysis of the GoM calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for conservatively estimating mitigation radii. In shallow water (<100 m), the depth of the calibration hydrophone (18 m) used during the GoM calibration survey was appropriate to sample the maximum sound level in the water column, and the field measurements reported in Table 1 of Tolstoy et al. (2009) for the 36-airgun array at a tow depth of 6 m can be used to derive mitigation radii.

The proposed survey would acquire data with the 36-airgun array at tow depths of 9 and 12 m. For deep water (>1000 m), we use the deep-water radii obtained from L-DEO model results down to a maximum water depth of 2000 m (Fig. 2 and 3). The radii for intermediate water depths (100–1000 m) are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (Fig. 16 in Appendix H of the PEIS). The shallow-water radii are obtained by scaling the empirically derived measurements from the GoM calibration survey to account for the differences in tow depth between the calibration survey (6 m) and the proposed survey (9 and 12 m). A simple scaling factor is calculated from the ratios of the isopleths calculated by the deep-water L-DEO model, which are essentially a measure of the energy radiated by the source array: the 150-decibel (dB) Sound Exposure Level (SEL)[1] corresponds to deep-water maximum radii of 9334 m and 11,250 m for 9 and 12-m tow depths, respectively (Fig. 2 and 3), and 7244 m for a 6-m tow depth (Fig. 4), yielding scaling factors of 1.29 and 1.55 to be applied to the shallow-water 6-m tow depth results. Similarly, the 170 dB SEL corresponds to maximum deep-water radii of 927 and 1117 m for 9 and 12-m tow depths (Fig. 2) and 719 m for 6-m tow depth (Fig. 4), yielding the same 1.29 and 1.55 scaling factors. Measured 160-, 180-, and 190-dB re 1µPa_{rms} distances in shallow water for the 36-airgun array towed at 6 m depth were 17.5 km, 1.6 km, and 458 m, respectively, based on a 95th percentile fit (Tolstoy et al. 2009). Multiplying by 1.29 to account for the tow depth difference between 6 and 9 m yields distances of 22.58 km, 2.06 km, and 591 m, respectively. Multiplying by 1.55 to account for the tow depth difference between 6 and 12 m yields distances of 27.13 km, 2.48 km, and 710 m, respectively.

[1] SEL (measured in dB re 1 µ$Pa^2 \cdot s$) is a measure of the received energy in the pulse and represents the SPL that would be measured if the pulse energy were spread evenly across a 1-s period. Because actual seismic pulses are less than 1 s in duration in most situations, this means that the SEL value for a given pulse is usually lower than the SPL calculated for the actual duration of the pulse. In this EA, we assume that rms pressure levels of received seismic pulses would be 10 dB higher than the SEL values predicted by L-DEO's model.



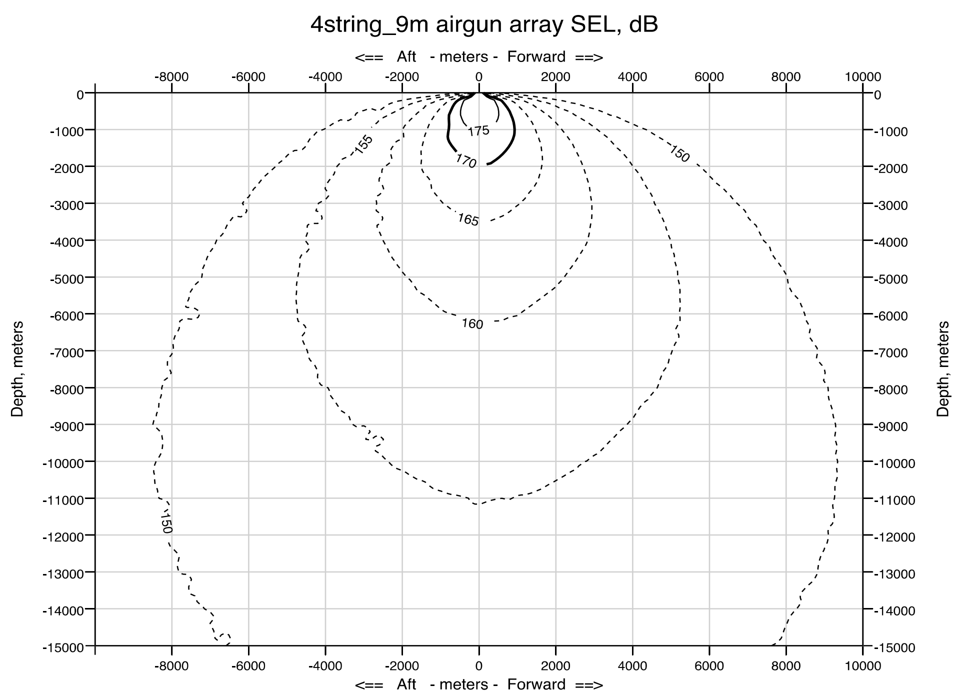


FIGURE 2. Modeled deep-water received sound levels (SELs) from the 36-airgun array planned for use during the proposed survey in the eastern Mediterranean Sea at a 9-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

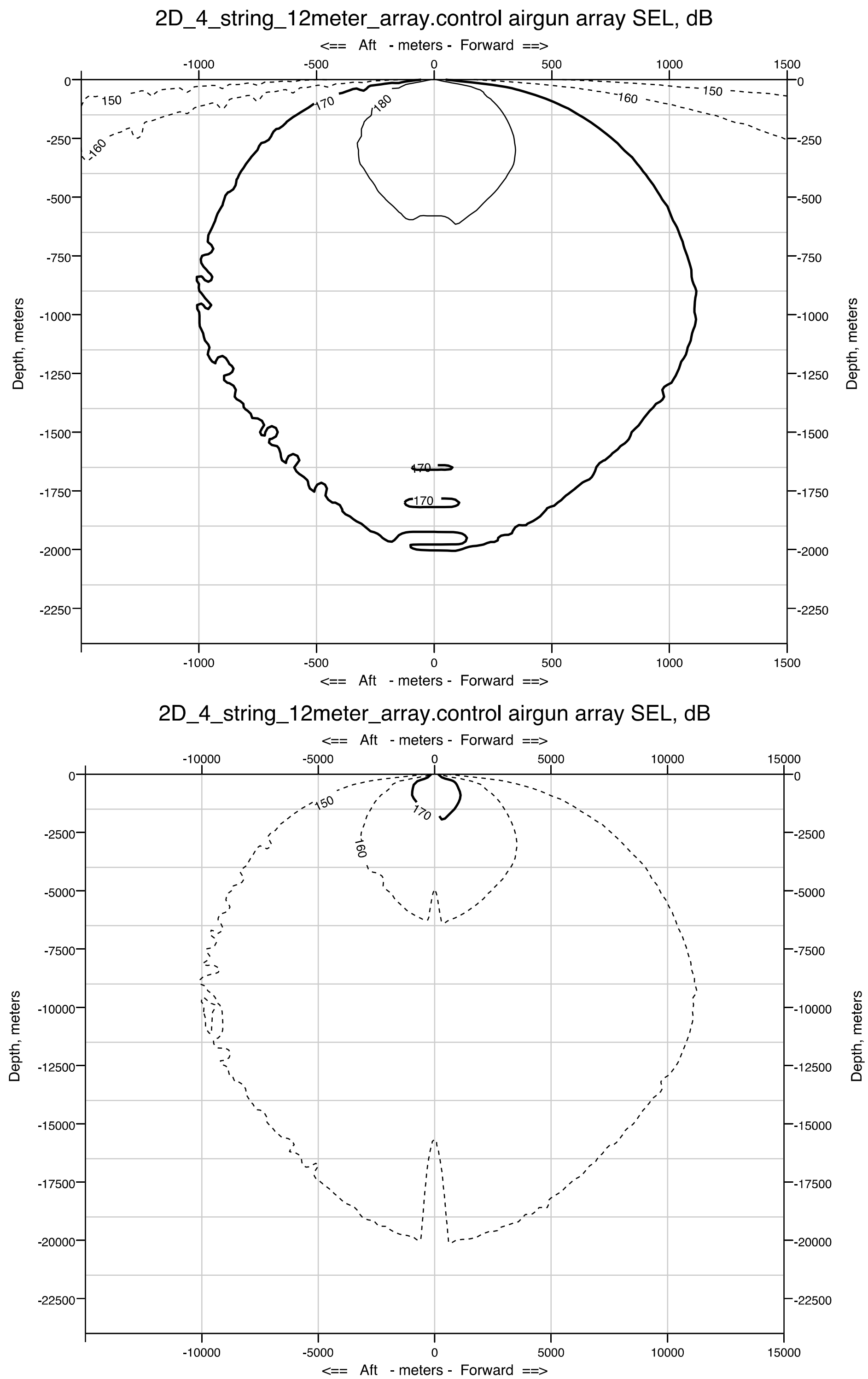


FIGURE 3. Modeled deep-water received sound levels (SELs) from the 36-airgun array planned for use during the proposed survey in the eastern Mediterranean Sea at a 12-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

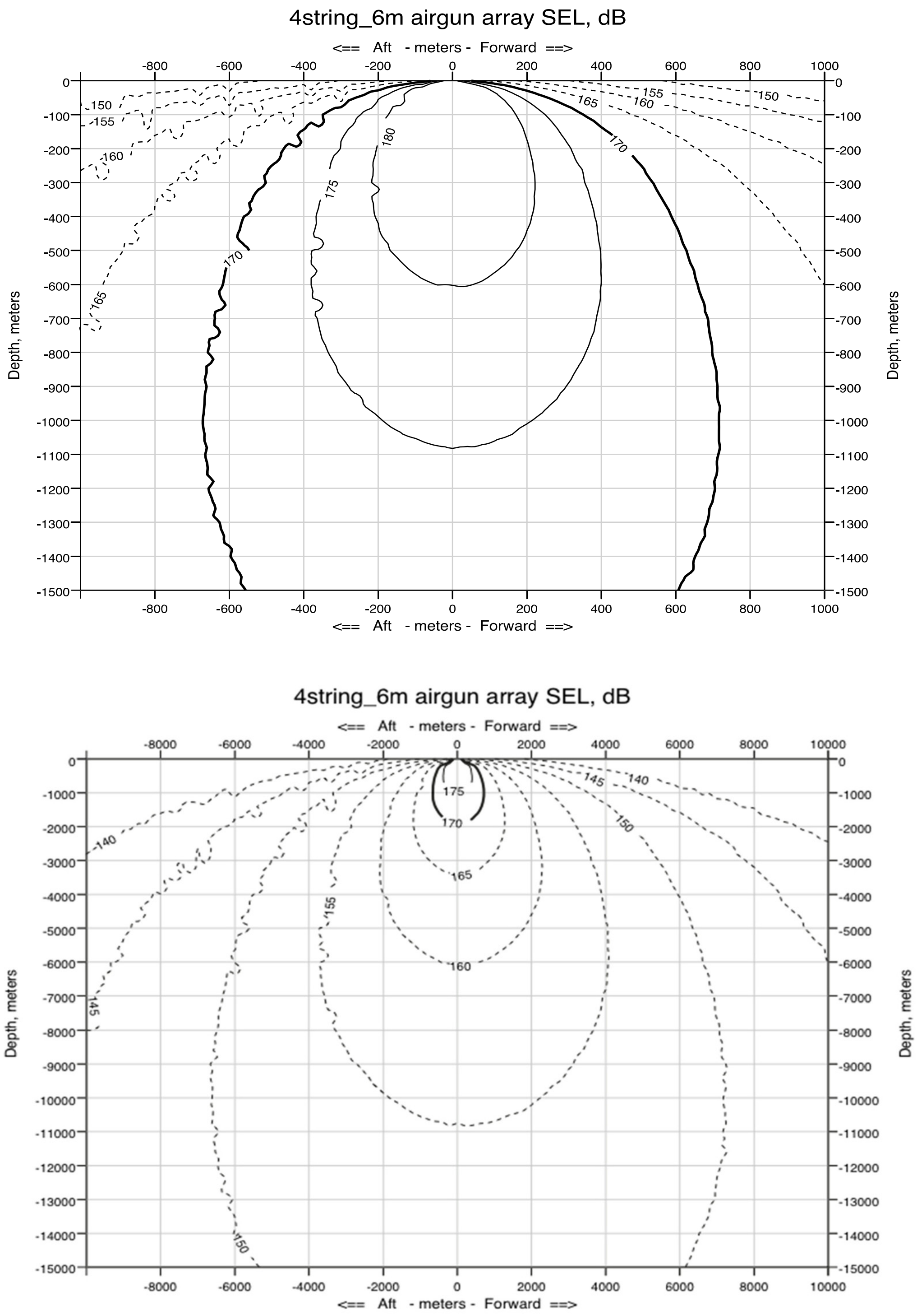


FIGURE 4. Modeled deep-water received sound levels (SELs) from the 36-airgun array at a 6-m tow depth used during the GoM calibration survey. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170 dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

Measurements have not been reported for the single 40-in^3 airgun. The 40-in^3 airgun fits under the low-energy source category in the PEIS. In § 2.4.2 of the PEIS, Alternative B (the Preferred Alternative) conservatively applies an exclusion zone (EZ) of 100 m for all low-energy acoustic sources in water depths >100 m. This approach is adopted here for the single Bolt 1900LL 40-in^3 airgun that would be used during power downs. L-DEO model results are used to determine the 160-dB$_{rms}$ radius for the 40-in^3 airgun at 12-m tow depth in deep water (Fig. 5). For intermediate-water depths, a correction factor of 1.5 was applied to the deep-water model results. For shallow water, a scaling of the field measurements obtained for the 36-airgun array was used: the 150-dB SEL level corresponds to a deep-water radius of 431 m for the 40-in^3 airgun at 12-m tow depth (Fig. 4) and 7244 for the 36-airgun array at 6-m tow depth (Fig. 2), yielding a scaling factor of 0.0595. Similarly, the 170-dB SEL level corresponds to a deep-water radius of 43 m for the 40-in^3 airgun at 12-m tow depth (Fig. 4) and 719 m for the 36-gun array at 6-m tow depth (Fig. 2), yielding a scaling factor of 0.0598. Measured 160-, 180-, and 190-dB re 1µPa$_{rms}$ distances in shallow water for the 36-airgun array towed at 6-m depth were 17.5 km, 1.6 km, and 458 m, respectively, based on a 95th percentile fit (Tolstoy et al. 2009). Multiplying by 0.0595 and 0.0598 to account for the difference in array sizes and tow depths yields distances of 1041 m, 96 m, and 27 m, respectively.

Table 1 shows the distances at which the 160-, 180-, and 190- dB re 1µPa$_{rms}$ sound levels are expected to be received for the 36-airgun array and the single (mitigation) airgun. The 180- and 190-dB re 1 µPa$_{rms}$ distances are the safety criteria as specified by NMFS (2000) for cetaceans and pinnipeds, respectively. The 180-dB distance would also be used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects per the IHAs.

A recent retrospective analysis of acoustic propagation of *Langseth* sources in a coastal/shelf environment from the Cascadia Margin off Washington suggests that predicted (modeled) radii (using an approach similar to that used here) for *Langseth* sources were 2–3 times larger than measured in shallow water, so in fact were very conservative (Crone et al. 2014). Similarly, preliminary analysis by Crone (2015, pers. comm.) of data collected during a survey off New Jersey in 2014 confirmed that *in situ* measurements and estimates of the 160- and 180-dB distances collected by the *Langseth* hydrophone streamer were significantly smaller than the predicted operational mitigation radii.

Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In December 2013, NOAA published draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013), although at the time of preparation of this document, the date of release of the final guidelines and how they will be implemented are unknown. As such, this application has been prepared in accordance with the current NOAA acoustic practices, and the procedures are based on best practices noted by Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), and Wright (2014).

Enforcement of mitigation zones via power and shut downs would be implemented in the Operational Phase, as described in § XI.

OBS and Land-based Seismometers Description and Deployment

The *Langseth* would deploy 93 OBSs at the beginning of the study and then recover the instruments after all of the proposed seismic profiles have been surveyed. In addition, 30 land seismometers would be used for the study; 29 would be located on Santorini (Thira) and one on Anáfi.

The OBSs that would be used during the cruise include 30 Woods Hole Oceanographic Institute (WHOI) and 63 Scripps Institution of Oceanography (SIO) OBSs. The WHOI D2 OBSs have a height of ~1 m and a maximum diameter of 50 cm. The anchor is made of hot-rolled steel and weighs 23 kg. The

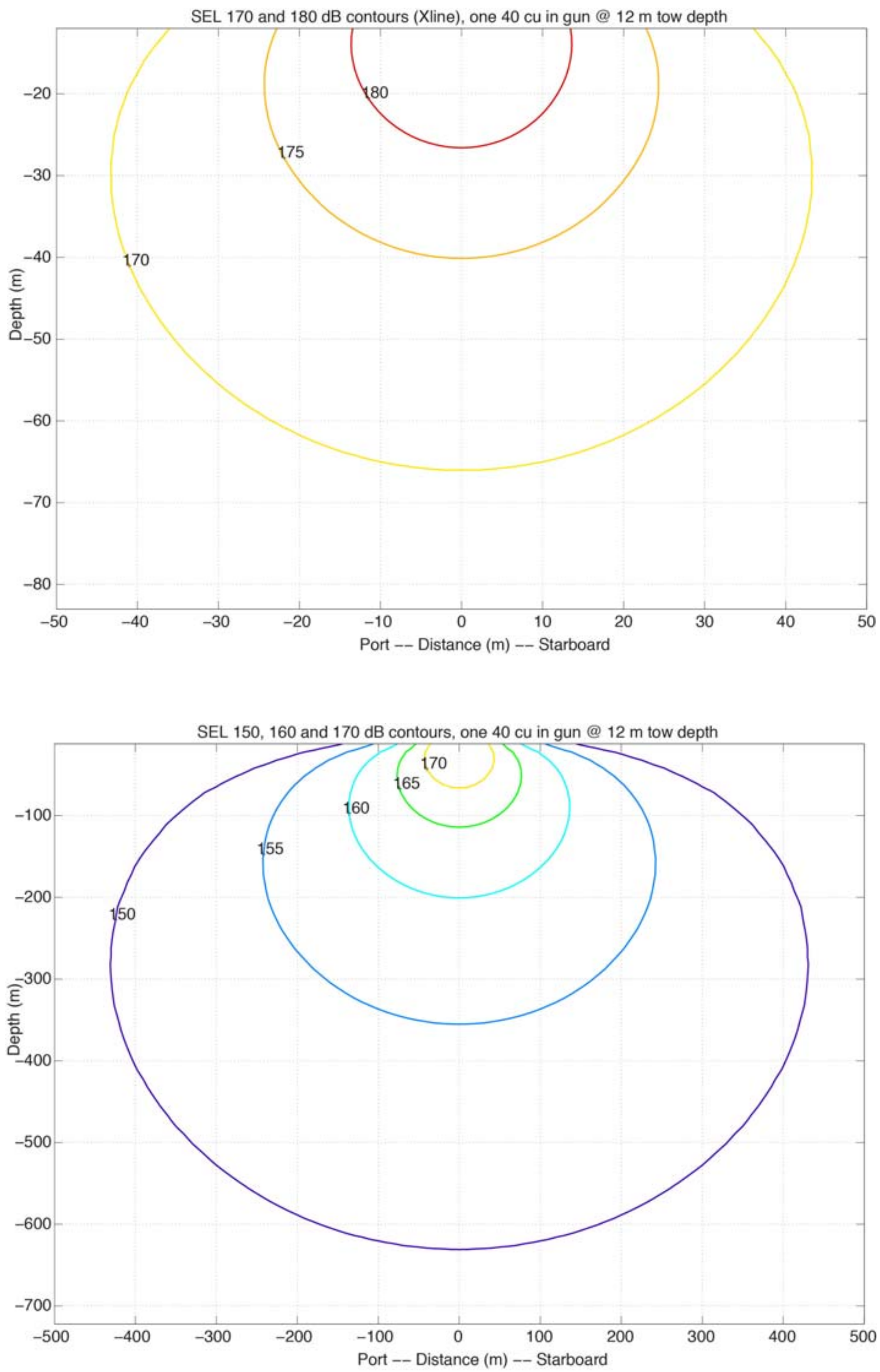


FIGURE 5. Modeled deep-water received sound levels (SELs) from a single 40-in^3 airgun towed at 12 m depth, which is planned for use as a mitigation gun during the proposed survey in the eastern Mediterranean Sea. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleths as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

TABLE 1. Predicted distances to which sound levels ≥190-, 180-, and 160-dB re 1 μPa_{rms} are expected to be received during the proposed survey in the eastern Mediterranean Sea. For the single mitigation airgun, the EZ is the conservative EZ for all low-energy acoustic sources in water depths >100 m defined in the PEIS.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted rms Radii (m)		
			190 dB	180 dB	160 dB
Single Bolt airgun, 40 in^3	9 or 12	>1000 m	100	100	431[1]
		100–1000 m	100	100	647[2]
		<100 m	27[3]	96[3]	1041[3]
4 strings, 36 airguns, 6600 in^3	9	>1000 m	286[1]	927[1]	5780[1]
		100–1000 m	429[2]	1391[2]	8670[2]
		<100 m	591[3]	2060[3]	22,580[3]
4 strings, 36 airguns, 6600 in^3	12	>1000 m	348[1]	1116[1]	6908[1]
		100–1000 m	522[2]	1674[2]	10,362[2]
		<100 m	710[3]	2480[3]	27,130[3]

[1] Distance is based on L-DEO model results.
[2] Distance is based on L-DEO model results with a 1.5 x correction factor between deep and intermediate water depths.
[3] Distance is based on empirically derived measurements in the GoM with scaling applied to account for differences in tow depth.

anchor dimensions are 2.5 × 30.5 × 38.1 cm. The SIO L-Cheapo OBSs have a height of ~0.9 m and a maximum diameter of 97 cm. The anchors are 36-kg iron grates with dimensions 7 × 91 × 91.5 cm.

Once an OBS is ready to be retrieved, an acoustic release transponder interrogates the instrument at a frequency of 8–11 kHz, and a response is received at a frequency of 11.5–13 kHz. The burn-wire release assembly is then activated, and the instrument is released from the anchor to float to the surface.

On land, seismic data would be acquired from 30 seismometers. Twenty existing, permanent land seismometers are located on Santorini, one permanent seismometer is located on Anáfi, and an additional nine temporary seismometers would be deployed on Santorini. The nine seismometers would be deployed typically in pre-disturbed areas. Seismometer installation usually involves using hand tools to dig a small trench (e.g., 15 cm deep and wide and ~46 cm long). Land-based deployments would follow Greek regulations and would be removed upon conclusion of the survey.

Description of Operations

The procedures to be used for the marine geophysical survey would be similar to those used during previous surveys by L-DEO and would use conventional seismic methodology. The survey would involve one source vessel, the *Langseth*. The *Langseth* would deploy an array of 36 airguns as an energy source with a total volume of ~6600 in^3. The receiving system would consist of 93 OBSs and 30 land seismometers for the Santorini survey in the Aegean Sea, and a single 8-km hydrophone streamer for the Hellenic subduction zone transect line that extends from the Aegean Sea to the southwest of Crete. As the airgun array is towed along the survey lines, the seismometers would receive the returning acoustic signals internally for later analysis, and the hydrophone streamer would transfer the data to the on-board processing system.

A total of ~2140 km of transect lines would be surveyed in the eastern Mediterranean Sea (Fig. 1). There could be additional seismic operations in the Santorini survey area in the Aegean Sea associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard. In our calculations (see § VII), 25% has been added for those additional operations. Repeat coverage would not be expected for the Hellenic subduction zone transect line that extends from the Aegean Sea to the southwest of Crete, and therefore no additional coverage was added. In addition to the operations of the airgun array, the ocean floor would be mapped with the Kongsberg EM 122 MBES and a Knudsen Chirp 3260 SBP. These sources are described in § 2.2.3.1 of the PEIS.

II. Dates, Duration, and Region of Activity

The date(s) and duration of such activity and the specific geographical region where it will occur.

The proposed Santorini survey would encompass the area ~36.1–36.8°N, ~24.7–26.1°E in the Aegean Sea; the Hellenic subduction zone transect line starts in the Aegean Sea at ~36.4°N, 23.9°E and runs to the southwest, ending at ~34.9°N, 22.6°E (Fig. 1). Water depths in the survey areas are ~20–3000+ m. The seismic survey would be conducted within the EEZ and territorial waters of Greece. Greece considers its territorial seas to extend out to 6 n.mi. as opposed to the typical 12-n.mi. limit.

It is proposed that the survey be conducted in fall/early winter 2015. The entire program would take ~29 days, including ~16 days of seismic surveying, 9 days of OBS deployment/retrieval, and ~2 days of streamer deployment/retrieval. It is proposed that the *Langseth* would depart from Piraievs, Greece, on 17 November 2015 and spend one day in transit to the proposed survey areas. The *Langseth* would arrive at Iraklio, Crete, on 15 December. Some minor deviation from these dates is possible, depending on logistics and weather. The ensuing analysis takes a seasonal approach in case of scheduling issues.

III. Species and Numbers of Marine Mammals in Area

The species and numbers of marine mammals likely to be found within the activity area

Twenty-three species of cetaceans (6 mysticetes and 17 odontocetes) and 2 pinniped species have been reported in the Mediterranean Sea (Reeves and Notarbartolo di Sciara 2006; Bellido et al. 2007; Gilmartin and Forcada 2009; IUCN 2012). To avoid redundancy, we have included the required information about the species and (insofar as it is known) numbers of these species in § IV, below.

IV. Status, Distribution and Seasonal Distribution of Affected Species or Stocks of Marine Mammals

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities

Sections III and IV are integrated here to minimize repetition.

Of the 25 marine mammal species that have been reported in the Mediterranean Sea, six are listed under the U.S. Endangered Species Act (ESA) as ***Endangered***: the North Atlantic right, humpback, fin, sei, and sperm whales; and the Mediterranean monk seal.

General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of marine mammals are given in § 3.6.1, § 3.7.1, and § 3.8.1 of the PEIS. The general distributions of marine mammals in various regions of the North Atlantic Ocean are discussed in the PEIS in § 3.6.2 and § 3.6.3 for mysticetes, § 3.7.2 and § 3.7.3 for odontocetes, and § 3.8.2 and § 3.8.3 for pinnipeds. The rest of this section deals with species distribution in the Mediterranean Sea. The main sources of information used here include reports and articles prepared by scientists from a number of Mediterranean research institutes including: Tethys Research Institute (Italy), MOm/Hellenic Society for the Study and Protection of the Monk Seal (Greece), Pelagos Cetacean Research Institute (Greece), and the Hellenic Centre for Marine Research (Greece). Reports and working papers produced by the International Whaling Commission (IWC) and scientific journal articles were also used.

Information on the occurrence near the proposed survey areas, habitat, population size, and conservation status for each of the cetacean and pinniped species that have been reported in the Mediterranean Sea is presented in Table 2. Twelve of these marine mammals (North Atlantic right, gray, sei, dwarf sperm, northern bottlenose, Gervais' beaked, Sowerby's beaked, Blainville's beaked, killer, and long-finned pilot whales; Indo-Pacific humpback dolphin; and hooded seal) either are considered vagrants in the Mediterranean Sea or have never been recorded in the eastern Mediterranean basin. Therefore, these species are extremely unlikely to occur near the proposed survey areas and are only briefly mentioned below. Detailed descriptions of the resident and visitor species in the Mediterranean Sea follow Table 2.

The North Atlantic right whale (*Eubalaena glacialis*) was historically abundant in the eastern North Atlantic where harvest activity was recorded from 1059 to 1982 (Aguilar 1986; Brown 1986). It has been suggested that the intense harvest activity in the 1900s had a catastrophic effect on this population; the eastern North Atlantic population likely numbers in the low tens of whales today and is considered a "relict" population by the IWC (IWC 2001). There have been only two confirmed occurrences of right whales in the Mediterranean Sea since the 1800s: one whale was captured off the coast of Italy in February 1877; and two whales were sighted off Algeria in January 1888, one of which was captured (Reeves and Notarbartolo di Sciara 2006).

The gray whale (*Eschrichtius robustus*) historically existed in the North Atlantic, where it is believed to have been eradicated in the 1700s (Lindquist 2000). In May 2010, a single gray whale was sighted and photographed off the Israeli Mediterranean shore, and then later in Spanish Mediterranean waters; this is the first recorded occurrence of a gray whale in the North Atlantic since the 1700s, and the first recorded occurrence in the Mediterranean Sea (Scheinin et al 2011; IUCN 2012). Scheinin et al. (2011) thought it most likely that it was a vagrant individual from the population of gray whales found in the eastern North Pacific.

The sei whale (*Balaenoptera borealis*) migrates seasonally, and in the eastern North Atlantic it has been observed to summer as far north as the sea between Greenland and Iceland; it might winter in the Canary Islands or farther south (Prieto et al. 2012). Occurrences (strandings and sightings) of the sei whale in the western Mediterranean Sea are considered extralimital: there were two confirmed occurrences off the coast of Spain in June 1952 and September 1973; and three confirmed occurrences off the coast of France in June 1921, August 1987, and September 1987 (Reeves and Notarbartolo di Sciara 2006).

The dwarf sperm whale (*Kogia sima*) is widely distributed in tropical and warm temperate shelf and slope waters (McAlpine 2009). There are only two confirmed occurrences, both strandings, of the dwarf sperm whale in the Mediterranean Sea: one on the western coast of Italy in May 1988 and a second on Sicily in September 2002 (Reeves and Notarbartolo di Sciara 2006).

The northern bottlenose whale (*Hyperoodon ampullatus*) is only found in the North Atlantic. There have been only two confirmed occurrences in the Mediterranean Sea: a mother and calf stranded and were captured off the coast of France in 1880, and one whale was sighted off Spain in the Alboran Sea (Reeves and Notarbartolo di Sciara 2006).

Gervais' beaked whale (*Mesoplodon europaeus*) occurs in tropical and warmer temperate waters of the Atlantic Ocean from Ireland to southeast Brazil (MacLeod et al. 2006; Jefferson et al. 2008). There is a single confirmed occurrence in the Mediterranean Sea: a female stranded in the Ligurian Sea on the coast of Italy in August 2001 (Podestà et al 2005 in Reeves and Notarbartolo di Sciara 2006).

TABLE 2. The habitat, occurrence, regional population sizes, and conservation status of marine mammals that could occur in or near the proposed survey areas in the eastern Mediterranean Sea.

Species	Occurrence	Habitat	Regional Abundance Estimate[1]	ESA[2]	IUCN Global[3] / Mediterranean[4]	CITES[5]
Mysticetes						
North Atlantic right whale	Extremely unlikely	Coastal, shelf	490[6]; vagrant	E	EN / N.A	I
Gray whale	Extremely unlikely	Coastal	N.A.; vagrant[7]	NL	LC / N.A.	I
Humpback whale	Rare	Coastal, banks, pelagic	11,570[8]; visitor	E	LC / N.A.	I
Common minke whale	Rare	Shelf, pelagic	107,205[9]; visitor	NL	LC / N.A.	I
Sei whale	Extremely unlikely	Pelagic, shelf edges	12-13,000[10]; vagrant	E	EN / N.A.	I
Fin whale	Rare	Pelagic, coastal	24,887[11]; ~5000[12]	E	EN / VU	I
Odontocetes						
Sperm whale	Uncommon	Slope, pelagic	13,190[14]; 200–250s[14]	E	VU / EN	I
Dwarf sperm whale	Extremely unlikely	Shelf, slope, pelagic	N.A.; vagrant	NL	DD / N.A.	II
Cuvier's beaked whale	Common	Slope	6532[15]; ~200?[16]	NL	LC / DD	II
Northern bottlenose whale	Extremely unlikely	Offshore, deep canyons	40,000[17]; vagrant	NL	DD / N.A.	I
Gervais' beaked whale	Extremely unlikely	Offshore	7092[18]; vagrant	NL	DD / N.A.	II
Sowerby's beaked whale	Extremely unlikely	Offshore, deep canyons	7092[18]; vagrant	NL	DD / N.A.	II
Blainville's beaked whale	Extremely unlikely	Pelagic, slope	7092[18]; vagrant	NL	DD / N.A.	II
Rough-toothed dolphin	Uncommon	Pelagic, shelf	N.A.; visitor[19]	NL	LC / L.C.	II
Indo-Pacific humpback dolphin	Extremely unlikely	Coastal	N.A.; vagrant	NL	NT / N.A.	I
Common bottlenose dolphin	Common	Coastal, offshore	Low 10,000s[20]	NL	LC / VU	II
Striped dolphin	Common	Pelagic, slope	233,584[21]	NL	LC / VU	II
Short-beaked common dolphin	Uncommon	Coastal, pelagic	19,428[22]	NL	LC / EN	II
Risso's dolphin	Uncommon	Slope, offshore islands	18,250[15]; 3000[23]	NL	LC / DD	II
False killer whale	Rare	Pelagic	N.A.; visitor	NL	DD / N.A.	II
Killer whale	Extremely unlikely	Coastal, pelagic	N.A.; visitor[24]	NL	DD / N.A.	II
Long-finned pilot whale	Extremely unlikely	Pelagic, shelf, slope	780,000[25]	NL	DD / DD	II
Harbor porpoise	Rare	Coastal	1000s[26]	NL	LC / EN[27]	II
Pinnipeds						
Hooded seal	Extremely unlikely	Pack ice, pelagic	N.A.; vagrant	NL	VU / N.A.	NL
Mediterranean monk seal	Common	Coastal	250–350[28]	E(F)	CR[29]	I

N.A. = Data not available or species status was not assessed.
[1] Reeves and Notarbartolo di Sciara (2006) except as noted; vagrant species are currently found only occasionally, whereas visitor species do not reproduce within a region but regularly occur there.
[2] U.S. Endangered Species Act (NMFS 2015): E = Endangered; T = Threatened; NL = Not Listed; F = Foreign.
[3] Classification from the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2014): CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient.
[4] IUCN conservation status of species resident in the Mediterranean Sea (IUCN 2012, 2014).
[5] Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2015): Appendix I = Threaten-

ed with extinction; Appendix II = not necessarily now threatened with extinction but may become so unless trade is closely controlled; NL = Not Listed.
[6] Abundance estimate for the North Atlantic (IWC 2015).
[7] IUCN (2012)
[8] Estimate for the Western North Atlantic (Stevick et al. 2003).
[9] Northeast Atlantic (Skaug et al. 2004).
[10] North Atlantic (Cattanach et al. 1993).
[11] Central and Northeast Atlantic (Víkingsson et al. 2009).
[12] Estimated number of adults in the Mediterranean population (IUCN 2012).
[13] For the northeast Atlantic, Faroes-Iceland, and the U.S. east coast (Whitehead 2002).
[14] Estimated population size for the Hellenic Trench (Frantzis et al. 2014).
[15] Western North Atlantic (Waring et al. 2014).
[16] An estimated 96–100 in the Gulf of Genova (eastern Ligurian Sea) and ~102 in the northern Alboran Sea (Cañadas 2011).
[17] Eastern North Atlantic (NAMMCO 1995).
[18] Estimate for *Mesoplodon* spp. in the western North Atlantic (Waring et al. 2014).
[19] A resident population in the eastern Mediterranean likely exists; population is unknown (IUCN 2012).
[20] Estimate for entire Mediterranean Sea (Reeves and Notarbartolo di Sciara 2006).
[21] Forcada and Hammond (1998) for the western Mediterranean plus Gómez de Segura et al. (2006) for the central Spanish Mediterranean.
[22] Northern Alboran Sea (Cañadas 2006).
[23] Estimate for the western Mediterranean (Perrin et al 1990 *in* Gaspari 2004; Pelagos Sanctuary 2015).
[24] IUCN (2012) classified the killer whale as a vagrant in the eastern Mediterranean Sea.
[25] Pilot whale estimate (*Globicephala* spp.) for the central and eastern North Atlantic (IWC 2015); there are no records of pilot whales in the eastern Mediterranean basin (Reeves and Notarbartolo di Sciara 2006).
[26] The Black Sea population is estimated at several thousand to the low tens of thousands (Reeves and Notarbartolo di Sciara 2006).
[27] The Black Sea harbor porpoise *Phocoena phocoena relicta* is considered *endangered* by the IUCN.
[28] Northeastern Mediterranean (MOm 2009).
[29] The Mediterranean monk seal has a single IUCN classification.

Sowerby's beaked whale (*M. bidens*) is the most northerly distributed of all the Atlantic species of Mesoplodon, where it occurs offshore and is often associated with deep canyons (Wojtek et al. 2014). There are two occurrences of Sowerby's beaked whale in the Mediterranean Sea: one female (tentative identification) stranded off the coast of Italy in the Tyrrhenian Sea in November 1927, and two whales (likely identification) stranded alive and released off the coast of France in August 1996 (Reeves and Notarbartolo di Sciara 2006).

Blainville's beaked whale (*M. densirostris*) is the most widely distributed Mesoplodon species (Mead 1989), although it is generally limited to pelagic tropical and warmer temperate waters (Jefferson et al. 2008). There is a single confirmed occurrence of Blainville's beaked whale in the Mediterranean Sea: a female stranded off the east coast of Spain in February 1983 (Casinos and Filella 1981 in Reeves and Notarbartolo di Sciara 2006).

The killer whale (*Orcinus orca*) is cosmopolitan and widely distributed and has been observed in all oceans of the world (Ford 2009). There are 26 known occurrences of killer whales in the western Mediterranean Sea and three known occurrences in the east: one off the coast of Israel, one captured between Sicily and Malta, and a pod sighted in the Ionian Sea in the 1970s (Reeves and Notarbartolo di Sciara 2006).

The long-finned pilot whale (*Globicephala melas*) occurs in temperate and subpolar waters and is found in the western Mediterranean Sea (Jefferson et al. 2008). However, there are no records of the long-finned pilot whale in the eastern Mediterranean basin (Reeves and Notarbartolo di Sciara 2006).

The Indo-Pacific humpback dolphin (*Sousa chinensis*) is found in coastal areas along the northern rim of the Indian Ocean and ranges north into the Red Sea (Jefferson et al. 2008). There are four known occurrences of Indo-Pacific humpback dolphins in the Mediterranean Sea: one sighting off the coast of Egypt, and three sightings in August 2000 off the coast of Israel (Reeves and Notarbartolo di Sciara 2006).

The hooded seal (*Cystophora cristata*) occurs throughout the central and western North Atlantic Ocean, and the limits of its distribution are correlated with the arctic pack ice. However, numerous extralimital records, particularly of juvenile seals, exist (Kovacs and Lavigne 1986). Bellido et al. (2007) documented eight occurrences of young hooded seals in the Alboran Sea during 1996–2006, and suggested that this is the eastern limit to the incursion of hooded seals into the Mediterranean Sea.

Mysticetes

Humpback Whale (*Megaptera novaeangliae*)

The humpback whale is cosmopolitan in distribution and is most common over the continental shelf and in coastal areas (Jefferson et al. 2008). In the North Atlantic, humpback whales migrate annually from high-latitude foraging areas in the summer to breeding grounds in the West Indies in winter (Clapham et al. 1993; Stevick et al. 1998; Kennedy et al. 2014). Four feeding aggregations of North Atlantic humpbacks have been identified: the Gulf of Maine, eastern Canada, West Greenland, and the eastern North Atlantic (Stevick et al. 2006).

Until very recently, humpback whales were considered extremely rare in the Mediterranean; before 1989, there were only two confirmed records of occurrence (in 1885 and 1986; Aguilar 1989). However, there have been an additional 12 confirmed records since 1990, and 8 of these have come from the eastern Mediterranean Sea (Frantzis et al. 2004; Frantzis 2009). There are three records of humpbacks in Greek Seas: two records from the Ionian Sea (one sighting and one whale found dead in a net), and one record of a whale sighted in the Aegean Sea in April 2001 in the Bay of Tolo to the northwest of the Santorini area (Frantzis et al. 2004). Frantzis et al. (2004) suggested that the recent increase in humpback whale occurrence in the Mediterranean might be attributable to spillover from an expanding North Atlantic population.

Common Minke Whale (*Balaenoptera acutorostrata*)

The minke whale has a cosmopolitan distribution that spans polar, temperate, and tropical regions (Jefferson et al. 2008). Four stocks are recognized in the North Atlantic: the Canadian East Coast, West Greenland, Central North Atlantic, and Northeast Atlantic stocks (Donovan 1991). However, genetic data suggest that there might be as few as two stocks in the North Atlantic (Anderwald et al. 2011). Some populations are known to migrate from high latitude summer feeding grounds to lower latitude winter breeding areas (Jefferson et al. 2008).

The minke whale is considered a visitor in the Mediterranean Sea; North Atlantic minke whales enter the Mediterranean via the Strait of Gibraltar (IUCN 2012). There are 30 records of minke whales in the Mediterranean Sea; 24 are from the western basin (Reeves and Notarbartolo di Sciara 2006; Öztürk et al. 2011). Two of the records from the eastern basin are from the Aegean Sea: a young minke whale was found dead, floating near Skiathos Island, northwestern Aegean Sea, in May 2000 (Verriopoulou et al. 2001); and another stranded on the coast of Turkey in August 2005 (Öztürk et al. 2011). The four other occurrences in the eastern basin are for the coast of Israel (3) and the Adriatic Sea (1; Reeves and Notarbartolo di Sciara 2006).

Fin Whale (*Balaenoptera physalus*)

The fin whale is widely distributed in all the world's oceans (Gambell 1985), but is most abundant in temperate and cold waters (Aguilar 2009). Most populations migrate seasonally between temperate waters where mating and calving occur in winter, and polar waters where feeding occurs in the summer. However, fin whale movements have been reported to be complex, and not all populations follow this simple pattern (Jefferson et al. 2008). Although a separate population of fin whales thought to be resident in the Mediterranean has been identified based on genetic data (Bérubé et al. 1998), fin whales from the northeast North Atlantic population sometimes penetrate into the Mediterranean Sea (Castellote et al. 2010; Giménez et al. 2013). The current population in the Mediterranean is believed to be ~5000 adults (IUCN 2012). Population structure in the Mediterranean is unknown: Mediterranean fin whales might belong to a single panmictic population or a number of metapopulations within the Mediterranean basin (Notarbartolo di Sciara et al. 2003).

Fin whales most commonly occur offshore, but can also be found in coastal areas (Aguilar 2009). In the North Atlantic, they are known to use the shelf edge as a migration route between summer feeding areas in high latitudes and southern wintering grounds (Evans 1987). Sergeant (1977) suggested that fin whales tend to follow steep slope contours, either because they detect them readily, or because the contours are areas of high biological productivity.

Fin whales in the Mediterranean are primarily observed in deep offshore waters, although they also occur over the continental shelf (Notarbartolo di Sciara et al. 2003). They have been observed to concentrate in areas of high productivity, such as the Ligurian-Corsican-Provencal Basin in the western Mediterranean Sea, particularly in the summer, but there is also evidence of seasonal movements between central and western portions of the basin to exploit available prey resources (Aissi et al. 2008). Although fin whales regularly occur in the western and central Mediterranean, they are very rare in the Aegean Sea and Levantine basins (Notarbartolo di Sciara et al. 2003). There are 36 sightings of fin whales recorded in Greek seas, the majority (31) of which occurred in the north Ionian Sea and Saronikos Gulf in the western Aegean Sea. Additionally, four sightings have been reported along the Hellenic Trench, including south of Crete and the waters between Kythira and Crete; no sightings were reported for the Cyclades or Sea of Crete (Frantzis 2009). Ten fin whale strandings were reported for Greek seas, including Saronikos Gulf; half of all strandings occurred after 1991 (Frantzis 2009).

Odontocetes

Sperm Whale (*Physeter macrocephalus*)

The sperm whale is widely distributed and occurs from the edge of the polar pack ice to the Equator in both hemispheres (Whitehead 2009). In general, it is distributed over large temperate and tropical areas that have high secondary productivity and steep underwater topography, such as volcanic islands (Jaquet and Whitehead 1996); its distribution and relative abundance can vary in response to prey availability, most notably squid (Jaquet and Gendron 2002). Sperm whales in the Mediterranean comprise a single population that is genetically different from that in the Atlantic (Drouot et al. 2004; Engelhaupt et al. 2009) and likely is small and isolated (Reeves and Notarbartolo di Sciara 2006). There is no reliable population estimate for the sperm whale population in the Mediterranean basin, but it is thought to number in the low hundreds (IUCN 2012). Frantzis et al. (2014) reported that 181 individual sperm whales have been photo-identified along the Hellenic Trench and suggested a local population size of 200–250 individuals.

Sperm whales can be found throughout the Mediterranean Sea, predominantly near steep slope and deep offshore waters (>2500 m) over the continental shelf where their primary prey, mesopelagic squid, are most abundant (Notarbartolo di Sciara et al. 2003; Azzellino et al. 2008; Moulins et al. 2008; Boisseau et al. 2010). There are numerous occurrences of sperm whales in the eastern Mediterranean, including frequent sightings in Greek seas, primarily along the Hellenic Trench including the waters between Kythira and Crete (Frantzis 2009; Frantzis et al. 2014). Reeves and Notarbartolo di Sciara (2006) identified the region of the Aegean Sea and south to the Hellenic Trench as being an area of "regular" occurrence for sperm whales. Notarbartolo di Sciara and Bearzi (2010) consider the Hellenic Trench to be critical habitat for Mediterranean sperm whales.

Frantzis et al. (2014) conducted summer surveys between 1998 and 2009 along the Hellenic Trench and observed a pronounced peak in sperm whale distribution along the 1000-m contour; 74% of visual encounters occurred within 3 km of the contour. Boisseau et al. (2010) encountered 17 groups of sperm whales in the Crete Trench during May–July 2007, with an encounter rate of 0.06 whales/100 n.mi. Sperm whale records exist throughout the Aegean Sea, including reported sightings for the Sea of Crete, east of Íos in the Cyclades, and north of Rhodes Island (Frantzis et al. 2003; Frantzis 2009; Dede et al. 2012). However, no sperm whales were sighted during a survey through the southern Aegean Sea during 2000 (Gannier et al. 2002). Sperm whales have also been detected acoustically in Rhodes Basin, south of Cyprus, western Crete, and in the Ikaria Basin, western Turkey (Gannier et al. 2002; Ryan et al. 2014). Additionally, 43 sightings of sperm whales were reported in Turkish waters during 1994–2012 (Öztürk et al. 2013). Twenty-six sperm whale strandings have been recorded in Greece, including in the Cyclades (one each at the islands of Íos and Náxos) and the northern and southwestern coasts of Crete (Frantzis et al. 2003; Frantzis 2009).

Cuvier's Beaked Whale (*Ziphius cavirostris*)

Cuvier's beaked whale is probably the most widespread and common of the beaked whales, although it is not found in high-latitude polar waters (Heyning 1989). It is rarely observed at sea and is known mostly from strandings; it strands more commonly than any other beaked whale (Heyning 1989). Cuvier's beaked whale occurs in the western and eastern basins of the Mediterranean Sea (Notarbartolo di Sciara 2002). Dalebout et al. (2005) examined mitochondrial DNA from Cuvier's beaked whales worldwide and recommended that whales in the Mediterranean Sea be considered an evolutionarily significant unit (ESU) distinct from other populations in the North Atlantic. Population size in the Mediterranean Sea is unknown except for two small areas: there are ~96–100 whales in the Gulf of Genova (eastern Ligurian Sea) and ~102 whales in the northern Alboran Sea (Cañadas 2011).

Cuvier's beaked whale is found in deep water over and near the continental slope (Gannier and Epinat 2008; Jefferson et al. 2008). Slope waters at depths between 200–2000 m appear to be preferred habitat of Cuvier's beaked whale in the Mediterranean Sea (DoN 2008). Deep-sea mud volcanoes in the eastern Mediterranean Sea, including the Napoli Mud Volcano in the Olimpi Mud Diapir Field south of Crete, are thought to show evidence of having been visited by Cuvier's beaked whales during foraging dives (Woodside et al. 2006).

Cañadas et al. (2012) compiled 23 sets of survey data (totaling 420,050 km of survey effort and 456 sightings over 21 years) and modeled habitat use by Cuvier's beaked whales in the Mediterranean Sea. Most of the waters in the proposed survey areas have been identified as being areas of medium predicted density relative to other areas of the Mediterranean (Cañadas et al. 2012). The Hellenic Trench is considered to be critical habitat for Cuvier's beaked whale (Notarbartolo di Sciara and Bearzi 2010). Reeves and Notarbartolo di Sciara (2006) identified the coastal waters of southern Crete as being an area of "regular" occurrence for Cuvier's beaked whale, where numerous sightings have been reported (Frantzis 2009). Sightings in the Aegean Sea have been reported for the Sea of Crete south of Santorini (1) and in the northwestern Aegean Sea (3, Frantzis 2009). Boisseau et al. (2010) encountered one group of three beaked whales, assumed to be Cuvier's beaked whales, in the Crete Trench during May–July 2007. Wojtek and Norman (2013) compiled stranding records of Cuvier's beaked whales worldwide and found 56 stranding events totaling 88 whales in Greece during 1803–2012. In the Mediterranean, strandings have been especially frequent along the Ligurian and Ionian coasts (Cañadas et al. 2012). Numerous stranding records exist for the northern and southern Aegean Sea (Frantzis 2009), including one record of a group of three whales that stranded at Melos Island in January 1999 (Podestá et al. 2006). Several strandings have also been reported for the northern and southern coasts of Crete, and one stranding was reported on the northern coast of Kythira (Podestá et al. 2006; Frantzis 2009). A mass stranding of Cuvier's beaked whales, coincident with naval exercises in the area, occurred in April 2014 in southeast Crete (Aguilar de Soto et al. 2014; Frantzis 2014).

Rough-toothed Dolphin (*Steno bredanensis*)

The rough-toothed dolphin is distributed worldwide in tropical, subtropical, and warm temperate waters (Miyazaki and Perrin 1994). It is generally seen in deep, oceanic water, although it can occur in shallow coastal waters in some locations (Jefferson et al. 2008). Previously considered an occasional visitor to the Mediterranean Sea (Reeves and Notarbartolo di Sciara 2006), regular occurrences of rough-toothed dolphins have since been documented in the eastern Mediterranean, where a resident population is thought to exist (Frantzis 2009). Population figures for the Mediterranean Sea are unknown (IUCN 2012).

There are a number of occurrences of rough-toothed dolphins in the eastern Mediterranean Sea, but no sightings have been reported for the Aegean Sea or the waters around Crete (Frantzis 2009). There are two records in the Ionian Sea: a group of ~160 was sighted 170 km south of Sicily in September 1985, and a pod of 8 was sighted 150 km west of Kefalonia Island in September 2003 (Watkins et al. 1987, Lacey et al. 2005 in Reeves and Notarbartolo di Sciara 2006). A group of nine rough-toothed dolphins was sighted off Libya in July–September 2003 (Boisseau et al. 2010). Three groups were sighted near Cyprus: six individuals were seen north of Cyprus in June 2007 (Boisseau et al. 2010), and three and nine were observed south of Cyprus in August–September 2013 (Ryan et al. 2014). Seven of the 10 records of rough-toothed dolphins in Israel are strandings (Reeves and Notarbartolo di Sciara 2006).

Common Bottlenose Dolphin (*Tursiops truncatus*)

The bottlenose dolphin occurs in tropical, subtropical, and temperate waters throughout the world; more is known about this species of dolphin than any other (Jefferson et al. 2008). However, modern field studies on the Mediterranean population did not begin until the late 1980s; therefore, much less is known about the bottlenose dolphins in this basin (Notarbartolo di Sciara and Bearzi 2005 *in* Bearzi et al. 2008). In many parts of the world, coastal and offshore ecotypes have been distinguished based on morphological, ecological, and physiological features (Jefferson et al. 2008). There is evidence suggestive of the existence of these ecotypes in the Mediterranean: dolphins from coastal Spain were distinguished from dolphins from offshore islands (i.e., Balearic Islands) based on contaminant profiles in their blubber (Borrell et al. 2007). Mediterranean bottlenose dolphins were found to be genetically differentiated from bottlenose dolphins inhabiting the contiguous eastern North Atlantic Ocean and the Black Sea (Natoli et al. 2005). Natoli et al. (2005) also found that bottlenose dolphins in the eastern and western Mediterranean basins could be differentiated from one another.

The total population size in the Mediterranean is unknown but has been estimated to be in the low 10,000s based on surveys completed in smaller areas (Reeves and Notarbartolo di Sciara 2006). It is thought that bottlenose dolphin abundance is declining in the Mediterranean based on local abundance trends and recent patterns in sightings and strandings (Reeves and Notarbartolo di Sciara 2006).

Bottlenose dolphins are patchily distributed in coastal waters and around offshore islands and archipelagos throughout the Mediterranean (Bearzi et al. 2008). Frantzis (2009) reported 305 sightings and 234 strandings of bottlenose dolphins throughout Greek Seas and along Greek coasts, respectively; both sightings and strandings were widely distributed. Sightings and strandings have been reported throughout the Aegean Sea and along the Hellenic Trench (Frantzis 2009). Reeves and Notarbartolo di Sciara (2006) identified the Cyclades as being an area of "regular" occurrence for bottlenose dolphins.

Sightings have been reported for a number of islands in the Cyclades, including the group of islands north of Íos, the coastal waters of western, northern, and southern Crete, Kythira, and Antikythera (Frantzis 2009). Strandings have been reported for Santorini and Íos, as well as numerous other islands in the Cyclades, and along the northern and western coasts of Crete (Frantzis 2009). Boisseau et al. (2010) reported six and two sightings of bottlenose dolphins during surveys of the Crete Trench during May–July 2007 and the Sea of Crete in September 2007, respectively. Gannier (2005) also sighted bottlenose dolphins in the Sea of Crete during surveys of the Levantine basin. During a dedicated harbor porpoise survey in the northern Aegean Sea in July 2013, the bottlenose dolphin was the most frequently encountered species and was most commonly observed in coastal waters; the encounter rate was 0.011 groups per 100 km (Ryan et al. 2014).

Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin has a cosmopolitan distribution in tropical to warm temperate waters (Perrin et al. 1994). Its primary range in the eastern Atlantic extends between ~30°S and ~50°N (Jefferson et al. 2008). Genetic studies indicate that the Mediterranean and eastern North Atlantic populations are isolated from each other with limited gene flow across the Strait of Gibraltar (García-Martinez et al. 1999; Valsecchi et al. 2004; Bourret et al. 2007). Population structure within the Mediterranean basin is uncertain, but genetic variation has been found within regions and between dolphins sampled inshore vs. offshore (Bourret et al. 2007; Gaspari et al. 2007a).

The striped dolphin is the most abundant dolphin in the Mediterranean Sea (IUCN 2012), although its abundance appears to decrease towards the eastern basin, likely reflecting a gradient in decreasing productivity (Notarbartolo di Sciara and Birkun 2010). There were an estimated 117,880 striped dolphins in the western Mediterranean subpopulation in 1991 (Forcada et al. 1994), and Forcada and Hammond (1998) provided an abundance estimate of 217,806. However, current abundance is thought to have declined because of disease outbreak, high levels of pollutants, and bycatch in pelagic driftnets (IUCN 2012). There are no population estimates for striped dolphins in the eastern Mediterranean basin.

The striped dolphin is pelagic and seems to prefer deep water seaward of the continental shelf (Davis et al. 1998). Reeves and Notarbartolo di Sciara (2006) classified much of the northern Mediterranean Sea, from the Strait of Gibraltar to Turkey just east of Rhodes Island, including the Aegean Sea and south to the Hellenic Trench, as its "regular" range. In Greece, the striped dolphin occupies continental slope and pelagic habitats; it is also occasionally found close to the coast where the continental slope is very steep (Frantzis 2009). Frantzis (2009) reported 523 sightings and 197 strandings throughout Greek seas and along coastlines, respectively. Sighting and stranding records exist throughout the Aegean Sea (Frantzis 2009). Frantzis (2009) reported numerous sightings in the Sea of Crete, south of Santorini, as well as off the western and southern coasts of Crete, south of Kythira and in the waters around Antikythera; strandings were reported for Santorini and other islands in the Cyclades, and for the northern and western coasts of Crete. Boisseau et al. (2010) encountered eight groups of striped dolphins in the Crete Trench during May–July 2007, with an encounter rate of 0.32 animals/100 n.mi. During a survey in the Sea of Crete, Boisseau et al. (2010) sighted four groups of striped dolphins; the encounter rate was 0.56 animals/100 n.mi. Striped dolphins were also seen in the Sea of Crete during surveys of the Levantine Basin by Gannier (2005). Almost 50% of the sightings made by Ryan et al. (2014) during their 2013 vessel-based survey were of striped dolphins: there were 10 sightings (group sizes 2–18) made during July–August in the northern Aegean Sea, and 6 sightings (group sizes 2–18) made during August–September in the Levantine Sea; the encounter rate in the Aegean Sea was 0.019 groups/100 km. The majority of sightings were made in offshore waters, but several were made in more coastal waters in the

Aegean Sea (Ryan et al. 2014). Striped dolphins have also been sighted near Cyprus and Israel (Boisseau et al. 2010; Dede et al. 2012; Kerem et al. 2012).

Short-beaked Common Dolphin (*Delphinus delphis*)

The short-beaked common dolphin is an oceanic species that is widely distributed in temperate to tropical waters of the Atlantic and Pacific oceans (Jefferson et al. 2008). It was widespread and abundant throughout much of the Mediterranean Sea until the population declined relatively quickly in the late 1960s; suggested causes of the decline included incidental bycatch in fishing gear, a reduction in prey availability, and high levels of pollutants (Bearzi et al. 2003). Today the short-beaked common dolphin is relatively abundant in the Alboran Sea, Sicily Channel around Malta, eastern Ionian Sea, Aegean Sea, and off western Sardinia and Israel (IUCN 2012). Cañadas and Hammond (2008) estimated an abundance of 19,428 in the Alboran Sea based on surveys from 1992 to 2004. Information on population size and trends is lacking for other areas in the Mediterranean (IUCN 2012).

In the Atlantic Ocean, short-beaked common dolphins usually occur along the shelf break at depths 200–300 m or over prominent underwater topography such as seamounts (Evans 1994). Cañadas and Hammond (2008) modeled habitat use in the Alboran Sea and found that groups with calves and groups that were feeding preferred more coastal waters. In Greece, the short-beaked common dolphin is present in the inner Ionian Sea and in the deeper waters of the eastern Gulf of Corinth; it is present and potentially common in portions of the Aegean Sea at water depths <200 m (Frantzis 2009). Frantzis (2009) reported a total of 140 sightings and 55 strandings in Greece, including sightings in the northern and southern Aegean Sea; several sightings have been reported for the Cyclades, and single sightings were made off Kythira and in the Sea of Crete, just south of Santorini (Frantzis 2009). There is a record of a single short-beaked common dolphin stranding in Crete in September 1991 (Van Bressem et al. 1993).

Boisseau et al. (2010) encountered one group of six short-beaked common dolphins in the Crete Trench during May–July 2007. Ryan et al. (2014) encountered 16 groups (group sizes 1–15) in the Thracian Sea during July 2013, and two groups of two (one offshore and one in coastal waters) during July–August 2103 in the Aegean Sea; the encounter rate in the Aegean Sea was 0.004 groups/100 km. There were three sightings of common dolphins in the coastal waters of Turkey in the Aegean Sea in spring 2005 (Dede and Öztürk 2007), and one sighting of two dolphins in water 2000 m deep west of Crete in July 2008 (Dede et al. 2012).

Risso's Dolphin (*Grampus griseus*)

Risso's dolphin is distributed worldwide in temperate and tropical oceans (Baird 2009a). It has an apparent preference for the continental shelf and slope waters (Jefferson et al. 2014), occurring in steep sections of the shelf 400–1000 m deep (Baird 2009a); it is also known to frequent seamounts and escarpments (Kruse et al. 1999). Risso's dolphins in the Mediterranean are genetically distinct from those in the eastern Atlantic (Gaspari et al. 2007b). Population abundance in the entire Mediterranean Sea is unknown (IUCN 2012), but a population size of 3000 individuals has been proposed (Perrin et al. 1990 in Gaspari 2004; Pelagos Sanctuary 2015) suggested a population size of 3000 individuals. Gómez de Segura et al. (2006) provided an abundance estimate of 493 Risso's dolphins for the central Spanish Mediterranean, and Airoldi et al. (2005) estimated the population size in the Ligurian Sea at 267 dolphins.

Risso's dolphin is found throughout the Mediterranean Sea, although most occurrences have been recorded in the northwestern part of the basin (Bearzi et al. 2011; Jefferson et al. 2014). There are 38 sightings and 34 strandings in Greece; the sightings are mainly from the Aegean Sea, but the strandings are roughly equally spread throughout the Ionian and Aegean seas and the Sea of Crete (Frantzis 2009). Sightings have been made in the Cyclades, just south of eastern Amorgós; sightings have also been reported for the waters off northwestern Crete near Antikythera, southwestern Crete, and a single sighting was reported just east of Kythira (Frantzis 2009). Boisseau et al. (2010) encountered two groups of Risso's dolphins in the Crete Trench during May–July 2007, with an encounter rate of 0.06/100 n.mi. There are also stranding records throughout the Cyclades, including Santorini, Melos, and Astipalea; and along the northwest coast of Crete (Frantzis et al. 2003; Frantzis 2009). Risso's dolphins were sighted near the Akté Peninsula, northern Aegean Sea, in July 2013, and between Rhodes and Cyprus, and to the southwest of Crete in August–September 2013 (Ryan et al. 2014). There was as single sighting off the coast of Turkey in July 2008 (Dede et al. 2012), and five strandings were reported along the Turkish coast during 1997–2011 (Öztürk et al. 2011).

False Killer Whale (*Pseudorca crassidens*)

The false killer whale is found worldwide in tropical and temperate waters generally between 50ºN and 50ºS (Odell and McClune 1999). It is widely distributed, but not abundant anywhere (Carwardine 1995). False killer whales generally inhabit deep, offshore waters, but sometimes are found over the continental shelf and occasionally move into very shallow water (Jefferson et al. 2008; Baird 2009b). False killer whales are gregarious and form strong social bonds, as is evident from their propensity to strand en masse (Baird 2009b).

The false killer whale is considered a visitor in the Mediterranean Sea (IUCN 2012). Frantzis (2009) reported 33 records in the Mediterranean Sea: 16 in the western basin and 17 in the eastern basin. The records for the eastern basin include two occurrences in Greece (a group of 7+ whales was photographed between Chios Island and the coast of Turkey in 1992, and single individual stranded in Argolikos Gulf, western Aegean Sea, in 1993), and a live stranding in the Turkish Aegean Sea at Izmir Bay (Frantzis 2009). Ryan et al. (2014) sighted a group of 3–4 false killer whales southwest of Cyprus while conducting a vessel-based survey during August–September 2013.

Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise inhabits cool temperate to subarctic waters of the Northern Hemisphere and is most often found in shallow coastal waters (Jefferson et al. 2008). Harbor porpoises in the northern Aegean Sea have been shown to be genetically similar to those in the Black Sea, and porpoises from both areas are genetically distinct from those in the Atlantic Ocean (Rosel et al. 2003; Viaud-Martínez et al. 2007). The Black Sea population is estimated at several thousands to the low ten thousands; the subpopulation resident in the northern Aegean Sea is thought to be the smallest (Reeves and Notarbartolo di Sciara 2006).

Frantzis (2009) reported one sighting and 13 strandings of harbor porpoises along the coast of the northern Aegean Sea. Frantzis (2009) also reported two strandings farther south in Greek waters: a harbor porpoise stranded alive in northern Evvoia in summer 2006, and a stranding occurred in the Saronikos Gulf in spring 2008. Ryan et al. (2014) completed the first dedicated survey for harbor porpoises in the northern Aegean Sea in July 2013 and confirmed the presence of porpoises in both Greek and Turkish waters of the Aegean Sea. Harbor porpoise detections were clustered in three areas: north of Thasos, southwest of Alexandroupolis, and Saros Bay (Ryan et al. 2014). In October 2006, a stranded porpoise was discovered on the Turkish coast of the Aegean Sea in Izmir Bay (Güçlüsoy 2008).

Mediterranean Monk Seal (*Monachus monachus*)

The Mediterranean monk seal is the most endangered seal species, with an estimated total population size of 350–450 (Jefferson et al. 2008). Extirpation along most mainland coasts of the Mediterranean has resulted in the existence of only three small, isolated populations in remote locations:

the smallest subpopulation in the archipelago of Madeira consists of 30–35 individuals (Pires et al. 2008); a subpopulation in the area of Cabo Blanco, Western Sahara, consists of ~150 individuals (González et al. 2002); and the largest subpopulation, found mainly in caves throughout the northeastern Mediterranean in Greece and Turkey, is estimated at ~250–350 individuals (Güçlüsoy et al. 2004; Gücü et al. 2004; MOm, 2009). The minimum population estimate for Greece is 170–220; this is considered a conservative estimate because several important pupping areas have not been systematically monitored (MOm 2009). More than 34 pups are likely born in Greece annually (Notarbartolo di Sciara et al. 2009). The greatest concentrations of Mediterranean monk seals are found in Greece and are located mainly over the Aegean and Ionian islands, and along the coastlines of the continental central and southern parts of the country (Adamantopoulou et al. 1999). The Eastern Mediterranean and Western Saharan populations are reproductively isolated (Schultz 2011).

The Mediterranean monk seal is non-migratory and has a very limited home range (Gücü et al. 2004; Dendrinos et al. 2007a; Adamantopoulou et al. 2011). It historically occupied open beaches, rocky shorelines, and spacious arching caves, but now almost exclusively uses secluded coastal caves for hauling out and breeding. Monk seals are more particular when selecting caves for breeding vs. caves for resting (Gücü et al. 2004; Karamanlidis et al. 2004; Dendrinos et al. 2007b). In Greece, the pupping season lasts from August to December with a peak in births during September–October (MOm 2009). Lactation lasts an average of 119 days (Aguilar et al. 2007). Monk seals are thought to be most vulnerable to human disturbance within the first six months after birth (Gücü et al. 2004).

Suitable shelters for resting and reproduction have been identified on the islands immediately north of Santorini, including Folégandros, Nisída Kardiótissi, Síkinos, Náxos, Irakleia, and Amorgós (MOm 2009). According to MOm (2009), the islands in and nearest to the proposed Santorini survey area, including Santorini, Therasia, Christianna, Anáfi, and Íos, do not have suitable shelters for monk seals, nor does Crete (MOm 2009). Notarbartolo di Sciara et al. (2009) also did not report any breeding on the island of Santorini; however, they considered the west coast of Santorini as an area of interest because of the presence of monk seal habitat. For example, Giakoumi et al. (2013) reported 1–5 caves on Santorini. According to NMFS (pers. comm.), there may be unreported breeding caves on Santorini; however, this information is not based on published literature. Sightings of monk seals have been made throughout the Aegean Sea, including western Santorini, Anáfi, Íos, northern and southern Crete, and near Kythira and Antikythera (MOm 2009; Notarbartolo di Sciara et al. 2009).

V. Type of Incidental Take Authorization Requested

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death), and the method of incidental taking.

L-DEO requests an IHA pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA) for incidental take by harassment during its planned seismic survey in the eastern Mediterranean Sea during November–December 2015.

The operations outlined in § I have the potential to take marine mammals by harassment. Sounds would be generated by the airguns used during the survey, by echosounders, and by general vessel operations. "Takes" by harassment would potentially result when marine mammals near the activity are exposed to the pulsed sounds generated by the airguns or echosounders. The effects would depend on the species of marine mammal, the behavior of the animal at the time of reception of the stimulus, as well as the distance and received level of the sound (see § VII). Disturbance reactions are likely amongst some of the marine mammals near the tracklines of the source vessel. No take by serious injury is expected, given the nature of the planned operations and the mitigation measures that are planned (see § XI, MITIGATION MEASURES). No lethal takes are expected.

VI. NUMBERS OF MARINE MAMMALS THAT COULD BE TAKEN

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in [section V], and the number of times such takings by each type of taking are likely to occur.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

VII. ANTICIPATED IMPACT ON SPECIES OR STOCKS

The anticipated impact of the activity upon the species or stock of marine mammal.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

- First we summarize the potential impacts on marine mammals of airgun operations, as called for in § VII. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, § 3.8.4.3, and Appendix E of the PEIS.
- Then we summarize the potential impacts of operations by the echosounders. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, § 3.8.4.3, and Appendix E of the PEIS.
- Finally, we estimate the numbers of marine mammals that could be affected by the proposed survey in the eastern Mediterranean Sea. This section includes a description of the rationale for the estimates of the potential numbers of harassment "takes" during the planned survey, as called for in § VI. Acoustic modeling was conducted by L-DEO, determined to be acceptable by NMFS to use in the calculation of estimated takes under the MMPA (e.g., NMFS 2013a,b).

Summary of Potential Effects of Airgun Sounds

As noted in the PEIS (§ 3.6.4.3, § 3.7.4.3, and § 3.8.4.3), the effects of sounds from airguns could include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007). In some cases, a behavioral response to a sound may in turn reduce the overall exposure to that sound (e.g., Finneran et al. 2015; Wensveen et al. 2015).

Permanent hearing impairment (PTS), in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not considered an injury (Southall et al. 2007; Le Prell 2012). Rather, the onset of TTS has been considered an indicator that, if the animal is exposed to higher levels of that sound, physical damage is ultimately a possibility. Nonetheless, recent research has shown that sound exposure can cause cochlear neural degeneration, even when threshold shifts and hair cell damage are reversible (Liberman 2013). These findings have raised some doubts as to whether TTS should continue to be considered a non-injurious effect (Weilgart 2014; Tougaard et al. 2015). Although the possibility cannot be entirely excluded, it is unlikely that the proposed survey would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. If marine mammals encounter the survey while it is underway, some behavioral disturbance could result, but this would be localized and short-term.

Tolerance

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers (e.g., Nieukirk et al. 2012). Several studies have shown that marine mammals at distances more than a few kilometers from operating seismic vessels often show no apparent response. That is often true even in cases when the pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen and toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to airgun pulses under some conditions, at other times mammals of all three types have shown no overt reactions. The relative responsiveness of baleen and toothed whales are quite variable.

Masking

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data on this. Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (e.g., Simard et al. 2005; Clark and Gagnon 2006), which could mask calls. Situations with prolonged strong reverberation are infrequent. However, it is common for reverberation to cause some lesser degree of elevation of the background level between airgun pulses (e.g., Gedamke 2011; Guerra et al. 2011, 2013; Klinck et al. 2012), and this weaker reverberation presumably reduces the detection range of calls and other natural sounds to some degree. Thus, airgun sounds could have masking effects and reduce the communication range especially of large whales (Nieukirk et al. 2012; Blackwell et al. 2013; Wittekind et al. 2013).

Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls usually can be heard between the seismic pulses (e.g., Nieukirk et al. 2012; Broker et al. 2013). In addition, some cetaceans are known to change their calling rates, shift their peak frequencies, or otherwise modify their vocal behavior in response to airgun sounds (e.g., Di Iorio and Clark 2010; Castellote et al. 2012; Blackwell et al. 2013, 2015; Cerchio et al. 2014). The hearing systems of baleen whales are undoubtedly more sensitive to low-frequency sounds than are the ears of the small odontocetes that have been studied directly (e.g., MacGillivray et al. 2014). The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking. In general, masking effects of seismic pulses are expected to be minor, given the normally intermittent nature of seismic pulses.

Disturbance Reactions

Disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Based on NMFS (2001, p. 9293), NRC (2005), and Southall et al. (2007), we believe that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially significant manner, do not constitute harassment or "taking". By potentially significant, we mean, 'in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations'.

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson et al. 1995; Wartzok et al. 2004; Southall et al. 2007; Weilgart 2007; Ellison et al. 2012). If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population (New et al. 2013). However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (e.g., Lusseau and Bejder 2007; Weilgart 2007). Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many marine mammals would be present within a particular distance of industrial activities and/or exposed to a particular level of industrial sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important degree by a seismic program are based primarily on behavioral observations of a few species. Detailed studies have been done on humpback, gray, bowhead, and sperm whales. Less detailed data are available for some other species of baleen whales and small toothed whales, but for many species, there are no data on responses to marine seismic surveys.

Baleen Whales.—Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the cases of migrating gray and bowhead whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors (Malme et al. 1984; Malme and Miles 1985; Richardson et al. 1995).

Responses of *humpback whales* to seismic surveys have been studied during migration, on summer feeding grounds, and on Angolan winter breeding grounds; there has also been discussion of effects on the Brazilian wintering grounds. Off Western Australia, avoidance reactions began at 5–8 km from the array, and those reactions kept most pods ~3–4 km from the operating seismic boat; there was localized displacement during migration of 4–5 km by traveling pods and 7–12 km by more sensitive resting pods of cow-calf pairs (McCauley et al. 1998, 2000). However, some individual humpback whales, especially males, approached within distances of 100–400 m.

In the northwest Atlantic, sighting rates were significantly greater during non-seismic periods compared with periods when a full array was operating, and humpback whales were more likely to swim away and less likely to swim towards a vessel during seismic vs. non-seismic periods (Moulton and Holst 2010). In contrast, sightings of humpback whales from seismic vessels off the U.K. from 1994 to 2010 indicated that detection rates were similar during seismic and non-seismic periods, although, sample sizes were small (Stone 2015). On their summer feeding grounds in southeast Alaska, there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 re 1 μPa on an approximate rms basis (Malme et al. 1985). It has been suggested that South Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys (Engel et al. 2004), but data from subsequent years, indicated that there was no observable direct correlation between strandings and seismic surveys (IWC 2007).

There are no data on reactions of *right whales* to seismic surveys. However, Rolland et al. (2012) suggested that ship noise causes increased stress in right whales; they showed that baseline levels of stress-related faecal hormone metabolites decreased in North Atlantic right whales with a 6-dB decrease in underwater noise from vessels. Wright et al. (2011) also reported that sound could be a potential source of stress for marine mammals.

Results from the closely related *bowhead whale* show that their responsiveness can be quite variable depending on their activity (migrating vs. feeding). Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with substantial avoidance occurring out to distances of 20–30 km from a medium-sized airgun source (Miller et al. 1999; Richardson et al. 1999). Subtle but statistically significant changes in surfacing–respiration–dive cycles were shown by traveling and socializing bowheads exposed to airgun sounds in the Beaufort Sea, including shorter surfacings, shorter dives, and decreased number of blows per surfacing (Robertson et al. 2013). More recent research on bowhead whales corroborates earlier evidence that, during the summer feeding season, bowheads are less responsive to seismic sources (e.g., Miller et al. 2005; Robertson et al. 2013).

Bowhead whale calls detected in the presence and absence of airgun sounds have been studied extensively in the Beaufort Sea. Bowheads continue to produce calls of the usual types when exposed to airgun sounds on their summering grounds, although numbers of calls detected are significantly lower in the presence than in the absence of airgun pulses (Blackwell et al. 2013, 2015). Blackwell et al. (2013) reported that calling rates in 2007 declined significantly where received SPLs from airgun sounds were 116–129 dB re 1 μPa; at SPLs <108 dB re 1 μPa, calling rates were not affected. When data for 2007–2010 were analyzed, Blackwell et al. (2015) reported an initial increase in calling rates when airgun pulses became detectable; however, calling rates leveled off at a received $CSEL_{10\text{-min}}$ (cumulative SEL over a 10-min period) of ~94 dB re 1 $\mu Pa^2 \cdot s$, decreased at $CSEL_{10\text{-min}}$ >127 dB re 1 $\mu Pa^2 \cdot s$, and whales were nearly silent at $CSEL_{10\text{-min}}$ >160 dB re 1 $\mu Pa^2 \cdot s$. Thus, bowhead whales in the Beaufort Sea apparently decreased their calling rates in response to seismic operations, although movement out of the area could also have contributed to the lower call detection rate (Blackwell et al. 2013, 2015).

A multivariate analysis of factors affecting the distribution of calling bowhead whales during their fall migration in 2009 noted that the southern edge of the distribution of calling whales was significantly closer to shore with increasing levels of airgun sound from a seismic survey a few hundred kilometers to the east of the study area (i.e., behind the westward-migrating whales; McDonald et al. 2010, 2011). It was not known whether this statistical effect represented a stronger tendency for quieting of the whales farther offshore in deeper water upon exposure to airgun sound, or an actual inshore displacement of whales.

Reactions of migrating and feeding (but not wintering) *gray whales* to seismic surveys have been studied. Off St. Lawrence Island in the northern Bering Sea, it was estimated, based on small sample sizes, that 50% of feeding gray whales stopped feeding at an average received pressure level of 173 dB re 1 μPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB re 1 μPa_{rms} (Malme et al. 1986, 1988). Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast (Malme et al. 1984; Malme and Miles 1985) and western Pacific gray whales feeding off Sakhalin Island, Russia (e.g., Gailey et al. 2007; Johnson et al. 2007; Yazvenko et al. 2007a,b).

Various species of *Balaenoptera* (blue, sei, fin, and minke whales) have occasionally been seen in areas ensonified by airgun pulses. Sightings by observers on seismic vessels using large arrays off the U.K. from 1994 to 2010 showed that the detection rate for minke whales was significantly higher when airguns were not operating; however, during surveys with small arrays, the detection rates for minke whales were similar during seismic and non-seismic periods (Stone 2015). Sighting rates for fin and sei whales were similar when large arrays of airguns were operating vs. silent. All baleen whales combined tended to exhibit localized avoidance, remaining significantly farther (on average) from large arrays (median CPA ~1.5 km) during seismic operations compared with non-seismic periods (median CPA ~1.0 km). In addition, fin and minke whales were more often oriented away from the vessel while a large airgun array was active compared with periods of inactivity. Singing fin whales in the Mediterranean moved away from an operating airgun array, and their song notes had lower bandwidths during periods with vs. without airgun sounds (Castellote et al. 2012).

During seismic surveys in the northwest Atlantic, baleen whales as a group showed localized avoidance of the operating array (Moulton and Holst 2010). Sighting rates were significantly lower during seismic operations compared with non-seismic periods. Baleen whales were seen on average 200 m farther from the vessel during airgun activities vs. non-seismic periods, and these whales more often swam away from the vessel when seismic operations were underway compared with periods when no airguns were operating (Moulton and Holst 2010). Blue whales were seen significantly farther from the vessel during single airgun operations, ramp up, and all other airgun operations compared with non-seismic periods (Moulton and Holst 2010). Similarly, fin whales were seen at significantly farther distances during ramp up than during periods without airgun operations; there was also a trend for fin whales to be sighted farther from the vessel during other airgun operations, but the difference was not significant (Moulton and Holst 2010). Minke whales were seen significantly farther from the vessel during periods with than without seismic operations (Moulton and Holst 2010). Minke whales were also more likely to swim away and less likely to approach during seismic operations compared to periods when airguns were not operating (Moulton and Holst 2010).

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades. The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year, and bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years.

Toothed Whales.—Little systematic information is available about reactions of toothed whales to sound pulses. However, there are recent systematic studies on sperm whales, and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies. Seismic operators and marine mammal observers on seismic vessels regularly see dolphins and other small toothed whales near operating airgun arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels (e.g., Stone and Tasker 2006; Moulton and Holst 2010; Barry et al. 2012; Wole and Myade 2014; Stone 2015). In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 km or less, and some individuals show no apparent avoidance.

Observations from seismic vessels using large arrays off the U.K. from 1994 to 2010 indicated that detection rates were significantly higher for killer whales, white-beaked dolphins, and Atlantic white-sided dolphins when airguns were not operating; detection rates during seismic vs. non-seismic periods were similar during seismic surveys using small arrays (Stone 2015). Detection rates for long-finned pilot whales, Risso's dolphins, bottlenose dolphins, and short-beaked common dolphins were similar during seismic (small or large array) vs. non-seismic operations. CPA distances for killer whales, white-beaked dolphins, and Atlantic white-sided dolphins were significantly farther (>0.5 km) from large airgun arrays during periods of airgun activity compared with periods of inactivity, with significantly more animals traveling away from the vessel during airgun operation. Observers' records suggested that fewer cetaceans were feeding and fewer delphinids were interacting with the survey vessel (e.g., bow-riding) during periods with airguns operating.

During seismic surveys in the northwest Atlantic, delphinids as a group showed some localized avoidance of the operating array (Moulton and Holst 2010). The mean initial detection distance was significantly farther (by ~200 m) during seismic operations compared with periods when the seismic source was not active; however, there was no significant difference between sighting rates (Moulton and Holst 2010). The same results were evident when only long-finned pilot whales were considered.

Preliminary findings of a monitoring study of narwhals in Melville Bay, Greenland (summer and fall 2012) showed no short-term effects of seismic survey activity on narwhal distribution, abundance, migration timing, and feeding habits (Heide-Jørgensen et al. 2013a). In addition, there were no reported effects on narwhal hunting. These findings do not seemingly support a suggestion by Heide-Jørgensen et al. (2013b) that seismic surveys in Baffin Bay may have delayed the migration timing of narwhals, thereby increasing the risk of narwhals to ice entrapment.

The beluga, however, is a species that (at least at times) shows long-distance (10s of km) avoidance of seismic vessels (e.g., Miller et al. 2005). Captive bottlenose dolphins and beluga whales exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys, but the animals tolerated high received levels of sound before exhibiting aversive behaviors (e.g., Finneran et al. 2000, 2002, 2005).

Most studies of sperm whales exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses; in most cases the whales do not show strong avoidance (e.g., Stone and Tasker 2006; Moulton and Holst 2010), but foraging behavior can be altered upon exposure to airgun sound (e.g., Miller et al. 2009). Based on data collected by observers on seismic vessels off the U.K. from 1994 to 2010, detection rates for sperm whales were similar when large arrays of airguns were operating vs. silent; however, during surveys with small arrays, the detection rate was significantly higher when the airguns were not in operation (Stone 2015). Preliminary data from the Gulf of Mexico show reduced sperm whale acoustic activity during periods with airgun operations (Sidorovskaia et al. 2014).

There are almost no specific data on the behavioral reactions of beaked whales to seismic surveys. Most beaked whales tend to avoid approaching vessels of other types (e.g., Würsig et al. 1998) and/or change their behavior in response to sounds from vessels (e.g., Pirotta et al. 2012). Thus, it is likely that most beaked whales would also show strong avoidance of an approaching seismic vessel. Observations from seismic vessels off the U.K. from 1994 to 2010 indicated that detection rates of beaked whales were significantly higher ($p<0.05$) when airguns were not operating vs. when a large array was in operation, although sample sizes were small (Stone 2015). Some northern bottlenose whales remained in the general area and continued to produce high-frequency clicks when exposed to sound pulses from distant seismic surveys (e.g., Simard et al. 2005).

The limited available data suggest that harbor porpoises show stronger avoidance of seismic operations than do Dall's porpoises. Based on data collected by observers on seismic vessels off the U.K. from 1994 to 2010, detection rates of harbor porpoises were significantly higher when airguns were silent vs. when large or small arrays were operating; in addition, harbor porpoises were seen farther away from the array when it was operating vs. silent, and were most often seen traveling away from the airgun array when it was in operation (Stone 2015). Thompson et al. (2013) reported decreased densities and reduced acoustic detections of harbor porpoise in response to a seismic survey in Moray Firth, Scotland, at ranges of 5–10 km (SPLs of 165–172 dB re 1 μPa, SELs of 145–151 dB μPa2 · s). For the same survey, Pirotta et al. (2014) reported that the probability of recording a porpoise buzz decreased by 15% in the ensonified area, and that the probability was positively related to the distance from the seismic ship; the decreased buzzing occurrence may indicate reduced foraging efficiency. Nonetheless, animals returned to the area within a few hours (Thompson et al. 2013). Kastelein et al. (2013a) reported that a harbor porpoise showed no response to an impulse sound with an SEL below 65 dB, but a 50% brief response rate was noted at an SEL of 92 dB and an SPL of 122 dB re 1 $\mu Pa_{0\text{-peak}}$. The apparent tendency for greater responsiveness in the harbor porpoise is consistent with its relative responsiveness to boat traffic and some other acoustic sources (Richardson et al. 1995; Southall et al. 2007).

Odontocete reactions to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for the more responsive of the mysticetes and some other odontocetes. A ≥170 dB disturbance criterion (rather than ≥160 dB) is considered appropriate for delphinids, which tend to be less responsive than the more responsive cetaceans.

Pinnipeds.—Pinnipeds are not likely to show a strong avoidance reaction to an airgun array. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds and only slight (if any) changes in behavior. However, telemetry work has suggested that avoidance and other behavioral reactions may be stronger than evident to date from visual studies (Thompson et al. 1998). Observations from seismic vessels operating large arrays off the U.K. from 1994 to 2010 showed that the detection rate for grey seals was significantly higher when airguns were not operating; for surveys using small arrays, the detection rates were similar during seismic vs. non-seismic operations (Stone 2015). No significant differences in detection rates were apparent for harbor seals during seismic and non-seismic periods. There were no significant differences in CPA distances of grey or harbour seals during seismic vs. non-seismic periods.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. TTS has been demonstrated and studied in certain captive odontocetes and pinnipeds exposed to strong sounds. However, there has been no specific documentation of TTS let alone permanent hearing damage, i.e., PTS, in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions.

Additional data are needed to determine the received sound levels at which small odontocetes would start to incur TTS upon exposure to repeated, low-frequency pulses of airgun sound with variable received levels. To determine how close an airgun array would need to approach in order to elicit TTS, one would (as a minimum) need to allow for the sequence of distances at which airgun pulses would occur, and for the dependence of received SEL on distance in the region of the seismic operation (e.g., Breitzke and Bohlen 2010; Laws 2012). At the present state of knowledge, it is also necessary to assume that the effect is directly related to total received energy (SEL); however, this assumption is likely an over-simplification (Finneran 2012). There is recent evidence that auditory effects in a given animal are not a simple function of received acoustic energy. Frequency, duration of the exposure, and occurrence of gaps within the exposure can also influence the auditory effect (Finneran and Schlundt 2010, 2011, 2013; Finneran et al. 2010a,b; Popov et al. 2011, 2013a; Finneran 2012; Kastelein et al. 2012a,b; 2013b,c, 2014, 2015; Ketten 2012).

Recent data have shown that the SEL required for TTS onset to occur increases with intermittent exposures, with some auditory recovery during silent periods between signals (Finneran et al. 2010b; Finneran and Schlundt 2011). Studies on bottlenose dolphins by Finneran et al. (2015) indicate that the potential for seismic surveys using airguns to cause auditory effects on dolphins could be lower than previously thought. Based on behavioral tests, Finneran et al. (2015) reported no measurable TTS in three bottlenose dolphins after exposure to 10 impulses from a seismic airgun with a cumulative SEL of up to ~195 dB re 1 μPa^2 · s. However, auditory evoked potential measurements were more variable; one dolphin showed a small (9 dB) threshold shift at 8 kHz (Finneran et al. 2015).

Recent studies have also shown that the SEL necessary to elicit TTS can depend substantially on frequency, with susceptibility to TTS increasing with increasing frequency above 3 kHz (Finneran and Schlundt 2010, 2011; Finneran 2012). When beluga whales were exposed to fatiguing noise with sound levels of 165 dB re 1 μPa for durations of 1–30 min at frequencies of 11.2–90 kHz, the highest TTS with the longest recovery time was produced by the lower frequencies (11.2 and 22.5 kHz); TTS effects also gradually increased with prolonged exposure time (Popov et al. 2013a).

Additionally, Popov et al. (2013b) reported that TTS produced by exposure to a fatiguing noise was larger during the first session (or naïve subject state) with a beluga whale than TTS that resulted from the same sound in subsequent sessions (experienced subject state). Similarly, several other studies have shown that some marine mammals (e.g., bottlenose dolphins, false killer whales) can decrease their hearing sensitivity in order to mitigate the impacts of exposure to loud sounds (e.g., Nachtigall and Supin 2013, 2014, 2015)

Previous information on TTS for odontocetes was primarily derived from studies on the bottlenose dolphin and beluga, and that for pinnipeds has mostly been obtained from California sea lions and elephant seals (see § 3.6.4.3, § 3.7.4.3, § 3.8.4.3, and Appendix E of the PEIS). Thus, it is inappropriate to assume that onset of TTS occurs at similar received levels in all cetaceans or pinnipeds (cf. Southall et al. 2007). Some cetaceans or pinnipeds could incur TTS at lower sound exposures than are necessary to elicit TTS in the beluga and bottlenose dolphin or California sea lion and elephant seal, respectively.

Several studies on TTS in porpoises (e.g., Lucke et al. 2009; Popov et al. 2011; Kastelein et al. 2012a, 2013a,b, 2014, 2015) indicate that received levels that elicit onset of TTS are lower in porpoises than in other odontocetes. Kastelein et al. (2012a) exposed a harbor porpoise to octave band noise centered at 4 kHz for extended periods of time. A 6-dB TTS occurred with SELs of 163 dB and 172 dB for low-intensity sound and medium-intensity sound, respectively; high-intensity sound caused a 9-dB TTS at a SEL of 175 dB (Kastelein et al. 2012a). Kastelein et al. (2013b) exposed a harbor porpoise to a long, continuous 1.5-kHz tone, which induced a 14-dB TTS with a total SEL of 190 dB. Popov et al. (2011) examined the effects of fatiguing noise on the hearing threshold of Yangtze finless porpoises when exposed to frequencies of 32–128 kHz at 140–160 dB re 1 μPa for 1–30 min. They found that an exposure of higher level and shorter duration produced a higher TTS than an exposure of equal SEL but of lower level and longer duration. Popov et al. (2011) reported a TTS of 25 dB for a Yangtze finless porpoise that was exposed to high levels of 3-min pulses of half-octave band noise centered at 45 kHz with an SEL of 163 dB.

Initial evidence from exposures to non-pulses has also suggested that some pinnipeds (harbor seals in particular) incur TTS at somewhat lower received levels than do most small odontocetes exposed for similar durations (Kastak et al. 1999, 2005, 2008; Ketten et al. 2001). Kastelein et al. (2012b) exposed two harbor seals to octave-band white noise centered at 4 kHz at three mean received SPLs of 124, 136, and 148 dB re 1 μPa; TTS >2.5 dB was induced at an SEL of 170 dB (136 dB SPL for 60 min), and the maximum TTS of 10 dB occurred after a 120-min exposure to 148 dB re 1 μPa or an SEL of 187 dB. Kastelein et al. (2013c) reported that a harbor seal unintentionally exposed to the same sound source with a mean received SPL of 163 dB re 1 μPa for 1 h induced a 44 dB TTS. For a harbor seal exposed to octave-band white noise centered at 4 kHz for 60 min with mean SPLs of 124–148 re 1 μPa, the onset of PTS would require a level of at least 22 dB above the TTS onset (Kastelein et al. 2013c).

Based on the best available information at the time, Southall et al. (2007) recommended a TTS threshold for exposure to single or multiple pulses of 183 dB re 1 $\mu Pa^2 \cdot s$ for all cetaceans and 173 dB re 1 $\mu Pa^2 \cdot s$ for pinnipeds in water. Tougaard et al. (2015) have suggested an exposure limit for TTS as an SEL of 100–110 dB above the porpoise pure tone hearing threshold at a specific frequency; they also suggested an exposure limit of $L_{eq\text{-}fast}$ (rms average over the duration of the pulse) of 45 dB above the hearing threshold for behavioral responses (i.e., negative phonotaxis). In addition, M-weighting, as used by Southall et al. (2007), might not be appropriate for the harbor porpoise (Wensveen et al. 2014; Tougaard et al. 2015); thus, Wensveen et al. (2014) developed six auditory weighting functions for the harbor porpoise that could be useful in predicting TTS onset. Gedamke et al. (2011), based on preliminary simulation modeling that attempted to allow for various uncertainties in assumptions and variability around population means, suggested that some baleen whales whose closest point of approach to a seismic vessel is 1 km or more could experience TTS.

It is unlikely that a marine mammal would remain close enough to a large airgun array for sufficiently long to incur TTS, let alone PTS. There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the possibility that some mammals close to an airgun array might incur at least mild TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (e.g., Richardson et al. 1995, p. 372ff; Gedamke et al. 2011). In terrestrial animals, exposure to sounds sufficiently strong to elicit a large TTS induces physiological and structural changes in the inner ear, and at some high level of sound exposure, these phenomena become non-recoverable (Le Prell 2012). At this level of sound exposure, TTS grades into PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS (e.g., Kastak and Reichmuth 2007; Kastak et al. 2008).

Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds with received levels ≥180 dB and 190 dB re 1 μPa_{rms}, respectively (NMFS 2000). These criteria have been used in establishing the exclusion (=shut-down) zones planned for the proposed seismic survey. However, those criteria were established before there was any information about minimum received levels of sounds necessary to cause auditory impairment in marine mammals.

Recommendations for science-based noise exposure criteria for marine mammals, frequency-weighting procedures, and related matters were published by Southall et al. (2007). Those recommendations were never formally adopted by NMFS for use in regulatory processes and during mitigation programs associated with seismic surveys, although some aspects of the recommendations have been taken into account in certain environmental impact statements and small-take authorizations. In December 2013, NOAA made available for public comment new draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013), taking at least some of the Southall et al. recommendations into account. At the time of preparation of this document, the date of release of the final guidelines and how they would be implemented are unknown.

Nowacek et al. (2013) concluded that current scientific data indicate that seismic airguns have a low probability of directly harming marine life, except at close range. Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airgun array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment (see § XI and § XIII). Also, many marine mammals and (to a limited degree) sea turtles show some avoidance of the area where received levels of airgun sound are high enough such that hearing impairment could potentially occur. In those cases, the avoidance responses of the animals themselves would reduce or (most likely) avoid any possibility of hearing impairment.

Non-auditory physical effects may also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong transient sounds.

There is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns. However, Gray and Van Waerebeek (2011) have suggested a cause-effect relationship between a seismic survey off Liberia in 2009 and the erratic movement, postural instability, and akinesia in a pantropical spotted dolphin based on spatially and temporally close association with the airgun array. Additionally, a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings (e.g., Castellote and Llorens 2013).

Non-auditory effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, are especially unlikely to incur non-auditory physical effects. The brief duration of exposure of any given mammal and the planned monitoring and mitigation measures would further reduce the probability of exposure of marine mammals to sounds strong enough to induce non-auditory physical effects.

Possible Effects of Other Acoustic Sources

The Kongsberg EM 122 MBES and Knudsen Chirp 3260 SBP would be operated from the source vessel during the proposed survey. Information about this equipment was provided in § 2.2.3.1 of the PEIS. A review of the expected potential effects (or lack thereof) of MBESs, SBPs, and pingers on marine mammals appears in § 3.6.4.3, § 3.7.4.3, and § 3.8.4.3 and Appendix E of the PEIS.

There has been some recent attention given to the effects of MBES on marine mammals, as a result of a report issued in September 2013 by an IWC independent scientific review panel linking the operation of an MBES to a mass stranding of melon-headed whales (*Peponocephala electra*; Southall et al. 2013) off Madagascar. During May–June 2008, ~100 melon-headed whales entered and stranded in the Loza Lagoon system in northwest Madagascar at the same time that a 12-kHz MBES survey was being conducted ~65 km away off the coast. In conducting a retrospective review of available information on the event, an independent scientific review panel concluded that the Kongsberg EM 120 MBES was the most plausible behavioral trigger for the animals initially entering the lagoon system and eventually stranding. The independent scientific review panel, however, identified that an unequivocal conclusion on causality of the event was not possible because of the lack of information about the event and a number of potentially contributing factors. Additionally, the independent review panel report indicated that this incident was likely the result of a complicated confluence of environmental, social, and other factors that have a very low probability of occurring again in the future, but recommended that the potential be considered in environmental planning. It should be noted that this event is the first known marine mammal mass stranding closely associated with the operation of an MBES. Leading scientific experts knowledgeable about MBES have expressed concerns about the independent scientific review panel analyses and findings (Bernstein 2013).

There is no available information on marine mammal behavioral response to MBES sounds (Southall et al. 2013). Much of the literature on marine mammal response to sonars relates to the types of sonars used in naval operations, including Low-Frequency Active (LFA) sonars (e.g., Miller et al. 2012; Sivle et al. 2012) and Mid-Frequency Active (MFA) sonars (e.g., Tyack et al. 2011; Melcón et al. 2012; Miller et al. 2012; DeRuiter et al. 2013a,b; Goldbogen et al. 2013; Baird et al. 2014; Wensveen et al. 2015). However, the MBES sounds are quite different from naval sonars. Ping duration of the MBES is very short relative to naval sonars. Also, at any given location, an individual marine mammal would be in the beam of the MBES for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; naval sonars often use near-horizontally-directed sound. In addition, naval sonars have higher duty cycles. These factors would all reduce the sound energy received from the MBES relative to that from naval sonars.

In the fall of 2006, an Ocean Acoustic Waveguide Remote Sensing (OAWRS) experiment was carried out in the Gulf of Maine (Gong et al. 2014); the OAWRS emitted three frequency-modulated (FM) pulses centered at frequencies of 415, 734, and 949 Hz (Risch et al. 2012). Risch et al. (2012) found a reduction in humpback whale song in the Stellwagen Bank National Marine Sanctuary during OAWRS activities that were carried out ~200 km away; received levels in the sanctuary were 88–110 dB re 1 μPa. In contrast, Gong et al. (2014) reported no effect of the OAWRS signals on humpback whale vocalizations in the Gulf of Maine. Range to the source, ambient noise, and/or behavioral state may have differentially influenced the behavioral responses of humpbacks in the two areas (Risch et al. 2014).

Deng et al (2014) measured the spectral properties of pulses transmitted by three 200-kHz echosounders, and found that they generated weaker sounds at frequencies below the center frequency (90–130 kHz). These sounds are within the hearing range of some marine mammals, and the authors suggested that they could be strong enough to elicit behavioral responses within close proximity to the sources, although they would be well below potentially harmful levels. Hastie et al. (2014) reported behavioral responses by grey seals to echosounders with frequencies of 200 and 375 kHz.

Despite the aforementioned information that has recently become available, and in agreement with § 3.6.7, 3.7.7, and 3.8.7 of the PEIS, the operation of MBESs, SBPs, and pingers is not likely to impact marine mammals, (1) given the lower acoustic exposures relative to airguns and (2) because the intermittent and/or narrow downward-directed nature of these sounds would result in no more than one or two brief ping exposures of any individual marine mammal given the movement and speed of the vessel.

Other Possible Effects of Seismic Surveys

Other possible effects of seismic surveys on marine mammals include masking by vessel noise, disturbance by vessel presence or noise, and injury or mortality from collisions with vessels or entanglement in seismic gear.

Vessel noise from the *Langseth* could affect marine animals in the proposed survey areas. Sounds produced by large vessels generally dominate ambient noise at frequencies from 20 to 300 Hz (Richardson et al. 1995). Ship noise, through masking, can reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (e.g., Richardson et al. 1995; Clark et al. 2009; Jensen et al. 2009; Gervaise et al. 2012; Hatch et al. 2012; Rice et al. 2014). In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking (Branstetter et al. 2013; Finneran and Branstetter 2013). In order to compensate for increased ambient noise, some cetaceans are known to increase the source levels of their calls in the presence of elevated noise levels from shipping, shift their peak frequencies, or otherwise change their vocal behavior (e.g., Parks et al. 2011; 2012; Castellote et al. 2012; Melcón et al. 2012;

Tyack and Janik 2013; Papale et al. 2015). Branstetter et al. (2013) reported that time-domain metrics are important in describing and predicting masking.

Baleen whales are thought to be more sensitive to sound at these low frequencies than are toothed whales (e.g., MacGillivray et al. 2014), possibly causing localized avoidance of the proposed survey areas during seismic operations. Reactions of gray and humpback whales to vessels have been studied, and there is limited information available about the reactions of right whales and rorquals (fin, blue, and minke whales). Reactions of humpback whales to boats are variable, ranging from approach to avoidance (Payne 1978; Salden 1993). Baker et al. (1982, 1983) and Baker and Herman (1989) found humpbacks often move away when vessels are within several kilometers. Humpbacks seem less likely to react overtly when actively feeding than when resting or engaged in other activities (Krieger and Wing 1984, 1986).

Many odontocetes show considerable tolerance of vessel traffic, although they sometimes react at long distances if confined by ice or shallow water, if previously harassed by vessels, or have had little or no recent exposure to ships (Richardson et al. 1995). Dolphins of many species tolerate and sometimes approach vessels. Some dolphin species approach moving vessels to ride the bow or stern waves (Williams et al. 1992). There are few data on the behavioral reactions of beaked whales to vessel noise, though they seem to avoid approaching vessels (e.g., Würsig et al. 1998) or dive for an extended period when approached by a vessel (e.g., Kasuya 1986). Based on a single observation, Aguilar Soto et al. (2006) suggest foraging efficiency of Cuvier's beaked whales may be reduced by close approach of vessels.

The PEIS concluded that project vessel sounds would not be at levels expected to cause anything more than possible localized and temporary behavioral changes in marine mammals, and would not be expected to result in significant negative effects on individuals or at the population level. In addition, in all oceans of the world, large vessel traffic is currently so prevalent that it is commonly considered a usual source of ambient sound.

Another concern with vessel traffic is the potential for striking marine mammals. Information on vessel strikes is reviewed in § 3.6.4.4 and § 3.8.4.4 of the PEIS. The PEIS concluded that the risk of collision of seismic vessels or towed/deployed equipment with marine mammals exists but is extremely unlikely, because of the relatively slow operating speed (typically 7–9 km/h) of the vessel during seismic operations, and the generally straight-line movement of the seismic vessel. There has been no history of marine mammal vessel strikes with the R/V *Langseth*, or its predecessor, R/V Maurice Ewing over the last two decades.

Numbers of Marine Mammals that could be "Taken by Harassment"

All expected takes would be "takes by harassment", involving temporary changes in behavior. The mitigation measures to be applied would minimize the possibility of injurious takes. (However, as noted earlier, there is no specific information demonstrating that injurious "takes" would occur even in the absence of the planned mitigation measures.) In the sections below, we describe methods to estimate the number of potential exposures to various received sound levels and present estimates of the numbers of marine mammals that could be affected during the proposed seismic program. The estimates are based on a consideration of the number of marine mammals that could be disturbed appreciably by operations with the 36-airgun array to be used during ~1105 km of seismic surveys outside the 6-n.mi. territorial seas of Greece. The main sources of distributional and numerical data used in deriving the estimates are described in the next subsection.

It is assumed that, during simultaneous operations of the airgun array and the other sources, any marine mammals close enough to be affected by the MBES and SBP would already be affected by the airguns. However, whether or not the airguns are operating simultaneously with the other sources, marine mammals are expected to exhibit no more than short-term and inconsequential responses to the MBES and SBP, given their characteristics (e.g., narrow downward-directed beam) and other considerations described in § 3.6.4.3, § 3.7.4.3, § 3.8.4.3, and Appendix E of the PEIS. Such reactions are not considered to constitute "taking" (NMFS 2001). Therefore, no additional allowance is included for animals that could be affected by sound sources other than airguns.

Basis for Estimating "Take by Harassment"

The estimates are based on a consideration of the number of marine mammals that could be within the area around the operating airgun array where received levels of sound >160 dB re 1 μPa_{rms} are predicted to occur (see Table 1). The estimated numbers are based on the densities (numbers per unit area) of marine mammals expected to occur in the area in the absence of a seismic survey. To the extent that marine mammals tend to move away from seismic sources before the sound level reaches the criterion level and tend not to approach an operating airgun array, these estimates are likely to overestimate the numbers actually exposed to the specified level of sound. The overestimation is expected to be particularly large when dealing with the higher sound-level criteria, e.g., 180 dB re 1 μPa_{rms}, as animals are more likely to move away before received levels reach 180 dB than they are to move away before it reaches (for example) 160 dB re 1 μPa_{rms}. Likewise, they are less likely to approach within the ≥180- or 190-dB re 1 μPa_{rms} radii than they are to approach within the considerably larger ≥160-dB radius.

Density estimates are not available for the proposed survey areas; density estimates from the nearest available Mediterranean regions were therefore applied to species expected to occur in the survey areas (Table 3). Densities for fin whales, sperm whales, striped dolphins and Risso's dolphins are based on visual surveys (and combined acoustic surveys for sperm whales) in the Ligurian Sea during October–March 2001–2004 (Laran et al. 2010). The densities were calculated using standard line-transect methods (Buckland et al. 2001); densities were corrected for trackline detection probability bias [f(0)] by the authors, but not availability [g(0)] bias. The density for short-beaked common dolphins is based on the Laran et al. (2010) striped dolphin density adjusted for the proportional difference between striped dolphin and common dolphin sightings from surveys of the Ionian Sea (Notarbartolo di Sciara et al. 1993). The density for common bottlenose dolphins is based on a 2010 aerial survey in the Adriatic Sea; this survey did not correct for perception or availability bias (Fortuna et al. 2011). The density for Cuvier's beaked whales is based on the density for sperm whales as described above and adjusted for the proportional difference in sighting rates and mean group sizes between sperm and Cuvier's beaked whales in the Mediterranean Sea (Boisseau et al. 2010). Species classified as vagrants in Table 2 and the long-finned pilot whale, for which there are no confirmed sightings in the eastern Mediterranean, are not included in Table 3. Species that could occur in the survey areas, including those classified as visitors, are included in Table 3, although density estimates are not available.

There is some uncertainty about the representativeness of the density data and the assumptions used in the calculations. The available densities are more than 10 years old in some cases and are not from the Aegean Sea, but from other regions of the Mediterranean Sea. Nonetheless, the approach used here is based on the best available data. Densities used for the calculations were for October–March (for most species) and July–August (for common bottlenose dolphins); densities for other seasons were not available. The calculated exposures that are based on these densities, therefore, are best estimates for the proposed survey for any time of the year (i.e., if the survey were proposed for spring or summer, the take estimates would remain the same).

The estimated numbers of individuals potentially exposed are based on the 160-dB re 1 μPa_{rms} criterion for all cetaceans and pinnipeds. It is assumed that marine mammals exposed to airgun sounds that strong could change their behavior sufficiently to be considered "taken by harassment". Table 3 shows the density estimates calculated as described above and the estimates of the number of different individual marine mammals that potentially could be exposed to ≥160 dB re 1 μPa_{rms} during the seismic survey if no animals moved away from the survey vessel. The *Requested Take Authorization* given in the far right column of Table 3 has has been increased to 1% of each species' regional population size, where available. For species for which population sizes are not available, we have included a *Requested Take Authorization* for the mean group size for the species in the Mediterranean (Boisseau et al. 2010).

It should be noted that the following estimates of exposures assume that the proposed survey would be completed; in fact, the ensonified area calculated using the planned number of line-kilometers for the Santorini survey area in the Aegean Sea have been increased by 25% to accommodate turns, lines that may need to be repeated, equipment testing, etc. As is typical during offshore seismic surveys, inclement weather and equipment malfunctions are likely to cause delays and might limit the number of useful line-kilometers of seismic operations that can be undertaken. Also, any marine mammal sightings within or near the designated EZ would result in the shut down of seismic operations as a mitigation measure.

Thus, the following estimates of the numbers of marine mammals potentially exposed to 160-dB re 1 μPa_{rms} sounds are precautionary and probably overestimate the actual numbers of marine mammals that could be involved. These estimates assume that there would be no weather, equipment, or mitigation delays, which is highly unlikely.

Consideration should be given to the hypothesis that delphinids are less responsive to airgun sounds than are mysticetes, as referenced in both the PEIS and "Summary of Potential Airgun Effects" of this document. The 160-dB (rms) criterion currently applied by NMFS, on which the following estimates are based, was developed based primarily on data from gray and bowhead whales. The estimates of "takes by harassment" of delphinids are thus considered precautionary. As noted previously, in December 2013, NOAA made available for public comment new draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013), although at the time of preparation of this document, the date of release of the final guidelines and how they would be implemented are unknown. Available data suggest that the current use of a 160-dB criterion could be improved upon, as behavioral response might not occur for some percentage of marine mammals exposed to received levels >160 dB, whereas other individuals or groups might respond in a manner considered as "taken" to sound levels <160 dB (NMFS 2013c). It has become evident that the context of an exposure of a marine mammal to sound can affect the animal's initial response to the sound (NMFS 2013c).

Potential Number of Marine Mammals Exposed

The number of different individuals that could be exposed to airgun sounds with received levels ≥160 dB re 1 μPa_{rms} on one or more occasions can be estimated by considering the total marine area that would be within the 160-dB radius around the operating seismic source on at least one occasion, along with the expected density of animals in the area. The number of possible exposures (including repeated exposures of the same individuals) can be estimated by considering the total marine area that would be within the 160-dB radius around the operating airguns, including areas of overlap. During the proposed Santorini survey in the Aegean Sea, the area including overlap is 6.8 times the area excluding overlap, so a marine mammal that stayed in that survey area during the survey could be exposed up to seven times, on

TABLE 3. Densities and estimates of the possible numbers of individuals that could be exposed to ≥160 dB re 1 µPa$_{rms}$ during the proposed seismic survey in the eastern Mediterranean Sea outside the 6-n.mi. territorial seas of Greece during November–December 2015. The proposed sound source consists of a 36-airgun array with a total discharge volume of ~6600 in^3. Species in italics are listed under the ESA as endangered. The column of numbers in boldface shows the numbers of Level B "takes" for which authorization is requested.

Species[1]	Reported Density (#/1000 km^2)	Correction Factor [2]	Estimated Density (#/1000 km^2)	Ensonified Area (km^2)	Calculated Take[3]	% of Regional Pop'n[4]	Requested Level B Take Authorization[5]
Mysticetes							
Humpback whale	*0*		*0*	*7686*	*0*	*1.0*	***116***
Minke whale	0		0	*7686*	0	*1.0*	**1072**
Fin whale	*2.0*[6]		*2.0*	*7686*	*15*	*1.0*	***50***
Odontocetes							
Sperm whale	*0.52*[6]		*0.52*	*7686*	*4*	*2.0*	***4***
Cuvier's beaked whale	N/A		1.56[7]	*7686*	12	6.0	**12**
Rough-toothed dolphin	0		0	*7686*	0	N/A	**8**
Common bottlenose dolphin	43[8]		43	*7686*	331	3.3	**331**
Striped dolphin	370[6]		370	*7686*	2844	1.2	**2844**
Short-beaked common dolphin	N/A		30[9]	*7686*	231	1.2	**231**
Risso's dolphin	35[6]		35	*7686*	269	9.0	**269**
False killer whale	0		0	*7686*	0	N/A	**3**
Harbor porpoise	0		0	*7686*	0	1.0	**10**
Pinnipeds							
Mediterranean monk seal	*0*		*0*	*7686*	*0*	*1.3*	***4***

N/A = not available.

[1] Not included are species considered to be vagrant in the Mediterranean or eastern Mediterranean (see Table 2).

[2] No additional correction factors were applied to densities.

[3] Calculated take is estimated density (reported density x correction factor) multiplied by the 160-dB ensonified area (including the 25% contingency for the Santorini survey area in the Aegean Sea).

[4] Requested takes expressed as percentages of the the populations in the Mediterranean or parts of the Mediterranean, where available (see Table 2).

[5] For species for which regional population sizes are available, requested take authorization was increased to at least 1% of population size. For species for which no regional population sizes are available (rough-toothed dolphin and false killer whale), requested take authorization was increased to mean group size in the Mediterranean Sea (Boisseau et al. 2010).

[6] Densities based on Laran et al. (2010).

[7] Density based on density for sperm whales (Laran et al. 2010) and adjusted for proportional difference in sighting rates and mean group sizes between sperm and Cuvier's beaked whales in the Mediterranean Sea (Boisseau et al. 2010).

[8] Density based on Fortuna et al. (2011).

[9] Density based Laran et al. (2010) striped dolphin winter density adjusted for the proportional difference in striped dolphin to common dolphin sightings as indicated by surveys of the Ionian Sea (Notarbartolo di Sciara et al. 1993).

average. There is no overlap for the single Hellenic subduction zone transect line. However, it is unlikely that a particular animal would stay in the area during the entire survey. The numbers of different individuals potentially exposed to ≥160 dB re 1 µPa$_{rms}$ were calculated by multiplying the expected species density times the expected area to be ensonified to that level during airgun operations excluding overlap. The area expected to be ensonified was determined by entering the planned survey lines into a MapInfo GIS, using the GIS to identify the relevant areas by "drawing" the applicable 160-dB buffer (see Table 1) around each seismic line, and then calculating the total area within the buffers.

Applying the approach described above, ~6822 km^2 (~7686 km^2 including the 25% contingency for the Santorini survey area only) would be within the 160-dB isopleth on one or more occasions outside of Greek territorial waters during the proposed survey. Because this approach does not allow for turnover in the mammal populations in the area during the course of the survey, the actual number of individuals exposed could be underestimated, although the conservative (i.e., probably overestimated) line-kilometer distances used to calculate the area could offset this. Also, the approach assumes that no cetaceans would move away or toward the trackline in response to increasing sound levels before the levels reach 160 dB as the *Langseth* approaches. Another way of interpreting the estimates is that they represent the number of individuals that are expected (in the absence of a seismic program) to occur in the waters that would be exposed to ≥160 dB re 1 μPa_{rms}.

The estimate of the number of individual marine mammals that could be exposed to seismic sounds with received levels ≥160 dB re 1 μPa_{rms} during the proposed survey is 3706 (Table 3). That total includes 19 cetaceans listed as ***Endangered*** under the ESA: 15 fin whales and 4 sperm whales, representing 0.3% and 2.0 % of their regional populations (see Table 2), respectively.

In addition, 12 Cuvier's beaked whales (6.0% of the regional population) could be exposed during the survey (Table 3). Most (99.2%) of the cetaceans potentially exposed would be delphinids; the striped, common bottlenose, Risso's, and short-beaked common dolphins are estimated to be the most common (and only) delphinid species in the area, with estimates of 2844 (1.2% of the regional population), 331 (3.3%), 269 (9.0%), and 231 (1.2%) exposed to ≥160 dB re 1 μPa_{rms}, respectively. All percentage estimates for most odontocetes are likely overestimates, in some cases considerable overestimates, because the population sizes are likely underestimates. This is because there are no truly regional population size estimates for the Mediterranean Sea for most of these species; estimates are only available for parts of the Mediterranean Sea.

Conclusions

The proposed seismic project would involve towing a 36-airgun array with a total discharge volume of 6600 in^3 that introduces pulsed sounds into the ocean. Routine vessel operations, other than the proposed seismic operations, are conventionally assumed not to affect marine mammals sufficiently to constitute "taking". In § 3.6.7, § 3.7.7, and § 3.8.7, the PEIS concluded that airgun operations with implementation of the proposed monitoring and mitigation measures could result in a small number of Level B behavioral effects in some mysticete, odontocete, and pinniped species and that Level A effects were highly unlikely.

Estimates of the numbers of marine mammals that could be exposed to airgun sounds during the proposed program have been presented, together with the requested "take authorization". The estimated numbers of animals potentially exposed to sound levels sufficient to cause appreciable disturbance are low percentages of the regional population sizes (Table 3). The estimates are likely overestimates of the actual number of animals that would be exposed to and would react to the seismic sounds. The reasons for that conclusion are outlined above. The relatively short-term exposures are unlikely to result in any long-term negative consequences for the individuals or their populations. Therefore, no significant impacts on cetaceans or pinnipeds would be expected from the proposed activity.

VIII. Anticipated Impact on Subsistence

The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses.

There is no subsistence hunting near the proposed survey areas, so the proposed activity would not have any impact on the availability of the species or stocks for subsistence users.

IX. ANTICIPATED IMPACT ON HABITAT

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

The proposed seismic survey would not result in any permanent impact on habitats used by marine mammals or to the food sources they use. The main impact issue associated with the proposed activity would be temporarily elevated noise levels and the associated direct effects on marine mammals, as discussed in § VII, above.

Effects of seismic sound on marine invertebrates (crustaceans and cephalopods), marine fish, and their fisheries are discussed in § 3.2.4 and § 3.3.4 and Appendix D of the PEIS. The PEIS concluded that there could be changes in behavior and other non-lethal, short-term, temporary impacts, and injurious or mortal impacts on a small number of individuals within a few meters of a high-energy acoustic source, but that there would be no significant impacts of NSF-funded marine seismic research on populations.

X. ANTICIPATED IMPACT OF LOSS OR MODIFICATION OF HABITAT ON MARINE MAMMALS

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed activity is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, because operations would be limited in duration. However, a small minority of the marine mammals that are present near the proposed activity may be temporarily displaced as much as a few kilometers by the planned activity.

XI. MITIGATION MEASURES

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Marine mammals and sea turtles are known to occur in the proposed study areas. To minimize the likelihood that impacts would occur to the species and stocks, airgun operations would be conducted in accordance with the MMPA and the ESA, including obtaining permission for incidental harassment or incidental 'take' of marine mammals and other endangered species. The proposed activity would take place in the EEZ of Greece, including territorial waters.

The following subsections provide more detailed information about the mitigation measures that are an integral part of the planned activity. The procedures described here are based on protocols used during previous L-DEO seismic research cruises as approved by NMFS, and on best practices recommended in Richardson et al (1995), Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), and Wright (2014).

Planning Phase

As discussed in § 2.4.1.1 of the PEIS, mitigation of potential impacts from the proposed activity begins during the planning phase of the proposed activity. Several factors were considered during the planning phase of the proposed activity, including

1. *Energy Source*—Part of the considerations for the proposed marine seismic survey was to evaluate whether the research objectives could be met with a smaller energy source than the full 36-airgun, 6600-in^3 *Langseth* array, and it was decided that the scientific objectives for the survey could not be met using a smaller source as they would not be sufficient to penetrate the lower crust and upper mantle to address the magma plumbing architecture. Because the choice of tow depth for each line would not be made until the survey, we have used the 12-m tow depth for all lines for the take estimate calculations, as that would result in the farthest sound propagation.
2. *Survey Timing*—The PIs worked with L-DEO and NSF to identify potential times to carry out the survey taking into consideration key factors such as environmental conditions (i.e., the seasonal presence of marine mammals, sea turtles, and seabirds), weather conditions, equipment, and optimal timing for other proposed seismic survey using the *Langseth*. Most marine mammal species are expected to occur in the area year-round, so altering the timing of the proposed project likely would result in no net benefits for those species.
3. *Mitigation Zones*—During the planning phase, mitigation zones for the proposed survey were calculated based on modeling by L-DEO for both the EZ and the safety zone; these zones are given in Table 1. The proposed survey would acquire data with the 36-airgun array at a tow depth of 9–12 m. For deep water (>1000 m), we use the deep-water radii obtained from L-DEO model results down to a maximum water depth of 2000 m. The radii for intermediate water depths (100–1000 m) are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve. The shallow-water radii are obtained by scaling the empirically derived measurements from the GoM calibration survey to account for the difference in tow depth between the calibration survey (6 m) and the proposed survey (9–12 m). A more detailed description of the modeling process used to develop the mitigation zones can be found in § I.

   Table 1 shows the 180-dB EZ and 160-dB "Safety Zone" (distances at which the rms sound levels are expected to be received) for the mitigation airgun and the 36-airgun array. The 160- and 180-dB re 1 μPa_{rms} distances are the criteria currently specified by NMFS (2000) for cetaceans. Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In December 2013, NOAA published draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013), although at the time of preparation of this application, the date of release of the final guidelines and how they will be implemented are unknown. As such, this document has been prepared in accordance with the current NOAA acoustic practices, and the procedures are based on best practices noted by Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), and Wright (2014).

   The 180-dB distance would also be used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects per the IHAs. Enforcement of mitigation zones via power and shut downs would be implemented in the Operational Phase, as noted below.

Mitigation During Operations

Mitigation measures that would be adopted during the proposed survey include (1) power-down procedures, (2) shut-down procedures, and (3) ramp-up procedures.

Power-down Procedures

A power down involves decreasing the number of airguns in use such that the radius of the 180-dB (or 190-dB) zone is decreased to the extent that marine mammals or turtles are no longer in or about to enter the EZ. The acoustic source would also be powered down in the event an ESA-listed seabird were observed diving or foraging within the designated EZ. During a power down, one airgun would be operated. The continued operation of one airgun is intended to alert marine mammals and turtles to the presence of the seismic vessel in the area. In contrast, a shut down occurs when all airgun activity is suspended.

If a marine mammal or turtle is detected outside the EZ but is likely to enter the EZ, the airguns would be powered down before the animal is within the EZ. Likewise, if a mammal or turtle is already within the EZ when first detected, the airguns would be powered down immediately. During a power down of the airgun array, the 40-in^3 airgun would be operated. If a marine mammal or turtle is detected within or near the smaller EZ around that single airgun (Table 1), it would be shut down (see next sub-section).

Following a power down, airgun activity would not resume until the marine mammal or turtle has cleared the safety zone. The animal would be considered to have cleared the safety zone if

- it is visually observed to have left the EZ, or
- it has not been seen within the zone for 15 min in the case of small odontocetes, or
- it has not been seen within the zone for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales, or
- the vessel has moved outside the EZ for turtles, e.g., if a turtle is sighted close to the vessel and the ship speed is 8.3 km/h, it would take the vessel ~15 min to leave the turtle behind.

During airgun operations following a shut down whose duration has exceeded the time limits specified above, the airgun array would be ramped up gradually. Ramp-up procedures are described below. During past *Langseth* marine geophysical surveys, following an extended power-down period, the seismic source followed ramp-up procedures to return to the full seismic source level. Under a power-down scenario, however, a single mitigation airgun still would be operating to alert and warn animals of the on-going activity. Furthermore, under these circumstances, ramp-up procedures may unnecessarily extend the length of the survey time needed to collect seismic data. L-DEO and NSF have concluded in consultation with NMFS that ramp up is not necessary after an extended power down. Therefore, this practice is not included here as part of the monitoring and mitigation plan.

Shut-down Procedures

The operating airgun(s) would be shut down if a marine mammal or turtle is seen within or approaching the EZ for the single airgun. The operating airgun(s) would also be shut down in the event an ESA-listed seabird were observed diving or foraging within the designated EZ.

Shut downs would be implemented (1) if an animal enters the EZ of the single airgun after a power down has been initiated, or (2) if an animal is initially seen within the EZ of the single airgun when more than one airgun (typically the full array) is operating. Airgun activity would not resume until the marine mammal or turtle has cleared the safety zone, or until the protected species observer (PSO) is confident that the animal has left the vicinity of the vessel. Criteria for judging that the animal has cleared the safety zone would be as described in the preceding subsection.

Ramp-up Procedures

A ramp-up procedure would be followed when the airgun array begins operating after a specified period without airgun operations. It is proposed that, for the present survey, this period would be ~8 min. Similar periods (~8–10 min) were used during previous L-DEO surveys. Ramp up would not occur if a marine mammal or sea turtle has not cleared the safety zone as described earlier.

Ramp up would begin with the smallest airgun in the array (40 in^3). Airguns would be added in a sequence such that the source level of the array would increase in steps not exceeding 6 dB per 5-min period. During ramp up, the PSOs would monitor the EZ, and if marine mammals or turtles are sighted, a power down or shut down would be implemented as though the full array were operational.

If the complete EZ has not been visible for at least 30 min prior to the start of operations in either daylight or nighttime, ramp up would not commence unless at least one airgun (40 in^3 or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the airgun array would not be ramped up from a complete shut down at night or in thick fog, because the outer part of the safety zone for that array would not be visible during those conditions. If one airgun has operated during a power-down period, ramp up to full power would be permissible at night or in poor visibility, on the assumption that marine mammals and turtles would be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away. Ramp up of the airguns would not be initiated if a sea turtle or marine mammal is sighted within or near the applicable EZs during the day or night.

As noted above under "Power-down Procedures", during past R/V *Langseth* marine geophysical surveys, following an extended power-down period, the seismic source followed ramp-up procedures to return to the full seismic source level. Currently, under a power-down scenario, however, a single mitigation airgun still would be operating to alert and warn animals of the on-going activity and therefore ramp-up is viewed unnecessary.

XII. PLAN OF COOPERATION

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;

(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;

(iii) A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

Not applicable. The proposed activity would take place in the Mediterranean Sea, and no activities would take place in or near a traditional Arctic subsistence hunting area.

XIII. MONITORING AND REPORTING PLAN

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding...

L-DEO proposes to sponsor marine mammal monitoring during the present project, in order to implement the proposed mitigation measures that require real-time monitoring and to satisfy the expected monitoring requirements of the IHA. L-DEO's proposed Monitoring Plan is described below. L-DEO understands that this Monitoring Plan would be subject to review by NMFS, and that refinements may be required.

The monitoring work described here has been planned as a self-contained project independent of any other related monitoring projects that may be occurring simultaneously in the same regions. L-DEO is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical and desirable.

Vessel-based Visual Monitoring

Observations by PSOs would take place during daytime airgun operations and nighttime start ups of the airguns. Airgun operations would be suspended when marine mammals, turtles, or diving ESA-listed seabirds are observed within, or about to enter, designated EZs [see § XI above] where there is concern about potential effects on hearing or other physical effects. PSOs would also watch for marine mammals and sea turtles near the seismic vessel for at least 30 min prior to the planned start of airgun operations. Observations would also be made during daytime periods when the *Langseth* is underway without seismic operations, such as during transits. PSOs would also watch for any potential impacts of the acoustic sources on fish.

During seismic operations, four visual PSOs (PSVOs) would be based aboard the *Langseth*. All PSOs would be appointed by L-DEO with NMFS concurrence. During the majority of seismic operations, two PSVOs would monitor for marine mammals and sea turtles around the seismic vessel. Use of two simultaneous observers would increase the effectiveness of detecting animals around the source vessel. However, during meal times, only one PSVO may be on duty. PSVO(s) would be on duty in shifts of duration no longer than 4 h. Other crew would also be instructed to assist in detecting marine mammals and turtles and implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew would be given additional instruction regarding how to do so.

The *Langseth* is a suitable platform for marine mammal and turtle observations. When stationed on the observation platform, the eye level would be ~21.5 m above sea level, and the observer would have a good view around the entire vessel. During daytime, the PSVO(s) would scan the area around the vessel systematically with reticle binoculars (e.g., 7×50 Fujinon), Big-eye binoculars (25×150), and with the naked eye. During darkness, night vision devices (NVDs) would be available (ITT F500 Series Generation 3 binocular-image intensifier or equivalent), when required. Laser rangefinding binoculars (Leica LRF 1200 laser rangefinder or equivalent) would be available to assist with distance estimation. Those are useful in training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly; that is done primarily with the reticles in the binoculars.

Passive Acoustic Monitoring

Passive acoustic monitoring (PAM) would take place to complement the visual monitoring program. Visual monitoring typically is not effective during periods of poor visibility or at night, and even with good visibility, is unable to detect marine mammals when they are below the surface or beyond visual range. Acoustical monitoring can be used in addition to visual observations to improve detection, identification, and localization of cetaceans. The acoustic monitoring would serve to alert PSVOs (if on duty) when vocalizing cetaceans are detected. It is only useful when marine mammals call, but it can be effective either by day or by night, and does not depend on good visibility. It would be monitored in real time so that the visual observers can be advised when cetaceans are detected.

The PAM system consists of hardware (i.e., hydrophones) and software. The "wet end" of the system consists of a towed hydrophone array that is connected to the vessel by a tow cable. The tow cable is 250 m long, and the hydrophones are fitted in the last 10 m of cable. A depth gauge is attached to the free end of the cable, and the cable is typically towed at depths <20 m. The array would be deployed from a winch located on the back deck. A deck cable would connect the tow cable to the electronics unit in the main computer lab where the acoustic station, signal conditioning, and processing system would be located. The acoustic signals received by the hydrophones are amplified, digitized, and then processed by the Pamguard software. The system can detect marine mammal vocalizations at frequencies up to 250 kHz.

One acoustic PSO or PSAO, in addition to the four PSVOs, would be on board. The towed hydrophones would ideally be monitored 24 h per day while at the seismic survey area during airgun operations, and during most periods when the *Langseth* is underway while the airguns are not operating. However, PAM may not be possible if damage occurs to the array or back-up systems during operations. One PSAO would monitor the acoustic detection system at any one time, by listening to the signals from two channels via headphones and/or speakers and watching the real-time spectrographic display for frequency ranges produced by cetaceans. The PSAO monitoring the acoustical data would be on shift for 1–6 h at a time. All observers are expected to rotate through the PAM position, although the most experienced with acoustics would be on PAM duty more frequently.

When a vocalization is detected while visual observations are in progress, the PSAO would contact the PSVO immediately, to alert him/her to the presence of cetaceans (if they have not already been seen), and to allow a power or shut down to be initiated, if required. The information regarding the call would be entered into a database. The data to be entered include an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position and water depth when first detected, bearing if determinable, species or species group (e.g., unidentified dolphin, sperm whale), types and nature of sounds heard (e.g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information. The acoustic detection could also be recorded for further analysis.

PSO Data and Documentation

PSOs would record data to estimate the numbers of marine mammals, turtles, and diving ESA-listed seabirds exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. They would also record any observations of fish potentially affected by the sound sources. Data would be used to estimate numbers of animals potentially 'taken' by harassment (as defined in the MMPA). They would also provide information needed to order a power or shut down of the airguns when a marine mammal, sea turtle, or diving ESA-listed seabird is within or near the EZ.

When a sighting is made, the following information about the sighting would be recorded:

1. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc.), and behavioral pace.
2. Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare.

The data listed under (2) would also be recorded at the start and end of each observation watch, and during a watch whenever there is a change in one or more of the variables.

All observations and power or shut downs would be recorded in a standardized format. Data would be entered into an electronic database. The accuracy of the data entry would be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database. These procedures would allow initial summaries of data to be prepared during and shortly after the field program, and would facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

Results from the vessel-based observations would provide

1. the basis for real-time mitigation (airgun power down or shut down);
2. information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS;
3. data on the occurrence, distribution, and activities of marine mammals, turtles, and diving ESA-listed seabirds in the area where the seismic study is conducted;
4. information to compare the distance and distribution of marine mammals, turtles, and diving ESA-listed seabirds relative to the source vessel at times with and without seismic activity;
5. data on the behavior and movement patterns of marine mammals and turtles seen at times with and without seismic activity; and
6. any observations of fish potentially affected by the sound sources.

A report would be submitted to NMFS and NSF within 90 days after the end of the cruise. The report would describe the operations that were conducted and sightings of marine mammals, turtles, and diving ESA-listed seabirds near the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report would summarize the dates and locations of seismic operations, all marine mammal, turtle, and diving ESA-listed seabird sightings (dates, times, locations, activities, associated seismic survey activities), and any observations of fish potentially affected by the sound sources. The report would also include estimates of the number and nature of exposures that could result in "takes" of marine mammals by harassment or in other ways.

XIV. Coordinating Research to Reduce and Evaluate Incidental Take

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

L-DEO and NSF would coordinate with applicable U.S. agencies (e.g., NMFS) and would comply with their requirements.

XV. Literature Cited

Adamantopoulou, S., E. Androukaki, and S. Kotomatas. 1999. The distribution of the Mediterranean monk seal in Greece based on an information network. **Contr. Zoogeogr. Ecol. East. Med. Reg.** 1:399-404. Accessed in February 2015 at http://www.mom.gr/LH2Uploads/ItemsContent/507/press.pdf.

Adamantopoulou, S., E. Androukaki, P. Dendrinos, S. Kotomatas, V. Paravas, M. Psaradellis, E. Tounta, and A.A. Karamanlidis. 2011. Movements of Mediterranean monk seals (*Monachus monachus*) in the eastern Mediterranean Sea. **Aquat. Mamm.** 37(3):256-261.

Aguilar, A. 1986. A review of old Basque whaling and its effect on the right whales (*Eubalaena glacialis*) of the North Atlantic. **Rep. Int. Whal. Comm. Spec. Iss.** 10:191-199.

Aguilar, A. 1989. A record of two humpback whales, *Megaptera novaeangliae*, in the western Mediterranean Sea. **Mar. Mamm. Sci.** 5(3):306-309.

Aguilar, A. 2009. Fin whale *Balaenoptera physalus*. p. 433-437 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Aguilar, A., L.H. Cappozzo, M. Gazo, T. Pastor, J. Forcada, and E. Grau. 2007. Lactation and mother-pup behaviour in the Mediterranean monk seal *Monachus monachus*: an unusual pattern for a phocid. **J. Mar. Biol. Assoc. U.K.** 87(1):93-99.

Aguilar Soto, N., M. Johnson, P.T. Madsen, P.L. Tyack, A. Bocconcelli, and J.F. Borsani. 2006. Does intense ship noise disrupt foraging in deep-diving Cuvier's beaked whales (*Ziphius cavirostris*)? **Mar. Mamm. Sci.** 22(3):690-699.

Aguilar de Soto N., A. Frantzis, A. Cañadas, and G. Notarbartolo di Sciara. 2014. Actions for the conservation of Cuvier's beaked whale: implementation of areas of special concern for beaked whales in the Mediterranean Sea. Working Pap. SC/65b/SM25. Int. Whal. Comm., Cambridge, U.K. 7 p.

Airoldi, S., F. Bendinoni, A. Azzellino, V. Fadda, and A. Profice. 2005. Abundance estimate of Risso's dolphins (*Grampus griseus*) in the western Ligurian Sea through photographic mark-recapture. p. 109 *In*: Abstracts, 19th Ann. Conf. Europ. Cetac. Soc. 2–7 Apr. 2005, La Rochelle, France.

Aissi, M., A. Celona, G. Comparetto, R. Mangano, M. Wurtz, and A. Moulins. 2008. Large-scale seasonal distribution of fin whales (*Balaenoptera physalus*) in the central Mediterranean Sea. **J. Mar. Biol. Assoc. U.K.** 88(6):1253-1261.

Anderwald, P., A.K. Daníelsdóttir, T. Haug, F. Larsen, V. Lesage, R.J. Reid, G.A. Víkingsson, and A.R. Hoezel. 2011. Possible cryptic stock structure for minke whales in the North Atlantic: implications for conservation and management. **Biol. Conserv.** 144(10):2479-2489.

Azzellino, A., S. Gaspari, S. Airoldi, and B. Nani. 2008. Habitat use and preferences of cetaceans along the continental slope and the adjacent pelagic waters in the western Ligurian Sea. **Deep Sea Res. I** 55(3):296-323.

Baird, R.W. 2009a. Risso's dolphin *Grampus griseus*. p. 975-976 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Baird, R.W. 2009b. False killer whale *Pseudorca crassidens*. p. 405-406 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Baird, R.W., S.W. Martin, D.L. Webster, and B.L. Southall. 2014. Assessment of modeled received sound pressure levels and movements of satellite-tagged odontocetes exposed to mid-frequency active sonar at the Pacific Missile Range Facility: February 2011 through February 2013. Prepared for U.S. Pacific Fleet, submitted to NAVFAC PAC by HDR Environmental, Operations and Construction, Inc. Accessed on 13 March 2015 at www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA602847.

Baker, C.S. and L.M. Herman. 1989. Behavioral responses of summering humpback whales to vessel traffic: experimental and opportunistic observations. NPS-NR-TRS-89-01. Rep. from Kewalo Basin Mar. Mamm. Lab., Univ. Hawaii, Honolulu, HI, for U.S. Natl. Park Serv., Anchorage, AK. 50 p. NTIS PB90-198409.

Baker, C.S., L.M. Herman, B.G. Bays, and W.F. Stifel. 1982. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska. Rep. from Kewalo Basin Mar. Mamm. Lab., Honolulu, HI, for U.S. Natl. Mar. Fish. Serv., Seattle, WA. 78 p.

Baker, C.S., L.M. Herman, B.G. Bays, and G.B. Bauer. 1983. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska: 1982 season. Rep. from Kewalo Basin Mar. Mamm. Lab., Honolulu, HI, for U.S. Nat. Mar. Mamm. Lab., Seattle, WA. 30 p.

Barry, S.B., A.C. Cucknell, and N. Clark. 2012. A direct comparison of bottlenose dolphin and common dolphin behaviour during seismic surveys when airguns are and are not being utilised. p. 273-276 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York. 695 p.

Bearzi, G., R.R. Reeves, G. Notarbartolo di Sciara, E. Politi, A. Cañadas, A. Frantzis, and B. Mussi. 2003. Ecology, status and conservation of short-beaked common dolphins *Delphinus delphis* in the Mediterranean Sea. **Mammal Rev.** 33(3):224-252.

Bearzi, G., S. Agazzi, S. Bonizzoni, M. Costa, and A. Azzellino. 2008. Dolphins in a bottle: abundance, residency patterns and conservation of bottlenose dolphins *Tursiops truncatus* in the semi-closed eutrophic Amvrakikos Gulf, Greece. **Aquat. Conserv. Mar. Freshw. Ecosyst.** 18(2):130-146.

Bearzi, G., R.R. Reeves, E. Remonato, N. Pierantonio, and S. Airoldi. 2011. Risso's dolphin *Grampus griseus* in the Mediterranean Sea. **Mammal. Biol.** 76(4):385-400.

Bellido, J.J., J.J. Castillo, M.A. Farfan, J.J. Martin, J.L. Mons, and R. Real. 2007. First records of hooded seals (*Cystophora cristata*) in the Mediterranean Sea. **J. Mar. Biol. Assoc. U.K.** 87(6):1791-1792.

Bernstein, L. 2013. The Washington Post: Health, Science, and Environment. Panel links underwater mapping sonar to whale stranding for first time. Published 6 October 2013. Accessed on 9 March 2015 at http://www.washingtonpost.com/national/health-science/panel-links-underwater-mapping-sonar-to-whale-stranding-for-first-time/2013/10/06/52510204-2e8e-11e3-bbed-a8a60c601153_story.html.

Bérubé, M., A. Aguilar, D. Dendanto, F. Larsen, G. Notarbartolo di Sciara, R. Sears, J. Sigurjónsson, J. Urban-R., and P.J. Palsbøll. 1998. Population genetic structure of North Atlantic, Mediterranean Sea, and Sea of Cortez fin whales, *Balaenoptera physalus* (Linnaeus1758): analysis of mitochondrial and nuclear loci. **Mol. Ecol.** 7(5):585-599.

Blackwell, S.B., C.S. Nations, T.L. McDonald, C.R. Greene, Jr., A.M. Thode, M. Guerra, and A.M. Macrander. 2013. Effects of airgun sounds on bowhead whale calling rates in the Alaskan Beaufort Sea. **Mar. Mamm. Sci.** 29(4):E342-E365.

Blackwell, S.B., C.S. Nations, T.L. McDonald, A.M. Thode, D. Mathias, K.H. Kim, C.R. Greene, Jr., and A.M. Macrander. 2015. Effects of airgun sounds on bowhead whale calling rates: evidence for two behavioral thresholds. **PLoS ONE** 10(6):e0125720. doi:10.1371/journal.pone.0125720.

Boisseau, O., C. Lacey, T. Lewis, A. Moscrop, M. Danbolt, and R. McLanaghan. 2010. Encounter rates of cetaceans in the Mediterranean Sea and contiguous Atlantic area. **J. Mar. Biol. Assoc. U.K**. 90(8):1589-1599.

Borrell, A., A. Aguilar, V. Tornero, M. Sequeira, G. Fernandez, and S. Alis. 2006. Organochlorine compounds and stable isotopes indicate bottlenose dolphin subpopulation structure around the Iberian Peninsula. **Environ. Int.** 32(4):516-523.

Bourret, V.J.R., M.R.J.M. Macé, and B. Crouau-Roy. 2007. Genetic variation and population structure of western Mediterranean and northern Atlantic *Stenella coeruleoalba* populations inferred from microsatellite data. **J. Mar. Biol. Assoc. U.K.** 87(1):265-269.

Branstetter, B.K., J.S. Trickey, H. Aihara, J.J. Finneran, and T.R. Liberman. 2013. Time and frequency metrics related to auditory masking of a 10 kHz tone in bottlenose dophins (*Tursiops truncatus*). **J. Acoust. Soc. Am.** 134(6):4556-4565.

Breitzke, M. and T. Bohlen. 2010. Modelling sound propagation in the Southern Ocean to estimate the acoustic impact of seismic research surveys on marine mammals. **Geophys. J. Int.** 181(2):818-846.

Broker, K., J. Durinck, C. Vanman, and B. Martin. 2013. Monitoring of marine mammals and the sound scape during a seismic survey in two license blocks in the Baffin Bay, West Greendland, in 2012. p. 32 *In*: Abstr. 20th Bienn. Conf. Biol. Mar. Mamm., 9–13 Dec. 2013, Dunedin, New Zealand. 233 p.

Brown, S.G. 1986. Twentieth-century records of right whales (*Eubalaena glacialis*) in the northeast Atlantic Ocean. **Rep. Int. Whal. Comm. Spec. Iss.** 10:121-127.

Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, Oxford, U.K. 448 p.

Cañadas, A. 2006. Towards conservation of dolphins in the Alborán Sea. Ph.D. dissertation, Universidad Autónoma de Madrid, Spain. 351 p.

Cañadas, A. 2011. Updated draft assessment of the conservation status of Cuvier's beaked whales in the Mediterranean Sea. Working Pap. SC/63/SM8. Int. Whal. Comm., Cambridge, U.K. 10 p.

Cañadas, A. and P.S. Hammond. 2008. Abundance and habitat preferences of the short-beaked common dolphin *Delphinus delphis* in the southwestern Mediterranean: implications for conservation. **Endang. Species Res**. 4(3):309-331.

Cañadas, A., A. B-Nagy, G. Bearzi, C. Cotte, C. Fortuna, A. Gannier, S. Laran, G. Lauriano, T. Lewis, A. Moulins, B. Mussi, X. Pastor, E. Politi, M. Pulcini, J.A. Raga, and L. Rendell. 2012. ACCOBAMS collaborative effort to map high-use areas by beaked whales in the Mediterranean. Rep. ACCOBAMS Sci. Comm. ACCOBAMS-SC8/2012/Doc 10. 8th Meet. Sci. Commit., 13–15 Nov. 2012, Monaco. Accessed in February 2015 at http://accobams.org/images/stories/Important_Documents/sc8_doc10.pdf.

Carwardine, M. 1995. Whales, dolphins and porpoises. Dorling Kindersley Publishing, Inc., New York. 256 p.

Castellote, M. and C. Llorens. 2013. Review of the effects of offshore seismic surveys in cetaceans: are mass strandings a possibility? Abstr. 3rd Int. Conf. Effects of Noise on Aquatic Life, Aug. 2013, Budapest, Hungary.

Castellote, M. C.W. Clark, and M.O. Lammers. 2010. Population identity and migration movements of fin whales (*Balaenoptera physalus*) in the Mediterranean Sea and Strait of Gibraltar. Working Pap. SC/62/SD2. Int. Whal. Comm., Cambridge, U.K. 16 p.

Castellote, M., C.W. Clark, and M.O. Lammers. 2012. Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. **Biol. Conserv**. 147(1):115-122.

Cattanach, K.L., J. Sigurjónsson, S.T. Buckland, and T. Gunnlaugsson. 1993. Sei whale abundance in the North

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):e86464. doi:10.1371/journal.pone.0086464.

Clapham, P.J., L.S. Baraff, C.A. Carlson, M.A. Christian, D.K. Mattila, C.A. Mayo, M.A. Murphy, and S. Pittman. 1993. Seasonal occurrence and annual return of humpback whales, *Megaptera novaeangliae*, in the southern Gulf of Maine. **Can. J. Zool.** 71(2):440-443.

Clark, C.W. and G.C. Gagnon. 2006. Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales. Working Pap. SC/58/E9. Int. Whal. Comm., Cambridge, U.K. 9 p.

Crone, T.J., M. Tolstoy, and H. Carton. 2014. Estimating shallow water sound power levels and mitigation radii for the R/V *Marcus G. Langseth* using an 8 km long MCS streamer. **Geochem. Geophys. Geosyst.** 15(10):3793-3807. doi:10.1002/2014GC005420.

Clark, C.W., W.T. Ellison, B.L. Southall, L. Hatch, S.M. Van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. **Mar. Ecol. Prog. Ser.** 395:201-222.

Dalebout, M.L., K.M. Robertson, A. Frantzis, D. Engelhaupt, A.A. Mignucci-Giannoni, P.J. Rosario-Delestre, and C.S. Baker. 2005. Worldwide structure of mtDNA diversity among Cuvier's beaked whales (*Ziphius cavirostris*): implications for threatened populations. **Mol. Ecol.** 14(11):3353-3371.

Davis, R.W., G.S. Fargion, N. May, T.D. Leming, M. Baumgartner, W.E. Evans, L.J. Hansen, and K. Mullin. 1998. Physical habitat of cetaceans along the continental slope in the north-central and western Gulf of Mexico. **Mar. Mamm. Sci.** 14(3):490-507.

Dede, A. and B. Öztürk. 2007. Cetacean observations in the Marmara and Aegean Sea in spring season 2005. **Rapp. Comm. Int. Mer Médit.** 38:455.

Dede, A., A. Saad, M. Fakhri, and B. Öztürk. 2012. Cetacean sightings in the eastern Mediterranean Sea during the cruise in summer 2008. **J. Black Sea/Med. Env.** 18(1):49-57.

Dendrinos, P., A.A. Karamanlidis, E. Androukaki, and B.J. McConnell. 2007a. Diving development and behavior of a rehabilitated Mediterranean monk seal (*Monachus monachus*). **Mar. Mamm. Sci.** 23(2):387-397.

Dendrinos, P., A.A. Karamanlidis, S. Kotomatas, A. Legakis, E. Tounta and J. Matthiopoulos. 2007b. Pupping habitat use in the Mediterranean monk seal: a long-term study. **Mar. Mamm. Sci.** 23(3):615-628.

Deng, Z.D., B.L. Southall, T.J. Carlson, J. Xu, J.J. Martinez, M.A. Weiland, and J.M. Ingraham. 2014. 200-kHz commercial sonar systems generate lower frequency side lobes audible to some marine mammals. **PLoS ONE** 9(4):e95315. doi:10.1371/journal.pone.0095315.

DeRuiter, S.L., I.L. Boyd, D.E. Claridge, C.W. Clark, C. Gagnon, B.L. Southall, and P.L. Tyack. 2013a. Delphinid whistle production and call matching during playback of simulated military sonar. **Mar. Mamm. Sci.** 29(2):E46-E59.

DeRuiter, S.L., B.L. Southall, J. Calambokidis, W.M.X. Zimmer, D. Sadykova, E.A. Falcone, A.S. Friedlaender, J.E. Joseph, D. Moretti, G.S. Schorr, L. Thomas, and P.L. Tyack. 2013b. First direct measurements of behavioural responses by Cuvier's beaked whales to mid-frequency active sonar. **Biol. Lett.** 9:20130223. doi:10.1098/rsbl.2013.0223.

Di Iorio, L. and C.W. Clark. 2010. Exposure to seismic survey alters blue whale acoustic communication. **Biol. Lett.** 6(1):51-54.

Diebold, J.B., M. Tolstoy, L. Doermann, S.L. Nooner, S.C. Webb, and T.J. Crone. 2010. R/V *Marcus G. Langseth* seismic source: modeling and calibration. **Geochem. Geophys. Geosyst.** 11(12):Q12012. doi:10.1029/2010GC003126. 20 p.

DoN (Department of the Navy). 2008. Marine resource assessment update for the eastern Mediterranean Sea. Department of the Navy, U.S. Fleet Forces Command, Norfolk, VA. Contract No. N62470-02-D-9997, CTO 0080. Prepared by GeoMarine, Inc., Hampton, VA. Accessed in February 2015 at https://www.navfac.navy.mil/content/dam/navfac/Environmental/PDFs/MRA/Eastern_Mediterranean_MRA.pdf.

Donovan, G.P. 1991. A review of IWC stock boundaries. **Rep. Int. Whal. Comm. Spec. Iss.** 13:39-68.

Drouot, V., M. Bérubé, A. Gannier, J.C. Goold, R.D. Reid, and P.J. Palsbøll. 2004. A note on genetic isolation of Mediterranean sperm whales (*Physeter macrocephalus*) suggested by mitochondrial DNA. **J. Cetac. Res. Manage.** 6(1):29-32.

Ellison, W.T., B.L. Southall, C.W. Clark, and A.S. Frankel. 2012. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. **Conserv. Biol.** 26(1):21-28.

Engel, M.H., M.C.C. Marcondes, C.C.A. Martins, F.O. Luna, R.P. Lima, and A. Campos. 2004. Are seismic surveys responsible for cetacean strandings? An unusual mortality of adult humpback whales in Abrolhos Bank, northeastern coast of Brazil. Working Pap. SC/56/E28. Int. Whal. Comm., Cambridge, U.K. 8 p.

Engelhaupt, D., R.A. Hoelzel, C. Nicholson, A. Frantzis, S. Mesnick, S. Gero, H. Whitehead, L. Rendell, P. Miller, R. De Stefanis, A. Cañadas, S. Airoldi, and A.A. Mignucci-Giannoni. 2009. Female philopatry in coastal basins and maledispersion across the North Atlantic in a highly mobile marine species, the sperm whale (*Physeter macrocephalus*). **Mol. Ecol.** 18(20):4193-4205.

Evans, P.G.H. 1987. The natural history of whales and dolphins. Christopher Helm, Bromley, Kent, U.K. 343 p.

Evans, W.E. 1994. Common dolphin, white-bellied porpoise *Delphinus delphis* Linnaeus, 1758. p. 191-224 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, San Diego, CA. 416 p.

Finneran, J.J. 2012. Auditory effects of underwater noise in odontocetes. p. 197-202 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Finneran, J.J. and B.K. Branstetter. 2013. Effects of noise on sound perception in marine mammals. p. 273-308 *In:* H. Brumm (ed.) Animal communication and noise. Springer Berlin, Heidelberg, Germany. 453 p.

Finneran, J.J. and C.E. Schlundt. 2010. Frequency-dependent and longitudinal changes in noise-induced hearing loss in a bottlenose dolphin (*Tursiops truncatus*) (L). **J. Acoust. Soc. Am.** 128(2):567-570.

Finneran, J.J. and C.E. Schlundt. 2011. Noise-induced temporary threshold shift in marine mammals. **J. Acoust. Soc. Am.** 129(4):2432. [supplemented by oral presentation at the ASA meeting, Seattle, WA, May 2011].

Finneran, J.J. and C.E. Schlundt. 2013. Effects of fatiguing tone frequency on temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*). **J. Acoust. Soc. Am.** 133(3):1819-1826.

Finneran, J.J., C.E. Schlundt, D.A. Carder, J.A. Clark, J.A. Young, J.B. Gaspin, and S.H. Ridgway. 2000. Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and beluga whale (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions. **J. Acoust. Soc. Am.** 108(1):417-431.

Finneran, J.J., C.E. Schlundt, R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. **J. Acoust. Soc. Am.** 111(6):2929-2940.

Finneran, J.J., D.A. Carder, C.E. Schlundt, and S.H. Ridgway. 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. **J. Acoust. Soc. Am.** 118(4):2696-2705.

Finneran, J.J., D.A. Carder, C.E. Schlundt, and R.L. Dear. 2010a. Growth and recovery of temporary threshold shift (TTS) at 3 kHz in bottlenose dolphins (*Tursiops truncatus*). **J. Acoust. Soc. Am.** 127(5):3256-3266.

Finneran, J.J., D.A. Carder, C.E. Schlundt, and R.L. Dear. 2010b. Temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*) exposed to intermittent tones. **J. Acoust. Soc. Am.** 127(5):3267-3272.

Finneran, J.J., J.S. Trickey, B.K. Branstetter, C.E. Schlundt, and K. Jenkins. 2011. Auditory effects of multiple underwater impulses on bottlenose dolphins (*Tursiops truncatus*). **J. Acoust. Soc. Am.** 130(4):2561.

Finneran, J.J., C.E. Schlundt, B.K. Branstetter, J.S. Trickey, V. Bowman, and K. Jenkins. 2015. Effects of multiple impulses from a seismic air gun on bottlenose dolphin hearing and behavior. **J. Acoust. Soc. Am.** 137(4):1634-1646.

Forcada, J. and P. Hammond. 1998. Geographical variation in abundance of striped and common dolphins of the western Mediterranean. **J. Sea Res.** 39(3-4):313-325.

Forcada, J., A. Aguilar, P.S. Hammond, X. Pastor, and R. Aguilar. 1994. Distribution and numbers of striped dolphins in the western Mediterranean Sea after the 1990 epizootic outbreak. **Mar. Mamm. Sci.** 10(2):137-150.

Ford, J.K.B. 2009. Killer whale *Orcinus orca*. p. 650-657 *In*: W.F Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Fortuna, C.M., D. Holcer, E. Filidei Jr, G.P. Donovan, and L. Tunesi. 2011. The first cetacean aerial survey in the Adriatic Sea: summer 2010. 7th Meeting of the ACCOBAMS Scientific committee, 16 p. Accessed on 14 March 2015 at https://bib.irb.hr/datoteka/560768.sc7_doc06.pdf.

Frantzis, A. 2009. Cetaceans in Greece: present status of knowledge. Initiative for the Conservation of Cetaceans in Greece, Athens, Greece. 94 p. Accessed in February 2015 at http://ioniandolphinproject.org/wp-content/uploads/2012/04/Technical-Report-2009-Frantzis.pdf.

Frantzis, A., P. Alexiadou, and K.C. Gkikopoulou. 2014. Sperm whale occurrence, site fidelity and population structure along the Hellenic Trench (Greece, Mediterranean Sea). **Aquat. Conserv. Mar. Freshw. Ecosyst.** 24(Suppl. 1):83-102.

Frantzis, A., P. Alexiadou, G. Paximadis, E. Politi, A. Gannier, and M. Corsini-Foka. 2003. Current knowledge of the cetacean fauna of the Greek Seas. **J. Cetac. Res. Manage.** 5(3):219-232.

Frantzis, A., O. Nikolaou, J.-M. Bompar, and A. Cammedda. 2004. Humpback whale (*Megaptera novaeangliae*) occurrence in the Mediterranean Sea. **J. Cetac. Res. Manage.** 6(1):25-28.

Gailey, G., B. Würsig, and T.L. McDonald. 2007. Abundance, behavior, and movement patterns of western gray whales in relation to a 3-D seismic survey, northeast Sakhalin Island, Russia. **Environ. Monit. Assessm.** 134(1-3):75-91.

Gambell, R. 1985. Fin whale *Balaenoptera physalus* (Linnaeus, 1758). p. 171-192 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 3: The Sirenians and baleen whales. Academic Press, London, U.K. 362 p.

Gannier, A. 2005. Summer distribution and relative abundance of delphinids in the Mediterranean Sea. **Rev. Écol. (Terre Vie)** 60:223-238.

Gannier, A. and J. Epinat. 2008. Cuvier's beaked whale distribution in the Mediterranean Sea: results from small boat surveys 1996–2007. **J. Mar. Biol. Assoc. U.K.** 88(6):1245-1251.

Gannier, A., V. Drouot, and J.C. Goold. 2002. Distribution and relative abundance of sperm whales in the Mediterranean Sea. **Mar. Ecol. Prog. Ser.** 243:281-293.

García-Martinez, J., A. Moya, J.A. Raga, and A. Latorre. 1999. Genetic differentiation in the striped dolphin *Stenella coeruleoalba* from European waters according to mitochondrial DNA (mtDNA) restriction analysis. **Mol. Ecol.** 8(6):1069-1073.

Gaspari, S. 2004. Social and population structure of striped and Risso's dolphins in the Mediterranean Sea. Ph.D. dissertation, Durham University. Accessed on 14 March 2015 at http://etheses.dur.ac.uk/3051/1/3051_1075.pdf?UkUDH:Cyt. 170 p.

Gaspari, S., A. Azzellino, S. Airoldi, and A.R. Hoelzel. 2007a. Social kin associations and genetic structuring of striped dolphin populations (*Stenella coeruleoalba*) in the Mediterranean Sea. **Mol. Ecol.** 16(4):2922-2933.

Gaspari S., S. Airoldi, and A.R. Hoelzel. 2007b. Risso's dolphins (*Grampus griseus*) in U.K. waters are differentiated from a population in the Mediterranean Sea and genetically less diverse. **Conserv. Genet.** 8(3):727-732.

Gedamke, J. 2011. Ocean basin scale loss of whale communication space: potential impacts of a distant seismic survey. p. 105-106 *In*: Abstr. 19th Bienn. Conf. Biol. Mar. Mamm., 27 Nov.–2 Dec. 2011, Tampa, FL. 344 p.

Gedamke, J., N. Gales, and S. Frydman. 2011. Assessing risk of baleen whale hearing loss from seismic surveys: the effects of uncertainty and individual variation. **J. Acoust. Soc. Am.** 129(1):496-506.

Gervaise, C., N. Roy, Y. Simard, B. Kinda, and N. Menard. 2012. Shipping noise in whale habitat: characteristics, sources, budget, and impact on belugas in Saguenay-St. Lawrence Marine Park hub. **J. Acoust. Soc. Am.** 132(1):76-89.

Giakoumi S., M. Sini, V. Gerovasileiou, T. Mazor, J. Beher, H.P. Possingham, A. Abdulla, M.E. Çinar, P. Dendrinos, A.C. Gucu, A.A. Karamanlidis, P. Rodic, P. Panayotidis, E. Taskin, A. Jaklin, E. Voultsiadou, C. Webster, A. Zenetos, and S. Katsanevakis. 2013. Ecoregion-based conservation planning in the Mediterranean: dealing with large-Scale heterogeneity. **PLoS ONE** 8(10):e76449. doi:10.1371/journal.pone.0076449.

Gilmartin, W.G. and J. Forcada. 2009. Monk seals *Monachus monachus*, *M. tropicalis*, and *M. schauinslandi*. p. 756-759 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Giménez, J., E. Gómez-Campos, A. Borrell, L. Cardona, and A. Aguilar. 2013. Isotopic evidence of limited exchange between Mediterranean and eastern Atlantic fin whales. **Rapid Commun. Mass Spectrom.** 27(15):1801-1806.

Goldbogen, J.A., B.L. Southall, S.L. DeRuiter, J. Calambokidis, A.S. Friedlaender, E.L. Hazen, E. Falcone, G. 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. **Proc. R. Soc. B.** 280:20130657. doi:10.1098/rspb.2013.0657.

Gómez de Segura, A., E.A. Crespo, S.N. Pedraza, P.S. Hammond, and J.A. Raga. 2006. Abundance of small cetaceans in waters of the central Spanish Mediterranean. **Mar. Biol.** 150(1):149-160.

Gong, Z., A.D. Jain, D. Tran, D.H. Yi, F. Wu, A. Zorn, P. Ratilal, and N.C. Makris. 2014. Ecosystem scale acoustic sensing reveals humpback whale behavior synchronous with herring spawning processes and re-evaluation finds no effect of sonar on humpback song occurrence in the Gulf of Maine in fall 2006. **PLoS ONE** 9(10):e104733. doi:10.1371/journal.pone.0104733.

González, L.M., M.A. Cedenilla, P.F. de Larrinoa, J.F. Layna, and F. Aparicio. 2002. Changes in the breeding variables of the Mediterranean monk seal (*Monachus monachus*) of Cabo Blanco Peninsula after a mass mortality episode. **Mammalia** 66(2):173-182.

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M.P. Simmonds, R. Swift, and D. Thompson. 2004. A review of the effects of seismic surveys on marine mammals. **Mar. Technol. Soc. J.** 37(4):16-34.

Gray, H. and K. Van Waerebeek. 2011. Postural instability and akinesia in a pantropical spotted dolphin, *Stenella attenuata*, in proximity to operating airguns of a geophysical seismic vessel. **J. Nature Conserv.** 19(6):363-367.

Güçlüsoy, H. 2008. The first confirmed report of the harbour porpoise (*Phocoena phocoena*) in the Turkish Aegean Sea. **Mar. Biodiv. Rec.** 1, e94. doi:10.1017/s1755262707009529.

Güçlüsoy, H., C.O. Kirac, N.O. Veryeri and Y. Savas. 2004. Status of the Mediterranean monk seal, *Monachus monachus* (Hermann, 1779) in the coastal waters of Turkey. **E.U. J. Fish. Aquat. Sci.** 21(3-4):201-210.

Gücü, A.C., G. Gücü, G., and H. Orek. 2004. Habitat use and preliminary demographic evaluation of the critically endangered Mediterranean monk seal (*Monachus monachus*) in the Cilician Basin (eastern Mediterranean). **Biol. Conserv.** 116(3):417-431.

Guerra, M., A.M. Thode, S.B. Blackwell, and M. Macrander. 2011. Quantifying seismic survey reverberation off the Alaskan North Slope. **J. Acoust. Soc. Am.** 130(5):3046-3058.

Guerra, M., P.J. Dugan, D.W. Ponirakis, M. Popescu, Y. Shiu, and C.W. Clark. 2013. High-resolution analysis of seismic airgun impulses and their reverberant field as contributors to an acoustic environment. Abstr. 3rd Int. Conf. Effects of Noise on Aquatic Life, Aug. 2013, Budapest, Hungary.

Hastie, G.D., C. Donovan, T. Götz, and V.M. Janik. 2014. Behavioral responses of grey seals (*Halichoerus grypus*) to high frequency sonar. **Mar. Poll. Bull.** 79(1-2):205-210.

Hatch, L.T., C.W. Clark, S.M. Van Parijs, A.S. Frankel, and D.W. Ponirakis. 2012. Quantifying loss of acoustic communication space for right whales in and around a U.S. National Marine Sanctuary. **Conserv. Biol.** 26(6):983-994.

Heide-Jørgensen, M.P., R.G. Hansen, S. Fossette, N.J. Nielsen, M.V. Jensen, and P. Hegelund. 2013a. Monitoring abundance and hunting of narwhals in Melville Bay during seismic surveys. Preliminary report from the Greenland Institute of Natural Resources. 59 p. Accessed on 13 March 2015 at http://www.natur.gl/fileadmin/user_files/Dokumenter/PAFU/Monitoring_abundance_and_hunting_of_narwhals_in_Melville_Bay_GINR_Preliminary_report_endelig__2_.pdf.

Heide-Jørgensen, M.P., R.G. Hansen, K. Westdal, R.R. Reeves, and A. Mosbech. 2013b. Narwhals and seismic exploration: is seismic noise increasing the risk of ice entrapments? **Biol. Conserv.** 158:50-54.

Heyning, J.E. 1989. Cuvier's beaked whale *Ziphius cavirostris* G. Cuvier, 1823. p. 289-308 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, San Diego, CA. 444 p.

IUCN (International Union for Conservation of Nature). 2012. Marine mammals and sea turtles of the Mediterranean and Black seas. IUCN, Gland, Switzerland and Malaga, Spain. 32 p. Accessed in March 2015 at https://portals.iucn.org/library/efiles/documents/2012-022.pdf.

IUCN (International Union for Conservation of Nature). 2014. The IUCN Red List of Threatened Species. Version 2014.3. Accessed on 9 February 2015 at http://www.iucnredlist.org.

IWC (International Whaling Commission). 2001. Report of the workshop on the comprehensive assessment of right whales: a worldwide comparison. **J. Cetac. Res. Manage. Spec. Iss.** 2:1-60.

IWC (International Whaling Commission). 2007. Report of the standing working group on environmental concerns. Annex K to Report of the Scientific Committee. **J. Cetac. Res. Manage**. 9(Suppl.):227-260.

IWC (International Whaling Commission). 2015. Whale population estimates. Accessed on 2 March 2015 at https://iwc.int/estimate.

Jaquet, N. and H. Whitehead. 1996. Scale-dependent correlation of sperm whale distribution with environmental features and productivity in the South Pacific. **Mar. Ecol. Prog. Ser.** 135(1-3):1-9.

Jaquet, N. and D. Gendron. 2002. Distribution and relative abundance of sperm whales in relation to key environmental features, squid landings and the distribution of other cetacean species in the Gulf of California, Mexico. **Mar. Biol.** 141(3):591-601.

Jefferson, T.A., M.A. Webber, and R.L. Pitman. 2008. Marine mammals of the world: a comprehensive guide to their identification. Elsevier, London, U.K. 573 p.

Jensen, F.H., L. Bejder, M. Wahlberg, N. Aguilar Soto, M. Johnson, and P.T. Madsen. 2009. Vessel noise effects on delphinid communication. **Mar. Ecol. Prog. Ser.** 395:161-175.

Jefferson, T.A., C.R. Weir, R.C. Anderson, L.T. Balance, R.D. Kenney, and J.J. Kiszka. 2014. Global distribution of Risso's dolphin *Grampus griseus*: a review and critical evaluation. **Mammal Rev.** 44(1):56-68. doi:10.1111/mam.12008.

Johnson, S.R., W.J. Richardson, S.B. Yazvenko, S.A. Blokhin, G. Gailey, M.R. Jenkerson, S.K. Meier, H.R. Melton, M.W. Newcomer, A.S. Perlov, S.A. Rutenko, B. Würsig, C.R. Martin, and D.E. Egging. 2007. A western gray whale mitigation and monitoring program for a 3-D seismic survey, Sakhalin Island, Russia. **Environ. Monit. Assessm.** 134(1-3):1-19.

Karamanlidis, A.A., R. Pires, N. Carina Silva, and H. Costa Neves. 2004. The availability of resting and pupping habitat for the critically endangered Mediterranean monk seal *Monachus monachus* in the archipelago of Madeira. **Oryx** 38(2):180-185.

Kastak, D. and C. Reichmuth. 2007. Onset, growth, and recovery of in-air temporary threshold shift in a California sea lion (*Zalophus californianus*). **J. Acoust. Soc. Am.** 122(5):2916-2924.

Kastak, D., R.L. Schusterman, B.L. Southall, and C.J. Reichmuth. 1999. Underwater temporary threshold shift induced by octave-band noise in three species of pinnipeds. **J. Acoust. Soc. Am.** 106(2):1142-1148.

Kastak, D., B.L. Southall, R.J. Schusterman, and C. Reichmuth Kastak. 2005. Underwater temporary threshold shift in pinnipeds: effects of noise level and duration. **J. Acoust. Soc. Am.** 118(5):3154-3163.

Kastak, D., J. Mulsow, A. Ghoul, and C. Reichmuth. 2008. Noise-induced permanent threshold shift in a harbor seal. **J. Acoust. Soc. Am.** 123(5):2986.

Kastelein, R., R. Gransier, L. Hoek, and J. Olthuis. 2012a. Temporary threshold shifts and recovery in a harbor porpoise (*Phocoena phocoena*) after octave-band noise at 4 kHz. **J. Acoust. Soc. Am.** 132(5):3525-3537.

Kastelein, R.A., R. Gransier, L. Hoek, A. Macleod, and J.M. Terhune. 2012b. Hearing threshold shifts and recovery in harbor seals (*Phoca vitulina*) after octave-band noise exposure at 4 kHz. **J. Acoust. Soc. Am.** 132(4):2745-2761.

Kastelein, R.A., N. Steen, R. Gransier, and C.A.F. de Jong. 2013a. Brief behavioral response threshold level of a harbor porpoise (*Phocoean phocoena*) to an impulsive sound. **Aquat. Mamm.** 39(4):315-323.

Kastelein, R.A., R. Gransier, and L. Hoek, and M. Rambags. 2013b. Hearing frequency thresholds of a harbour porpoise (*Phocoena phocoena*) temporarily affected by a continuous 1.5-kHz tone. **J. Acoust. Soc. Am.** 134(3):2286-2292.

Kastelein, R., R. Gransier, and L. Hoek. 2013c. Comparative temporary threshold shifts in a harbour porpoise and harbour seal, and severe shift in a seal (L). **J. Acoust. Soc. Am.** 134(1):13-16.

Kastelein, R.A., L. Hoek, R. Gransier, M. Rambags, and N. Clayes. 2014. Effect of level, duration, and inter-pulse interval of 1–2 kHz sonar signal exposures on harbor porpoise hearing. **J. Acoust. Soc. Am.** 136:412-422.

Kasuya, T. 1986. Distribution and behavior of Baird's beaked whales off the Pacific coast of Japan. **Sci. Rep. Whales Res. Inst.** 37:61-83.

Kennedy, A.S., A.N. Zerbinid, O.V. Vasquez, N. Gandilhon, P.J. Clapham, and O. Adam. 2014. Local and migratory movements of humpback whales (*Megaptera novaeangliae*) satellite-tracked in the North Atlantic Ocean. **Can. J. Zool.** 92(1):8-17.

Kerem, D., N. Hadar, O. Goffman, A. Scheinin, R. Kent, O. Boisseau, and U. Schattner. 2012. Update on the cetacean fauna of the eastern Mediterranean Levantine Basin. **Open Mar. Biol. J.** 6:6-27.

Ketten, D.R. 2012. Marine mammal auditory system noise impacts: evidence and incidence. p. 207-212 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Ketten, D.R., J. O'Malley, P.W.B. Moore, S. Ridgway, and C. Merigo. 2001. Aging, injury, disease, and noise in marine mammal ears. **J. Acoust. Soc. Am.** 110(5, Pt. 2):2721 (Abstract).

Klinck, H., S.L. Nieukirk, D.K. Mellinger, K. Klinck, H. Matsumoto, and R.P. Dziak. 2012. Seasonal presence of cetaceans and ambient noise levels in polar waters of the North Atlantic. **J. Acoust. Soc. Am.** 132(3):EL176-EL181.

Kovacs K.M. and D.M. Lavigne. 1986. *Cystophora cristata*. **Mamm. Species** 258:1-9.

Krieger, K.J. and B.L. Wing. 1984. Hydroacoustic surveys and identification of humpback whale forage in Glacier Bay, Stephens Passage, and Frederick Sound, southeastern Alaska, summer 1983. NOAA Tech. Memo. NMFS F/NWC-66. U.S. Natl. Mar. Fish. Serv., Auke Bay, AK. 60 p. NTIS PB85-183887.

Krieger, K.J. and B.L. Wing. 1986. Hydroacoustic monitoring of prey to determine humpback whale movements. NOAA Tech. Memo. NMFS F/NWC-98. U.S. Natl. Mar. Fish. Serv., Auke Bay, AK. 63 p. NTIS PB86-204054.

Kruse, S., D.K. Caldwell, and M.C. Caldwell. 1999. Risso's dolphin *Grampus griseus* (G. Cuvier, 1812). p. 183-212 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 6: The second book of dolphins and the porpoises. Academic Press, San Diego, CA. 486 p.

Laran, S., C. Joiris, A. Gannier, and R.D. Kenney. 2010. Seasonal estimates of densities and predation rates of cetaceans in the Liguruan Sea, northwestern Mediterranean Sea: an initial examination. **J. Cetac. Res. Manage.** 11(1):31-40.

Laws, R. 2012. Cetacean hearing-damage zones around a seismic source. p. 473-476 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Le Prell, C.G. 2012. Noise-induced hearing loss: from animal models to human trials. p. 191-195 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Liberman, C. 2013. New perspectives on noise damage. Abstr. 3rd Int. Conf. Effects of Noise on Aquatic Life, Aug. 2013, Budapest, Hungary.

Lindquist, O. 2000. The North Atlantic gray whale *Eschrichtius robustus*: an historical outline based on Icelandic, Danish–Icelandic, English and Swedish sources dating from ca 1000 AD to 1792. Ph.D. thesis, Universities of St Andrews and Stirling, Scotland. 53 p.

Lucke, K., U. Siebert, P.A. Lepper and M.-A. Blanchet. 2009. Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. **J. Acoust. Soc. Am.** 125(6):4060-4070.

Lusseau, D. and L. Bejder. 2007. The long-term consequences of short-term responses to disturbance experience from whalewatching impact assessment. **Int. J. Comp. Psych.** 20(2-3):228-236.

MacGillivray, A.O., R. Racca, and Z. Li. 2014. Marine mammal audibility of selected shallow-water survey sources. **J. Acoust. Soc. Am.** 135(1):EL35-EL40.

MacLeod, C.D., W.F. Perrin, R. Pitman, J. Barlow, L.T. Ballance, A. D'Amico, T. Gerrodette, G. Joyce, K.D. Mullin, D. Palka, and G.T. Waring. 2006. Known and inferred distributions of beaked whale species (Cetacea: Ziphiidae). **J. Cetac. Res. Manage.** 7(3):271-286.

Malme, C.I. and P.R. Miles. 1985. Behavioral responses of marine mammals (gray whales) to seismic discharges. p. 253-280 *In*: G.D. Greene, F.R. Engelhard, and R.J. Paterson (eds.), Proc. Workshop on Effects of Explosives Use in the Marine Environment, Jan. 1985, Halifax, NS. Tech. Rep. 5. Can. Oil & Gas Lands Admin., Environ. Prot. Br., Ottawa, Ont. 398 p.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 5586. Rep. from Bolt Beranek & Newman Inc., Cambridge, MA, for MMS, Alaska OCS Region, Anchorage, AK. NTIS PB86-218377.

Malme, C.I., P.R. Miles, P. Tyack, C.W. Clark, and J.E. Bird. 1985. Investigation of the potential effects of underwater noise from petroleum industry activities on feeding humpback whale behavior. BBN Rep. 5851.

OCS Study MMS 85-0019. Rep. from BBN Labs Inc., Cambridge, MA, for MMS, Anchorage, AK. NTIS PB86-218385.

Malme, C.I., B. Würsig, J.E. Bird, and P. Tyack. 1986. Behavioral responses of gray whales to industrial noise: feeding observations and predictive modeling. BBN Rep. 6265. OCS Study MMS 88-0048. Outer Contin. Shelf Environ. Assess. Progr., Final Rep. Princ. Invest., NOAA, Anchorage, AK. 56(1988):393-600. NTIS PB88-249008.

Malme, C.I., B. Würsig, B., J.E. Bird, and P. Tyack. 1988. Observations of feeding gray whale responses to controlled industrial noise exposure. p. 55-73 *In*: W.M. Sackinger, M.O. Jeffries, J.L. Imm, and S.D. Treacy (eds.), Port and Ocean Engineering Under Arctic Conditions Vol. II. Symposium on noise and marine mammals. Univ. Alaska Fairbanks, Fairbanks, AK. 111 p.

McAlpine, D.F. 2009. Pygmy and dwarf sperm whales *Kogia breviceps* and *K. sima*. p. 936-938 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

McCauley, R.D., M.-N. Jenner, C. Jenner, K.A. McCabe, and J. Murdoch. 1998. The response of humpback whales (*Megaptera novaeangliae*) to offshore seismic survey noise: preliminary results of observations about a working seismic vessel and experimental exposures. **APPEA J.** 38:692-707.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: analysis of airgun signals; and effects of air gun exposure on humpback whales, sea turtles, fishes and squid. Rep. from Centre for Marine Science and Technology, Curtin Univ., Perth, Western Australia, for Australian Petrol. Produc. & Explor. Assoc., Sydney, NSW. 188 p.

McDonald, T.L., W.J. Richardson, K.H. Kim, and S.B. Blackwell. 2010. Distribution of calling bowhead whales exposed to underwater sounds from Northstar and distant seismic surveys, 2009. p. 6-1 to 6-38 *In*: W.J. Richardson (ed.), Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar oil development, Alaskan Beaufort Sea: comprehensive report for 2005–2009. LGL Rep. P1133-6. Rep. from LGL Alaska Res. Assoc. Inc., Anchorage, AK, Greeneridge Sciences Inc., Santa Barbara, CA, WEST Inc., Cheyenne, WY, and Applied Sociocult. Res., Anchorage, AK, for BP Explor. (Alaska) Inc., Anchorage, AK. 265 p.

McDonald, T.L., W.J. Richardson, K.H. Kim, S.B. Blackwell, and B. Streever. 2011. Distribution of calling bowhead whales exposed to multiple anthropogenic sound sources and comments on analytical methods. p. 199 *In*: Abstr. 19th Bienn. Conf. Biol. Mar. Mamm., 27 Nov.–2 Dec. 2011, Tampa, FL. 344 p.

Mead, J.G. 1989. Beaked whales of the genus *Mesoplodon*. p. 349-430 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, San Diego, CA. 442 p.

Melcón, M.L., A.J. Cummins, S.M. Kerosky, L.K. Roche, S.M. Wiggins, and J.A. Hildebrand. 2012. Blue whales response to anthropogenic noise. **PLoS ONE** 7(2):e32681. doi:10.1371/journal.pone.0032681.

Miller, G.W., R.E. Elliott, W.R. Koski, V.D. Moulton, and W.J. Richardson. 1999. Whales. p. 5-1 to 5-109 *In:* W.J. Richardson (ed.), Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic program in the Alaskan Beaufort Sea, 1998. LGL Rep. TA2230-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Western Geophysical, Houston, TX, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 390 p.

Miller, G.W., V.D. Moulton, R.A. Davis, M. Holst, P. Millman, A. MacGillivray, and D. Hannay. 2005. Monitoring seismic effects on marine mammals—southeastern Beaufort Sea, 2001–2002. p. 511-542 *In:* S.L. Armsworthy, P.J. Cranford, and K. Lee (eds.), Offshore oil and gas environmental effects monitoring/approaches and technologies. Battelle Press, Columbus, OH. 631 p.

Miller, P.J.O., M.P. Johnson, P.T. Madsen, N. Biassoni, M. Quero, and P.L. Tyack. 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 Res. I** 56(7):1168-1181.

Miller, P.J.O., P.H. Kvadsheim, F.P.A. Lam, P.J. Wensveen, R. Antunes, A.C. Alves, F. Visser, L. Kleivane, P.L. Tyack, and L.D. Sivle. 2012. The severity of behavioral changes observed during experimental exposures of killer (*Orcinus orca*), long-finned pilot (*Globicephala melas*), and sperm whales (*Physeter macrocephalus*) to naval sonar. **Aquat. Mamm.** 38(4):362-401.

Miyazaki, N. and W.F. Perrin. 1994. Rough-toothed dolphin *Steno bredanensis* (Lesson, 1828). p. 1-21 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, San Diego, CA. 416 p.

MOm. 2009. Status of the Mediterranean monk seal (*Monachus monachus*) population in Greece. Unpublished report by MOm/Hellenic Society for the Study and Protection of the Monk Seal. Athens, Greece. 36 p. Accessed in February 2015 at http://thalassaproject.mom.gr/LH2Uploads/ItemsContent/46/Status-of-the-Mediterranean-monk-seal-in-Greece.pdf.

Moulins, A., M. Rosso, M. Ballardini and M. Wurtz. 2008. Partitioning of the Pelagos Sanctuary (north-western Mediterranean Sea) into hotspots and coldspots of cetacean distributions. **J. Mar. Biol. Assoc. U.K.** 88(6):1273-1281.

Moulton, V.D. and M. Holst. 2010. Effects of seismic survey sound on cetaceans in the Northwest Atlantic. Environ. Stud. Res. Funds Rep. 182. St. John's, Nfld. 28 p. Accessed in March 2015 at http://www.esrfunds.org/pdf/182.pdf.

Nachtigall, P.E. and A.Y. Supin. 2013. A false killer whale reduces its hearing sensitivity when a loud sound is preceded by a warning. **J. Exp. Biol.** 216(16):3062-3070.

Nachtigall, P.E. and A.Y. Supin. 2014. Conditioned hearing sensitivity reduction in the bottlenose dolphin (*Tursiops truncatus*). **J. Exp. Biol.** 217(15):2806-2813.

Nachtigall, P.E. and A.Y. Supin. 2015. Conditioned frequency-dependent hearing sensitivity reduction in the bottlenose dolphin (*Tursiops truncatus*). **J. Exp. Biol.** 218(7):999-1005.

NAMMCO (North Atlantic Marine Mammal Commission). 1995. Report of the joint meeting of the Scientific Committee working groups on northern bottlenose and killer whales and management procedures. p. 90-104 *In*: NAMMCO Annual Report 1995: Report of the third meeting of the Scientific Committee. NAMMCO, Tromsø, Norway. Accessed in March 2015 at http://www.nammco.no/webcronize/images/Nammco/743.pdf.

Natoli A., A. Birkun, A. Aguilar, A. Lopez, and A.R. Hoelzel. 2005. Habitat structure and the dispersal of male and female bottlenose dolphins (*Tursiops truncatus*). **Proc. R. Soc. B** 272(1569):1217-26.

New, L.F., J. Harwood, L. Thomas, C. Donovan, J.S. Clark, G. Hastie, P.M. Thompson, B. Cheney, L. Scott-Hayward, and D. Lusseau. 2013. Modelling the biological significance of behavioural change in coastal bottlenose dolphins in response to disturbance. **Function. Ecol.** 27(2):314-322.

Nieukirk, S.L., D.K. Mellinger, S.E. Moore, K. Klinck, R.P. Dziak, and J. Goslin. 2012. Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999–2009. **J. Acoust. Soc. Am.** 131(2):1102-1112.

NMFS (National Marine Fisheries Service). 2000. Small takes of marine mammals incidental to specified activities: marine seismic-reflection data collection in southern California/Notice of receipt of application. **Fed. Regist.** 65(60, 28 Mar.):16374-16379.

NMFS (National Marine Fisheries Service). 2001. Small takes of marine mammals incidental to specified activities: oil and gas exploration drilling activities in the Beaufort Sea/Notice of issuance of an incidental harassment authorization. **Fed. Regist.** 66(26, 7 Feb.):9291-9298.

NMFS (National Marine Fisheries Service). 2013a. Takes of marine mammals incidental to specified activities; marine geophysical survey on the Mid-Atlantic Ridge in the Atlantic Ocean, April 2013, through June 2013. Notice; issuance of an incidental harassment authorization. **Fed. Regist.** 78 (72, 15 Apr.):22239-22251.

NMFS (National Marine Fisheries Service). 2013b. Takes of marine mammals incidental to specified activities; marine geophysical survey in the northeast Atlantic Ocean, June to July 2013. Notice; issuance of an incidental harassment authorization. **Fed. Regist.** 78 (109, 6 Jun.):34069-34083.

NMFS (National Marine Fisheries Service). 2013c. Effects of oil and gas activities in the Arctic Ocean: supplemental draft environmental impact statement. U.S. Depart. Commerce, NOAA, NMFS, Office of Protected Resources. Accessed in June 2015 at http://www.nmfs.noaa.gov/pr/permits/eis/arctic_sdeis.pdf.

NMFS (National Marine Fisheries Service). 2015. Endangered and threatened marine species under NMFS' jurisdiction. Accessed on 9 February 2015 at http://www.nmfs.noaa.gov/pr/species/esa/.

NOAA (National Oceanic and Atmospheric Administration). 2013. Draft guidance for assessing the effects of anthropogenic sound on marine mammals/Acoustic threshold levels for onset of permanent and temporary threshold shifts. Draft: 23 Dec. 2013. 76 p. Accessed in March 2015 at http://www.nmfs.noaa.gov/pr/acoustics/draft_acoustic_guidance_2013.pdf.

Notarbartolo di Sciara, G. 2002. Cetacean species occurring in the Mediterranean and Black Seas. *In:* G. Notarbartolo di Sciara (ed.) Cetaceans of the Mediterranean and Black Seas: state of knowledge and conservation strategies. Section 3. A report to the ACCOBAMS Interim Secretariat. ACCOBAMS Interim Secretariat, Monaco. Accessed in February 2015 at http://www.oceandocs.org/bitstream/1834/840/1/ Notarbartolo2.pdf.

Notarbartolo di Sciara, G. and G. Bearzi. 2010. National strategy and action plan for the conservation of cetaceans in Greece, 2010-2015. Initiative for the Conservation of Cetaceans in Greece, Athens. 55 p.

Notarbartolo di Sciara, G. and A. Birkun, Jr. 2010. Conserving whales, dolphins and porpoises in the Mediterranean and Black Seas: an ACCOBAMS status report. Monaco, 212 p. Accessed in March 2015 at http://accobams.org/index.php?option=com_docman&task=cat_view&gid=41&Itemid=50&limitstart=5.

Notarbartolo di Sciara, G., M.C. Venturino, M. Zanardelli, G. Bearzi, F.J. Borsani, and B. Cavalloni. 1993. Cetaceans in the central Mediterranean Sea: distribution and sighting frequencies. **Boll. Zool.** 60(1):131-138.

Notarbartolo di Sciara, G., M. Zanardelli, M. Jahoda, S. Panigada, and S. Airoldi. 2003. The fin whale *Balaenoptera physalus* (L. 1758) in the Mediterranean Sea. **Mammal Rev.** 33(2):105-150.

Notarbartolo di Sciara, G., S. Adamantopoulou, E. Androukaki, P. Dendrinos, A. Karamanlidis, V. Paravas, and S. Kotomoatas. 2009. National strategy and action plan for the conservation of the Mediterranean monk seal in Greece, 2009–2015. Report on evaluationg the past and structuring the future. Publication prepared as part of the LIFE-Nature Project: MOFI: Monk seal and fisheries: mitigating the conflict in Greek Seas. Hellenic Society for the study and protection of the Mediterranean monk seal (Mom), Athens. 70 p. Accessed in June 2015 at http://www.monachus-guardian.org/library/notarb09b.pdf.

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. **Mammal Rev.** 37(2):81-115.

Nowacek, D.P., K. Bröker, G. Donovan, G. Gailey, R. Racca, R.R. Reeves, A.I. Vedenev, D.W. Weller, and B.L. Southall. 2013. Responsible practices for minimizing and monitoring environmental impacts of marine seismic surveys with an emphasis on marine mammals. **Aquat. Mamm.** 39(4):356-377.

NRC (National Research Council). 2005. Marine mammal populations and ocean noise/Determining when noise causes biologically significant effects. U.S. Nat. Res. Counc., Ocean Studies Board, Committee on characterizing biologically significant marine mammal behavior (Wartzok, D.W., J. Altmann, W. Au, K. Ralls, A. Starfield, and P.L. Tyack). Nat. Acad. Press, Washington, DC. 126 p.

NSF (National Science Foundation). 2012. Record of Decision for marine seismic research funded by the National Science Foundation. June 2012. 41 p. Accessed in March 2015 at http://www.nsf.gov/geo/oce/ envcomp/rod-marine-seismic-research-june2012.pdf.

NSF and USGS (National Science Foundation and U.S. Geological Survey). 2011. Final Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey. Accessed in March 2015 at http://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis-with-appendices.pdf.

Odell, D.K. and K.M. McClune. 1999. False killer whale *Pseudorca crassidens* (Owen, 1846). p. 213-243 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 6: The second book of dolphins and the porpoises. Academic Press, San Diego, CA. 486 p.

Öztürk, A.A., A.M. Tonay, and A. Dede. 2011. Strandings of the beaked whales, Risso's dolphins, and a minke whale on the Turkish coast of the eastern Mediterranean Sea. **J. Black Sea/Medit. Env.** 17(3):269-274.

Öztürk, A.A., A.M. Tonay, and A. Dede. 2013. Sperm whale (*Physeter macrocephalus*) sightings in the Aegean and Mediterranean part of Turkish waters. **J. Black Sea/Medit. Env.** 19(2):69-177.

Papale, E., M. Gamba, M. Perez-Gil, V.M. Martin, and C. Giacoma. 2015. Dolphins adjust species-specific frequency parameters to compensate for increasing background noise. **PLoS ONE** 10(4):e0121711. doi:10.1371/journal.pone.0121711.

Parks, S.E. M. Johnson, D. Nowacek, and P.L. Tyack. 2011. Individual right whales call louder in increased environmental noise. **Biol. Lett.** 7(1):33-35.

Parks, S.E., M.P. Johnson, D.P. Nowacek, and P.L. Tyack. 2012. Changes in vocal behaviour of North Atlantic right whales in increased noise. p. 317-320 *In*: A.N. Popper and A. Hawkins (eds.), The effects of noise on aquatic life. Springer, New York, NY. 695 p.

Payne, R. 1978. Behavior and vocalizations of humpback whales (*Megaptera* sp.). *In*: K.S Norris and R.R. Reeves (eds.), Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*) in Hawaii. MCC-77/03. Rep. from Sea Life Inc., Makapuu Pt., HI, for U.S. Mar. Mamm. Comm., Washington, DC.

Pelagos Sanctuary. 2015. Risso's dolphin. Accessed on 14 March 2015 at http://www.sanctuaire-pelagos.org/en/species-of-the-sanctuary/risso-s-dolphin-eng.

Perrin, W.F., C.E. Wilson, and F.I. Archer II. 1994. Striped dolphin *Stenella coeruleoalba* (Meyen, 1833). p. 129-159 *In*: S. H. Ridgway and R. J. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, San Diego, CA. 416 p.

Pierson, M.O., J.P. Wagner, V. Langford, P. Birnie, and M.L. Tasker. 1998. Protection from, and mitigation of, the potential effects of seismic exploration on marine mammals. Chapter 7 *In*: M.L. Tasker and C. Weir (eds.), Proc. Seismic Mar. Mamm. Worksh., London, U.K., 23-25 June 1998.

Pires, R., H.C. Neves, and A.A. Karamanlidis. 2008. The critically endangered Mediterranean monk seal (*Monachus monachus*) in the archipelago of Madeira: priorities for conservation. **Oryx** 42(2):278-285.

Pirotta, E., R. Milor, N. Quick, D. Moretti, N. Di Marzio, P. Tyack, I. Boyd, and G. Hastie. 2012. Vessel noise affects beaked whale behavior: results of a dedicated acoustic response study. **PLoS ONE** 7(8):e42535. doi:10.1371/journal.pone.0042535.

Pirotta, E., K.L. Brookdes, I.M. Graham, and P.M. Thompson. 2014. Variation in harbour porpoise activity in response to seismic survey noise. **Biol. Lett.** 10:20131090. doi:10.1098/rsbl.2013.1090.

Podestá, M., A. D'Amico, G. Pavan, A. Drouga, A. Komnenou, and N. Portunato. 2006. A review of *Ziphius cavirostris* strandings in the Mediterranean Sea. **J. Cetac. Res. Manage.** 7(3):251-261.

Popov, V.V., A.Y. Supin, D. Wang, K. Wang, L. Dong, and S. Wang. 2011. Noise-induced temporary threshold shift and recovery in Yangtze finless porpoises *Neophocaena phocaenoides asiaeorientalis*. **J. Acoust. Soc. Am.** 130(1):574-584.

Popov, V.V., A.Y. Supin, V.V. Rozhnov, D.I. Nechaev, E.V. Sysuyeva, V.O. Klishin, M.G. Pletenko, and M.B. Tarakanov. 2013a. Hearing threshold shifts and recovery after noise exposure in beluga whales, *Delphinapterus leucas*. **J. Exp. Biol.** 216(9):1587-1596.

Popov, V., A. Supin, D. Nechaev, and E.V. Sysueva. 2013b. Temporary threshold shifts in naïve and experienced belugas: learning to dampen effects of fatiguing sounds? Abstr. 3rd Int. Conf. Effects of Noise on Aquatic Life, Aug. 2013, Budapest, Hungary.

Prieto, R., D. Janiger, M.A. Silva, G.T. Waring, and J.M. Gonçalves. 2012. The forgotten whale: a bibliometric analysis and literature review of the North Atlantic sei whale *Balaenoptera borealis*. **Mammal Rev.** 42(3):235-272.

Reeves, R. and G. Notarbartolo di Sciara. 2006. The status and distribution of cetaceans in the Black Sea and Mediterranean Sea. IUCN Centre for Mediterranean Cooperation. Malaga, Spain. 137 p. Accessed in February 2015 at http://www.cetaceanalliance.org/download/literature/Reeves_Notarbartolo_2006.pdf.

Rice, A.N., J.T. Tielens, B.J. Estabrook, C.A. Muirhead, A. Rahaman, M. Guerra, and C.W. Clark. 2014. Variation of ocean acoustic environments along the western North Atlantic coast: a case study in context of the right whale migration route. **Ecol. Inform.** 21:89-99.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press, San Diego, CA. 576 p.

Richardson, W.J., G.W. Miller, and C.R. Greene, Jr. 1999. Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea. **J. Acoust. Soc. Am.** 106(4, Pt. 2):2281 (Abstract).

Risch, D., P.J. Corkeron, W.T. Ellison, and S.M. Van Parijs. 2012. Changes in humpback whale song occurrence in response to an acoustic source 200 km away. **PLoS One** 7:e29741. doi:10.1371/journal.pone.0029741.

Risch, D., P.J. Corkeron, W.T. Ellison, and S.M. Van Parijs. 2014. Formal comment to Gong et al.: Ecosystem scale acoustic sensing reveals humpback whale behavior synchronous with herring spawning processes and re-evaluation finds no effect of sonar on humpback song occurrence in the Gulf of Maine in fall 2006. **PLoS One** 9(10):e109225. doi:10.1371/journal.pone.0109225.

Robertson, F.C., W.R. Koski, T.A. Thomas, W.J. Richardson, B. Würsig, and A.W. Trites. 2013. Seismic operations have variable effects on dive-cycle behavior of bowhead whales in the Beaufort Sea. **Endang. Species Res.** 21(2):143-160.

Rolland, R.M., S.E. Parks, K.E. Hunt, M. Castellote, P.J. Corkeron, D.P. Nowacek, S.K. Water, and S.D. Kraus. 2012. Evidence that ship noise increases stress in right whales. **Proc. R. Soc. B** 279(1737):2363-2368.

Rosel, P.E., A. Frantzis, C. Lockyer, and A. Komnenou. 2003. Source of Aegean Sea harbour porpoises. **Mar. Ecol. Prog. Ser.** 247:257-261.

Ryan C., A.C. Cucknell, M. Romagosa, O. Boisseau, A. Moscrop, A. Frantzis, and R. McLanaghan. 2014. A visual and acoustic survey for marine mammals in the eastern Mediterranean Sea during summer 2013. Rep. from Marine Conservation Research International, Essex, UK. For IFAW. 55 p. Accessed in February 2015 at https://www.bodc.ac.uk/data/information_and_inventories/cruise_inventory/report/songofthewhale2013.pdf.

Salden, D.R. 1993. Effects of research boat approaches on humpback whale behavior off Maui, Hawaii, 1989−1993. p. 94 *In*: Abstr. 10th Bienn. Conf. Biol. Mar. Mamm. Nov. 1993, Galveston, TX. 130 p.

Scheinin, A.P., D. Kerem, C.D. Macleod, M. Gazo, C.A. Chicote, and M. Castellote. 2011. Gray whale (*Eschrichtius robustus*) in the Mediterranean Sea: anomalous event or early sign of climate-driven distribution change? **Mar. Biodivers. Rec.** 4:e28. doi:10.1017/s1755267211000072.

Schultz, J.K. 2011. Population genetics of the monk seals (Genus *Monachus*): a review. **Aquat. Mamm.** 37(3):227-235.

Sergeant, D.E. 1977. Stocks of fin whales *Balaenoptera physalus* L. in the North Atlantic Ocean. **Rep. Int. Whal. Comm.** 27:460-473.

Sidorovskaia, N., B. Ma, A.S. Ackleh, C. Tiemann, G.E. Ioup, and J.W. Ioup. 2014. Acoustic studies of the effects of environmental stresses on marine mammals in large ocean basins. p. 1155 *In:* AGU Fall Meeting Abstracts, Vol. 1. Accessed in June 2015 at https://agu.confex.com/agu/fm14/meetingapp.cgi#Paper/10591.

Simard, Y., F. Samaran, and N. Roy. 2005. Measurement of whale and seismic sounds in the Scotian Gully and adjacent canyons in July 2003. p. 97-115 *In*: K. Lee, H. Bain, and C.V. Hurley (eds.), Acoustic monitoring and marine mammal surveys in The Gully and outer Scotian Shelf before and during active seismic surveys. Environ. Stud. Res. Funds Rep. 151. 154 p. (Published 2007).

Skaug, H.J., N. Øien, T. Schweder, and G. Bøthun. 2003. Current abundance of minke whales in the northeastern Atlantic; variability in time and space. **Can. J. Fish. Aquat. Sci.** 61(6):870-886.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. **Aquat. Mamm.** 33(4):411-522.

Southall, B.L., T. Rowles, F. Gulland, R.W. Baird, and P.D. Jepson. 2013. Final report of the Independent Scientific Review Panel investigating potential contributing factors to a 2008 mass stranding of melon-headed whales (*Peponocephala electra*) in Antsohihy, Madagascar. Accessed in March 2015 at http://iwc.int/2008-mass-stranding-in-madagascar.

Stevick, P.T., N. Øien, and D.K. Mattila. 1998. Migration of a humpback whale between Norway and the West Indies. **Mar. Mamm. Sci**. 14(1):162-166.

Stevick, P.T., J. Allen, P.J. Clapham, N. Friday, S.K. Katona, F. Larsen, J. Lien, D.K. Mattila, P.J. Palsbøll, J. Sigurjónsson, T.D. Smith, N. Øien, and P.S. Hammond. 2003. North Atlantic humpback whale abundance and rate of increase four decades after protection from whaling. **Mar. Ecol. Prog. Ser.** 258:263-273.

Stevick, P.T., J. Allen, P.J. Clapham, S.K. Katona, F. Larsen, J. Lien, D.K. Mattila, P.J. Palsbøll, R. Sears, J. Sigurjónsson, T.D. Smith, G. Vikingsson, N. Øien, and P.S. Hammond. 2006. Population spatial structuring on the feeding grounds in North Atlantic humpback whales (*Megaptera novaeangliae*). **J. Zool.** 270(2):244-255.

Stone, C.J. 2015. Marine mammal observations during seismic surveys from 1994–2010. JNCC Rep. No. 463a. 64 p.

Stone, C.J. and M.L. Tasker. 2006. The effects of seismic airguns on cetaceans in U.K. waters. **J. Cetac. Res. Manage.** 8(3):255-263.

Thompson, D., M. Sjöberg, E.B. Bryant, P. Lovell, and A. Bjørge. 1998. Behavioural and physiological responses of harbour (*Phoca vitu\lina*) and grey (*Halichoerus grypus*) seals to seismic surveys. p. 134 *In:* Abstr. 12th Bienn. Conf. and World Mar. Mamm. Sci. Conf., 20-25 Jan., Monte Carlo, Monaco. 160 p.

Thompson, P.M., K.L. Brookes, I.M. Graham, T.R. Barton, K. Needham, G. Bradbury, and N.D. Merchant. 2013. Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. **Proc. R. Soc. B** 280:20132001. doi:10.1098/rspb.2013.2001.

Tolstoy, M., J. Diebold, L. Doermann, S. Nooner, S.C. Webb, D.R. Bohenstiehl, T.J. Crone, and R.C. Holmes. 2009. Broadband calibration of R/V *Marcus G. Langseth* four-string seismic sources. **Geochem. Geophys. Geosyst.** 10:Q08011. doi:10.1029/2009GC002451.

Tougaard, J., A.J. Wright, and P.T. Madsen. 2015. Cetacean noise criteria revisited in light of proposed exposure limits for harbour porpoises. **Mar. Poll. Bull.** 90(1-2):196-208.

Tyack, P.L. and V.M. Janik. 2013. Effects of noise on acoustic signal production in marine mammals. p. 251-271 *In*: H. Brumm (ed.). Animal communication and noise. Springer, Berlin, Heidelberg, Germany. 453 p.

Tyack, P.L., W.M.X. Zimmer, D. Moretti, B.L. Southall, D.E. Claridge, J.W. Durban, C.W. Clark, A. D'Amico, N. DiMarzio, S. Jarvis, E. McCarthy, R. Morrissey, J. Ward, and I.L. Boyd. 2011. Beaked whales respond to simulated and actual navy sonar. **PLoS One** 6(e17009). doi:10.1371/journal.pone.0017009.

UNEP-WCMC (United Nations Environment Programme-World Conservation Monitoring Centre). 2015. Convention on International Trade in Endangered Species of Wild Flora and Fauna. Appendices I, II, and II. Valid from 5 February 2015. Accessed on 9 February 2015 at http://www.cites.org/eng/app/appendices.php.

Valsecchi, E., W. Amos, J.A. Raga, M. Podestà, and W. Sherwin. 2004. The effects of inbreeding on mortality during a morbillivirus outbreak in the Mediterranean striped dolphin (*Stenella coeruleoalba*). **Anim. Conserv.** 7(2):139-146.

Van Bressem, M.-F., I.K.G. Visser, R.L. De Swart, C. Örvell, L. Stanzani, E. Androukaki, K. Siakavara, and A.D.M.E. Osterhaus. 1993. Dolphin morbillivirus infection in different parts of the Mediterranean Sea. **Arch. Virol.** 129(1-4):235-242.

Verriopoulou, A., E. Tounta, and P. Dendrinos. 2001. First report of a minke whale (*Balaenoptera acutorostrata* Lacépède, 1804) in Hellenic waters. **Aquat. Mamm.** 27(2):137-139.

Viaud-Martínez, K.A., M.M. Vergara, P.E. Gol'din, V. Ridoux, A.A. Öztürk, B. Öztürk, P.E. Rosel, A. Frantzis, A. Komnenou, and A.J. Bohonak. 2007. Morphological and genetic differentiation of the Black Sea harbour porpoise *Phocoena phocoena*. **Mar. Ecol. Prog. Ser.** 338:281-294.

Víkingsson, G.A., D.G. Pike, G. Desportes, N. Øien, Th. Gunnlaugsson, and D. Bloch. 2009. Distribution and abundance of fin whales (*Balaenoptera physalus*) in the northeast and central Atlantic as inferred from the North Atlantic sightings surveys 1987–2001. **NAMMCO Sci. Publ**. 7:49-72.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2014. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments—2013. NOAA Tech. Memo. NMFS-NE-228. Nat. Mar. Fish. Serv., Northeast Fish. Sci. Center, Woods Hole, MA. 464 p.

Wartzok, D., A.N. Popper, J. Gordon, and J. Merrill. 2004. Factors affecting the responses of marine mammals to acoustic disturbance. **Mar. Technol. Soc. J.** 37(4):6-15.

Weilgart, L.S. 2007. A brief review of known effects of noise on marine mammals. **Int. J. Comp. Psychol.** 20(2):159-168.

Weilgart, L.S. 2014. Are we mitigating underwater noise-producing activities adequately? A comparison of Level A and Level B cetacean takes. Working pap. SC/65b/E07. Int. Whal. Comm., Cambridge, U.K. 17 p.

Weir, C.R. and S.J. Dolman. 2007. Comparative review of the regional marine mammal mitigation guidelines implemented during industrial seismic surveys, and guidance towards a worldwide standard. **J. Int. Wildl. Law Policy** 10(1):1-27.

Wensveen, P.J., L.A.E. Huijser, L. Hoek, and R.A. Kastelein. 2014. Equal latency contours and auditory weighting functions for the harbour porpoise (*Phocoena phocoena*). **J. Exp. Biol.** 217(3):359-369.

Wensveen, P.J., A.M. von Benda-Beckmann, M.A. Ainslie, F.P.A. Lam, P.H. Kvadsheim, P.L. Tyack, and P.J.O. Miller. 2015. How effectively do horizontal and vertical response strategies of long-finned pilot whales reduce sound exposure from naval sonar? **Mar. Environ. Res.** 106:68-81.

Whitehead, H. 2002. Estimates of the current global population size and historical trajectory for sperm whales. **Mar. Ecol. Prog. Ser.** 242:295-304.

Whitehead, H. 2009. Sperm whale *Physeter macrocephalus*. p. 1091-1097 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA. 1316 p.

Williams, T.M, W.A. Friedl, M.L. Fong, R.M. Yamada, P. Sideivy, and J.E. Haun. 1992. Travel at low energetic cost by swimming and wave-riding bottlenose dolphins. **Nature** 355(6363):821-823.

Wittekind, D., J. Tougaard, P. Stilz, M. Dähne, K. Lucke, C.W. Clark, S. von Benda-Beckmann, M. Ainslie, and U. Siebert. 2013. Development of a model to assess masking potential for marine mammals by the use of airguns in Antarctic waters. Abstr. 3rd Int. Conf. Effects of Noise on Aquatic Life, Aug. 2013, Budapest, Hungary.

Wojtek, B. and S.A. Norman. 2013. *Ziphius cavirostris* strandings—a short review. Working Pap. SC/65a/SM01. Int. Whal. Comm., Cambridge, U.K. 14 p.

Wojtek, B., P. Cermeño, and S.A. Norman. 2014. *Mesoplodon bidens* strandings—a short review. Working Pap. SC/65b/SM02. Int. Whal. Comm., Cambridge, U.K. 11 p.

Wole, O.G. and E.F. Myade. 2014. Effect of seismic operations on cetaceans sightings off-shore Akwa Ibom State, south-south, Nigeria. **Int. J. Biol. Chem. Sci.** 8(4):1570-1580.

Woodside, J.M., L. David, A. Frantzis, and S.K. Hooker. 2006. Gouge marks on deep-sea mud volcanoes in the eastern Mediterranean: caused by Cuvier's beaked whales? **Deep-Sea Res. I** 53(11):1762-1771.

Wright, A.J. 2014. Reducing impacts of human ocean noise on cetaceans: knowledge gap analysis and recommendations. 98 p. World Wildlife Fund Global Arctic Programme, Ottawa, Ont.

Wright, A.J., T. Deak, and E.C.M. Parsons. 2011. Size matters: management of stress responses and chronic stress in beaked whales and other marine mammals may require larger exclusion zones. **Mar. Poll. Bull.** 63(1-4):5-9.

Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. **Aquat. Mamm.** 24(1):41-50.

Yazvenko, S.B., T.L. McDonald, S.A. Blokhin, S.R. Johnson, S.K. Meier, H.R. Melton, M.W. Newcomer, R.M. Nielson, V.L. Vladimirov, and P.W. Wainwright. 2007a. Distribution and abundance of western gray whales during a seismic survey near Sakhalin Island, Russia. **Environ. Monit. Assess.** 134(1-3):45-73.

Yazvenko, S.B., T.L. McDonald, S.A. Blokhin, S.R. Johnson, H.R. Melton, and M.W. Newcomer. 2007b. Feeding activity of western gray whales during a seismic survey near Sakhalin Island, Russia. **Environ. Monit. Assess.** 134(1-3):93-106.