PROPOSED ACTION: Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Southeast Pacific Ocean, 2016-2017.

TYPE OF STATEMENT: Final Environmental Assessment

LEAD AGENCY:
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

RESPONSIBLE OFFICIAL:
Donna S. Wieting, Director
Office of Protected Resources,
National Marine Fisheries Service

FOR FURTHER INFORMATION:
Jordan Carduner
National Marine Fisheries Service
Office of Protected Resources
Permits and Conservation Division
1315 East West Highway
Silver Spring, MD 20910
301-427-8401

LOCATION: The southeast Pacific Ocean, offshore Chile.

ABSTRACT: This Environmental Assessment analyzes the environmental impacts of the National Marine Fisheries Service, Office of Protected Resources proposed issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory, for the taking, by harassment, of marine mammals, incidental to a marine geophysical survey in the Southeast Pacific Ocean, 2016-2017.

DATE: July 2016

CONTENTS

LIST OF ABBREVIATIONS OR ACRONYMS

Authorization	Incidental Harassment Authorization
CFR	Code of Federal Regulations
Commission	Marine Mammal Commission
dB	decibel
EA	Environmental Assessment
EEZ	Economic Exclusion Zone
EIS	Environmental Impact Statement
E.O.	Executive Order
ESA	Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq*.)
EZ	Exclusion zone
FONSI	Finding of No Significant Impact
FR	*Federal Register*
ft	feet
Hz	hertz
ITA	Incidental Take Authorization
ITS	Incidental Take Statement
kHz	kilohertz
km	kilometer
km^2	square kilometer
m	meter
mi	mile
mi^2	square mile
MMPA	Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1631 *et seq*.)
µPa	micropascal
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq*.)
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NSF	National Science Foundation
OBS	ocean bottom seismometer
OMB	Office of Management and Budget
Opinion	Biological Opinion

CHAPTER 1 – INTRODUCTION AND PURPOSE AND NEED

1.1 BACKGROUND

The Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1631 et seq.) prohibits the incidental taking of marine mammals. The incidental take of a marine mammal falls under three categories: mortality, serious injury or harassment (i.e., injury and behavioral effects). Harassment[1] is any act of pursuit, torment or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment) or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns (Level B harassment). Disruption of behavioral patterns includes, but is not limited to, migration, breathing, nursing, breeding, feeding or sheltering. However, there are exceptions to the prohibition on take in Section 101(a)(5)(D) of the MMPA that gives the National Marine Fisheries Service (NMFS) the authority to authorize the incidental but not intentional take of small numbers of marine mammals by harassment provided certain determinations are made and statutory and regulatory procedures are met. Refer to Chapter 2 for details regarding this exception and NMFS' authorization criteria.

NMFS also promulgated regulations to implement the provisions of the MMPA governing the taking and importing of marine mammals, 50 Code of Federal Regulations (CFR) Part 216 and produced Office of Management and Budget (OMB)-approved application instructions (OMB Number 0648-0151) that prescribe the procedures necessary to apply for permits. All applicants must comply with these regulations and application instructions in addition to the provisions of the MMPA.

1.1.1 APPLICANT'S INCIDENTAL TAKE AUTHORIZATION REQUEST

Lamont-Doherty Earth Observatory of Columbia University (Lamont-Doherty) requested an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment incidental to conducting marine geophysical (seismic) surveys in the southeast Pacific Ocean.

Lamont-Doherty proposes to conduct three two-dimensional (2-D) seismic surveys on the R/V Marcus G. Langseth[2] (Langseth) in the southeast Pacific Ocean. Each of the proposed seismic surveys is in the exclusive economic zone (EEZ) of Chile (Figure 1). The purpose of the northern seismic survey is to image the structure of the upper and lower plates in the region that slipped during the 2014 Pisagua/Iquique earthquake. The purpose of the central seismic survey is to examine the extent and location of seafloor displacement and related subsurface fault movement related to the recent slip that occurred during the September 16, 2015, Illapel earthquake. The purpose of the southern seismic survey is to image the characteristics of the plate-boundary thrust, sediment subduction, and upper plate structure within the 2010 Maule rupture segment and the 1960 Valdivia rupture area. Lamont-Doherty's application (NSF, 2016) for more information about the proposed seismic surveys.

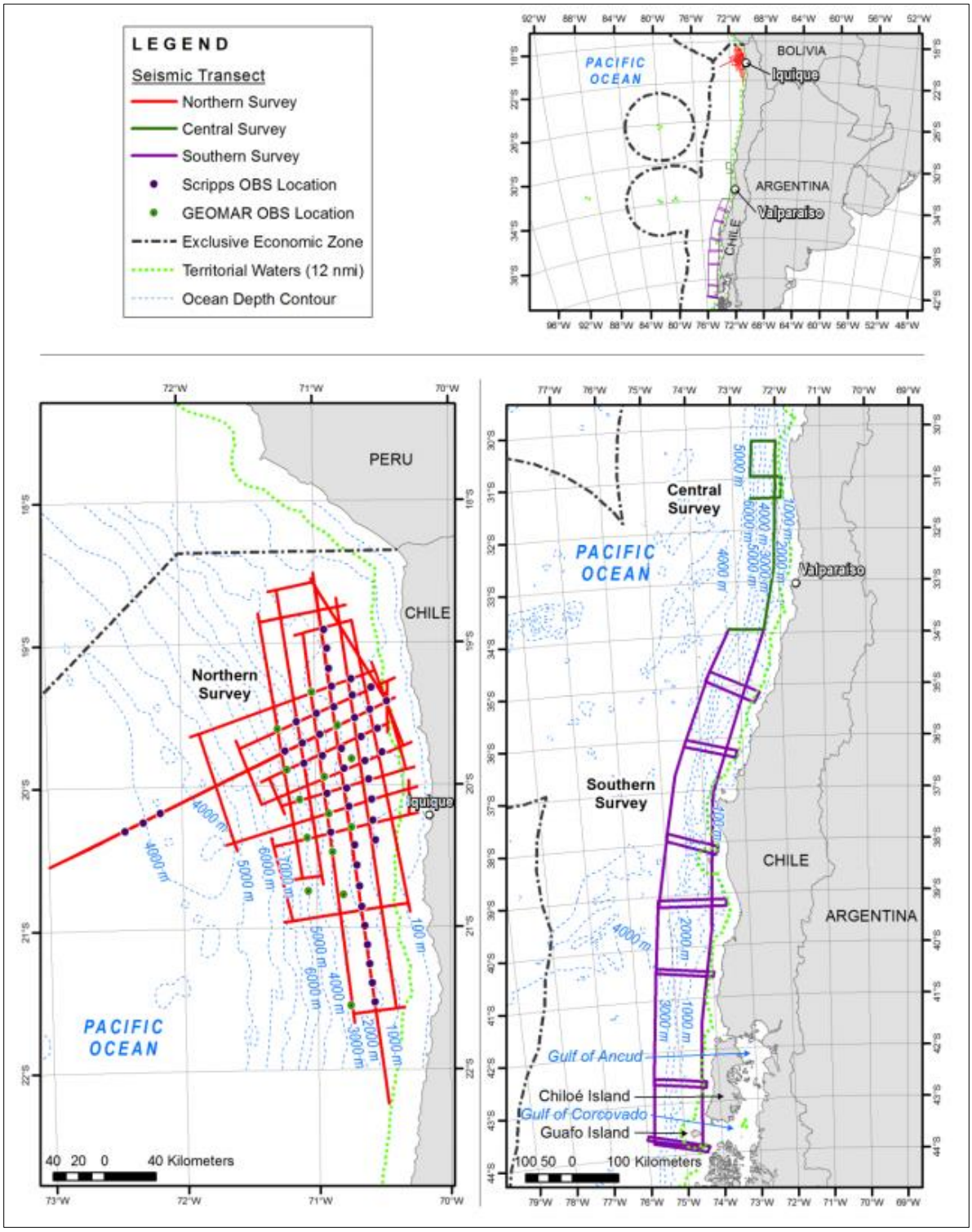
NSF supports scientific research in the mathematical, physical, medical, biological, social, and other sciences pursuant to the National Science Foundation Act of 1950, as amended (NSF Act; 42 U.S.C. 1861-75). NSF considers proposals submitted by organizations and makes contracts and/or other arrangements (*i.e.*, grants, loans, and other forms of assistance) to support scientific research activities. In 2015, an NSF-expert panel recommended a research proposal titled "*A high-resolution controlled-source seismic experiment to elucidate geologic controls on megathrust slip: the 2014*

[1] As defined in the MMPA for non-military readiness activities (Section 3 (18)(A))

[2] NSF owns and operates the R/V Marcus G. Langseth under a cooperative agreement with Lamont-Doherty.

Pisagua, Chile earthquake sequence as a natural laboratory" (NSF Award #1459368) for funding and ship time on the *Langseth*. As the federal action agency for this award, NSF has funded the proposed seismic survey in the southeast Pacific Ocean, as a part of the NSF Act of 1950.

Figure 1: Proposed locations of seismic surveys in the southeast Pacific Ocean.



1.1.2 MARINE MAMMALS IN THE ACTION AREA

Based on the best available information, there are 44 marine mammal species with confirmed or potential occurrence in the proposed action area (See Table 1). These species would most likely be harassed incidental to Lamont-Doherty conducting the seismic survey (See Chapter 2, Table 5, Take Estimates).

Table 1 - General information on marine mammals that could potentially occur in the three proposed survey areas within the southeast Pacific Ocean.

Species	Regulatory Status[1, 2]	Species Abundance[3]	Local Occurrence	Habitat
Antarctic minke whale (*Balaenoptera bonaerensis*)	MMPA - NC ESA – NL	515,000	North – Rare Central/South – Uncommon	Coastal, pelagic
Blue whale (*B. musculus*)	MMPA - D ESA – EN	10,000[4]	North – Common Central/South – Common	Coastal, shelf, pelagic
Bryde's whale (*Balaenoptera edeni*)	MMPA - NC ESA – NL	43,633[5]	North – Common Central/South – Common	Coastal, pelagic
Common minke whale (*B. acutorostrata*)	MMPA -NC ESA – NL	515,000	North – Rare Central/South – Uncommon	Coastal, pelagic
Fin whale (*B. physalus*)	MMPA - D ESA – EN	22,000	North – Rare Central/South – Common	Shelf, slope, pelagic
Humpback whale (*Megaptera novaengliae*)	MMPA - D ESA – EN	42,000	North – Common Central/South – Common	Coastal, shelf, pelagic
Pygmy right whale (*Caperea marginata*)	MMPA - NC ESA – NL	Unknown	North – Unknown Central/South – Rare	Coastal, oceanic
Sei whale (*B. borealis*)	MMPA - D ESA – EN	10,000	North – Uncommon Central/South – Uncommon	Pelagic
Southern right whale (*Eubalaena australis*)	MMPA - D ESA – EN	12,000	North – Rare Central/South – Rare	Coastal, oceanic
Sperm whale (*Physeter macrocephalus*)	MMPA - D ESA – EN	355,000[6]	North – Common Central/South – Common	Pelagic, deep seas
Dwarf sperm whale (*Kogia sima*)	MMPA - NC ESA – NL	170,309[7]	North – Rare Central/South – Rare	Shelf, pelagic
Pygmy sperm whale (*K. breviceps*)	MMPA - NC ESA – NL	170,309[7]	North – Rare Central/South – Rare	Shelf, pelagic
Andrew's beaked whale (*Mesoplodon bowdoini*)	MMPA - NC ESA – NL	25,300[8]	North – Unknown Central/South – Rare	Pelagic
Blainville's beaked whale (*M.densirostris*)	MMPA - NC ESA – NL	25,300[8]	North – Uncommon Central/South – Uncommon	Pelagic
Cuvier's beaked whale (*Ziphius cavirostris*)	MMPA - NC ESA – NL	20,000[8]	North – Uncommon Central/South – Uncommon	Slope, pelagic
Gray's beaked whale (*M. grayi*)	MMPA - NC ESA – NL	25,300[8]	North – Rare Central/South – Rare	Pelagic
Hector's beaked whale (*M. hectori*)	MMPA - NC ESA – NL	25,300[8]	North – Unknown Central/South – Rare	Pelagic
Pygmy beaked whale (*Mesoplodon peruvianus*)	MMPA - NC ESA – NL	25,300[8]	North – Rare Central/South – Rare	Pelagic
Shepherd's beaked whale (*Tasmacetus shepherdi*)	MMPA - NC ESA – NL	25,300[8]	North – Unknown Central/South – Rare	Pelagic
Spade-toothed whale (*Mesoplodon traversii*)	MMPA - NC ESA – NL	25,300[8]	North – Unknown Central/South – Rare	Pelagic
Strap-toothed beaked whale (*M. layardii*)	MMPA - NC ESA – NL	25,300[8]	North – Unknown Central/South – Rare	Pelagic
Southern bottlenose whale (*Hyperoodon planifrons*)	MMPA - NC ESA – NL	72,000[9]	North – Unknown Central/South – Uncommon	Pelagic
Chilean dolphin (*Cephalorhynchus eutropia*)	MMPA - NC ESA – NL	10,000	North – Unknown Central/South – Uncommon	Coastal
Rough-toothed dolphin (*Steno bredanensis*)	MMPA - NC ESA – NL	107,633[10]	North – Rare Central/South – Unknown	Oceanic
Common bottlenose dolphin (*Tursiops truncatus*)	MMPA - NC ESA – NL	335,834[10]	North – Abundant Central/South – Common	Coastal, pelagic, shelf
Striped dolphin (*S. coeruleoalba*)	MMPA - NC ESA – NL	964,362[10]	North – Abundant Central/South – Common	Shelf edge, pelagic
Short-beaked common dolphin (*Delphinus delphis*)	MMPA - NC ESA – NL	1,766,551[11]	North – Abundant Central/South – Abundant	Coastal, shelf
Long-beaked common dolphin (*Delphinus capensis*)	MMPA - NC ESA – NL	144,000[12]	North – Uncommon Central/South – Unknown	Coastal, shelf
Dusky dolphin (*Lagenorhynchus obscurus*)	MMPA - NC ESA – NL	25,880[13]	North – Abundant Central/South – Abundant	Shelf, slope
Peale's dolphin	MMPA - NC	Unknown	North – Unknown	Coastal

(*Lagenorhynchus australis*)	ESA – NL		Central/South – Uncommon	
Hourglass dolphin (*Lagenorhynchus cruciger*)	MMPA - NC ESA – NL	144,300[14]	North – Unknown Central/South – Rare	Pelagic
Southern right whale dolphin (*Lissodelphis peronii*)	MMPA - NC ESA – NL	Unknown	North – Uncommon Central/South – Common	Pelagic
Risso's dolphin (*Grampus griseus*)	MMPA - NC ESA – NL	110,457[10]	North – Common Central/South – Uncommon	Shelf, slope
Pygmy killer whale (*Feresa attenuate*)	MMPA - NC ESA – NL	38,900[8]	North – Rare Central/South – Uncommon	Oceanic, pantropical
False killer whale (*Pseudorca crassidens*)	MMPA - NC ESA – NL	39,800[8]	North – Uncommon Central/South – Rare	Pelagic
Killer whale (*Orcinus orca*)	MMPA - NC ESA – NL	50,000	North – Rare Central/South – Rare	Coastal, shelf, pelagic
Long-finned pilot whale (*Globicephala melas*)	MMPA - NC ESA – NL	200,000[15]	North – Rare Central/South – Rare	Coastal, pelagic
Short-finned pilot whale (*Globicephala macrorhynchus*)	MMPA - NC ESA – NL	589,315[16]	North – Rare Central/South – Rare	Coastal, pelagic
Burmeister's porpoise (P*hocoena spinipinnis*)	MMPA - NC ESA – NL	Unknown	North – Coastal Central/South – Coastal	Coastal
Juan Fernandez fur seal (*Arctocephalus philippii*)	MMPA - NC ESA – NL	32,278[17]	North – Rare Central/South – Rare	Coastal, pelagic
South American fur seal (*Arctocephalus australis*)	MMPA - NC ESA – NL	250,000	North – Rare Central/South – Rare	Coastal, shelf, slope
South American sea lion (*Otaria byronia*)	MMPA - NC ESA – NL	397,771[18]	North – Abundant Central/South – Abundant	Coastal, shelf
Southern elephant seal (*Mirounga leonina*)	MMPA - NC ESA – NL	640,000[19]	North – Abundant Central/South – Abundant	Coastal, pelagic

[1] MMPA: NC= Not classified; D= Depleted;
[2] ESA: EN = Endangered, T = Threatened, DL = Delisted, NL = Not listed.
[3] Except where noted best estimate abundance information obtained from the International Whaling Commission's whale population estimates (IWC, 2016) or from the International Union for Conservation of Nature and Natural Resources Red List of Threatened Species website (IUCN, 2016). Unknown = Abundance information does not exist for this species.
[4] IUCN's best estimate of the global population is 10,000 to 25,000.
[5] Estimate from IUCN's webpage for Bryde's whales. Southern Hemisphere: southern Indian Ocean (13,854); western South Pacific (16,585); and eastern South Pacific (13,194).
[6] Whitehead (2002).
7 Estimate from IUCN's webpage for *Kogia* spp. Eastern Tropical Pacific (ETP) (150,000); Hawaii (19,172); Gulf of Mexico (742); and western Atlantic (395).
[8] Wade and Gerrodette (1993).
[9] South of 60°S from the 1885/1986–1990/1991 IWC/IDCR and SOWER surveys (Branch and Butterworth, 2001).
[10] ETP, line-transect survey, August-December 2006 (Gerrodette *et al*., 2008).
[11] ETP, southern stock, 2000 survey (Gerrodette and Forcada 2002).
[12] Gerrodette and Palacios (1996) estimated 55,000 within Pacific coast waters of Mexico, 69,000 in the Gulf of California, and 20,000 off South Africa. IUCN, 2016.
[13] IUCN, 2016 and Markowitz, 2004.
[14] Kasamatsu and Joyce, 1995.
[15] Abundance estimates for beaked, southern bottlenose, and pilot whales south of the Antarctic Convergence in January (Kasamatsu and Joyce, 1995).
[16] Gerrodette and Forcada (2002).
[17] 2005/2006 minimum population estimate (Osman, 2008).
[18] Crespo *et al*. (2012). Current status of the South American sea lion along the distribution range.
[19] Hindell and Perrin (2009).

1.2 PURPOSE AND NEED

1.2.1 DESCRIPTION OF THE PROPOSED ACTION

NMFS proposes to issue an IHA to Lamont-Doherty pursuant to Section 101(a)(5)(A) of the MMPA and 50 CFR Part 216. The IHA will be valid from August 2016 through July 2017 and authorizes takes, by Level A and Level B harassment, of marine mammals incidental to conducting seismic surveys. An acoustic stimulus generated by the seismic airgun array used for conducting seismic surveys has potential to cause marine mammals within or near the proposed survey locations to be

behaviorally disturbed, therefore, warrant an IHA from NMFS. NMFS' proposed action is a direct outcome of Lamont-Doherty requesting an authorization to take marine mammals.

1.2.2 PURPOSE

The purpose of our proposed action is to authorize take of marine mammals incidental to the Lamont-Doherty proposed seismic surveys. The IHA, if issued, would provide Lamont-Doherty an exception from the take prohibitions contained in the MMPA. To authorize the incidental take of small numbers of marine mammals, NMFS will evaluate the best available scientific information to determine whether the take would have a negligible impact on marine mammals or stocks and whether the activity would have an unmitigable impact on the availability of affected marine mammal species for subsistence use. NMFS cannot issue this IHA if it would result in more than a negligible impact on marine mammals or stocks or would result in an unmitigable impact on subsistence uses. In addition, we must prescribe, the permissible methods of taking and other means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat, paying particular attention to rookeries, mating grounds, and other areas of similar significance. If appropriate, we must prescribe means of effecting the least practicable impact on the availability of the species or stocks of marine mammals for subsistence uses. IHAs must also include requirements or conditions pertaining to the monitoring and reporting, in large part to better understand the effects of such taking on the species.

1.2.3 NEED

U.S. citizens seeking to obtain authorization for the incidental take of marine mammals under NMFS jurisdiction must submit such a request (in the form of an application). On March 21, 2016, Lamont-Doherty submitted an adequate and complete application demonstrating both the need and potential eligibility for authorization under the MMPA. NMFS now has a corresponding duty to determine whether and how to authorize take of marine mammals incidental to the activities described Lamont-Doherty's application (LGL, 2016). NMFS' responsibilities under section 101(a)(5)(A) of the MMPA and its implementing regulations establish and frame the need for NMFS proposed action.

1.3 THE ENVIRONMENTAL REVIEW PROCESS

In accordance with the Council on Environmental Quality (CEQ) Regulations and Agency policies for implementing the National Environmental Policy Act (NEPA), NMFS, to the fullest extent possible, integrates the requirements of NEPA with other regulatory processes required by law or by agency practice so that all procedures run concurrently, rather than consecutively. This includes coordination within National Oceanic Atmospheric Administration (NOAA), (e.g., the Office of the National Marine Sanctuaries) and with other regulatory agencies (e.g., the U.S. Fish and Wildlife Service), as appropriate, during NEPA reviews prior to implementation of a proposed action to ensure that requirements are met. Regarding the issuance of authorizations, we rely substantially on the public process required by the MMPA for preparing proposed authorizations to develop and evaluate relevant environmental information and provide a meaningful opportunity for public participation when we prepare corresponding NEPA documents. We fully consider public comments received in response to the publication of proposed authorizations during the corresponding NEPA review process.

1.3.1 NATIONAL ENVIRONMENTAL POLICY ACT

NEPA requires federal agencies to examine the environmental impacts of their proposed actions within the United States and its territories. A NEPA analysis is a detailed public document that provides an assessment of the potential effects a major federal action may have on the human

environment, which includes the natural and physical environment. Major federal actions include activities that federal agencies fully or partially fund, regulate, conduct or approve. NMFS' issuance of authorizations allow for the taking of marine mammals albeit consistent with provisions under the MMPA and incidental to the applicant's activities, is considered a major federal action; therefore, NMFS analyzes the environmental effects associated with authorizing incidental takes of protected species and prepares the appropriate NEPA documentation.

1.3.2 SCOPING AND PUBLIC INVOLVEMENT

The NEPA process enable's NMFS to make decisions based on an understanding of the environmental consequences and take actions to protect, restore, and enhance the environment. An integral part of the NEPA process is public involvement. Early public involvement facilitates the development of an EA and informs the scope of issues to be addressed in the EA. NMFS determined that the publication of the proposed IHA and draft EA is the appropriate step to involve the public in order to understand the public concerns for the proposed action, identify significant issues related to the proposed action and obtain the necessary information to complete an analysis.

On May 19, 2016, we published the proposed IHA in the Federal Register (81 FR 23117) with our preliminary determinations. The notice included a detailed description of the proposed action resulting from the MMPA consultation process; consideration of environmental issues and impacts of relevance related to the proposed issuance of the IHA; and potential mitigation and monitoring measures to avoid and minimize potential adverse impacts to marine mammals and their habitat. The notice of the proposed IHA, the draft EA and the corresponding public comment period are instrumental in providing the public with information on relevant environmental issues and offering the public a meaningful opportunity to provide comments for our consideration in both the MMPA and NEPA decision-making processes.

During the 30-day public comment period following the publishing of the proposed IHA in the Federal Register (81 FR 23117), NMFS received comment letters from the Marine Mammal Commission (Commission) and from the Marcus Langseth Science Oversight Committee, as well as one comment from a member of the general public. The Commission expressed concerns regarding Lamont-Doherty's method to estimate exclusion and buffer zones; uncertainty in the representativeness of marine mammal density data and the assumptions used to calculate estimated takes; and the extent to which the monitoring requirements result in accurate reporting of the types of taking and the numbers of animals taken by the proposed activity. The comment letter from the Marcus Langseth Science Oversight Committee affirmed that there is significant support from the Committee for the IHA to be issued for the proposed activity and for the survey to be conducted. The comment received from a private citizen expressed concern that the project would result in the deaths of marine mammals. NMFS has posted the comments online at: *http://www.nmfs.noaa.gov/pr/permits/incidental*. A more detailed summary of the comments, and NMFS' responses to those comments, will be included in the Federal Register notice for the issued IHA, if NMFS determines the IHA should be issued.

1.4 OTHER ENVIRONMENTAL LAWS OR CONSULTATIONS

NMFS must comply with all applicable federal environmental laws, regulations, and Executive Orders (E.O.s) necessary to implement a proposed action. NMFS evaluation of and compliance with environmental laws, regulations and E.O.s is based on the nature and location of the applicants

proposed activities and NMFS proposed action. Therefore, this section only summarizes environmental laws and consultations applicable to NMFS issuance of an IHA to Lamont-Doherty. There are no other environmental laws, regulations, E.O.s, consultations, federal permits or licenses applicable NMFS issuance of an IHA to Lamont-Doherty.

1.4.1 ENDANGERED SPECIES ACT

The Endangered Species Act (ESA) established protection over and conservation of threatened and endangered species (T&E) and the ecosystems upon which they depend. An endangered species is a species in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the near future throughout all or in a significant portion of its range. The USFWS and NMFS jointly administer the ESA and are responsible for the listing of species (designating a species as either threatened or endangered) and designating geographic areas as critical habitat for (T&E) species. The ESA generally prohibits the "take" of an ESA-listed species unless an exception or exemption applies. The term "take" as defined in Section 3 of the ESA means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Section 7(a)(2) requires each federal agency to ensure that any action it authorizes, funds or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action may affect a listed species, that agency is required to consult with NMFS and/or the USFWS under procedures set out in 50 CFR Part 402. NMFS and USFWS can also be action agencies under Section 7. Informal consultation is sufficient for species the action agency determines are not likely to be adversely affected if NMFS or USFWS concurs with the action agency's findings, including any additional measures mutually agreed upon as necessary and sufficient to avoid adverse impacts to listed species and/or designated critical habitat.

The NSF determined that the proposed geophysical surveys are likely to result in take of six species of marine mammals under NMFS's jurisdiction that are listed as endangered under the ESA: blue, fin, humpback, sei, sperm, and southern right whales. Therefore, the NSF (the lead federal agency which owns and operates the *Langseth*) requested initiation of formal consultation on their action under section 7 of the ESA with the NMFS Office of Protected Resources (OPR) ESA Interagency Cooperation Division. The NMFS OPR Permits and Conservation Division's issuance of an Authorization for the incidental taking of marine mammals is also a federal action subject to ESA section 7 consultation requirements. As such, the NMFS OPR Permits and Conservation Division requested initiation of formal consultation under Section 7 of the ESA with the OPR ESA Interagency Cooperation Division, on our proposed issuance of an IHA to take marine mammals, by harassment, incidental to the NSF's proposed seismic surveys. There is no designated critical habitat for any of the ESA-listed species within the action area; thus, our proposed Authorization would not affect any of these species' critical habitats. The NMFS OPR ESA Interagency Cooperation Division initiated formal consultation with NSF and with the NMFS OPR Permits and Conservation Division and issued a Biological Opinion in July 2016 which determined the action would not jeopardize the continued existence of any marine mammal species and would not destroy or adversely modify critical habitat.

1.4.2 E.O. 12114: ENVIRONMENTAL EFFECTS ABROAD OF MAJOR FEDERAL ACTIONS

The requirements for Executive Order (E.O.) 12114 are discussed in NSF's draft environmental analysis (NSF 2016). We incorporate this document by reference in this EA. Briefly, the provisions of E.O. 12114 apply to major federal actions that occur or have effects outside of U.S. territories (the

United States, its territories, and possessions). Accordingly, NSF prepares environmental analyses for major federal actions which could have environmental impacts anywhere beyond the territorial jurisdiction of the United States. NOAA, as a matter of policy, prepares NEPA analyses for proposed major federal actions occurring within its territorial waters, the U.S. EEZ, the high seas, and the EEZs of foreign nations up to the nation's territorial sea.

1.5 DOCUMENT SCOPE

This EA was prepared in accordance with NEPA (42 USC 4321, et seq.), CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508). The analysis in this EA addresses potential impacts to the human environment and natural resources, specifically marine mammals and their habitat, resulting from NMFS' proposed action to authorize incidental takes associated with the Lamont-Doherty's seismic surveys. We analyze direct, indirect, and cumulative impacts related to authorizing incidental take of marine mammals under the MMPA. The scope of our analysis is limited to the decision for which we are responsible (i.e. whether or not to issue the IHA). This EA is intended to provide focused information on the primary issues and impacts of environmental concern, which is our issuance of the IHA authorizing the take of marine mammals incidental the Lamont-Doherty seismic surveys and the mitigation and monitoring measures to minimize the effects of that take. For these reasons, this EA does not provide a detailed evaluation of the effects to the elements of the human environment listed in Table 2 below.

Table 2 Components of the human environment not requiring further evaluation

Biological	Physical	Socioeconomic / Cultural
Amphibians	Air Quality	Commercial Fishing
Humans	Essential Fish Habitat	Military Activities
Non-Indigenous Species	Geography	Oil and Gas Activities
	Land Use	Recreational Fishing
	Oceanography	Shipping and Boating
	State Marine Protected Areas	National Historic Preservation Sites
	Federal Marine Protected Areas	National Trails and Nationwide Inventory of Rivers
	National Estuarine Research Reserves	Low Income Populations
	National Marine Sanctuaries	Minority Populations
	Park Land	American Indian Religious Freedom Act
	Prime Farmlands	Indigenous Cultural Resources
	Wetlands	
	Wild and Scenic Rivers	Public Health and Safety
	Ecologically Critical Areas	Historic and Cultural Resources
	Districts, Sites, and Highways	

1.5.1 Other Factors Influencing the Scope of the Analysis

This EA provides analyses and evaluation of the potential noise impacts to the affected environment that would result from acoustic stimuli associated with conducing seismic surveys. After conducting a review of the information and analyses for sufficiency and adequacy, NMFS incorporates by reference the relevant analyses within the following documents per 40 CFR 1502.21 and NAO 216-6 § 5.09(d):

- 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 Southeast Pacific Ocean, 2016/2017 (LGL, 2016).
- *Draft Environmental Analysis of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Southeast Pacific Ocean, 2016/2017* (NSF, 2016).
- *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* (NSF/USGS, 2011); and
- *Record of Decision for Marine Seismic Research Funded by the National Science Foundation. June, 2012* (NSF, 2012).
- *Environmental Assessment for the Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Atlantic Ocean, April - June, 2013* (NMFS, 2013a);
- *Environmental Assessment: Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Northeast Atlantic Ocean, June to July 2013* (NMFS, 2013b);
- *Environmental Assessment on the Issuance of an Incidental Harassment Authorization to Lamont Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Northwest Atlantic Ocean, June – August, 2014* (NMFS, 2014); and
- *Environmental Assessment on the Proposed Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Northwest Atlantic Ocean, June – August, 2015(NMFS, 2015b).*
- *Proposed Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Eastern Mediterranean Sea, Mid-November – December 2015 (NMFS, 2015a)*

CHAPTER 2 – ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 INTRODUCTION

As described in Chapter 1, the National Marine Fisheries Service (NMFS) Proposed Action is to issue an Incidental Harassment Authorization (IHA) to authorize the take of small numbers of marine mammals incidental to Lamont-Doherty's proposed seismic surveys. NMFS' Proposed Action is triggered by Lamont-Doherty's request for an incidental take authorization per the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 *et seq.*). In accordance with the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) Regulations, and Agency policies, NMFS is required to consider alternatives to a the Proposed Action. This includes the no action and other reasonable course of action associated with authorizing incidental take of protected species. The evaluation of alternatives under NEPA assists NMFS with ensuring that any unnecessary impacts are avoided through an assessment of alternative ways to achieve the purpose and need for our Proposed Action that may result in less environmental harm. To warrant detailed evaluation under NEPA, an alternative must be reasonable along with

meeting the stated purpose and need for the proposed action. For the purposes of this EA, an alternative will only meet the purpose and need if it satisfies the requirements under section 101(a)(5)(D) the MMPA. Therefore, NMFS applied the following screening criteria to the alternatives to identify which alternatives to carry forward for analysis. Accordingly, an alternative must meet the following criteria to be considered "reasonable".

- The action must not violate any federal laws or regulations.
- The action is consistent with the goals and requirements of MMPA and its implementing regulations.
- The action includes NMFS authorization criteria, specifically:
    - Prescribing permissible methods of take
    - Addressing other means of effecting the least practicable adverse impact on the species or stocks of marine mammals and their habitat, paying particular attention to rookeries, mating grounds, and other areas of similar significance.
- The action includes proposed mitigation measures (including consideration of the following factors in relation to one another):
    - The manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals;
    - The proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and
    - The practicability of the measure for applicant implementation

Based on this evaluation, only one alternative was identified as reasonable and, along with the no-action alternative, is evaluated in detail in this draft EA. Section 2.4 presents alternatives considered but eliminated from further review.

2.2 DESCRIPTION OF LAMONT-DOHERTY'S PROPOSED ACTIVITIES

We presented a general overview of Lamont-Doherty's proposed seismic survey operations in the proposed IHA, (81 FR 23117). Also, in Lamont-Doherty's application (LGL, 2016) and NSF's draft environmental analysis (NSF, 2016), describe the survey protocols in detail. We incorporate those descriptions by reference in this EA and briefly summarize them here.

2.2.1 SPECIFIED TIME AND SPECIFIED AREA

The surveys off Chile are proposed for 2016/2017 and would take approximately 60 days with the potential for an additional increase in number of days by 25 percent as a contingency for equipment failures, resurveys, or other operational needs. The surveys may occur at any time during the period of August 2016 to July 2017. The proposed survey off northern Chile would consist of approximately 45 days of science operations that include approximately 28 days of seismic operations, approximately 13 days of ocean bottom seismometer (OBS) deployment/retrieval, and approximately four days of transit and towed equipment deployment/retrieval. The central proposed survey would involve approximately six days, including approximately five days of seismic operations and approximately one day of equipment deployment/ retrieval time. The southern proposed survey would involve approximately 32 days of science operations including approximately 27 days of seismic operations, and approximately five days of transit and towed equipment deployment/retrieval. The Authorization, if issued, would be effective from August 2016 to July 2017.

The proposed survey off northern Chile would occur within the area located at approximately 70.2–73.2°W, 18.3–22.4°S, the central proposed survey would occur within approximately 71.8–73.4°W, 30.1–33.9°S, and the southern proposed survey would occur within approximately 72.2–76.1°W, 33.9–44.1°S. Water depths in the proposed survey areas range from approximately 50 to 7,600 m (164 to 25,000 ft). The proposed seismic surveys would be conducted within the EEZ of Chile; only a small proportion of the surveys would take place in territorial waters (see Figure 1).

2.2.2 SEISMIC SURVEY OPERATIONS

Source Vessel: The *Langseth* is 71.5 m (235 ft) long vessel with a gross tonnage of 3,834 pounds. The vessel's speed during operations would be approximately 4.5 knots (kt) (8.3 km/hour (hr); 5.1 miles per hour (mph)). It has an observation tower that is 21.5 m (71 ft) above sea level providing protected species observers an unobstructed view around the entire vessel.

Transects: A total of approximately 9,633 km (5,986 mi) of transect lines would be surveyed in the southeast Pacific Ocean: approximately 4,543 km (2,823 mi) off northern Chile, approximately 791 km (491 mi) during the central survey, and approximately 4,299 km (2,671 mi) during the southern survey. There could be additional seismic operations associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard.

Seismic Airguns: During the survey, the *Langseth* would deploy 36 airguns as an energy source with a total volume of 6,600 cubic inches (in^3). The airguns are a mixture of Bolt 1500LL and Bolt 1900LLX airguns ranging in size from 40 to 220 in^3, with a firing pressure of 1,950 pounds per square inch. The dominant frequency components range from zero to 188 Hertz (Hz). The nominal source levels of the airgun subarrays on the *Langseth* range from 246 to 253 dB re: 1 µPa (peak-to-peak). The 4-string array would be towed at a depth of 9 to 12 m (30 to 39 ft) during the northern proposed survey; the central and southern proposed surveys would use a tow depth of 9 m (30 ft). The shot intervals would range from 25 to 50 m (82 to 164 ft) for multi-channel seismic (MCS) acquisition, 100–150 m (328 – 492 ft) for simultaneous MCS and tomography acquisition, and 300 m (984 ft) for tomography acquisition.

Receiving System: The receiving system would consist of up to 68 OBSs deployed for the northern survey site, and a single 8- to 15-km (5 – 8.3 mi) hydrophone streamer for all surveys. As the *Langseth* tows the airgun array along the survey lines, the OBSs and hydrophone streamer would receive the returning acoustic signals and transfer the data to the on-board processing system.

The *Langseth* would deploy the OBSs on the sea floor at the beginning of each of five survey sections, then recover the instruments and redeploy them at the next survey section. Each seismometer is approximately 0.9 m (2.9 ft) high with a maximum diameter of 97 centimeters (cm) (3.1 ft). An anchor, made of a rolled steel bar grate which measures approximately 7 by 91 by 91.5 cm (3 by 36 by 36 inches) and weighs 45 kilograms (99 pounds) would anchor the seismometer to the seafloor.

Multibeam Echosounder: The *Langseth* would operate a Kongsberg EM 122 multibeam echosounder concurrently during airgun operations to map characteristics of the ocean floor. The *Langseth* would not operate the multibeam echosounder during transits to and from the survey area, (*i.e.*, when the airguns are not operating). The hull-mounted echosounder emits brief pulses of sound (also called a ping) (10.5 to 13.0 kilohertz (kHz) in a fan-shaped beam that extends downward and to the sides of the ship. The nominal source level for the multibeam echosounder is 242 dB re: 1 µPa.

Sub-bottom Profiler: The *Langseth* would also operate a Knudsen Chirp 3260 sub-bottom profiler concurrently during airgun and echosounder operations to provide information about the sedimentary features and bottom topography. The *Langseth* would not operate sub-bottom profiler

during transits to and from the survey area, (*i.e.*, when the airguns are not operating). The hull-mounted profiler emits a ping with a dominant frequency component at 3.5 kHz. The nominal source level for the profiler is 204 dB re: 1 μPa.

Ballast Water Requirements: The proposed seismic research would not result in discharges of any pollutants or non-indigenous species or into ocean waters. The operation of the *Langseth* would only result in discharges incidental to normal operations of a surface vessel (NSF/USGS, 2011).

2.3 DESCRIPTION OF ALTERNATIVES

2.3.1 ALTERNATIVE 1 – ISSUANCE OF AN AUTHORIZATION WITH MITIGATION MEASURES

The Proposed Action constitutes the Preferred Alternative. Under this alternative, we would issue an Authorization (valid from August 2016 through July 2017) to Lamont-Doherty allowing the incidental take, by harassment, of marine mammals subject to the mandatory mitigation and monitoring measures and reporting requirements set forth in the Authorization, subject to changes based on consideration of public comments.

MITIGATION MEASURES

As described in Section 1.2, NMFS must prescribe the means of affecting the least practicable adverse impact on the species or stocks of marine mammals and their habitat. In order to do so, we must consider Lamont-Doherty's proposed mitigation measures, as well as other potential measures. NMFS' evaluation of potential measures includes consideration of the following factors in relation to one another: (1) the manner in which, and the degree to which, we expect the successful implementation of the measure to minimize adverse impacts to marine mammals; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation.

Any additional mitigation measure proposed by NMFS beyond what the applicant proposes should be able to or have a reasonable likelihood of accomplishing or contributing to the accomplishment of one or more of the following goals:

- Avoidance or minimization of marine mammal injury, serious injury, or death wherever possible;
- A reduction in the numbers of marine mammals taken (total number or number at biologically important time or location);
- A reduction in the number of times the activity takes individual marine mammals (total number or number at biologically important time or location);
- A reduction in the intensity of the anticipated takes (either total number or number at biologically important time or location);
- Avoidance or minimization of adverse effects to marine mammal habitat, paying special attention to the food base; activities that block or limit passage to or from biologically important areas; permanent destruction of habitat; or temporary destruction/disturbance of habitat during a biologically important time; and
- For monitoring directly related to mitigation, an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

To reduce the potential for disturbance from acoustic stimuli associated with the activities, Lamont-Doherty has agreed to implement the following monitoring and mitigation measures for marine mammals. These include:

1) Establish a 180 dB re: 1 µPa and 190 dB re: 1 µPa exclusion zone (Dunn & Hernandez) for marine mammals before the full array (*i.e.*, 6,660 in^3) or a single airgun (*i.e.*, 40 in^3) is in operation (Table 4).
2) Utilize NMFS-qualified, vessel-based Protected Species Observers (PSOs) to visually watch for and monitor marine mammals near the seismic source vessel during daytime operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during start-ups of sound sources day or night. Two PSOs would observe the exclusion and disturbance zones. When practicable, as an additional means of visual observation, the *Langseth's* vessel crew may also assist in detecting marine mammals.
3) Visually observe the entire extent of the EZ (180 dB re: 1 µPa for cetaceans and 190 dB re: 1 µPa for pinnipeds) using NMFS-qualified PSOs, for at least 30 minutes (min) prior to starting the airgun array (day or night).
4) Implement a ramp-up procedure when initiating the seismic operations or any time after the entire array has been shut down for more than 8 minutes, which means start the smallest sound source first and add sound sources in a sequence such that the source level of the array shall increase in steps not exceeding approximately 6 dB per 5-minute period. During ramp-up, the PSOs would monitor the EZ, and if they sight marine mammals, they would implement a power-down or shutdown as though the full array were operational. Therefore, initiation of ramp-up procedures from shutdown requires that the PSOs visually observe the full EZ described in Measures 1 and 3.
5) Power-down or shutdown the sound source(s) if a PSO detects a marine mammal that is within, approaches, or enters the applicable EZ. A shutdown means that the crew shuts down all operating sound sources (*i.e.*, turned off). A power-down means reducing the number of operating sound sources to a single operating 40 in^3 airgun, which reduces the EZ to the degree that the animal(s) is no longer within or about to enter it.
6) Set the shot interval for the single operating 40 in^3 airgun to one shot per minute.
7) Following a power-down, the *Langseth* crew would not resume full airgun activity until the marine mammal has cleared the 180- or 190-dB exclusion zone. The observers would consider the animal to have cleared the exclusion zone if:
    a. the observer has visually observed the animal leave the exclusion zone; or
    b. an observer has not sighted the animal within the exclusion zone for 15 minutes for species with shorter dive durations (*i.e.*, small odontocetes or pinnipeds), or 30 minutes for species with longer dive durations (*i.e.*, mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales).
8) Following a power-down, the *Langseth* crew would resume operating the airguns at full power after 15 minutes of sighting any species with short dive durations (*i.e.*, small odontocetes or pinnipeds). Likewise, the crew would resume airgun operations at full power after 30 minutes of sighting any species with longer dive durations (*i.e.*, mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales).
9) Following a shutdown for more than 8 min and subsequent animal departure, survey operations may resume following ramp-up procedures described in Measure 4.

10) The seismic survey may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire applicable EZs can be effectively monitored visually (*i.e.*, PSO(s) must be able to see the extent of the entire applicable EZ).

11) No initiation of survey operations involving the use of sound sources is permitted from a shutdown position at night or during low-light hours (such as in dense fog or heavy rain) 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 vessel's crew would not ramp up the airgun array from a complete shutdown at night or in thick fog, because the outer part of the EZ would not be visible during those conditions.

12) Alter speed or course during seismic operations if a marine mammal, based on its position and relative motion, appears likely to enter the relevant EZ. If speed or course alteration is not safe or practicable, or if after implementing an alteration the marine mammal still appears likely to enter the EZ, further mitigation measures, such as a power-down or shutdown, shall be taken.

13) Power down the airgun array for concentrations of six or more animals are within the 160-dB buffer zone and avoid concentrations of humpback , sei, fin, blue, and/or sperm whales (if possible (*i.e.*, exposing concentrations of animals to 160 dB re 1 µPa). For purposes of the survey, a concentration or group of whales will consist of six or more individuals visually sighted that do not appear to be traveling (*e.g.*, feeding, socializing, etc.); and

EXCLUSION ZONES

Table 4 – Predicted distances to which sound levels greater than or equal to 160 re: 1 µPa could be received during the proposed survey areas within the southeast Pacific Ocean.

Source and Volume (in^3)	Tow Depth (m)	Water Depth (m)	Predicted RMS Distances[1] (m)		
			190 dB	180 dB	160 dB
Single Bolt airgun (40 in^3)	9 or 12	< 100	100[2]	100[2]	1,041
		100 to 1,000	100	100	647
		> 1,000	100	100	431
36-Airgun Array (6,600 in^3)	9	< 100	591	2,060	22,580
		100 to 1,000	429	1,391	8,670
		> 1,000	286	927	5,780
36-Airgun Array (6,600 in^3)	12	< 100	710	2,480	27,130
		100 to 1,000	522	1,674	10,362
		> 1,000	348	1,116	6,908

[1] Predicted distances based on information presented in Lamont-Doherty's application.
[2] NMFS required Lamont-Doherty to expand the exclusion zone for the mitigation airgun to 100 m (328 ft) in shallow water.

MONITORING MEASURES

Lamont-Doherty proposes to sponsor marine mammal monitoring during the present project, in order to implement the mitigation measures that require real-time monitoring and to satisfy the monitoring requirements of section 101(a)(5)(D).

In addition to the PSOs described above, the Authorization would require Lamont-Doherty to use a passive acoustic monitoring (PAM) system, to the maximum extent practicable, to detect, and allow some localization of marine mammals around the *Langseth* during all airgun operations and during most periods when airguns are not operating. When the PAM operator detects an

animal, he/she must notify the PSO immediately of a vocalizing marine mammal so the *Langseth* crew can initiate a power-down or shut-down, if required.

REPORTING MEASURES

Lamont-Doherty would submit a draft report to NMFS and the Foundation within 90 days after the end of the cruise. The report would describe the operations conducted and sightings of marine mammals near the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring. The report must contain and summarize the following information:

1) Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings;
2) Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity (number of power-downs and shutdowns), observed throughout all monitoring activities;
3) An estimate of the number (by species) of: (A) pinnipeds that have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re: 1 µPa and/or 190 dB re: 1 µPa with a discussion of any specific behaviors those individuals exhibited; and (B) cetaceans that have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to 160 dB re: 1 µPa and/or 180 dB re: 1 µPa with a discussion of any specific behaviors those individuals exhibited.
4) A description of the implementation and effectiveness of the: (A) terms and conditions of the Biological Opinion's Incidental Take Statement (ITS); and (B) mitigation measures required by our Authorization. For the Biological Opinion, the report shall confirm implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on ESA-listed marine mammals.

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the Authorization, such as serious injury, or mortality (*e.g.*, ship-strike, gear interaction, and/or entanglement), Lamont-Doherty would immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS. Lamont-Doherty may not resume activities until we are able to review the circumstances of the prohibited take. The report must include the following information:

1) Time, date, and location (latitude/longitude) of the incident;
2) The *Langseth's* speed during and leading up to the incident;
3) Description of the incident;
4) Status of all sound source use in the 24 hours preceding the incident;
5) Water depth;
6) Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, and visibility);
7) A description of marine mammal observations in the 24 hours preceding the incident;
8) Species identification or description of the animal(s) involved;
9) The fate of the animal(s); and

10) Photographs or video footage of the animal (if equipment is available).

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the PSO determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.*, in less than a moderate state of decomposition as we describe in the next paragraph), Lamont-Doherty would immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS. The report must include the same information identified in the paragraph above this section. Activities may continue while we review the circumstances of the incident. We would work with Lamont-Doherty to determine whether modifications in the activities are appropriate.

In the event that Lamont-Doherty discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the authorized activities (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), Lamont-Doherty would report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS within 24 hours of the discovery. Lamont-Doherty would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS. Activities may continue while we review the circumstances of the incident.

TAKE ESTIMATES

For this proposed action, NMFS re-evaluated and revised the take estimates presented in Lamont-Doherty's application (LGL, 2016) and in NSF's draft environmental analysis (NSF, 2016). NMFS presented this re-evaluation in our *Federal Register* notice of the proposed Authorization. Thus, this Preferred Alternative would satisfy the purpose and need of our proposed action under the MMPA – issuance of an Authorization, along with required mitigation measures and monitoring that meets the standards set forth in section 101(a)(5)(D) of the MMPA and the implementing regulations, based on the best available information.

Table 5 – Take estimates of the possible numbers of individuals that could be exposed to ≥160 and 180 or 190 dB re 1 µPa rms, during the northern, central, and southern proposed seismic surveys, outside of territorial waters, off Chile in the southeast Pacific Ocean in 2016/2017.

Species	Estimated Level A Take[1]	Estimated Level B Take	Total Estimated Take	Percent of Population[2]
Southern right whale	0	225	225	1.875%
Pygmy right whale	0	120	120	Unknown
Humpback whale	0	143	143	0.340%
Common (dwarf) minke whale	0	75	75	0.015%
Antarctic minke whale	0	41	41	0.008%
Bryde's whale	0	43	43	0.099%
Sei whale	0	126	126	1.260%
Fin whale	75	293	368	1.673%
Blue whale	49	257	306	3.060%
Sperm whale	0	184	184	0.051%
Dwarf sperm whale	117	776	893	0.524%
Pygmy sperm whale	75	546	621	0.365%
Cuvier's beaked whale	75	477	552	2.760%
Shepard's beaked whale	0	120	120	0.474%
Pygmy beaked whale	0	143	143	0.565%
Gray's beaked whale	69	294	363	1.435%

Blainville's beaked whale	35	192	227	0.897%
Hector's beaked whale	0	52	52	0.206%
Gray's beaked whale	69	294	363	1.435%
Andrew's beaked whale	0	52	52	0.206%
Strap-toothed beaked whale	0	52	52	0.206%
Spade-toothed beaked whale	0	52	52	0.206%
Southern bottlenose whale	0	102	102	0.142%
Chilean dolphin	172	958	1,130	11.300%
Rough-toothed dolphin	105	490	595	0.553%
Common bottlenose dolphin	303	1,654	1,957	0.583%
Striped dolphin	1,093	6,096	7,189	0.745%
Short-beaked common dolphin	11,581	66,723	78,304	4.433%
Long-beaked common dolphin	665	3,605	4,270	2.965%
Dusky dolphin	539	3,232	3,771	14.571%
Peal's dolphin	172	958	1,130	Unknown
Hourglass dolphin	0	200	200	0.139%
Southern right whale dolphin	149	985	1,134	Unknown
Risso's dolphin	557	3,093	3,650	3.304%
Pygmy killer whale	0	185	185	0.476%
False killer whale	0	279	279	0.701%
Killer whale	0	76	76	0.152%
Short-finned pilot whale	0	1,500	1,500	0.255%
Long-finned pilot whale	0	116	116	0.058%
Burmeister's porpoise	722	4,309	5,031	Unknown
Juan Fernandez fur seal	0	150	150	0.465%
South American fur seal	998	5,760	6,758	2.703%
South American sea lion	10,445	59,580	70,025	17.604%
Southern elephant seal	0	160	160	0.040%

[1] The Level A estimates are overestimates of predicted impacts to marine mammals as the estimates do not take into consideration the required mitigation measures for shutdowns or power downs if a marine mammal is likely to enter the 180 or 190 dB exclusion zone while the airguns are active.

[2] Authorized Level A and B takes (used by NMFS as proxy for number of individuals exposed) expressed as the percent of the population listed in Table 1. Unknown = Abundance size not available.

2.3.2 ALTERNATIVE 2 – NO ACTION ALTERNATIVE

The No Action Alternative is the baseline against which the impacts of a proposed action are compared. For the purposes of the analysis in this EA, under the No Action Alternative, NMFS would not issue an IHA Lamont-Doherty, which would be based on an inability to make one of the findings required by section 101(a)(5)(D) of the MMPA. If Lamont-Doherty conducts the seismic surveys without an IHA and incidental take occurs, they will be subject to the MMPA's penalty provisions (16 U.S.C. 1375 Section 105). However, Lamont-Doherty has indicated it would not proceed with their proposed activities absent an IHA.

2.4 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER CONSIDERATION

NMFS considered whether other alternatives could meet the purpose and need and support the Lamont-Doherty's request for an IHA to conduct seismic surveys and have eliminated them from further consideration and analysis because they do not meet the purpose and need for the proposed action.

1) **Issuance of an Authorization with No Mitigation and Monitoring:** We considered an alternative that would allow for the issuance of an Authorization with no required mitigation or monitoring but eliminated this Alternative from consideration, as it would not be in

compliance with the MMPA. For that reason, we do not analyze this alternative further in this document.

2) **Alternate Survey Timing:** This measure would require Lamont-Doherty to conduct research after the winter season. However, this alternative failed to meet the statutory and regulatory requirements of the MMPA for an Authorization, as Lamont-Doherty did not request nor submit an application (*i.e.*, under the MMPA the Secretary shall issue an Authorization upon request) to conduct the seismic survey at an alternate time. For this reason, we do not analyze this alternative further in this document.

CHAPTER 3 – AFFECTED ENVIRONMENT

NMFS reviewed all possible environmental, cultural, historical, social, and economic resources based on the geographic location associated with NMFS proposed action and alternatives and POKs request for an incidental take authorization. Based on this review, this section describes the affected environment and existing (baseline) conditions for select resource categories. As explained in Chapter 1, certain resource categories not affected by NMFS proposed action and alternatives were not be carried forward for further consideration or evaluation in this draft EA (See Table 2). Chapter 4 provides an analysis and description of environmental impacts associated with the affected environment.

3.1 PHYSICAL ENVIRONMENT

As discussed in Chapter 1, NMFS' proposed action and alternatives relate only to the issuance of our Authorization of incidental take of marine mammals and not to the physical environment. Certain aspects of the physical environment are not relevant to our proposed action (see section 1.3.2 - Scope of Environmental Analysis).

The Chilean marine ecosystem pelagic territory is made up of three regions: the northern upwelling (18–30ºS), central/southern upwelling (30–42ºS), and austral fjords (42–55ºS) regions. Upwelling occurs in the northern region year-round, but is more seasonal in the central/southern region. In the northern upwelling region, most of the biological production takes place near the coast, in association with a narrow (<10 km) continental shelf (NSF, 2016). The shelf is much wider (up to ~40 km) in the central region, and upwelling is stronger in the spring and summer (NSF, 2016). The northern and central regions are also subject to high environmental variability caused by the ENSO (El Niño Southern Oscillation and LNSO (La Niña Southern Oscillation), which cause important changes in species community composition and abundance (NSF, 2016). The northern, central, and southern Chile Humboldt upwelling regions are also identified as EBSAs under the Convention on Biological Diversity (NSF, 2016).

3.1.1 MARINE MAMMAL HABITAT

We presented information on marine mammal habitat and the potential impacts to marine mammal habitat in our *Federal Register* notice of the proposed Authorization. Also, NSF presented more detailed information on the physical and oceanographic aspects of the southeast Pacific Ocean environment in the draft environmental analysis (NSF, 2016). In summary, the marine mammals in the survey area use the pelagic, open ocean waters, but may have differing habitat preferences based on their life history functions (NSF, 2016).

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 MARINE MAMMALS

We provide information on the possible or confirmed occurrence in the survey area in section 1.1.2 of this EA (Table 1) which provided information on the stock, regulatory status, abundance, occurrence, seasonality, and hearing ability of the marine mammals in the action area. Lamont-Doherty's application and NSF's EA also provided distribution, life history, and population size information for marine mammals within the action area. We incorporate those descriptions by reference and have previously summarized the information in Table 1.

CHAPTER 4 – ENVIRONMENTAL CONSEQUENCES

NMFS reviewed all possible direct, indirect, cumulative, short-term, long-term, irreversible, and irretrievable impacts to protected species, their environment, associated with NMFS proposed action and alternatives. Based on this review, this section describes the potential environmental consequences for the physical and biological resources described in Chapter 3. The overall approach to this analysis included resource-specific impacts and analysis for individual stressors or multiple stressors, examination of protected species population-level impacts and consideration of mitigations to reduce identified potential impact. The Federal Register notice (81 FR 23117) requesting comments on the proposed IHA facilitated an analysis of these impacts due to our proposed issuance of an IHA but information is summarized within the following subsections.

4.1 EFFECTS OF ALTERNATIVE 1 – ISSUANCE OF AN AUTHORIZATION WITH MITIGATION MEASURES

Alternative 1 is the Preferred Alternative, where we would issue an Authorization to Lamont-Doherty allowing the take by harassment, of marine mammals, incidental to the proposed survey from August 2016 through July 2017, subject to the mandatory mitigation and monitoring measures and reporting requirements set forth in the proposed Authorization, if issued.

4.1.1 IMPACTS TO MARINE MAMMAL HABITAT

NMFS' proposed action would have no additive or incremental effect on the physical environment beyond those resulting from the proposed survey activities. Lamont-Doherty's proposed seismic survey is not located within a marine sanctuary, wildlife refuge, a National Park, or other conservation area. The proposed activity— which uses one seismic source vessel—would minimally add to vessel traffic in the region and would not result in substantial damage to ocean and coastal habitats that might constitute marine mammal habitats. Finally, the Authorization would not impact physical habitat features, such as substrates and/or water quality.

Prey: The overall response of fishes and squids from the seismic survey is to exhibit responses including no reaction or habituation (Peña, Handegard, & Ona, 2013) to startle responses and/or avoidance (Fewtrell & McCauley, 2012) and vertical and horizontal movements away from the sound source. We expect that the seismic survey would have no more than a temporary and minimal adverse effect on any fish or invertebrate species. Although there is a potential for injury to fish or marine life in close proximity to the vessel, we expect that the impacts of the seismic survey on fish and other marine life specifically related to acoustic activities would be temporary in nature, negligible, and would not result in substantial impact to these species or to their role in the ecosystem.

4.1.2 IMPACTS TO MARINE MAMMALS

We expect that Lamont-Doherty's 3-D seismic survey has the potential to take marine mammals by harassment, as defined by the MMPA. Acoustic stimuli generated by the airgun arrays (and to a

lesser extent the multibeam echosounder, sub-bottom profiler, and acoustic Doppler current profiler) may affect marine mammals in one or more of the following ways: behavioral disturbance, tolerance, masking of natural sounds, and temporary or permanent hearing impairment, or non-auditory physical effects (Richardson, Greene, Malme, & Thomson, 1995).

Our *Federal Register* notice of proposed Authorization, Lamont-Doherty's application (LGL, 2016) and in NSF's draft environmental analysis (NSF, 2016) provide detailed descriptions of these potential effects of seismic surveys on marine mammals. We incorporate those discussions by reference here and summarize our consideration of additional studies submitted during the public comment period in the following sections.

The effects of noise on marine mammals are highly variable, ranging from minor and negligible to potentially significant, depending on the intensity of the source, the distances between the animal and the source, and the overlap of the source frequency with the animals' audible frequency. Nevertheless, monitoring and mitigation measures required by us for Lamont-Doherty's proposed activities would effectively reduce any significant adverse effects of these sound sources on marine mammals.

Behavioral Disturbance: The studies discussed in the *Federal Register* notice for the proposed Authorization note that there is variability in the behavioral responses of marine mammals to noise exposure. It is important to consider context in predicting and observing the level and type of behavioral response to anthropogenic signals (Ellison, Southall, Clark, & Frankel, 2012).

Marine mammals may react to sound when exposed to anthropogenic noise. These behavioral reactions are often shown as: changing durations of surfacing and dives number of blows per surfacing; changing direction and/or speed; reduced/increased vocal activities; changing or cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where noise sources are located; and/or flight responses (*e.g*., pinnipeds flushing into water from haul-outs or rookeries). The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Richardson et al., 1995; Southall et al., 2007).

Studies have shown that underwater sounds from seismic activities are often readily detectable by marine mammals in the water at distances of many kilometers (Castellote, Clark, & Lammers, 2012). Many studies have also shown that marine mammals at distances more than a few kilometers away often show no apparent response when exposed to seismic activities (e.g., Akamatsu, Hatakeyama, & Takatsu, 1993; Harris, Miller, & Richardson, 2001; Madsen & Møhl, 2000; Malme, Miles, Clark, Tyack, & Bird, 1983, 1984; Richardson, Würsig, & Greene Jr., 1986; Weir, 2008). Other studies have shown that marine mammals continue important behaviors in the presence of seismic pulses (e.g., Dunn & Hernandez, 2009; Greene Jr., Altman, & Richardson, 1999; Holst & Beland, 2010; Holst & Smultea, 2008; Holst, Smultea, Koski, & Haley, 2005; Nieukirk, Stafford, Mellinger, Dziak, & Fox, 2004; Richardson et al., 1986; Smultea, Holst, Koski, & Stoltz, 2004).

In a passive acoustic research program that mapped the soundscape in the North Atlantic Ocean, Clark and Gagnon (2006) reported that some fin whales in the northeast Pacific Ocean stopped singing for an extended period starting soon after the onset of a seismic survey in the area. The authors could not determine whether or not the whales left the area ensonified by the survey, but the

evidence suggests that most, if not all, of the singers remained in the area. When the survey stopped temporarily, the whales resumed singing within a few hours and the number of singers increased with time. Also, one whale continued to sing while the seismic survey was actively operating (Figure 4, Clark & Gagnon, 2006). The authors concluded that there is not enough scientific knowledge to adequately evaluate whether or not these effects on singing or mating behaviors are significant or would alter survivorship or reproductive success.

MacLeod et al. (2006) discussed the possible displacement of fin and sei whales related to distribution patterns of the species during a large-scale, offshore seismic survey along the west coast of Scotland in 1998. The authors hypothesized about the relationship between the whale's absence and the concurrent seismic activity, but could not rule out other contributing factors (Macleod et al., 2006; Parsons et al., 2009). We would expect that marine mammals may briefly respond to underwater sound produced by Lamont-Doherty's seismic survey by slightly changing their behavior or relocating a short distance. Based on the best available information, we expect short-term disturbance reactions that are confined to relatively small distances and durations (D. R. Thompson, Sjoberg, Bryant, Lovell, & Bjorge, 1998; P. M. Thompson et al., 2013), with no long-term effects on recruitment or survival of marine mammals.

McDonald et al. (1995) tracked blue whales relative to a seismic survey with a 1,600 in^3 airgun array. One whale started its call sequence within 15 km (9.3 mi) from the source, then followed a pursuit track that decreased its distance to the vessel where it stopped calling at a range of 10 km (6.2 mi) (estimated received level at 143 dB re: 1 μPa (peak-to-peak)). After that point, the ship increased its distance from the whale which continued a new call sequence after approximately one hour and 10 km (6.2 mi) from the ship. The authors reported that the whale had taken a track paralleling the ship during the cessation phase but observed the whale moving diagonally away from the ship after approximately 30 minutes continuing to vocalize. Because the whale may have approached the ship intentionally or perhaps was unaffected by the airguns, the authors concluded that there was insufficient data to infer conclusions from their study related to blue whale responses (McDonald et al., 1995).

McCauley et al. (2000; 1998) studied the responses of migrating humpback whales off western Australia to a full-scale seismic survey with a 16-airgun array (2,678 in^3) and to a single, 20-in^3airgun. Both studies point to a contextual variability in the behavioral responses of marine mammals to sound exposure. The mean received level for initial avoidance of an approaching airgun was 140 dB re: 1 μPa for humpback whale pods containing females. In contrast, some individual humpback whales, mainly males, approached within distances of 100 to 400 m (328 to 1,312 ft), where sound levels were 179 dB re: 1 μPa (McCauley et al., 2000). The authors hypothesized that the males gravitated towards the single operating air gun possibly due to its similarity to the sound produced by humpback whales breaching. Despite the evidence that some humpback whales exhibited localized avoidance reactions at received levels below 160 dB re: 1 μPa, the authors found no evidence of any gross changes in migration routes, such as inshore/offshore displacement during seismic operations (McCauley et al., 2000; McCauley et al., 1998).

DeRuiter *et al*. (2013) recently observed that beaked whales (considered a particularly sensitive species) exposed to playbacks (*i.e*., simulated) of U.S. Navy tactical mid-frequency active sonar from 89 to 127 dB re: 1 μPa at close distances responded notably by altering their dive patterns. In contrast, individuals showed no behavioral responses when exposed to similar received levels from *actual* U.S. Navy tactical mid-frequency active sonar operated at much further distances (DeRuiter

et al., 2013). As noted earlier, one must consider the importance of context (*e.g.*, the distance of a sound source from the animal) in predicting behavioral responses.

Tolerance: With repeated exposure to sound, many marine mammals may habituate to the sound at least partially (Richardson & Wursig, 1997). Bain and Williams (2006) examined the effects of a large airgun array (maximum total discharge volume of 1,100 in^3) on six species in shallow waters off British Columbia and Washington: harbor seal, California sea lion (*Zalophus californianus*), Steller sea lion (*Eumetopias jubatus*), gray whale (*Eschrichtius robustus*), Dall's porpoise (*Phocoenoides dalli*), and the harbor porpoise. Harbor porpoises showed reactions at received levels less than 145 dB re: 1 µPa at a distance of greater than 70 km (43 miles) from the seismic source (Bain & Williams, 2006). However, the tendency for greater responsiveness by harbor porpoise is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson et al., 1995; Southall et al., 2007). In contrast, the authors reported that gray whales seemed to tolerate exposures to sound up to approximately 170 dB re: 1 µPa (Bain & Williams, 2006) and Dall's porpoises occupied and tolerated areas receiving exposures of 170–180 dB re: 1 µPa (Bain & Williams, 2006; Parsons et al., 2009). The authors observed several gray whales that moved away from the airguns toward deeper water where sound levels were higher due to propagation effects resulting in higher noise exposures (Bain & Williams, 2006). However, it is unclear whether their movements reflected a response to the sounds (Bain & Williams, 2006). Thus, the authors surmised that the lack of gray whale responses to higher received sound levels were ambiguous at best because one expects the species to be the most sensitive to the low-frequency sound emanating from the airguns (Bain & Williams, 2006).

Pirotta et al. (2014) observed short-term responses of harbor porpoises to a 2-D seismic survey in an enclosed bay in northeast Scotland which did not result in broad-scale displacement. The harbor porpoises that remained in the enclosed bay area reduced their buzzing activity by 15% during the seismic survey (Pirotta et al., 2014). Thus, animals exposed to anthropogenic disturbance may make trade-offs between perceived risks and the cost of leaving disturbed areas (Pirotta et al., 2014). However, unlike the semi-enclosed environment described in the Scottish study area, Lamont-Doherty's seismic study occurs in the open ocean. Because Lamont-Doherty would conduct the survey in an open ocean area, we do not anticipate that the seismic survey would entrap marine mammals between the sound source and the shore as marine mammals can temporarily leave the survey area during the operation of the airgun(s) to avoid acoustic harassment.

Masking: Studies have shown that marine mammals are able to compensate for masking by adjusting their acoustic behavior such as shifting call frequencies and increasing call volume and vocalization rates. For example, blue whales increase call rates when exposed to seismic survey noise in the St. Lawrence Estuary (Di Iorio & Clark, 2010). North Atlantic right whales exposed to high shipping noise increased call frequency (Parks, Clark, & Tyack, 2007), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller, Biassoni, Samuels, & Tyack, 2000).

Risch *et al*. (2012) documented reductions in humpback whale vocalizations in the Stellwagen Bank National Marine Sanctuary concurrent with transmissions of the Ocean Acoustic Waveguide Remote Sensing (OAWRS) low-frequency fish sensor system at distances of 200 km from the source. The recorded OAWRS produced series of frequency modulated pulses and the signal received levels ranged from 88 to 110 dB re: 1 µPa (Risch et al., 2012). The authors hypothesized that individuals did not leave the area but instead ceased singing and noted that the duration and frequency range of the OAWRS signals (a novel sound to the whales) were similar to those of natural humpback whale

song components used during mating (Risch et al., 2012). Thus, the novelty of the sound to humpback whales in the study area provided a compelling contextual probability for the observed effects (Risch et al., 2012). However, the authors did not state or imply that these changes had long-term effects on individual animals or populations (Risch et al., 2012). The changes in vocal behaviors related to mating activities do not apply to the marine mammal species present in the area of Lamont-Doherty's seismic survey. Again, Lamont-Doherty's study area is well away from any known breeding grounds for low frequency cetaceans, thereby reducing further the likelihood of causing an effect on marine mammal mating behaviors.

We expect that masking effects of seismic pulses would be limited in the case of smaller odontocetes given the intermittent nature of seismic pulses (22 or 65 seconds) plus the fact that sounds important to them are predominantly at much higher frequencies than are the dominant components of airgun sounds. Pinnipeds have best hearing sensitivity and/or produce most of their sounds at frequencies higher than the dominant components of airgun sounds, but there is some overlap in the frequencies of the airgun pulses and the calls. However, the intermittent nature of airgun pulses presumably reduces the potential for masking.

Hearing Impairment: Marine mammals exposed to high intensity sound repeatedly or for prolonged periods can experience hearing threshold shift (Akamatsu et al.), which is the loss of hearing sensitivity at certain frequency ranges (Finneran, Carder, Schlundt, & Ridgway, 2005; Kastak & Schusterman, 1998; Kastak, Schusterman, Southall, & Reichmuth, 1999; C. E. Schlundt, J. J. Finneran, B. K. Branstetter, J. S. Trickey, & Jenkins, 2013; C. R. Schlundt, Finneran, Carder, & Ridgway, 2000).

Lucke et al. (2009) found a threshold shift (Akamatsu et al.) of a harbor porpoise after exposing it to airgun noise with a received sound pressure level (SPL) at 200.2 dB (peak –to-peak) re: 1 μPa, which corresponds to a sound exposure level of 164.5 dB re: 1 μPa^2 s after integrating exposure. NMFS currently uses the root-mean-square (rms) of received SPL at 180 dB and 190 dB re: 1 μPa as the threshold above which permanent threshold shift (PTS) could occur for cetaceans and pinnipeds, respectively. Because the airgun noise is a broadband impulse, one cannot directly determine the equivalent of rms SPL from the reported peak-to-peak SPLs. However, applying a conservative conversion factor of 16 dB for broadband signals from seismic surveys (McCauley et al., 2000) to correct for the difference between peak-to-peak levels reported in Lucke et al. (2009) and rms SPLs, the rms SPL for TTS would be approximately 184 dB re: 1 μPa, and the received levels associated with PTS (Level A harassment) would be higher. This is still above our current 180 dB rms re: 1 μPa threshold for injury. However, we recognize that TTS of harbor porpoises is lower than other cetacean species empirically tested (Finneran & Schlundt, 2010; Finneran, Schlundt, Carder, & Ridgway, 2002; Kastelein & Jennings, 2012).

Studies by Kujawa and Liberman (2009) and Lin et al. (2011) found that despite completely reversible threshold shifts that leave cochlear sensory cells intact, large threshold shifts could cause synaptic level changes and delayed cochlear nerve degeneration in mice and guinea pigs, respectively. We note that the high level of TTS that led to the synaptic changes shown in these studies is in the range of the high degree of TTS that Southall et al. (2007) used to calculate PTS levels. It is unknown whether smaller levels of TTS would lead to similar changes. We, however, acknowledge the complexity of noise exposure on the nervous system, and will re-examine this issue as more data become available.

A recent study on bottlenose dolphins (C. E. Schlundt et al., 2013) measured hearing thresholds at multiple frequencies to determine the amount of TTS induced before and after exposure to a sequence of impulses produced by a seismic air gun. The air gun volume and operating pressure varied from 40-150 in^3 and 1000-2000 psi, respectively. After three years and 180 sessions, the authors observed no significant TTS at any test frequency, for any combinations of air gun volume, pressure, or proximity to the dolphin during behavioral tests (C. E. Schlundt et al., 2013). Schlundt et al. (2013) suggest that the potential for airguns to cause hearing loss in dolphins is lower than previously predicted, perhaps as a result of the low-frequency content of air gun impulses compared to the high-frequency hearing ability of dolphins.

The predicted distances at which sound levels could result in Level A harassment are relatively small. The avoidance behaviors observed in Thompson et al.'s (1998) study supports our expectation that individual marine mammals would avoid exposure at higher levels. Also, it is unlikely that animals would encounter repeated exposures at very close distances to the sound source because Lamont-Doherty would implement the required shutdown and power down mitigation measures to ensure that marine mammals do not approach the applicable exclusion zones for Level A harassment. We also expect that the required vessel-based visual monitoring of the exclusion zones and implementation of mitigation measures would mitigate instances of Level A harassment.

Strandings: In 2013, an International Scientific Review Panel (ISRP) investigated a 2008 mass stranding of approximately 100 melon-headed whales in a Madagascar lagoon system (Southall, Rowles, Gulland, Baird, & Jepson, 2013) associated with the use of a high-frequency mapping system. The report indicated that the use of a 12-kHz multibeam echosounder was the most plausible and likely initial behavioral trigger of the mass stranding event. This was the first time that a relatively high-frequency mapping sonar system had been associated with a stranding event. However, the report also notes that there were several site- and situation-specific secondary factors that may have contributed to the avoidance responses that lead to the eventual entrapment and mortality of the whales within the Loza Lagoon system (*e.g.*, the survey vessel transiting in a north-south direction on the shelf break parallel to the shore may have trapped the animals between the sound source and the shore driving them towards the Loza Lagoon). They concluded that for odontocete cetaceans that hear well in the 10-50 kHz range, where ambient noise is typically quite low, high-power active sonars operating in this range may be more easily audible and have potential effects over larger areas than low frequency systems that have more typically been considered in terms of anthropogenic noise impacts (Southall et al., 2013). However, the risk may be very low given the extensive use of these systems worldwide on a daily basis and the lack of direct evidence of such responses previously (Southall et al., 2013).

We have considered the potential for behavioral responses and injury or mortality from Lamont-Doherty's use of the multibeam echosounder. Given that Lamont-Doherty proposes to conduct the survey offshore and transit in a manner that would not entrap marine mammals in shallow water, we do not anticipate that the use of the source during the seismic survey would entrap marine mammals between the vessel's sound sources and the Grecian coastline. In addition the proposed Authorization outlines reporting measures and response protocols intended to minimize the impacts of, and enhance the analysis of, any potential stranding in the survey area.

In sum, we interpret these effects on all marine mammals as falling within the MMPA definition of Level A and B harassment. We expect these impacts to be minor because we do not anticipate measurable changes to the population or measurable impacts to rookeries, mating grounds, and other areas of similar significance.

Under the Preferred Alternative, we would authorize incidental take, by harassment only, of 38 species of marine mammals. Based on our best professional judgment and our evaluation of all of the available data, we expect no long-term or substantial adverse effects on marine mammals, their habitats, or their role in the environment.

Lamont-Doherty proposed a number of monitoring and mitigation measures for marine mammals as part of our evaluation for the Preferred Alternative. In consideration of the potential effects of the proposed seismic survey, we determined that the mitigation and monitoring measures described in section 2.3.1 of this EA would be appropriate for the preferred alternative to meet the Purpose and Need.

Serious Injury or Mortality: Lamont-Doherty did not request authorization to take marine mammals by serious injury or mortality. Based on the results of our analyses, Lamont-Doherty's environmental analyses, and previous monitoring reports for the same activities, we do not expect Lamont-Doherty's planned activities to result in serious injury or mortality within the action area. The required mitigation and monitoring measures would minimize any potential risk for marine mammals. Although considered unlikely, any Level A harassment potentially incurred would be expected to be in the form of some smaller degree of permanent hearing loss due in part to the required monitoring measures for detecting marine mammals and required mitigation measures for power downs or shut downs of the airgun array if any animal is likely to enter the Level A exclusion zone. Neither mortality nor complete deafness of marine mammals is expected to result from this survey.

Vessel Strikes: The potential for striking marine mammals is a concern with vessel traffic. Studies have associated ship speed with the probability of a ship strike resulting in an injury or mortality of an animal. However, it is highly unlikely that Lamont-Doherty would strike a marine mammal given the *Langseth's* slow survey speed (8 to 12 km/hr; 4 to 6 kt). Moreover, mitigation measures would be required of Lamont-Doherty to reduce speed or alter course if a collision with a marine mammal appears likely.

Estimated Take of Marine Mammals by Level A and Level B Incidental Harassment: We expect that the survey would cause a short-term behavioral disturbance for marine mammals in the proposed area. We anticipate that take, by Level B harassment, of 44 species of marine mammals under our jurisdiction could result from the specified activity. Although unlikely, we also anticipate that a small amount of take by Level A harassment of 26 species of marine mammals could occur during the planned surveys. . For each species, these estimates are small numbers relative to the population sizes.

Table 5 in the Federal Register notice of the proposed IHA (81 FR 23117) outlines the density estimates or estimated group size for marine mammals in the action area, the number of takes proposed for authorizationd, the percentage of each population or stock that would be authorized by us for take as a result of Lamont-Doherty's activities, and the population trend for each species.

4.2 Effects of Alternative 2– No Action Alternative

Under the No Action Alternative, NMFS would not issue an Authorization to Lamont-Doherty. As a result, Lamont-Doherty would not receive an exemption from the MMPA prohibitions against the take of marine mammals. NSF has stated that Lamont-Doherty would not conduct the survey in the

absence of an Authorization. Thus, Lamont-Doherty would not conduct the seismic survey and marine mammals present in the survey area would not be incidentally harassed. This alternative would eliminate any potential risk to marine mammals in the proposed seismic survey locations. The impacts to the human environment resulting from the No Action alternative—no issuance of the Authorization—would be less than the Preferred Alternative.

4.2.1 Impacts to Marine Mammal Habitat

Under the No Action Alternative, Lamont-Doherty would not conduct the seismic survey and marine mammal habitat would not be affected by the seismic survey. This alternative would eliminate any potential risk to the environment from the proposed research activities.

4.2.2 Impacts to Marine Mammals

Under this No Action Alternative, Lamont-Doherty would not conduct the seismic survey and marine mammals present in the survey area would not be incidentally harassed. This alternative would eliminate any potential risk to the environment from the proposed research activities, and the applicant would not receive an exemption from the MMPA and ESA prohibitions against take.

Under this No Action Alternative, the proposed action has no unmitigable adverse impact to subsistence uses, as there are no permitted subsistence uses of marine mammals in the region.

4.5 Compliance with Necessary Laws – Necessary Federal Permits

NMFS determined that the issuance of an Authorization is consistent with the applicable requirements of the MMPA, ESA, E.O. 12114, and our regulations. Please refer to section 1.4 of this EA for more information.

4.6 Unavoidable Adverse Impacts

Lamont-Doherty's application, our *Federal Register* notice of a proposed Authorization, and other environmental analyses identified previously summarize unavoidable adverse impacts to marine mammals or the populations to which they belong or on their habitats, as well as subsistence uses of marine mammals, occurring in the seismic survey area. We incorporate those documents by reference.

We acknowledge that the incidental take Authorization would potentially result in unavoidable adverse impacts. However, we do not expect Lamont-Doherty's activities to have adverse consequences on the viability of marine mammals in the southeast Pacific Ocean. We do not expect the marine mammal populations in that area to experience reductions in reproduction, numbers, or distribution that might appreciably reduce their likelihood of surviving and recovering in the wild. We expect that the numbers of individuals of all species taken by harassment would be small (relative to species or stock abundance), that the seismic survey and the take resulting from the seismic survey activities would have a negligible impact on the affected species or stocks of marine mammals, and that there would not be any relevant subsistence impacts.

4.7 Cumulative Effects

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR §1508.7). Cumulative impacts can result from individually minor but collectively significant actions that take place over a period of time.

The proposed seismic survey would add another, albeit temporary, activity to the marine environment in the southeast Pacific Ocean for a comparatively short period of time. Lamont-Doherty's application (LGL, 2016) and in NSF's draft environmental analysis (NSF, 2016) summarize the potential cumulative effects to marine mammals or the populations to which they belong to and their habitats within the survey area. This section incorporates Lamont-Doherty's application (LGL, 2016) and in NSF's draft environmental analysis (NSF, 2016) by reference and provides a brief summary of the human-related activities affecting the marine mammal species in the action area.

4.7.1 Previous Seismic Research Surveys in the Same Area

In 2012, a low energy seismic survey was conducted off of Maule, Chile to study how the outer accretionary wedge was responding to a change in stress resulting from a megathrust earthquake that occurred on 27 February 2010. The low energy seismic source was active for approximately149 hours (approximately 6 days) during 1,105 km of survey tracklines (NSF, 2016). Monitoring and mitigation measures were implemented during the survey; the majority of sightings and mitigation measures implemented were for pinnipeds (NSF, 2016).

4.7.2 Future Seismic Research in the Southeast Pacific Ocean

Other scientific seismic research activities could be conducted in the project area in the future; however, aside from those that are covered in this EA, no other marine geophysical surveys using the *Langseth* are currently proposed in the region in the foreseeable future and there are no other seismic surveys with an Authorization from NMFS scheduled to occur in international waters southeast Pacific Ocean August 2016 through July 2017. Therefore, we are unaware of any synergistic impacts to marine resources associated with reasonably foreseeable future actions that may be planned or occur within the same region of influence.

4.7.3 Vessel Traffic

Vessel traffic in and around the proposed survey areas would primarily consist of commercial shipping vessels, with the addition of fishing, recreational, passenger, tug/towing/pilot, military, and research vessels, particularly in the nearshore portions of the area. Based on data made available through the Automated Mutual-Assistance Vessel Rescue (AMVER) system managed by the U.S. Coast Guard, fewer than 4 commercial vessels per month typically passed through the northern proposed survey area during 2007–2013, although up to 14 vessels per month were occasionally observed (2013 data are available for January–June, the most recent data available as of September 2015) (USCG 2013). Between 4 and 49 commercial vessels per month passed through the central proposed survey area during this period, with the greatest amount of traffic generally observed in spring or summer (USCG 2013). Five to 14 commercial vessels per month generally passed through the southern proposed survey area during this period, occasionally increasing up to 49 vessels (USCG 2013). According to Colpaert et al. (2015), ship traffic has increased considerably in the Chiloé-Corcovado area over the last decade.

The total transit distance of ~11,500 km (including transit to and from port, and OBS deployment/ recovery) by the *Langseth* would be small relative to total transit length for vessels operating in the general region around the proposed survey areas. Thus, the addition of Lamont-Doherty's vessel traffic to existing shipping and fishing operations is expected to result in a only a minor increase in overall ship traffic.

4.7.4 MILITARY ACTIVITY

The Chilean Navy operates out of five bases (Naval Zones) throughout Chile: Iquique at ~20.3°S, Talcahuano at ~36.7°S, Valparaíso at ~33°S, Puerto Montt at 41.5°S, and Punta Arenas at ~53°S (Santos 2014). There have been several military exercises that have either occurred near the proposed survey areas or otherwise involved Chilean naval forces that may have transited through them during April–June 2015. These included search and rescue missions including off Puerto Montt; drills including coastline combat, an amphibious landing, and a man overboard simulation in the Region of Magallanes; a gathering of several National Fleet ships in Iquique; and a naval exercise in Puerto Montt (Diálogo 2015; NAFC 2015). There are no known conflicts with the Proposed Action with future Chilean military activities; through the U.S. State Department, Lamont-Doherty is seeking authorization from Chile for clearance to operate in support of the research activity within its EEZ.

4.7.5 FISHERIES

The capture, possession, and trade of cetaceans are prohibited in Chile. However, incidental bycatch mortality remains an issue (Reyes and Oporto 1994), as does directed take, especially for small cetaceans which are often used as bait and occasionally for human consumption. Limited opportunistic sampling indicates that fisheries-related mortalities, including directed takes, affect several cetacean species at unknown levels (Van Waerebeek et al. 1999). Despite the moratorium on the capture of cetaceans in Chilean waters, small cetacean takes have been documented in Chile, including the hunting of Peale's dolphin, Chilean dolphin, and Commerson's dolphin for crab bait in southern Chile, and harpooning and net entanglements of southern right whale dolphins off central and northern Chile (Van Waerebeek et al. 1999). Van Waerebeek et al. (1999) described nine cases of confirmed bycatch, suspected bycatch, or confirmed intentional take in north-central Chile; the species targeted included Burmeister's porpoise (3) and the pygmy sperm whale (3), long-beaked common dolphin (1), long-finned pilot whale (1), and pygmy beaked whale (1). Common bottlenose and common dolphins, as well as Burmeister's porpoise, are also taken as bycatch in fisheries in Peru (Mangel et al. 2008). A review of reported marine mammal bycatch in gillnet fisheries pre-1990 and during the period 1990–2010 identified four species caught off the coast of Chile, including Chilean dolphins, southern right whale dolphins, Burmeister's porpoise and minke whale (Reeves et al. 2013).

There might be some localized avoidance by marine mammals of fishing vessels near the proposed survey areas. Lamont-Doherty's operations in the proposed survey areas are limited in duration (total of ~80 days), and the addition of Lamont-Doherty's operations to existing commercial fishing operations is expected to result in only a negligible increase in overall disturbance effects on marine mammals and no increase in serious injuries or mortality in marine mammals.

4.7.6 OIL AND GAS

Chile's state-owned oil and gas company, Empresa Nacional del Petróleo, has partnered with international oil companies in recent years and current exploration and exploitation activity is focused in the Magallanes and Tierra del Fuego regions, in the south of the country, away from the proposed survey areas. To the north of the proposed survey areas, Peru offshore oil and gas exploration has mainly occurred in the northern part of the country, but recent activity in the central and southern regions have increased, including prospecting seismic surveys in 2014 in advance of a 2014 lease block bidding round. Seismic survey activity plans for 2016 and 2017 are currently not available, but any activities would be expected to occur well north of the proposed survey areas.

4.7.6 CLIMATE CHANGE

4.7.6.1 INTRODUCTION

Climate change is a global issue and greenhouse gas emissions are a concern from a cumulative perspective because individual sources of greenhouse gas emissions are not large enough to have an appreciable impact on climate change. Greenhouse gases are compounds that contribute to the greenhouse effect, a natural phenomenon in which these gases trap heat within the surface-troposphere (lowest portion of the earth's atmosphere) system, causing heating (radiative forcing) at the surface of the earth. Scientific evidence indicates a trend of increasing global temperature over the past century due to increasing greenhouse gas emissions from human activities (Karl, Melillo, & Peterson, 2009). Additionally, the Intergovernmental Panel on Climate Change reports that physical and biological systems on all continents, and in most oceans, are already being affected by climate changes and that there is strong evidence for global warming associated weather changes and that humans have "very likely" contributed to this problem through burning fossil fuels and adding other "greenhouse gases" to the atmosphere (IPCC, 2007a, 2007b). Finally, some of the major potential concerns for the marine environment as a result of global warming include sea temperature rise, melting of polar ice, rising sea levels, changes to major ocean current systems and ocean acidification.

4.7.6.2 CLIMATE CHANGE AND THE SOUTHEAST PACIFIC OCEAN

With the large degree of uncertainty on the impact of climate change to marine mammals in the southeast Pacific Ocean, we recognize that warming of this region could affect the prey base and habitat quality for marine mammals. Nonetheless, we expect that the conduct of the seismic survey and the issuance of an IAH to Lamont-Doherty would not result in any noticeable contributions to climate change.

4.7.8 Cumulative Effects Summary

The impacts of conducting the seismic survey on marine mammals are specifically related to acoustic activities, and these are expected to be temporary in nature, negligible, and would not result in substantial impacts to marine mammals or to their role in the ecosystem. We do not expect that the issuance of an IHA to Lamont-Doherty would have a significant cumulative effect on the human environment, due to the required mitigation and monitoring measures described in Section 2.3.1

NMFS does not expect that Lamont-Doherty's proposed seismic surveys would have effects that could cause significant or long-term consequences for individual marine mammals or their populations alone or in combination with past or present activities discussed above.

CHAPTER 5 – LIST OF PREPARERS AND AGENCIES CONSULTED

Agencies Consulted:

Marine Mammal Commission
4340 East West Highway, Room 700
Bethesda, Maryland 20814

NOAA – National Marine Fisheries Service
Office of Protected Resources
Endangered Species Act Interagency Cooperation Division
1315 East West Highway, SSMC 3
Silver Spring, MD 20910

National Science Foundation
Office of General Counsel
4201 Wilson Blvd.
Arlington, VA 22230

Prepared By:

Jordan Carduner
Fisheries Biologist
Incidental Take Program
Permits and Conservation Division
Office of Protected Resources
NOAA, National Marine Fisheries Service

REFERENCES

Akamatsu, T., Hatakeyama, Y., & Takatsu, N. (1993). Effects of pulse sounds on escape behavior of false killer whales. *Bulletin - Japanese Society of Scientific Fisheries, 59*, 1297-1297.

Bain, D. E., & Williams, R. (2006). *Long-range effects of airgun noise on marine mammals: responses as a function of received sound level and distance*. Cambridge, UK.

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

Clark, C. W., & Gagnon, G. C. (2006). Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales. *IWC/SC/58 E, 9*.

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

Di Iorio, L., & Clark, C. W. (2010). Exposure to seismic survey alters blue whale acoustic communication. *Biology Letters, 6*(1), 51-54.

Dunn, R. A., & Hernandez, O. (2009). Tracking blue whales in the eastern tropical Pacific with an ocean-bottom seismometer and hydrophone array. *The Journal of the Acoustical Society of America, 126*(3), 1084-1094.

Ellison, W., Southall, B., Clark, C., & Frankel, A. (2012). A New Context-Based Approach to Assess Marine Mammal Behavioral Responses to Anthropogenic Sounds. *Conservation Biology, 26*(1), 21-28.

Fewtrell, J. L., & McCauley, R. D. (2012). Impact of air gun noise on the behaviour of marine fish and squid. *Marine pollution bulletin, 64*(5), 984-993.

Finneran, J. J., Carder, D. A., Schlundt, C. E., & Ridgway, S. H. (2005). Temporary threshold shift in bottlenose dolphins (Tursiops truncatus) exposed to mid-frequency tones. *The Journal of the Acoustical Society of America, 118*, 2696.

Finneran, J. J., & Schlundt, C. E. (2010). Frequency-dependent and longitudinal changes in noise-induced hearing loss in a bottlenose dolphin (Tursiops truncatus). *The Journal of the Acoustical Society of America, 128*(2), 567-570.

Finneran, J. J., Schlundt, C. E., Carder, D. A., & Ridgway, S. H. (2002). Auditory filter shapes for the bottlenose dolphin (Tursiops truncatus) and the white whale (Delphinapterus leucas) derived with notched noise. *The Journal of the Acoustical Society of America, 112*(1), 322-328.

Greene Jr., C. R., Altman, N. S., & Richardson, W. J. (1999). The influence of seismic survey sounds on bowhead whale calling rates. *The Journal of the Acoustical Society of America, 106*(4), 2280-2280.

Harris, R. E., Miller, G. W., & Richardson, W. J. (2001). Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea. *Marine Mammal Science, 17*(4), 795-812.

Holst, M., & Beland, J. (2010). Marine mammal and sea turtle monitoring during Lamont-Doherty Earth Observatory's Shatsky Rise marine seismic program in the Northwest Pacific Ocean, July–September

2010. LGL Rep. TA4873-3. Rep. from LGL Ltd., (pp. 70 p.). King City, Ontario for Lamont-Doherty Earth Observatory of Columbia Univ., Palisades, NY.

Holst, M., & Smultea, M. A. (2008). Marine mammal and sea turtle monitoring during Lamont-Doherty Earth Observatory's marine seismic program off Central America, Feburary-April 2008 (pp. 133). Palisades, New York: Lamont-Doherty Earth Observatory of Columbia University.

Holst, M., Smultea, M. A., Koski, W. R., & Haley, B. (2005). Marine mammal and sea turtle monitoring during Lamont-Doherty Earth Observatory's marine seismic program in the Eastern Tropical Pacific Ocean off Central America, November–December 2004. *Report from LGL Ltd., King City, Ontario, for Lamont-Doherty Earth Observatory of Columbia Univ., Palisades, NY, and National Marine Fisheries Service, Silver Spring, MD. Report TA2822-30. 125 p.*

IPCC. (2007a). Climate Change 2007: Synthesis Report. Valencia, Spain: Intergovernmental Panel on Climate Change.

IPCC. (2007b). IPCC, 2007: Climate change 2007: The physical science basis. Contribution of Working Group I to the fourth assessment report of the Intergovernmental Panel on Climate Change *Editors: Solomon, S., Qin, D., Manning, M., Chen, Z.,*

Marquis, M., Averyt, K.B., Tignor, M., Miller, H. L., .

IUCN. (2016). International Union for Conservation of Nature and Natural Resources Red List of Threatened Species website. Retrieved March 2016, from http://www.iucnredlist.org/.

IWC. (2016). Whale Population Estimates. The International Whaling Commission's most recent information on estimated abundance. Retrieved March 2016, from https://iwc.int/estimate.

Karl, T., Melillo, J., & Peterson, T. (2009). Global climate change impacts in the United States. *Global climate change impacts in the United States*.

Kastak, D., & Schusterman, R. J. (1998). Low-frequency amphibious hearing in pinnipeds: Methods, measurements, noise, and ecology. *The Journal of the Acoustical Society of America, 103*(4), 13.

Kastak, D., Schusterman, R. J., Southall, B. L., & Reichmuth, C. J. (1999). Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. *The Journal of the Acoustical Society of America, 106*(2), 1142-1148.

Kastelein, R. A., & Jennings, N. (2012). Impacts of anthropogenic sounds on Phocoena phocoena (harbor porpoise) in *The Effects of Noise on Aquatic Life* (pp. 311-315): Springer.

Kujawa, S. G., & Liberman, M. C. (2009). Adding insult to injury: cochlear nerve degeneration after "temporary" noise-induced hearing loss. *The Journal of Neuroscience, 29*(45), 14077-14085.

LGL. (2015). 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. Prepared by LGL Limited environmental research associates. LGL Report FA0041-2. 67.

LGL. (2016). 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 Southeast Pacific Ocean, 2016/2017. Prepared by LGL Limited Environmental Research Associates. LGL Report FA0063-2. 86.

Lin, H. W., Furman, A. C., Kujawa, S. G., & Liberman, M. C. (2011). Primary neural degeneration in the Guinea pig cochlea after reversible noise-induced threshold shift. *Journal of the Association for Research in Otolaryngology, 12*(5), 605-616.

Lucke, K., Siebert, U., Lepper, P. A., & Blanchet, M.-A. (2009). Temporary shift in masked hearing thresholds in a harbor porpoise (Phocoena phocoena) after exposure to seismic airgun stimuli. *The Journal of the Acoustical Society of America, 125*(6), 4060-4070.

Macleod, K., Simmonds, M. P., & Murray, E. (2006). Abundance of fin (Balaenoptera physalus) and sei whales (B. borealis) amid oil exploration and development off northwest Scotland. *Journal of Cetacean Research and Management, 8*(3), 247.

Madsen, P. T., & Møhl, B. (2000). Sperm whales (Physeter catodon L. 1758) do not react to sounds from detonators. *The Journal of the Acoustical Society of America, 107*(1), 668-671.

Malme, C. I., Miles, P. R., Clark, C. W., Tyack, P., & Bird, J. E. (1983). *Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Final report for the period of 7 June 1982 - 31 July 1983* Anchorage, AK. Report No. 5366. 64 pp.

Malme, C. I., Miles, P. R., Clark, C. W., Tyack, P., & Bird, J. E. (1984). *Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior: phase II: January 1984 migration*. (5586). Anchorage, AK. 357 pp.

McCauley, R. D., Fewtrell, J., Duncan, A. J., Jenner, C., Jenner, M.-N., Penrose, J. D., . . . McCabe, K. (2000). Marine Seismic Surveys: Analysis And Propagation of Air-Gun Signals; And Effects of Air-Gun Exposure On Humpback Whales, Sea Turtles, Fishes and Squid. *Rep. from Centre for Marine Science and Technology, Curtin Univ., Perth, Western Australia, for Australian Petrol. Produc. & Explor. Association*, 203 pages.

McCauley, R. D., Jenner, M. N., Jenner, C., McCabe, K. A., & Murdoch, J. (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 Journal, 38*(1), 692-707.

McDonald, M. A., Hildebrand, J. A., & Webb, S. C. (1995). Blue and fin whales observed on a seafloor array in the northeast Pacific. *Journal of the Acoustical Society of America, 98*(2 Part 1), 712-721.

Miller, P. J. O., Biassoni, N., Samuels, A., & Tyack, P. L. (2000). Whale songs lengthen in response to sonar. *Nature, 405*(6789), 903-903.

Nieukirk, S. L., Stafford, K. M., Mellinger, D. K., Dziak, R. P., & Fox, C. G. (2004). Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean. *The Journal of the Acoustical Society of America, 115*(4), 1832-1843.

NMFS. (2013a). Environmental Assessment for the Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Atlantic Ocean, April - June, 2013 (Vol. National Marine Fisheries Service, pp. 36). Silver Spring, MD.

NMFS. (2013b). Environmental Assessment: Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Northeast Atlantic Ocean, June to July 2013 (Vol. National Marine Fisheries Service, pp. 39). Silver Spring, MD.

NMFS. (2014). Environmental Assessment on the Issuance of an Incidental Harassment Authorization to Lamont Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Northwest Atlantic Ocean, June – August, 2014 (Vol. National Marine Fisheries Service, pp. 50). Silver Spring, MD.

NMFS. (2015a). *Proposed Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Eastern Mediterranean Sea, Mid-November – December 2015.* Silver Spring, MD.

NMFS. (2015b). Proposed Issuance of an Incidental Harassment Authorization to Lamont-Doherty Earth Observatory to Take Marine Mammals by Harassment Incidental to a Marine Geophysical Survey in the Northwest Atlantic Ocean, June – August, 2015 (Vol. National Marine Fisheries Service, pp. 54). Silver Spring, MD.

NSF. (2012). National Science Foundation. Record of Decision for marine seismic research funded by the National Science Foundation. June 2012 (pp. 41 pp).

NSF. (2015). Draft Environmental Analysis of a Marine Geophysical Survey by the *R/V Marcus G. Langseth* in the Eastern Mediterranean Sea, November-December, 2015. LGL Report FA0041-1. Revised 24 August 2015 (Vol. National Science Foundation, pp. 107). King City, Ontario: Prepared by LGL Ltd., environmental research associates for the Division of Ocean Sciences.

NSF. (2016). *Draft Environmental Analysis of a Marine Geophysical Survey by the R/V Marcus G. Langseth in the Southeast Pacific Ocean, 2016-2017.* King City, Ontario: LGL Ltd., Environmental Research Associates.

NSF/USGS. (2011). 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 (Vol. National Science Foundation and the U.S. Geological Survey, pp. 801). Arlington, VA.

Parks, S. E., Clark, C. W., & Tyack, P. L. (2007). Short- and long-term changes in right whale calling behavior: The potential effects of noise on acoustic communication. *Journal of the Acoustical Society of America, 122*(6), 3725-3731. doi: 10.1121/1.2799904

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

Peña, H., Handegard, N. O., & Ona, E. (2013). Feeding herring schools do not react to seismic air gun surveys. *ICES Journal of Marine Science: Journal du Conseil*, fst079.

Pirotta, E., Brookes, K. L., Graham, I. M., & Thompson, P. M. (2014). Variation in harbour porpoise activity in response to seismic survey noise. *Biology Letters, 10*(5), 20131090.

Richardson, W. J., Greene, C. R., Malme, C. I., & Thomson, D. H. (1995). *Marine Mammals and Noise*. San Diego, California: Academic Press.

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

Richardson, W. J., Würsig, B., & Greene Jr., C. R. (1986). Reactions of bowhead whales, Balaena mysticetus, to seismic exploration in the Canadian Beaufort Sea. *The Journal of the Acoustical Society of America, 79*(4), 1117-1128.

Risch, D., Corkeron, P. J., Ellison, W. T., & Van Parijs, S. M. (2012). Changes in humpback whale song occurrence in response to an acoustic source 200 km away. *PloS one, 7*(1), e29741.

Schlundt, C. E., J. J. Finneran, B. K. Branstetter, J. S. Trickey, & Jenkins, K. (2013). *Auditory effects of multiple impulses from a seismic air gun on bottlenose dolphins (Tursiops truncatus).* Paper presented at the Twentieth Biennial Conference on the Biology of Marine Mammals Dunedin, New Zealand.

Schlundt, C. R., Finneran, J. J., Carder, D. A., & Ridgway, S. H. (2000). Temporary shift in masked hearing thresholds of bottlenose dolphins, Tursiops truncatus, and white whale, Delphinapterus leucas, after exposure to intense tones. *Journal of the Acoustical Society of America, 107*(6), 3496-3508.

Smultea, M. A., Holst, M., Koski, W. R., & Stoltz, S. (2004). Marine mammal monitoring during Lamont-Doherty Earth Observatory's seismic program in the Southeast Caribbean Sea and adjacent Atlantic Ocean, April-June 2004. LGL Rep. TA2822-26 King City, Ontario.

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Jr., G., . . . Tyack, P. L. (2007). Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals, 33*(4), 411-522.

Southall, B. L., Rowles, T., Gulland, F., Baird, R. W., & Jepson, P. D. (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 (pp. 75): Madagascar.

Thompson, D. R., Sjoberg, M., Bryant, M. E., Lovell, P., & Bjorge, A. (1998). Behavioural and physiological responses of harbour (Phoca vitulina) and grey (Halichoerus grypus) seals to seismic surveys. *Report to European Commission of BROMMAD Project. MAS2 C, 7940098*.

Thompson, P. M., Brookes, K. L., Graham, I. M., Barton, T. R., Needham, K., Bradbury, G., & Merchant, N. D. (2013). Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. *Proceedings of the Royal Society B: Biological Sciences, 280*(1771), 20132001.

Wade, P. R., & Gerrodette, T. (1993). Estimates of cetacean abundance and distribution in the eastern tropical Pacific. *Report of the International Whaling Commission, 43*(477-493).

Weir, C. R. (2008). Short-finned pilot whales (Globicephala macrorhynchus) respond to an airgun ramp-up procedure off Gabon. *Aquatic Mammals, 34*(3), 349-354.

Whitehead, H. (2002). Estimates of the current global population size and historical trajectory for sperm whales. *Marine Ecology Progress Series, 242*, 295-304.