Application for Incidental Harassment Authorization

for the Non-Lethal Taking of Marine Mammals:

Site Characterization Surveys

Lease OCS-A 0519

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Application for Incidental Harassment Authorization for the Non-Lethal Taking of Marine Mammals: Site Characterization Surveys Lease OCS-A 0519

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List of Acronyms

µPa	micropascal
AA	Applied Acoustics
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AWS	Atlantic white-sided (dolphin)
BOEM	Bureau of Ocean Energy Management
CETAP	Cetacean and Turtles Assessment Program
CFR	Code of Federal Regulations
CPT	cone penetration testing
DoN	Department of the Navy
dB	decibel
DMA	Dynamic Management Area
DP	dynamic positioning
DPS	distinct population segment
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
ESA	Endangered Species Act
ESL	sound exposure source level
ET	EdgeTech
FR	Federal Register
GAPS	Global Acoustic Positioning System
HF	high frequency
HRG	high-resolution geophysical
IHA	Incidental Harassment Authorization
ISO	International Organization for Standardization
J	joule
LF	low frequency
MABS	Mid-Atlantic Baseline Studies/Maryland Baseline Studies
MBES	multibeam echosounder
MF	mid frequency
MMPA	Marine Mammal Protection Act
NARWSS	North Atlantic Right Whale Sighting Survey
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
OCS	Outer Continental Shelf
OPR	Office of Protected Resources
PAM	Passive Acoustic Monitoring
PBR	Potential Biological Removal
Project Area	Lease Area and associated export cable corridors
PW	phocid pinniped in water
PSO	Protected Species Observer
PTS	permanent threshold shift
re	referenced to
RPM	Reasonable and Prudent Measure
RWSAS	Right Whale Sighting Advisory System
SAR	Stock Assessment Report
SBP	sub-bottom profiler
SCOT	Screening Out Team

List of Acronyms
(Continued)

SEL_{cum}	cumulative sound exposure level
Skipjack	Skipjack Offshore Energy, LLC
SL	source level
SL_{pk}	zero to peak source level
SL_{rms}	root-mean-square source level
SMA	Seasonal Management Area
SFV	sound field verification
SOC	Standard Operating Condition
SPL	sound pressure level
SPL_{pk}	zero to peak sound pressure level
SPL_{rms}	root-mean-square sound pressure level
SSS	side-scan sonar
TTS	temporary threshold shift
UME	Unusual Mortality Event
USBL	ultra-short baseline
USFWS	U.S. Fish and Wildlife Service
WEA	wind energy area
WFA	weighing factor adjustment
ZOI	zone of influence

1.0 Description of Proposed Activities

The Applicant submits this request for Incidental Harassment Authorization (IHA) pursuant to Section 101(a)(5) of the Marine Mammal Protection Act (MMPA) for the incidental take of small numbers of marine mammals by Level B harassment during site characterization surveys which include high-resolution geophysical (HRG) surveys and geotechnical surveys. The information provided in this document is submitted in response to the requirements of 50 Code of Federal Regulations (CFR) § 216.104 to allow for the incidental harassment of small numbers of marine mammals resulting from the execution of marine site characterization surveys.

1.1 PROJECT DESCRIPTION

Skipjack Offshore Energy, LLC (Skipjack) (Applicant) on its behalf and on behalf of any successors in interest or assignee, submits this application to the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) requesting the issuance of an IHA to allow for the incidental harassment of small numbers of marine mammals resulting from the execution of site characterization surveys. The Applicant is proposing to conduct site characterization surveys (geophysical and geotechnical) within federal waters located in the area of Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS) Lease Area OCS-A 0519 (Lease Area) and along potential submarine cable routes to landfall locations in Maryland and Delaware. **Figure 1** shows the Lease Area and survey boundaries (gray shaded area) for the site characterization surveys, which include potential cable routes (Project Area).

The Applicant proposes to conduct site characterization surveys of the Project Area using active acoustic sources and geotechnical sampling equipment. HRG equipment and geotechnical equipment will be deployed from multiple vessels during the site characterization activities conducted within the wind farm and cable route areas. Up to 3 vessels may survey concurrently on the Lease. The HRG surveys will be conducted between September 30, 2019 and September 29, 2020. Within this 365-day window, a maximum of 200 HRG survey days are expected to be required to complete the site characterization surveys needed. Geotechnical surveys will be conducted throughout the year.

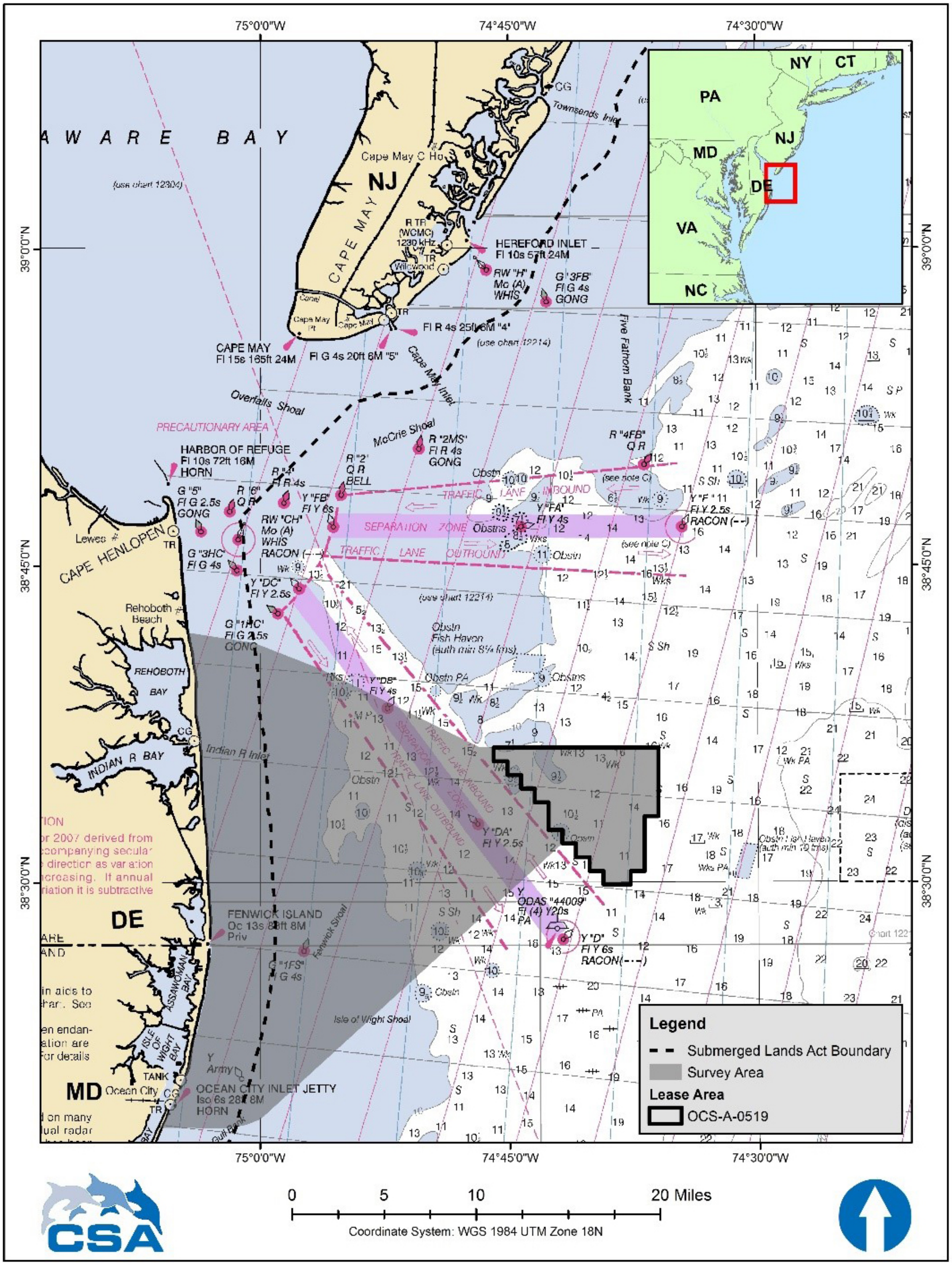

Figure 1. Survey Area for the site characterization surveys.

1.2 ACTIVITIES CONSIDERED IN THIS APPLICATION

Site characterization surveys will include HRG surveys and geotechnical investigations. Only HRG survey activities and geotechnical activities using electromechanical sources are considered in this application. Noise from borehole drilling is not expected to have source levels (SLs) that reach 120 decibel referenced to 1 micropascal meter (dB re 1 µPa m), and noise produced during geotechnical sampling is expected to attenuate to below a root-mean-square sound pressure level (SPL_{rms}) of 120 dB re 1 µPa before the 150-m isopleth (Bureau of Ocean Energy Management [BOEM], 2013). Field studies conducted off the coast of Virginia by Tetra Tech on behalf of Dominion Energy to determine the underwater noise produced by borehole drilling and cone penetration testing (CPT) (e.g., seafloor deployed 200 kN CPT Rig and Seabed CPT) confirmed that these activities do not result in underwater noise levels that are harassing or harmful to marine mammals (Dominion Resources Inc., 2013, 2014; Tetra Tech, 2014; DONG Energy, 2016). Although underwater noise produced by the dynamic positioning (DP) thrusters associated with geotechnical vessels has the potential to reach Level B acoustic threshold levels (DONG, 2016), NMFS determined that with the Standard Operating Conditions (SOCs) and the Reasonable and Prudent Measures (RPMs) as defined in the Biological Opinion dated April 10, 2013 for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic OCS in Massachusetts, Rhode Island, New York and New Jersey Wind Energy Areas resulting from BOEM Endangered Species Act (ESA) consultation (NMFS, 2013), that the proposed construction activities may adversely affect but are not likely to jeopardize the continued existence of threatened or endangered species. Furthermore, the behavioral responses from vessel noise during construction activities are expected to be temporary, or short-term in duration and would not affect the reproduction, survival, or recovery of threatened or endangered species (NMFS, 2013). Therefore, only geophysical survey activities using HRG survey equipment are considered for the take assessment in this application.

All survey activities will utilize the survey methods and acoustic sources identified below. Survey activities will be executed in compliance with the July 2015 BOEM *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585* (BOEM, 2015).

1.2.1 Acoustic Analysis of Activities Considered in this Application

1.2.1.1 Acoustic Terminology

This document follows International Organization for Standardization (ISO) 18405:2017 (ISO, 2017) for all acoustic terminology. Underwater acoustic SLs, exposure levels, and associated measurements are expressed in dB re 1 µPa. In turn, acoustic metrics can be expressed in several ways depending on the quantity being reported. **Table 1** provides a list of the acoustic units used in this document.

Table 1. Acoustic metric definitions and their units used in this document.

Quantity	Abbreviation	Units	Reference
Sound Pressure Levels			
Sound pressure level	SPL	dB re 1 µPa	ISO 18405[1]
Root-mean-square sound pressure level	SPL_{rms}	dB re 1 µPa	ISO 18405[1]
Peak sound pressure level (zero to peak [SPL_{0-pk}] is a synonym)	SPL_{pk}	dB re 1 µPa	ISO 18405[1]
Cumulative sound exposure level	SEL_{cum}	dB re 1 µPa^2 s	ISO 18406[2]
Source Level	SL	dB re 1 µPa m	ISO 18405[1]
Source Level (root-mean-square)	SL_{rms}	dB re 1 µPa m	ISO 18405[1]
Source Level (zero to peak)	SL_{pk}	dB re 1 µPa m	Ainslie, 2010[3]

Table 1. (Continued).

Quantity	Abbreviation	Units	Reference
Source Exposure Source Level	ESL	dB re 1 μPa^2 m^2	Ainslie, 2010[3]

-- = not applicable; dB re 1 μPa = decibel referenced to 1 micropascal.
[1]International Organization for Standardization (ISO). 2017. ISO 18405:2017 Underwater Acoustics – Terminology. International Organization for Standardization, Geneva, Switzerland.
[2]ISO. 2017. ISO 18406:2017 Underwater acoustics – Measurement of radiated underwater sound from percussive pile driving. International Organization for Standardization, Geneva, Switzerland.
[3]Ainslie, M.A. 2010. Principles of sonar performance modeling. Springer-Verlag Heidelberg. 723 pp. DOI 10.1007/978-3-540-87662-5.

1.2.1.2 Regulatory Criteria

The included analysis applies the most recent noise exposure criteria utilized by NMFS Office of Protected Resources (OPR) to estimate acoustic harassment (NMFS, 2018a). The MMPA defines two levels of harassment: Level A harassment is statutorily defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild; Level B harassment is any act of pursuit, torment, or annoyance that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. The NMFS acoustic criteria were developed primarily to address the regulatory requirements of the MMPA when assessing the effect of sound on marine mammal species. In the guidance, NMFS establishes acoustic thresholds that, if exceed, have the potential to cause auditory injury or behavioral disturbance for marine mammals. In 2018, NMFS published a revision to the acoustic guidance for marine mammals for use in impact assessments (NMFS, 2018a).

<u>Hearing Groups</u>

Recognizing that marine mammal species do not have equal hearing capabilities, marine mammals are separated into hearing groups (NMFS, 2018a). There are four hearing groups of the marine mammals potentially occurring in the Project Area:

- Low-frequency (LF) cetaceans – Mysticetes with a collective generalized hearing range of approximately 7 Hz to 35 kHz;
- Mid-frequency (MF) cetaceans – most dolphins, all toothed whales except for *Kogia* spp., and all beaked and bottlenose whales with a generalized hearing range of approximately 150 Hz to 160 kHz;
- High-frequency (HF) cetaceans – all true porpoises and *Kogia* spp. with a generalized hearing range of approximately 275 Hz to 160 kHz; and
- Phocid pinnipeds in water (PW) – all true seals with a generalized hearing range of 50 Hz to 86 kHz.

The 2018 NMFS guidance also defines an otariid pinniped underwater hearing group; however this group does not occur within the Project Area. In addition, NMFS recognizes two main types of sound sources: impulsive and non-impulsive, Non-impulsive sources are further broken down into continuous or intermittent categories. All sources are also categorized as moving or stationary depending on the operation of the source. The sound sources of potential concern during site characterization surveys include stationary non-impulsive sources and moving impulsive sources. The acoustic thresholds are used to establish the ensonified area of received sound pressure level (SPL) or cumulative sound exposure levels (SEL_{cum}) depending on the source type and marine mammal hearing group.

<u>Impact Levels</u>

Level A auditory impacts under the MMPA include permanent threshold shift (PTS), which is a condition that occurs when sound intensity is very high and/or of such long duration that the result is a permanent loss of hearing sensitivity which is an irreversible auditory tissue injury (Southall et al., 2007). Level A thresholds are defined as sound exposures that potentially elicit the onset of a PTS in marine mammal hearing. For impulsive noises, both zero to peak sound pressure level (SPL_{pk}) and SEL_{cum} criteria are identified to account for the intensity of impulsive sounds and the duration required to elicit PTS. Due to difference in acoustic properties of the sources, only the SEL_{cum} metric is used to define the threshold criteria for non-impulsive sounds.

Level B harassment impacts include temporary threshold shift(s) (TTS) and behavioral responses. Compared to PTS, TTS is a lesser impact to hearing. TTS results when sounds of sufficient loudness cause a transient condition in which an animal's hearing sensitivity over the frequency band of exposure is impaired for a period of time (minutes to days). A TTS does not cause permanent damage and is not considered a tissue injury (Richardson et al., 1995; Southall et al., 2007). Similarly, underwater sound may elicit a behavioral response from marine mammals that may or may not be biologically significant. In principle, behavioral thresholds are lower than TTS thresholds. TTS thresholds are defined in the 2018 criteria; however, TTS thresholds and behavioral response thresholds have not yet been separated within a regulatory framework and are all considered Level B harassment. NMFS currently uses an unweighted root-mean-square SPL (SPL_{rms}) to assess Level B behavioral impacts (NMFS, 2012, 2018a).

Currently, the regulatory framework uses interim guidance to define Level B thresholds (NMFS, 2012). The corresponding Level A and Level B acoustic threshold criteria are summarized in **Table 2**.

Table 2. Summary of interim (2012) and 2018 National Marine Fisheries Service (NMFS) regulatory levels for Level A and Level B acoustic exposure from impulsive and non-impulsive sources.

Marine Species Acoustic Threshold Levels for Impulsive and Non-Impulsive Sources					
Source Type	Non-Impulsive		Impulsive - Peak		Impulsive - Exposure
Functional Group	Level B[1]	Level A[2]	Level B[1]	Level A[3]	Level A[2]
Low-Frequency Cetacean	120‡	199†	160‡	219†	183†
Mid-Frequency Cetacean		198†		230†	185†
High-Frequency Cetacean		173†		202†	155†
Phocid Seals (in water)		201†		218†	185†

[1]Units expressed as SPL_{rms} in dB re 1 µPa.
[2]Units expressed as SEL_{cum} in dB re 1 µPa^2 s (weighted).
[3]Units expressed as SPL_{pk} in dB re 1 µPa (unweighted).
µPa = micropascal; dB = decibel; SEL_{cum} = cumulative sound exposure level; SPL_{pk} = zero to peak sound pressure level; SPL_{rms} = root-mean-square sound pressure level.
‡ NMFS. 2012. Marine Mammal Acoustic Thresholds. Internet website: https://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html. Accessed 1 July 2019.
†NMFS. 2018. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. NOAA Technical Memorandum NMFS-OPR-59. 167 pp.

1.3 SURVEY EQUIPMENT

HRG surveys will use the equipment categories described below:

Shallow Penetration Sub-bottom Profilers (SBP; Chirps) to map the near-surface stratigraphy (top 0 to 5 m) of sediment below seabed). A chirp system emits sonar pulses that increase in frequency from about 2 to 20 kHz over time. The pulse length frequency range can be adjusted to meet project variables. Typically mounted on the hull of the vessel or from a side pole.

Medium Penetration SBPs (Boomers) to map deeper subsurface stratigraphy as needed. A boomer is a broad-band sound source operating in the 3.5 Hz to 10 kHz frequency range. This system is commonly mounted on a sled and towed behind the vessel.

Medium Penetration SBPs (Sparkers) to map deeper subsurface stratigraphy as needed. Sparkers create acoustic pulses from 50 Hz to 4 kHz omnidirectionally from the source that can penetrate several hundred meters into the seafloor. Typically towed behind the vessel with adjacent hydrophone arrays to receive the return signals.

Parametric SBPs, also called sediment echosounders, for providing high data density in sub-bottom profiles that are typically required for cable routes, very shallow water, and archaeological surveys. Typically mounted on the hull of the vessel or from a side pole.

Acoustic Cores to provide multi-aspect acoustic intensity imaging to delineate sub-seabed stratigraphy and buried geohazards. Although acoustic cores are used for geotechnical investigations, they operate acoustic sources (chirps and a parametric sonar) to achieve the data collection. They are stationary sources mounted on the seafloor approximately 3.5 m (11.5 ft) above the seabed.

Ultra-Short Baseline (USBL) Positioning and Global Acoustic Positioning System (GAPS) to provide high accuracy ranges by measuring the time between the acoustic pulses transmitted by the vessel transceiver and a transponder, or beacon, necessary to produce the acoustic profile. It is a two-component system with a hull or pole mounted transceiver and one to several transponders mounted either on the seabed or on other survey equipment.

Multibeam Echosounders (MBES) to determine water depths and general bottom topography. MBES sonar systems project sonar pulses in several angled beams from a transducer mounted to a ship's hull. The beams radiate out from the transducer in a fan-shaped pattern orthogonally to the ship's direction.

Side-scan Sonar (SSS) for seabed sediment classification purposes and to identify natural and man-made acoustic targets on the seafloor. The sonar device emits conical or fan-shaped pulses down toward the seafloor in multiple beams at a wide angle, perpendicular to the path of the sensor through the water. The acoustic return of the pulses is recorded in a series of cross-track slices, which can be joined to form an image of the sea bottom within the swath of the beam. Typically towed beside or behind the vessel or from an autonomous vehicle.

The operational parameters (e.g., operating frequency, SL, pulse duration, ping rate) for each piece of equipment, as well as the output parameters (e.g., SPLs, propagation distance, frequency content) are generally similar within each category and therefore the overall magnitude of impact radii can often be predicted based on the equipment category (Crocker and Fratatonio, 2016).

The operational parameters for each piece of equipment are typically provided as a range of options that can be specified by the user. The precise settings are often field-specific depending on each contractor's individual survey methodologies and data needs. The selected parameters will affect the impact analysis for each piece of equipment within each category; therefore, the parameters used in the analysis must be as closely aligned as possible with the expected operation at the time of the survey. This information helps determine the expected acoustic output for this project by selecting the appropriate measurements reported in Crocker and Fratantonio (2016). For equipment that were not measured by Crocker and Fratantonio (2016), manufacturer information was used with the most applicable operational parameters reported during *in situ* measurements previously collected by the Applicant through lease stipulated sound field verification (SFV) surveys and are used to estimate the acoustic output.

SFV measurements were conducted by the Applicant on this Lease and other wind farm areas between 2015 and 2018. The SFV reports used in this acoustic assessment were provided to NMFS under separate cover. **Table 3** provides the SFV references, date conducted, Lease area in which it was completed, and the equipment tested. However, due to significant variation in SFV methodologies and SFV reporting NMFS OPR provided supplemental guidance to the Applicant in July, 2019, which did not allow the use of SFV results. Because there are no standardized field measurements for HRG survey equipment, NMFS recommended that the controlled measurements provided in Crocker and Fratantonio (2016) be the primary reference for equipment source levels (SLs) with manufacturer information supplementing for equipment that was not measured in the Crocker and Fratantonio (2016) study. Where applicable, SFV measurements are provided in equipment descriptions to supplement the data used in the analysis; however, SFV measurements were not used to define SLs or acoustic threshold distances.

Table 3. Sound field verification (SFV) measurements conducted on Applicant wind farm leases or other locations.

Reference	Date	Lease Area	Equipment
MAI, 2018a	3-Aug-2018	OCS-A-0482	*EdgeTech 512i* Chirp
MAI, 2018b	21-Aug-2018	OCS-A-0482	*Sonardyne RovNav5* Acoustic Release; *Applied Acoustics* S-Boom (700 J & 1000 J); *EdgeTech 2000*-DSS (combined side-scan sonar and sub-bottom profiler); *IXSEA GAPSII* USBL
Subacoustech & EPI, 2018	13-Jul-2018	OCS-A-0498	*Innomar SES2000* Medium parametric SBP
NCE & RPS, 2018	28-May-2018	Not Reported	*Applied Acoustics* Triple Plate S-Boom (1000 J)
Pangeo Subsea, 2018	2-April-2018	Not within Lease	*Pangeo* Acoustic Corer
Subacoustech & EPI , 2017[1]	15/16-Jul-2017	OCS-A-0486	*EdgeTech 3200XS Chirp*; *Reson 7101* MBES; *EdgeTech 4200* SSS; *Applied Acoustics Dura Spark*
Gardline Technical Memo (undated)[2]	18-Aug-2016	OCS-A-0500	*Sonardyne Ranger 2* USBL; *GeoPulse* SBP; *Geo-Source* 600 J Sparker; *GeoSource* 800 J Sparker

J = joule; MAI = Marine Acoustics, Inc.; MBES= multibeam echosounder; NCE = Noise Control Engineering; OCS = Outer Continental Shelf; RPS = RPS Group PLC; SBP = sub-bottom profiler; SSS= side-scan sonar; USBL = ultra-short baseline positioning beacons and transponders.

[1]Operating parameters were not recorded and apparent peak source levels for non-impulsive sources were provided with no scatter plots or raw data, rendering most of the SFV information unusable for equipment source level purposes; however, distances to several impact isopleths for some equipment were well-reported.

[2]A technical memorandum was generated after agency consultation on 3-Apr-2017 to clarify SFV measurements reported in an SFV report submitted on 9-Dec-2016 by Gardline. Due to technical issues with the report, data were reanalyzed and updated in the technical memorandum (L. Morse, Ørsted, pers. Comm.).

References:

MAI. 2018a. Sound Source Verification: EdgeTech 512i chirp sonar supporting Deepwater Wind's Skipjack Wind Farm Project off Maryland and Delaware. MAI 1046, TN 18-025.

MAI. 2018b. Sound Source Verification: supporting Deepwater Wind's Skipjack Wind Farm Project off Maryland and Delaware. MAI 1046. TN 18-027.

NCE and RPS Group. 2018. HRG Survey Equipment Acoustic Field Verification Report. Prepared for Terrasond on behalf of Ørsted. Report by RPS and Noise Control Engineering, May 28, 2018.

Pangeo Subsea. 2018. Acoustic corer sound source analysis and environmental impact for South Fork Wind Farm. RPT-08082-1. April 2, 2018. 56 pp.

Subacoustech. 2017. Deepwater Wind Sound Source Verification. Unpublished (commercial in confidence) report submitted to Deepwater Wind, LLC. 17 July 2017. 20 pp.

Subacoustech. 2018. Sound source verification for high resolution geophysical survey equipment, Fugro Enterprise. Subacoustech Environmental Report P236R0202. Submitted to Fugro on 28 May 2018.

Although, the final equipment choices will vary depending on the final survey design, vessel availability, make and model updates, and survey contractor selection, all sources that are representative of those that could be employed during the HRG surveys are provided in **Table 4** along with details of the parameters used in acoustic analyses within this Application.

Table 4. List of all representative geophysical sound sources that may be used during the site characterization surveys that were assessed for potential acoustic impacts. All source information that was used to calculate threshold isopleths are provided in the table.

Equipment	Source Type	Frequency used for WFA in User Spreadsheets	Reference for SL	Operational Parameters					
			CF= Crocker and Fratantonio (2016) **MAN** = Manufacturer	Operating Frequency (kHz)	SL_{rms} (dB re 1 µPa m)	SL_{pk} (dB re 1 µPa m)	Pulse Duration (Width) (millisecond)	Repetition Rate (Hz)	Beam Pattern(degrees)
Shallow Sub-bottom Profilers (Chirps)									
Teledyne Benthos Chirp III - TTV 170	Non-impulsive, mobile, intermittent	2	MAN	2–7	197	-	5–60	15	100
EdgeTech SB 216 (2000DS or 3200 top unit)	Non-impulsive, mobile, intermittent	2	MAN	2–16 2–8	195	-	20	6	24
EdgeTech 424	Non-impulsive, mobile, intermittent	4	CF	4–24	176	-	3.4	2	71
EdgeTech 512	Non-impulsive, mobile, intermittent	0.7	CF	0.7–12	179	-	9	8	80
GeoPulse 5430A	Non-impulsive, mobile, intermittent	2	MAN	2–17	196		50	10	55
Parametric Sub-bottom Profilers									
Innomar SES-2000 Medium 100 SBP	Non-impulsive, mobile, intermittent	85	MAN	85–115	247	-	0.07–2	40–100	1–3.5
Innomar SES-2000 Standard & Plus	Non-impulsive, mobile, intermittent	85	MAN	85–115	236	-	0.07–2	60	1–3.5
Innomar SES-2000 Medium 70	Non-impulsive, mobile, intermittent	60	MAN	60–80	241	-	0.1–2.5	40	1–3.5
Innomar SES-2000 Quattro	Non-impulsive, mobile, intermittent	85	MAN	85–115	245	-	0.07–1	60	1–3.5
Medium Sub-bottom Profilers (Sparkers and Boomers)									
GeoMarine Geo-Source 800J Sparker	Impulsive, Mobile	0.5	CF Proxy (ELC820 sparker)[1]	0.05–5	203	213	3.4	0.41	Omni
GeoMarine Geo-Source 600J Sparker	Impulsive, Mobile	0.2	CF Proxy (ELC820 sparker)[1]	0.2–5	201	212	5.0	0.41	Omni
GeoMarine Geo-Source 400J Sparker	Impulsive, Mobile	0.2	CF Proxy (ELC820 sparker)[1]	0.2–5	195	208	7.2	0.41	Omni
GeoResource 800J Sparker System	Impulsive, Mobile	1.9	CF Proxy (ELC820 sparker)[1]	0.05–5	203	213	3.4	0.41	Omni

Table 4. (Continued).

Equipment	Source Type	Frequency used for WFA in User Spreadsheets	Reference for SL	Operational Parameters					
			CF= Crocker and Fratantonio (2016) **MAN** = Manufacturer	Operating Frequency (kHz)	SL_{rms} (dB re 1 µPa m)	SL_{pk} (dB re 1 µPa m)	Pulse Duration (Width) (millisecond)	Repetition Rate (Hz)	Beam Pattern(degrees)
Applied Acoustics Duraspark 400[2]	Impulsive, Mobile	0.3	CF	0.3–1.2	203	211	1.1	0.4	Omni
Applied Acoustics triple plate S-Boom (700–1000J)[3]	Impulsive, Mobile	0.1	CF	0.1–5	205	211	0.6	3	80
Acoustic Corers									
PanGeo (LF Chirp)	Non-impulsive, stationary, intermittent	2	MAN	2–6.5	177.5	-	4.5	0.06	73
PanGeo (HF Chirp)	Non-impulsive, stationary, intermittent	4.5	MAN	4.5–12.5	177.5	-	4.5	0.06	73
Pangeo Parametric Sonar[4]	Non-impulsive, stationary, intermittent	102	MAN	90–115	239	-	0.25	40	3.5
Positioning Systems									
Sonardyne Ranger 2 - Transponder	Non-impulsive, mobile, intermittent	26	MAN	19–34	194	-	5	1	Omni
Sonardyne Ranger 2 USBL HPT 3000/5/7000 Transceiver	Non-impulsive, mobile, intermittent	26	MAN	19–34	194	-	5	1	Not Reported
Sonardyne Scout Pro Transponder	Non-impulsive, mobile, intermittent	42.5	MAN	35–50	188	-	5	3	Not Reported
IxSea GAPS Beacon System	Non-impulsive, mobile, intermittent	8	MAN	8–16	188		12	1	Omni
Easytrak Nexus 2 USBL Transceiver	Non-impulsive, mobile, intermittent	18	MAN	18–32	192		5	2	Omni
Kongsberg HiPAP 501/502 USBL Tranceiver	Non-impulsive, mobile, intermittent	27	MAN	27–30.5	190		2	1	15
EdgeTech BATS II Transponder	Non-impulsive, mobile, intermittent	17	MAN	17–30	Not Reported		5	3	Not Reported
Multi-beam and Side Scan Sonar (All equipment scanned out of analysis due to operational frequencies above 200 kHz)									
Reson SeaBat 7125 Multibeam Echosounder	Non-impulsive, mobile, intermittent	-	-	200 or 400	220	-	0.03–0.3	-	-
RESON 700	Non-impulsive, mobile, intermittent	-	-	200 or 400	162	-	0.33	-	-

Table 4. (Continued).

Equipment	Source Type	Frequency used for WFA in User Spreadsheets	Reference for SL	Operational Parameters					
			CF= Crocker and Fratantonio (2016) **MAN** = Manufacturer	Operating Frequency (kHz)	SL_{rms} (dB re 1 µPa m)	SL_{pk} (dB re 1 µPa m)	Pulse Duration (Width) (millisecond)	Repetition Rate (Hz)	Beam Pattern(degrees)
R2SONIC	Non-impulsive, mobile, intermittent	-	-	200 or 400	162	-	0.11	-	-
Klein 3900 SSS	Non-impulsive, mobile, intermittent	-	-	>445 kHz	242	-	0.025	-	-
EdgeTech 4000 & 4125 SSS	Non-impulsive, mobile, intermittent	-	-	410 kHz	225	-	10	-	-
EdgeTech 4200 SSS	Non-impulsive, mobile, intermittent	-	-	>300 kHz	215	-	0.025	-	-

"-" = not applicable or reportable; dB re 1 µPa m = decibel referenced to 1 micropascal meter; GAPS = Global Acoustic Positioning System; HF = high-frequency; LF = low-frequency; omni = omnidirectional source; SBP = sub-bottom profiler; SL_{pk} = zero to peak source level; SL_{rms} = root-mean-square source level; SSS = side scan sonar; USBL = ultra-short baseline; WFA = weighting factor adjustment.

[1] ELC820 sparker measured in Crocker and Fratantonio (2016) represents the most applicable model and operating parameters to the 400-, 600-, and 800- J sparkers expected for use during surveys.

[2] The Dura-Spark setting for analysis used the Crocker and Fratantonio (2016) measurement results for operating at 500J with 400 tips; this is the most applicable setting for the operations expected during the survey.

[3]Crocker and Fratantonio (2016) provide S-boom measurements using two different power sources (CSP-D700 and CSP-N). The CSP-D700 power source was used in the 700J measurements but not in the 1000J measurements. The CSP-N source was measured for both 700J and 1000J operations but resulted in a lower source levels; therefore, the single maximum source level value was used for both operational levels of the S-boom.

[4]The Pangeo acoustic corer parametric sonar was scanned out of further analysis due to high frequency content, operational beam width of less than eight degrees, and stationary operational position of less than 3.5 m above the seabed (Pangeo Subsea, 2018).

Crocker, S.E., and F.D Fratantonio. 2016. Characteristics of sounds emitted during high-resolution marine geophysical surveys. NUWC-NPT Technical Report 12,203. 24 March 2016. 266 pp.

Pangeo Subsea. 2018. Acoustic corer sound source analysis and environmental impact for South Fork Wind Farm. RPT-08082-1. April 2, 2018. 56 pp.

1.4 Distances to Regulatory Acosutic Thresholds

Operational SLs and operational parameters will vary throughout the survey and therefore a level of judgement is required to establish appropriate parameters and SLs to estimate the distances to regulatory thresholds. Typically, field-measured data is considered the best available science for HRG sources due to the highly site- and result- specific variables that direct frequency content, power, beamwidths, and other user-defined parameters. The same equipment used in a deep-water, clay bottom environment may be operated very differently, and therefore produce different acoustic propagation characteristics, than if it were operated in a shallow-water, sand bottom environment. However, recent communication with NMFS OPR indicates that, due to inconsistencies in field verifications conducted on existing wind leases, Crocker and Fratantonio (2016) measurements are preferable to field measurement results. Therefore, the following hierarchy was used for selecting input to the NMFS User Spreadsheet (NMFS, 2018b) and transmission loss equations:

- For equipment that was measured in Crocker and Fratantonio (2016), the reported SL for the most likely operational parameters was selected;

- For equipment not measured in Crocker and Fratantonio (2016) the best available manufacturer specifications were selected. Use of manufacturer specifications represent the absolute maximum output of any source and do not adequately represent the operational source and therefore should be considered an overestimate of the sound propagation range for that equipment; and

- For equipment that was not measured in Crocker and Fratantonio, and did not have sufficient manufacturer information, the closest proxy source measured in Crocker and Fratantonio (2016) was used.

Because impulsive sources use dual metrics, SEL_{cum} and SPL_{pk}, for Level A exposure criteria, the metric resulting in the largest isopleth distance was used to determine the ZOI for exposure estimation. Weighting factor adjustments (WFAs) for Level A isopleths, used to account for differences in marine mammal hearing, were determined by examining the frequency range and spectral densities for each source and comparing it to the Applicable Frequencies Table located in the WFA tab of the NMFS User Spreadsheet (NMFS, 2018b). If the determined frequency was lower than the applicable frequency for all hearing groups, it was entered as the WFA. When the frequency of a source exceeded the applicable frequency for a certain hearing group, an additional worksheet was created that applied the “use” frequency of the exceeded hearing group as indicated by NMFS (NMFS, 2018b).

The User Spreadsheet does not calculate distances to Level B thresholds; instead, the range to the Level B thresholds was determined by applying spherical spreading loss to the SL for that equipment. The operational depth and directionality can greatly influence how the sound propagates and the resulting isopleth distance, so these parameters were considered for sources that had reported beamwidths. Surface-towed omni-directional sources (e.g., sparkers, boomers) and equipment with wide (>180°) reported beamwidths are expected to propagate further in the horizontal direction and produce larger ensonified fields. For these sources, the rate of transmission loss was estimated using spherical spreading loss to calculate the distance to the Level B threshold.

Sources that project a narrow beam, often in frequencies above 10 kHz directed at the seabed are expected to have smaller isopleths and less horizontal propagation due to the directionality of the source and faster attenuation rate of higher frequencies. Narrow beamwidths allow geophysical equipment to be highly directional, focusing its energy in the vertical direction and minimizing horizontal propagation, which greatly reduces the possibility of direct path exposure to receivers (i.e., marine mammals) from sounds emitted by these sources. Therefore, for sources with beamwidths less than 180°, isopleth distances were calculated following NMFS OPR interim guidance (July 2019) to account for the influence of beamwidth and frequency on the horizontal propagation of these sources.

The operational characteristics and supplemental source information considered in the analyses for this Application, as well as justification for selected proxy equipment categories are provided below. The estimated distances to Level A and Level B isopleths calculated for each marine mammal hearing group are given in **Table 5**.

USBL and GAPS: There are no relevant information sources or measurement data within the Crocker and Fratantonio (2016) reference for USBLs, and limited manufacturer SL_{rms} information. USBL systems have two components, a hull- or pole-mounted transceiver and a separate transponder on the seafloor or built in with the other equipment. The transceiver may have a wide (>180°) or narrow beamwidth depending on the utility. Because of the variability in positioning systems, the maximum omnidirectional output was used for isopleth calculations. This approach is likely highly conservative given the typical placement of the transceiver directly on or beside the vessel and the directionality of the transponders.

Parametric SBPs: There are no relevant information sources or measurement data within the Crocker and Fratantonio (2016) reference for parametric SBPs. Source information is available from the manufacturer; however, no field measurements or propagation characteristics are provided with the manufacturer specifications. Due to the highly specialized nature of these sonars (high frequencies and narrow beamwidth) the source information alone is not sufficient in fully evaluating the expected propagation. Like the USBLs, the parametric sonars are hull- or side pole-mounted and not towed behind the vessel. This configuration significantly reduces the likelihood of the beam intersecting an animal.

The Innomar SES-2000 SBP use the principle of "parametric" or "nonlinear" acoustics to generate short, very narrow-beam sound pulses at very high frequencies (generally around 100 kHz). The transducer projects a beamwidth of approximately 1° to 3.5°. The narrow beamwidth significantly reduces the impact range of the source while the high frequencies of the source are rapidly attenuated in sea water, both aspects of which are typically not well-captured in the NOAA user spreadsheets used to calculate Level A isopleths. Therefore, the manufacturer reported SL_{rms} was converted to sound exposure source level (ESL) then exposure distances were calculated for each hearing group following guidance provided by NMFS OPR (July 2019) which considers both the beamwidth and frequency absorption as previously mentioned.

Pangeo Acoustic Corer: Unlike the other geophysical sources which are mobile sources, acoustic corers are stationary and made up of three distinct sound sources comprised of high frequency parametric sonar, a high frequency chirp sonar, and a low frequency chirp sonar; with each source having its own transducer. The corer is seabed-mounted so that SFVs conducted on similar towed equipment are unlikely to be fully comparable.

The beam width of the parametric sonar is narrow (3.5° - 8°) and the sonar is operated roughly 3.5 m (11.5 ft) above the seabed with the transducer pointed directly downwards. This configuration represents the expected operation of the acoustic corer during the survey to maximize the energy channeled into the seabed and subsequently results in nominal horizontal propagation. There are no relevant information sources or measurement data within the Crocker and Fratantonio (2016) reference for acoustic corers, however an acoustic assessment, similar to an SFV, and a modeling assessment was conducted for the acoustic corer by the manufacturer. The modeling assessment showed much larger propagation distances than those that were measured in the field (Pangeo Subsea, 2018), further demonstrating the significant reduction in operational propagation distances for these highly directional, seabed mounted sources. Based on the configuration and operational parameters of the parametric sonar used in the acoustic corer, it is not expected to propagate to any threshold SPLs appreciably; therefore only the LF and HF chirps are considered in the impact analysis.

Shallow SBPs (Chirps): Crocker and Fratantonio (2016) tested two chirps, the EdgeTech (ET) models 424 and 512i. SFVs were completed on four chirps: the ET 216 with a 2000DS top side unit, the ET 512, the ET 216 with a 3200 top side unit, and the GeoPulse 5430A. SFVs for this group measured a maximum SPL_{rms} of 153 dB re 1 µPa at 30 m.

Medium SBPs (Boomer/Sparkers): Crocker and Fratantonio (2016) measurements are available for two identical equipment models proposed for the survey (Applied Acoustics [AA] Duraspark and AA S-boom) and one comparable equipment model (ELC820 sparker). SFVs for this group measured a maximum SPL_{rms} of 177 dB re 1 µPa at 35 m from the source.

MBES and SSS: SFVs were conducted for one MBES and one SSS; Crocker and Fratantonio (2016) provide measurements for several makes and models of the MBES and SSS. Geophysical and geotechnical equipment were reviewed along with the Screening Out Team (SCOT) assessment conducted by BOEM for geotechnical and geophysical surveys in the Gulf of Mexico (BOEM, 2017). In this review, sources with operating frequencies above 180 kHz were strongly recommended to be screened out of impact assessments because they typically operate at frequencies above marine mammal hearing thresholds and only a small portion of the signal energy could be within marine mammal hearing ranges. Other sources that were strong candidates for being screened out were those that operate within marine mammal frequency bands but have low SLs (a single pulse at less than 200 dB re 1 µPa m) (BOEM, 2017). All the proposed SSS and MBES sources have operating frequencies above 200 kHz and are therefore scanned out of the equipment as having the potential to produce acoustic impacts to marine mammal. These sources are not discussed further in this Application.

Sources will be operated at varied power levels throughout a survey in order to maximize the desired output data and compensate for environmental conditions and interactions with other equipment. Therefore, while full or near-full power operations of the equipment is assumed, the actual operational level, and subsequently the SLs, could vary throughout the survey.

Table 5. Maximum distance to calculated weighted Level A and unweighted Level B thresholds for each sound source or comparable sound source category† for all marine mammal hearing groups.

Source	Distance to Level A Threshold (m)					Distance to Level B (m)
	LF	MF	HF (SEL_{cum})	HF (SPL_{pk})	PW	All
Shallow Sub-bottom Profilers						
TB Chirp III	<1	0	<1	-	<1	48
ET 216 Chirp	<1	0	<1	-	0	9
ET 424 Chirp	0	0	0	-	0	4
ET 512i Chirp	0	0	0	-	0	6
GeoPulse 5430	<1	0	<1	-	0	21
Parametric Sub-bottom Profilers						
Innomar Parametric SBPs[1]	<1	<1	1.2	-	<1	1
Medium Sub-bottom Profilers						
AA Triple plate S-Boom (700/1000J)	<1	0	0	2.8	0	34
AA Dura-Spark 400	<1	0	0	2.8	0	141
GeoSource 400 J Sparker	<1	0	0	2.0	0	56
GeoSource 600 J Sparker	<1	0	<1	3.2	<1	112
GeoSource 800 J Sparker	<1	0	<1	3.5	<1	141
Acoustic Corers						
Pangeo Acoustic Corer (LF Chirp)	<1	0	<1	-	0	4
Pangeo Acoustic Corer (HF Chirp)	<1	0	<1	-	0	4
Acoustic Positioning						
USBL and GAPS (all models)	0	0	<1	-	0	50

†The Level A and B isopleths were calculated to comprehensively assess the potential impacts of the predicted source operations as required for this Application. However, as described in Section 5.0, Level A takes are not expected.
- = not applicable; AA = Applied Acoustics; ET = EdgeTech; GAPS = Global Acoustic Positioning System;
HF = high-frequency; J = joules; LF= low-frequency; MF = mid-frequency; PW = Phocids in water; SBP = sub-bottom profiler; SEL_{cum} = cumulative sound exposure level in decibel referenced to 1 micropascal squared second; SPL_{pk} = zero to peak sound pressure level in decibel referenced to 1 micropascal; TB = teledyne benthos; USBL = ultra-short baseline.
[1]The level A distances for the Innomar parametric sonar are based on ESL and use beamwidth and frequency absorption factors (NMFS OPR guidance July 2019) rather than the NOAA User Spreadsheet.

1.4.1 Environmental Assessments of Site Characterization Geophysical Sources

The operation of certain geophysical equipment has the potential to cause acoustic harassment to marine species, in particular marine mammals (NMFS, 2018a). Operating mode, frequency, and beam direction all affect sound propagation. Site characterization geophysical sources were addressed extensively in the

Environmental Assessment (EA) prepared by BOEM for site assessment activities on the Atlantic OCS offshore New Jersey, Delaware, Maryland, and Virginia (Mid-Atlantic EA) (BOEM, 2012) as well as an EA prepared by BOEM for wind leases on the Atlantic OCS offshore Rhode Island and Massachusetts (RI-MA EA) (BOEM, 2013).

The Mid-Atlantic EA (BOEM, 2012) refers to an acoustic evaluation conducted by Cape Wind Associates for its project on Horseshoe Shoal offshore Massachusetts to estimate the distances to the 180 and 160 dB re 1 µPa SPL_{rms} isopleths produced by site characterization survey sources. No references are supplied for this acoustic evaluation; however, it is assumed to be the sound source verification study conducted by Jasco Applied Sciences within Nantucket Sound between 6 and 7 July 2012 (Martin et al., 2012). The RI-MA EA (BOEM, 2013) used modeled sound information from the then-draft *Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas: Programmatic Environmental Impact Statement*, which was finalized in 2014 (BOEM, 2014), and represents a more applicable acoustic analysis for the mid-Atlantic region.

The modeled area of ensonification for some geophysical survey equipment showed potential Level B thresholds at distances beyond what BOEM considered could be effectively (visually)monitored from a vessel for the presence of marine mammals. However, NMFS determined that with SOCs and RPMs, as defined in the Biological Opinions dated April 10, 2013 for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic OCS in Massachusetts, Rhode Island, New York, and New Jersey Wind Energy Areas (WEAs), and the July 19, 2013 Biological Opinion for Programmatic Geological and Geophysical Activities in the Mid and South Atlantic Planning Areas from 2013 to 2020 resulting from BOEM ESA consultation, that the proposed geophysical surveys may adversely affect but are not likely to jeopardize the continued existence of threatened or endangered species. Furthermore, the behavioral responses from geophysical and geotechnical activities are expected to be temporary and would not affect the reproduction, survival, or recovery of threatened or endangered species.

2.0 Survey Dates, Duration, and Specific Geographic Region

2.1 SURVEY ACTIVITY DATES AND DURATION

Site characterization surveys will occur between October 1st, 2019 and September 30th, 2020. During this 365-day period, geophysical surveys will be conducted for up to 200 days. Survey operations are proposed to be conducted 24 hours per day to minimize the overall duration of survey activities and the associated period of potential impact on marine species.

2.2 SPECIFIC GEOGRAPHIC REGION

The Applicant's survey activities will occur within the Project Area in federal waters in the Lease Area and along potential export cable routes to landfall locations in Delaware and Maryland, as shown in **Figure 1**. The Lease Area is approximately 106.6 km^2 (26,341 acres) and is within the Delaware WEA of BOEM's Mid-Atlantic planning area. Water depths in the Lease Area range from 19 to 40 m (62 to 131 ft). Water depths along the submarine cable corridor in federal waters range from 12 to 28 m (39 to 92 ft). The closest point to shore is approximately 18 km (11 mi) due east from Rehoboth Beach, Delaware.

2.3 SURVEY ACTIVITIES

The geophysical survey will be conducted within the Lease Area and along export cable routes (**Figure 1**). Geophysical survey activities will include multibeam depth sounding, seafloor imaging, and shallow and medium penetration sub-bottom profiling using combinations of the equipment listed in **Table 4** to meet BOEM requirements as set out in the *2015 Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585* (BOEM, 2015).

Geophysical surveys are expected to use several equipment types concurrently in order to collect multiple aspects of geophysical data along one transect. Selection of equipment combinations is based on specific survey objectives. Field operation modes of each source are based on survey parameters and ongoing modification due to field conditions and data quality constraints.

3.0 Species and Numbers of Marine Mammals

3.1 PROTECTED POPULATIONS

All marine mammal species are protected under the MMPA. Some marine mammal stocks (defined as a group of nonspecific individuals that are managed separately) (Hayes et al., 2019) may be designated as strategic under the MMPA, which requires the jurisdictional agency (NMFS or U.S. Fish and Wildlife Service [USFWS]) to impose additional protection measures.

A stock is considered strategic if:

- Direct human-caused mortality exceeds its Potential Biological Removal (PBR) level (defined as the maximum number of animals, not including natural mortality, that can be removed from the stock while allowing the stock to reach or maintain its optimum sustainable population level);
- It is listed under the ESA;
- It is declining and likely to be listed under the ESA; or
- It is designated as depleted under the MMPA.

A depleted species or population stock is defined by the MMPA as any case in which:

- The Secretary, after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals established under MMPA Title II, determines that a species or population stock is below its optimum sustainable population;
- A State, to which authority for the conservation and management of a species or population stock is transferred under Section 109 of the MMPA, determines that such species or stock is below its optimum sustainable population; or
- A species or population stock is listed as an endangered species or a threatened species under the ESA.

Some species are further protected under the ESA. Under the ESA, a species is considered endangered if it is "in danger of extinction throughout all or a significant portion of its range." A species is considered threatened if it "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."

3.2 MARINE MAMMAL SPECIES

There are 36 species (comprising 37 stocks) of marine mammals in the western North Atlantic OCS Region that are protected by the MMPA (**Table 6**) (BOEM, 2012). The marine mammal assemblage comprises 31 species cetaceans, including 25 members of the suborder Odontoceti (toothed whales, dolphins, and porpoises) and 6 of the suborder Mysticeti (baleen whales). There are five whale species listed as endangered under the ESA with ranges that include the Project Area:

- Fin whale (*Balaenoptera physalus*);
- Sei whale (*Balaenoptera borealis*);
- Blue whale (*Balaenoptera musculus*);
- North Atlantic right whale (*Eubalaena glacialis*);
- Sperm whale (*Physeter macrocephalus*).

Along with cetaceans, seals are also protected under the MMPA; four species of phocids (true seals) with ranges that include the Project Area include harbor seals (*Phoca vitulina*), gray seals (*Halichoerus grypus*), harp seals (*Pagophilus groenlandicus*), and hooded seals (*Cystiphora cristata*) (Waring et al., 2008). Finally, one species of sirenian, the Florida manatee (*Trichechus manatus*), is an occasional visitor to the region during summer months (USFWS, 2019). The manatee is listed as threatened under the ESA and is protected under the MMPA along with the other marine mammals.

The expected occurrence of each species is based on the following criteria and/or on the habitat models (i.e., Best et al., 2012; Roberts et al., 2016; Roberts, 2018) for the Project Area and for species available in the model analyses:

- Common – occurring consistently in moderate to large numbers;
- Regular – occurring in low to moderate numbers on a regular basis or seasonally;
- Uncommon – occurring in low numbers or on an irregular basis;
- Rare – records for some years but limited; and
- Not expected – range includes the Project Area but due to habitat preferences and distribution information, species are not expected to occur in the Project Area although records may exist for adjacent waters.

The protection status, stock identification, occurrence, and abundance estimates of the species listed in **Table 6** are discussed in more detail in **Section 4.0**.

Table 6. Marine mammals protected by the Marine Mammal Protection Act with geographic ranges that include the Project Area (Hayes et al., 2019; Waring et al., 2015).

Common Name	Scientific Name	Stock	Federal ESA/MMPA Status	Relative Occurrence in the Region	Population (Best Estimate)[1]
Fin whale	*Balaenoptera physalus*	Western North Atlantic	ESA Endangered/ Depleted and Strategic	Regular	1,618
Sei whale	*Balaenoptera borealis*	Nova Scotia	ESA Endangered/ Depleted and Strategic	Uncommon	357
Minke whale	*Balaenoptera acutorostrata*	Canadian East Coast	Protected	Regular	2,591
Blue whale	*Balaenoptera musculus*	Western North Atlantic	ESA Endangered/ Depleted and Strategic	Rare	440
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	Protected	Common	896
North Atlantic right whale	*Eubalaena glacialis*	Western North Atlantic	ESA Endangered/ Depleted and Strategic	Regular	451 (N_{min} = 445)
Sperm whale	*Physeter macrocephalus*	North Atlantic	ESA Endangered/ Depleted and Strategic	Uncommon	2,288
Dwarf sperm whale	*Kogia sima*	Western North Atlantic	Protected	Rare	3,785
Pygmy sperm whale	*Kogia breviceps*	Western North Atlantic	Protected	Rare	3,785

Table 6. (Continued).

Common Name	Scientific Name	Stock	Federal ESA/MMPA Status	Relative Occurrence in the Region	Population (Best Estimate)[1]
Killer whale	*Orcinus orca*	Western North Atlantic	Protected	Rare	unknown
Pygmy killer whale	*Feresa attenuata*	Western North Atlantic	Protected	Not Expected	unknown
False killer whale	*Pseudorca crassidens*	Western North Atlantic	Strategic	Rare	442
Northern bottlenose whale	*Hyperoodon ampullatus*	Western North Atlantic	Protected	Not Expected	unknown
Cuvier's beaked whale	*Ziphius cavirostris*	Western North Atlantic	Protected	Rare	6,532
Mesoplodon beaked whales	*Mesoplodon* spp.	Western North Atlantic	Depleted	Rare	7,092
Melon-headed whale	*Peponocephala electra*	Western North Atlantic	Protected	Not Expected	unknown
Risso's dolphin	*Grampus griseus*	Western North Atlantic	Protected	Common	18,250
Long-finned pilot whale	*Globicephala melas*	Western North Atlantic	Strategic	Common	5,636
Short-finned pilot whale	*Globicephala macrorhynchus*	Western North Atlantic	Strategic	Uncommon	28,924
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic	Protected	Uncommon	48,819
White-beaked dolphin	*Lagenorhynchus albirostris*	Western North Atlantic	Protected	Rare	2,003
Common dolphin	*Delphinus delphis*	Western North Atlantic	Protected	Common	70,184
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic	Protected	Uncommon	44,715
Pantropical spotted dolphin	*Stenella attenuata*	Western North Atlantic	Protected	Rare	3,333
Striped dolphin	*Stenella coeruleoalba*	Western North Atlantic	Protected	Rare	54,807
Fraser's dolphin	*Lagenodelphis hosei*	Western North Atlantic	Protected	Rare	unknown
Rough toothed dolphin	*Steno bredanensis*	Western North Atlantic	Protected	Rare	136
Clymene dolphin	*Stenella clymene*	Western North Atlantic	Protected	Not Expected	unknown
Spinner dolphin	*Stenella longirostris*	Western North Atlantic	Protected	Rare	unknown
Common bottlenose dolphin[2]	*Tursiops truncatus*	Western North Atlantic, Offshore	Protected	Uncommon	77,532
Common bottlenose dolphin[2]	*Tursiops truncatus*	Western North Atlantic, northern migratory coastal	Strategic	Common	6,639
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy	Protected	Uncommon	79,833
Harbor seal	*Phoca vitulina*	Western North Atlantic	Protected	Regular	75,834

Table 6. (Continued).

Common Name	Scientific Name	Stock	Federal ESA/MMPA Status	Relative Occurrence in the Region	Population (Best Estimate)[1]
Gray seal	*Halichoerus grypus*	Western North Atlantic	Protected	Regular	27,131
Harp seal	*Pagophilus groenlandica*	Western North Atlantic	Protected	Rare	unknown
Hooded seal	*Cystophora cristata*	Western North Atlantic	Protected	Rare	unknown
Florida manatee[3]	*Trichechus manatus*	-	ESA Threatened/ Depleted and Strategic	Rare	unknown

ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act; NMFS = National Marine Fisheries Service.
[1]Best estimate from the most recently updated NOAA Stock Assessment Reports.
[2]Common bottlenose dolphins likely to occur in this area belong to two distinct stocks.
[3]Under management jurisdiction of United States Fish and Wildlife Service rather than National Marine Fisheries Service.
Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds). 2019. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2018. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NOAA Technical Memorandum NMFS-NE-258. 306 pp.
Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2015. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments – 2014. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NOAA Technical Memorandum NMFS-NE-231. 370 pp.

4.0 Affected Species Status and Distribution

Of the 36 marine mammal species with geographic ranges that include the Project Area (**Table 6**), 16 species can be reasonably expected to reside, traverse, or occasionally visit the Project Area and may be considered affected. Species information is based on NMFS stock assessment reports (SARs) (Waring et al., 2007, 2015; Hayes et al., 2017, 2018, 2019), and regional survey records (e.g., Cetacean and Turtle Assessment Program [CETAP] 1982; Atlantic Marine Assessment Program for Protected Species [AMAPPS], 2010 to 2014; North Atlantic Right Whale Sighting Survey (NARWSS) and Right Whale Sighting Advisory System (RWSAS); BOEM Mid-Atlantic EA [BOEM, 2012]); and preliminary results (unpublished) of mitigation surveys conducted by the Applicant during 2017 and 2018.

Affected species are those that have a common, uncommon, or regular relative occurrence in Project Area (**Table 5**) or have a very wide distribution with limited distribution or abundance details. Species not expected or rare are not carried forward in this application. Therefore, the Applicant requests an IHA for Level B disturbance for the 16 species (one of which comprises 2 stocks) listed below and described in the following sections.

- North Atlantic right whale (*Eubalaena glacialis*)
- Humpback whale (*Megaptera novaeangliae*)
- Fin whale (*Balaenoptera physalus*)
- Sei whale (*Balaenoptera borealis*)
- Minke whale (*Balaenoptera acutorostrata*)
- Sperm whale (*Physeter microcephalus*)
- Risso's dolphin (*Grampus griseus*)
- Long-finned pilot whale (*Globicephala melas*)
- Short-finned pilot whale (*Globicephala macrorhynchus*)
- Atlantic white-sided dolphin (*Lagenorhynchus acutus*)
- Common dolphin (*Delphinus delphis*)
- Atlantic spotted dolphin (*Stenella frontalis*)
- Common bottlenose dolphin (*Tursiops truncatus*)
    - Western North Atlantic offshore stock
    - Northern coastal migratory stock
- Harbor porpoise (*Phocoena phocoena*)
- Harbor seal (*Phoca vitulina*)
- Gray seal (Halichoerus grypus)

Species will not be equally affected by the proposed activities due to individual exposure patterns, the context in which noise is received, and, most prominently, individual hearing sensitivities. To account for this sensitivity, marine mammal species are categorized into functional hearing groups that are designated to better predict and quantify impacts of noise (NMFS, 2018a; Southall et al., 2007, 2019). These functional hearing groups are described below with associated reference frequencies. While all these species likely hear beyond these bounds, primary sensitivities fall within the listed frequencies (**Section 1.2.1.1**).

The following information summarizes data on the status and trends, distribution and habitat preferences, behavior and life history, and auditory capabilities of marine mammals found in the Project Area as available in published literature and reports, including NMFS marine mammal stock assessment reports (Waring et al., 2007, 2010, 2015; Hayes et al., 2017, 2018, 2019).

4.1 MYSTICETES

4.1.1 North Atlantic Right Whale (*Eubalaena glacialis*)

The North Atlantic right whale is the only member of the mysticete family Balaenidae found in western North Atlantic waters. It is medium in size compared to other mysticete species, with adult sizes ranging from 14 to 17 m (46 to 56 ft) (Waring et al., 2015). They are skim feeders (feeding, often at or near the surface, by moving through the water with mouths open, trapping food as water passed through baleen plates) relying primarily on zooplankton, including copepods, euphausiids, and cyprids. The North Atlantic right whale is listed as endangered and is considered one of the most endangered large whale species in the world (Jefferson et al., 2011). The most recent SAR estimates a population size of only 451 individuals (Hayes et al., 2019), which has recovered only slightly from the estimated 100 individuals in the 1930s just prior to the species being afforded protection (Reeves, 2001). The western North Atlantic minimum stock size is based on a published state-space model of the sighting histories of individual whales using photo identification techniques (Hayes et al., 2019). A review of the photo-ID recapture database from 2017 indicated that 440 individually recognized whales were known to be alive in 2016, which represents the minimum population size estimate (Hayes et al., 2019).

Right whales have been sighted in the Mid-Atlantic Bight in all months of the year but show peak abundances to the north of Cape Cod Bay during late winter and Georges Basin in late summer (Winn et al., 1986; Kenney et al., 1995, 2001). The most recent NMFS SAR (Hayes et al., 2019) identified seven areas where western North Atlantic right whales aggregate seasonally: the coastal waters of the southeastern United States; the Great South Channel; Jordan Basin; Georges Basin along the northeastern edge of Georges Bank; Cape Cod and Massachusetts Bays; the Bay of Fundy; and the Roseway Basin on the Scotian Shelf (Brown et al., 2001; Cole et al., 2013). Several of these congregation areas correlate with seasonally high copepod concentrations (Pendleton et al., 2009). New England waters are a primary feeding habitat for the North Atlantic right whale during late winter through spring with feeding moving into deeper and more northerly waters during summer and fall. Less is known regarding winter distributions; however, it is understood that calving takes place during this time in coastal waters of the southeastern United States.

Passive acoustic studies of North Atlantic right whales have demonstrated their year-round presence in the Gulf of Maine (Morano et al., 2012; Bort et al., 2015), New Jersey (Whitt et al., 2013), and Virginia (Salisbury et al., 2016). Additionally, right whales were acoustically detected off Georgia and North Carolina during 7 of the 11 months monitored (Hodge et al., 2015). All of this work further demonstrates the highly mobile nature of right whales. Movements within and between habitats are extensive and the area off the Mid-Atlantic states is an important migratory corridor. While no critical habitat is listed within the Project Area, 11 North Atlantic right whales were identified in the Mid-Atlantic Baseline Studies (MABS) surveys conducted between 2012 and 2014 with total of nine sightings occurring in February (n = 5) and March (n = 4) (Williams et al., 2015a, b). Davis et al. (2017) recently examined detections from passive acoustic monitoring devices and documented a broad-scale use of much more of the U.S. eastern seaboard than was previously believed, and an apparent shift in habitat use patterns to the south of traditionally identified North Atlantic right whale congregations. Increased use of Cape Cod Bay and decreased use of the Great South Channel were also observed (Davis et al., 2017). Additionally, reports from the 2013 NARWSS and RWSAS for the Mid-Atlantic Region (**Figure 2**) (New Jersey through Virginia) contained 22 right whale records: January (1), February (4), March (5), June (4), July (5), November (1), and December (1) (Khan et al., 2018).

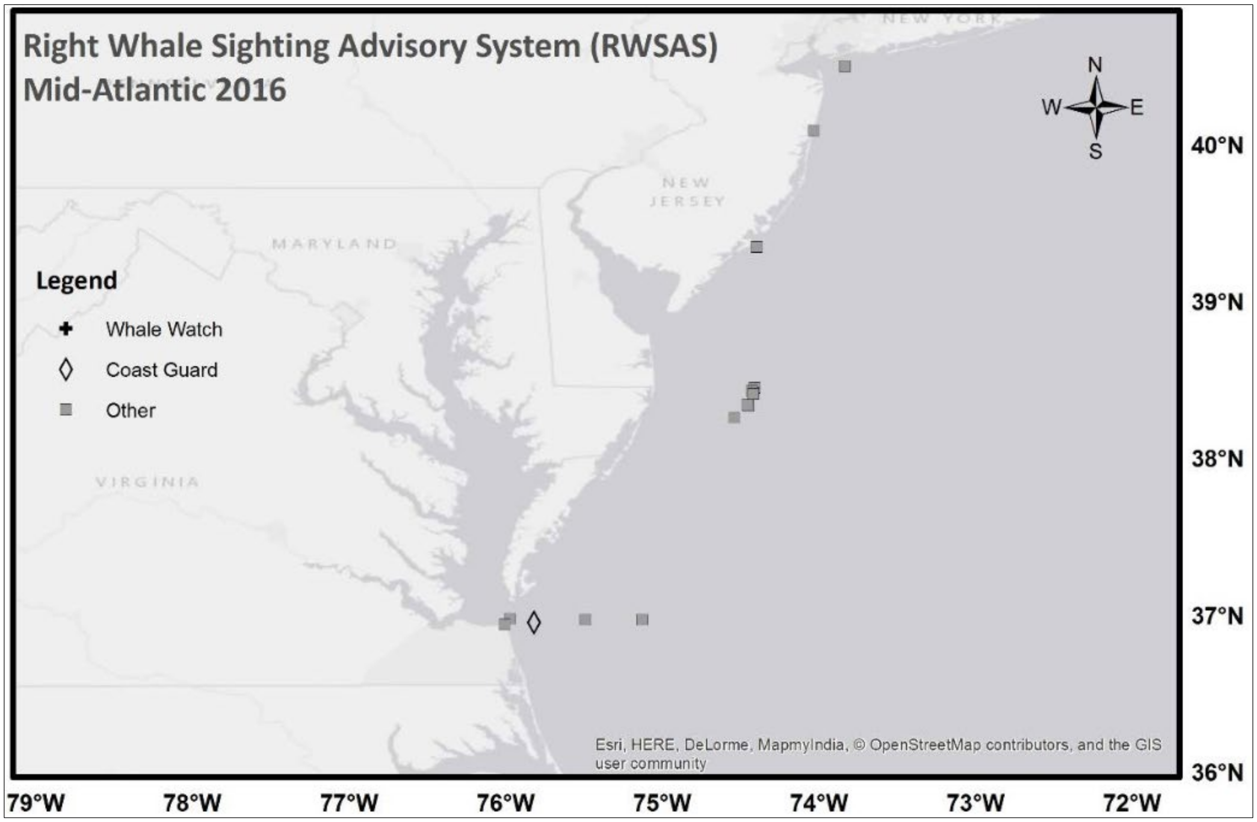

Figure 2. Locations of all North Atlantic right whale (*Eubalaena glacialis*) sightings reported to the Right Whale Sighting Advisory System (RWSAS) within the Mid-Atlantic region in 2016, shown by reporting source. The category "Other" includes reports made by the general public, commercial ships, and fishing vessels. Unconfirmed reports were excluded. (Figure from Khan et al. 2018)

The major threat to the North Atlantic right whale stock is human-caused mortality (for the years 2012 to 2016) through incidental fishery entanglement that averaged 5.15 incidents per year and ship strikes that averaged 0.41 incident records per year based on data from 2012 through 2016 (Hayes et al., 2019). The SAR for North Atlantic right whales sets the PBR level at 0.9; therefore, any mortality or serious injury for this stock can be considered significant. The Western North Atlantic stock is considered strategic by NMFS because the average annual human-related mortality and serious injury exceeds PBR, and because the North Atlantic right whale is an endangered species.

Seasonal Management Areas (SMAs) for reducing ship strikes of the North Atlantic right whale have also been designated in the U.S. and Canada. All vessels greater than 19.8 m (65 ft) in overall length must operate at speeds of 10 knots or less within these areas during specified time periods. The closest SMA to the Project Area is at the entrance to Delaware Bay, which is, in effect, seasonal from November 1 to April 30 (**Figure 3**).

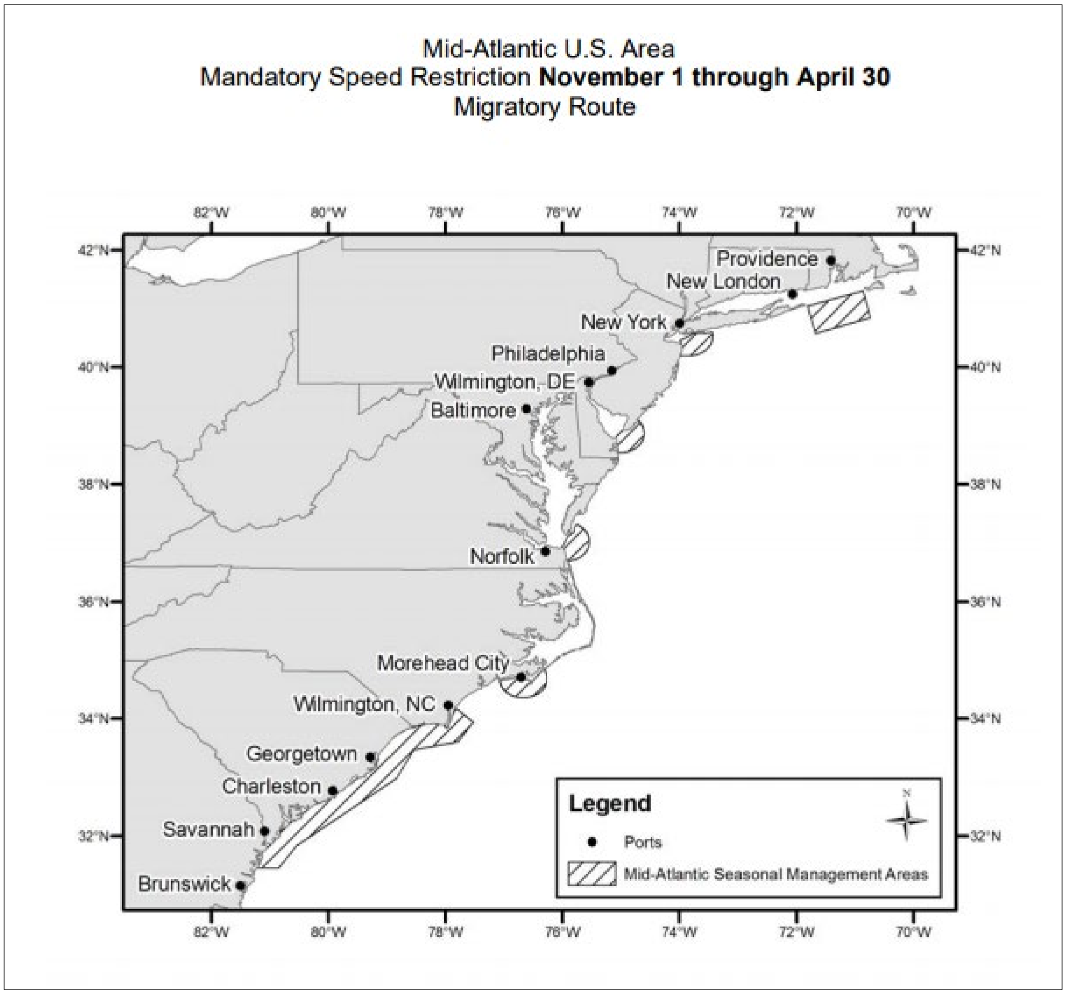

Figure 3. Mid-Atlantic Seasonal Management Areas for North Atlantic right whales (*Eubalaena glacialis*). (https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-ship-strikes-north-atlantic-right-whales; accessed Sept 2, 2019)

The North Atlantic right whale underwent a NMFS 5-year review in 2017, which resulted in no change to its listing status. In 2009, NMFS received a petition to expand the critical habitat, and the agency considered this petition in the rulemaking process. In January 2016, two additional units comprising over 102,000 km^2 (29,763 nmi^2) of marine habitat were designated as critical habitat to encompass the northeast feeding area in the Gulf of Maine/Georges Bank and the southeast calving grounds from North Carolina to Florida.

The following final rules notices are associated with the North Atlantic right whale:

- Critical Habitat Designation: 59 *FR* 28805, June 3, 1994;
- Atlantic Large Whale Take Reduction Plan: 62 *FR* 39157, July 22, 1997;
- Federal Regulations Governing the Approach to North Atlantic Right Whales: 69 *FR* 69536, November 30, 2004;
- Final Rule to Implement Speed Restrictions to Reduce the Threat of Ship Collisions with North Atlantic Right Whales: 73 *FR* 60173, October 10, 2008;
- Findings on Petition to Revise Critical Habitat: 75 *FR* 61690, October 6, 2010;

- Final Rule to Remove the Sunset Provision of the Final Rule Implementing Vessel Speed Restrictions to Reduce the Threat of Ship Collisions with North Atlantic Right Whales 78 *FR* 73726 December 9, 2013; and
- Final Rule for North Atlantic Right Whale (*Eubalaena glacialis*) Critical Habitat 81 *FR* 4838, January 27, 2016.

Vessel noise resulting from the proposed activity has the potential to disturb North Atlantic right whales. North Atlantic right whales are LF cetaceans that vocalize using a number of distinctive call types, most of which have peak acoustic energy below 500 Hz. Most vocalizations do not go above 4 kHz (Matthews et al., 2014). One typical right whale vocalization is the "up call"; a short sweep that rises from roughly 50 to 440 Hz over a period of 2 seconds. These up calls are characteristic of right whales and are used by research and monitoring programs for species presence. A characteristic "gunshot" call is believed to be produced by male right whales. These pulses can have SLs of 174 to 192 dB re 1 µPa m with frequency range from 50 to 2,000 Hz (Parks et al., 2005; Parks and Tyack, 2005). Other tonal calls range from 20 to 1,000 Hz and have SLs between 137 and 162 dB re 1 µPa m. These LF signals can be masked by human activities including vessel noise. Studies have shown that right whales increase their call amplitude with a rise in background noise, indicating that right whales may attempt to modify their vocalizations to compensate for increased noise within their acoustic environment (Parks et al., 2011). Rolland et al. (2012) correlated noise pollution to an increase in stress-related fecal hormone metabolites in North Atlantic right whales, suggesting that noise pollution may affect the recovery of the species.

4.1.2 Humpback Whale (*Megaptera novaeangliae*)

The humpback whale is a robust and medium-sized mysticete, and adults range from 15 to 18 m (50 to 60 ft) in length. Humpback whales are distinguished from all other cetaceans by their long flippers, which are approximately one-third the length of the body (Jefferson et al., 2008). One species of the humpback whale is currently recognized (Committee on Taxonomy, 2018). Humpback whales are largely piscivorous, feeding primarily on herring, sand lance, and other small fishes as well as Euphausiids in the Gulf of Maine (Hayes et al., 2019). Humpbacks show fidelity to feeding sites; however, local distribution is driven by prey availability and bathymetry resulting in the whales transiting widely throughout their feeding habitat between spring and fall in search of prey.

Sightings of humpback whales in the Mid-Atlantic are common (Barco et al., 2002) as are strandings (Wiley et al., 1995). Barco et al. (2002) suggested that the Mid-Atlantic region primarily represents a supplemental winter feeding ground used by humpbacks. Humpbacks occur both offshore and inshore including sightings within Chesapeake Bay. During the MABS surveys, a total of 13 humpback whales were recorded between 2012 and 2014; eight during the winter, one during the summer, and four during the fall (Williams et al., 2015a, b). In 2016, a high number of humpback mortalities prompted NMFS to declare as Unusual Mortality Event (UME) starting in January (NMFS, 2019a). As of July 2019 a total of 100 humpback whales have been found dead between Maine and Florida. Of these mortalities, seven occurred in Delaware, two in Maryland, seven in New Jersey, and 19 in New York. Of the carcasses examined, approximately 50% had evidence of human interaction such as vessel strike or entanglement (NMFS, 2019a).

The humpback whales occurring within the Project Area are believed to be mainly part of the Gulf of Maine stock (Hayes et al., 2019). Humpback whales have a global distribution and follow a migratory pattern of feeding in the high latitudes during summers and spending winters in the lower latitudes for calving and mating. The Gulf of Maine stock follows this pattern with winters spent in the Caribbean and West Indies; although acoustic recordings show a small number of males persisting in Stellwagen Bank throughout the year (Vu et al., 2012). The Gulf of Maine stock is estimated at 896 individuals (Hayes et al., 2019).

On September 8, 2016, NMFS published a final decision changing the status of humpback whales under the ESA (81 *FR* 62259), effective as of October 11, 2016. Previously, humpback whales were listed under the ESA as an endangered species worldwide. In the 2016 decision, NMFS recognized the existence of 14 distinct population segments (DPSs), of which four were listed as endangered, one was listed as threatened, and the remaining nine did not warrant protection under the ESA. A status review of the humpback whale was undertaken by NMFS in 2015 (Bettridge et al., 2015) to identify taxonomic units such as DPSs and assess the extinction risk of these units. To be considered a DPS, a population, or group of populations, must be “discrete” from the remainder of the taxon to which it belongs; and “significant” to the taxon to which it belongs. Information on distribution, ecological situation, genetics, and other factors is used to evaluate a population’s discreteness and significance. This review process resulting in the identification of a West Indies DPS, which includes the Gulf of Maine stock. The West Indies DPS was considered not to be at risk of extinction. Subsequently, the Gulf of Maine stock is not a strategic stock and no critical habitat has been designated for the humpback whale (Hayes et al., 2019).

Primary threats to humpback whales are fishing gear entanglements and ship strikes. Mortality and serious injury records for large whales in the Northwest Atlantic over a 40-year period (1970 to 2009) were reviewed for assessing the magnitude of human related mortalities (van der Hoop et al., 2013). Results showed that roughly 27% of mortalities and serious injuries were humpback whales. Of the humpback records where a cause could be determined (203 records), 57% of mortalities were caused by entanglements in fishing gear and 15% were attributable to vessel strikes. Glass et al. (2009) reported that between 2002 and 2006, humpback whales belonging to the Gulf of Maine stock were involved in 77 confirmed fishing gear entanglements and 9 confirmed ship strikes. Humpback records assessed between 2012 and 2016 resulted in a minimum annual rate of human-caused mortality and serious injury to the Gulf of Maine stock of 9.9 animals per year (Hayes et al., 2019). This value includes an annual rate of incidental fishery interactions (7.1) and vessel strikes (2.8) (Hayes et al., 2019).

Like other large whales, increases in noise levels may affect this species’ ability to transmit and access acoustic cues in the environment. For example, Clark et al. (2009) predicted an 8% reduction in communication space due to shipping for singing humpback whales in the northeast. Humpbacks are LF species but have one of the most varied vocal repertoires of the baleen whales. Male humpbacks will arrange vocalizations into a complex, repetitive sequence to produce a characteristic “song.” Songs are variable but typically occupy in frequency bands between 300 and 3,000 Hz and last upwards of 10 minutes. Songs are predominately produced while on breeding grounds; however, they have been recorded on feeding grounds throughout the year (Clark and Clapham, 2004; Vu et al., 2012). Typical feeding calls are centered at 500 Hz with some other calls and songs reaching 20 kHz. Common humpback calls also contain series of grunts between 25 and 1,900 Hz as well as strong, LF pulses (with SLs up to 176 dB re 1 µPa m) between 25 and 90 Hz (Clark and Clapham, 2004; Vu et al., 2012).

Feeding is the principal activity of humpback whales in New England waters, and their distribution in this region has been largely correlated to prey species and abundance (Payne et al., 1986; Payne and Heinemann, 1990).

4.1.3 Fin Whale (*Balaenoptera physalus*)

Fin whales are a widely distributed species found in all oceans of the world. The fin whale is listed as endangered under the ESA and a Final Recovery Plan for fin whales is available for review (NMFS, 2010). Fin whales transit between summer feeding grounds in the high latitudes and their wintering, calving, or mating habitats in low latitudes or offshore. However, acoustic records indicate that fin whale populations may be less migratory than other mysticetes whose populations make distinct annual migrations (Watkins et al., 2000). Fin whales typically feed on sea lance, capelin, krill, herring, copepods, and squid in deeper waters near the edge of the continental shelf (90 to 180 m [295 to 591 ft]) but will migrate towards coastal areas following prey distribution.

Along the Atlantic seaboard they are mainly found from Cape Hatteras northward with a distribution in both continental shelf and deep water habitats (Hayes et al., 2019). The Northern fin whale subspecies is found within the Project Area. Fin whales accounted for 46% of the large whales sighted during aerial surveys along the continental shelf (CETAP, 1982) between Cape Hatteras and Nova Scotia from 1978 to 1982. The MABS surveys (Williams et al., 2015a, b) reported two fin whales during the winter and two during the spring. The fin whales that occur with the Project Area are part of the Western North Atlantic stock of fin whales. This is considered a strategic stock because fin whales are listed as endangered throughout their range. In 2011, NMFS concluded a 5-year status review of the fin whale and determined that there should be no change in its listing status (NMFS, 2011).

There is no designated critical habitat for the fin whale (Waring et al., 2015). A recent population abundance estimate for the Western North Atlantic stock is 1,618 individuals (minimum population estimate for this stock is 1,234) (Hayes et al., 2019).

Threats to fin whales are entanglements in fishing gear and ship strikes. For the time period between 2012 through 2016, the minimum annual rate of human-caused mortality and serious injury to fin whales was 2.5 per year. This value includes 1.1 fishery interaction records per year and 1.4 vessel strike records per year (Hayes et al., 2019).

Fin whales produce short duration, down sweep calls between 15 and 30 Hz, typically termed "20-Hz pulses" as well as tonal calls up to 150 Hz. The SL of the fin whale vocalizations can reach 186 dB re1 µPa m, making it one of the most powerful biological sounds in the ocean (Charif et al., 2002).

4.1.4 Sei Whale (*Balaenoptera borealis*)

Sei whales are a widespread species throughout the world's temperate, subpolar, subtropical, and tropical oceans. The sei whale is the third largest cetacean (following the blue and fin whales), with adult length ranging from 16 to 20 m (52 to 66 ft) (Waring et al., 2015). It is very similar in appearance to fin and Bryde's whales (*Balaenoptera edeni*). Two subspecies of sei whales are currently recognized (Committee on Taxonomy, 2018) and the Northern sei whale (*B. b. borealis*) is known to occur within the Project Area. The sei whales occurring in the Project Area are part of the Nova Scotia stock (formerly the western North Atlantic stock). Sei whales are most common in deeper waters along the continental shelf edge (Hayes et al., 2017) but will forage occasionally in shallower, inshore waters. There is no designated critical habitat for this species.

Sei whales are most abundant in northeastern U.S. waters during the spring, with sightings concentrated along the eastern and southwestern margins of Georges Bank in the area of Hydrographer Canyon (CETAP, 1982). Less is known about the sei whale in the mid-Atlantic region. Only one sei whale was reported during the MABS surveys, and this sighting occurred during the winter survey (Williams et al., 2015a). The sei whale feeds primarily on euphausiids and copepods, but will also prey upon fish, and local abundance is largely driven by prey availability. The occurrence and abundance of sei whales on feeding grounds may shift dramatically from one year to the next.

The best estimate of abundance for the Nova Scotia stock is 357; however, this estimate is considered low and limited given the known range of the sei whale (Hayes et al., 2019). From 2012 through 2016, the minimum rate of confirmed human-caused serious injury and mortality to the Nova Scotia stock was 0.6 per year, which was attributed only to vessel collisions, unlike the 2008 to 2012 records which were split equally with 0.4 per year due to fisheries interactions and 0.4 per year due to vessel strikes (Hayes et al., 2019). The Nova Scotia stock is strategic because the species is listed as endangered under the ESA and the average human-related mortality and serious injury exceeds the PBR.

There are limited confirmed sei whale vocalizations; however, studies indicate that this species produces several, mainly LF (<1,000 Hz) vocalizations. Several calls attributed to sei whales include pulse trains up to 3 kHz, broadband "growl" and "whoosh" sounds between 100 and 600 Hz, tonal calls and upsweeps between 200 and 600 Hz, and down sweeps between 34 and 100 Hz (Baumgartner et al., 2008; Rankin and Barlow, 2007; McDonald et al., 2005).

4.1.5 Minke Whale (*Balaenoptera acutorostrata*)

The minke whale is a small mysticete that is divided into two species: the common minke whale and the Antarctic minke whale. The common minke whale is further divided into three subspecies (Committee on Taxonomy, 2018). The subspecies *B. a. acutorostrata* occurs throughout the North Atlantic. Adult common minke whales reach a length of 8.8 m (29 ft) (Jefferson et al., 2008, Waring et al., 2015). Generally, minke whales occupy warmer waters during the winter and travel north to colder regions in the summer, with some animals migrating as far as the ocean continuous ice edge. Little is known about their specific movements through the Mid-Atlantic region; however, acoustic detections show that minke whales migrate south in mid-October to early November and return from wintering grounds starting in March through early April (Risch et al., 2014). Northward migration appears to track the warmer waters of the Gulf Stream along the continental shelf, while southward migration is made farther offshore (Risch et al., 2014). The MABS surveys reported six minke whales between 2012 and 2014; one during spring surveys, two during fall surveys, and three during winter surveys (Williams et al., 2015a, b).

The minke whales that occur within the Project Area are part of the Canadian East Coast stock, which is one of four stocks in the North Atlantic. This stock is not considered strategic under the MMPA because minke whales are not listed as threatened or endangered. The best population estimate for the Canadian East Coast stock is 2,591 whales (Hayes et al., 2019). Minke whales are frequently observed in coastal or shelf waters along with humpback and fin whales owing to their piscivorous feeding habitats where prey includes sand lance and herring.

Like other baleen whales, threats to minke whales include ship strikes and fisheries interactions. However, unlike the larger whales, minke whales are more susceptible to bycatch threats from bottom trawls, lobster trap/pot, gillnet, and purse seine fisheries. During the period from 2012 to 2016, the average annual minimum detected human-caused mortality and serious injury was 7.5 minke whales per year. This number was composed of 0.2 whales per year from US fisheries bycatch, 6.3 whales per year from U.S. and Canadian entanglement data, and 1.0 whale per year from ship strikes (Hayes et al., 2019). Vessel strikes have been documented from New York, North Carolina, New Jersey, and Virginia (Hayes et al., 2017). Additionally, minke whales continue to be hunted as part of an ongoing whaling industry in the northeastern North Atlantic, the North Pacific, and Antarctic (Reeves et al., 2012).

Minke whale recordings have resulted in some of the most variable and unique vocalizations of any marine mammals. Common calls for minke whales found in the North Atlantic include repetitive, LF (100 to 500 Hz) pulse trains that may consist of either grunt-like pulses or thump-like pulses. The thumps are very short duration (50 to 70 milliseconds) with peak energy between 100 and 200 Hz. The grunts are slightly longer in duration (165 to 320 milliseconds) with most energy between 80 and 140 Hz. In addition, minke whales will repeat a 6 to 14-minute pattern of 40 to 60 second pulse trains over several hours (Risch et al., 2014). Minke whales produce a unique sound called the "boing" which consists of a short pulse at 1.3 kHz followed by an undulating tonal call around 1.4 kHz. This call was widely recorded but remained unidentified for many years and scientists widely speculated as to its source (Rankin and Barlow, 2005). The call frequency of minke whales suggest a hearing sensitivity higher than that of other baleen whales.

4.2 ODONTOCETES

4.2.1 Sperm Whale (*Physeter macrocephalus*)

Sperm whales are listed as endangered under the ESA and are considered a strategic stock by NMFS (Waring et al., 2015). Data are insufficient to assess population trends, and the current abundance estimate was based on only a fraction of the known stock range (Waring et al., 2007). The best recent abundance estimate for sperm whales is the sum of the estimates from the two 2011 U.S. Atlantic surveys 2,288 with a minimum population estimate of 1,815 (Hayes et al., 2019).

In winter, sperm whales concentrate east and northeast of Cape Hatteras. In spring, distribution shifts northward to east of Delaware and Virginia, and is widespread throughout the central Mid-Atlantic Bight and the southern part of Georges Bank. In the fall, sperm whale occurrence on the continental shelf south of New England reaches peak levels, and there remains a continental shelf edge occurrence in the Mid-Atlantic Bight (Waring et al., 2015). No sperm whales were recorded during the MABS surveys. CETAP and NMFS Northeast Fisheries Science Center sightings in shelf-edge and off-shelf waters included many social groups with calves/juveniles (CETAP, 1982). Sperm whales were usually seen at locations corresponding to the tops of the seamounts and rises and did not generally occur over the slopes. Sperm whales were recorded at the surface over depths varying from 800 to 3,500 m (2,625 to 11,483 ft). Although the likelihood of occurrence within the Project Area remains very low, the sperm whale was included as an affected species because of its high seasonal densities east of the Project Area.

Sperm whales are in the MF hearing group, with an estimated auditory range of 150 Hz to 160 kHz (Southall et al., 2007). Sperm whales produce short-duration repetitive broadband clicks used for communication and echolocation. These clicks range in frequency from 0.1 to 30 kHz, with dominant frequencies between the 2 to 4 kHz and 10 to 16 kHz ranges (Department of the Navy [DoN], 2008). Echolocation clicks from adult sperm whales are highly directional clicks and have a SL estimated at up to 236 dB re 1 μPa m.

4.2.2 Risso's Dolphin (*Grampus griseus*)

Risso's dolphins are large dolphins with a characteristic blunt head and light coloration, often with extensive scarring. Adults reach body lengths of over 3.8 m (12.5 ft) (Jefferson et al., 2008, Waring et al., 2015)

The status of the Western North Atlantic stock of the Risso's dolphin in the U.S. Atlantic EEZ is not well documented. An abundance estimate of 18,250 Risso's dolphins was generated from a shipboard and aerial survey conducted between central Florida to the lower Bay of Fundy during June to August 2011 (Palka, 2012). Risso's dolphins are not listed as threatened or endangered under the ESA and the Western North Atlantic stock is not considered strategic under the MMPA.

Risso's dolphins are widely distributed in tropical and temperate seas. In the western North Atlantic they occur from Florida to eastern Newfoundland (Leatherwood et al., 1976; Baird and Stacey, 1991). Risso's dolphins occur along the continental shelf edge from Cape Hatteras to Georges Bank during spring, summer, and autumn. In winter, they occur in oceanic (slope) waters within the Mid-Atlantic Bight (Waring et al., 2014). The majority of sightings during the 2011 surveys occurred along the continental shelf break with generally lower sighting rates over the continental slope (Palka, 2012).

Risso's dolphins are in the MF functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al., 2007). Vocalizations range from 400 Hz to 65 kHz (DoN, 2008).

4.2.3 Short-finned Pilot Whale (*Globicephala macrorhynchus*)

Short-finned pilot whales are similar in size to long-finned pilot whales (**Section 4.2.5**), with body lengths between 5.5 and 7 m (18 and 20 ft) (Jefferson et al., 2011). Data indicate that short-finned pilot whales inhabit primarily the southeast Atlantic and Caribbean, however, strandings have been documented as far north as Massachusetts. In the northern extent of their range, short-finned pilot whales are thought to inhabit primarily offshore habitats, so while they could potentially be encountered in the Project Area, they are not expected to be as common as long-finned pilot whales (Hayes et al., 2019). Short-finned pilot whales are not listed under the ESA, and the North Atlantic stock is not considered strategic. Recent surveys conducted between central Florida and Georges Bank in the summer of 2016 provide an abundance estimate of 28,924 for this species in the western North Atlantic (Hayes et al., 2019).

There is limited information on the distribution of short-finned pilot whales; they prefer warmer or tropical waters and deeper waters offshore, and in the northeast, they are often sighted near the Gulf Stream (Hayes et al., 2019). Like the long-finned morphotype, short-finned pilot whales are social and are often observed in groups of 20 to 50 animals. They have been given the nickname "cheetahs of the deep sea" due to the high-speed dives that this species undertakes while foraging in relation to other deep-diving cetacean species (Aguilar Soto et al., 2008; NMFS, 2019b).

The annual rate of fisheries-related injury and mortality for short-finned pilot whales is uncertain due to the fact that bycatch rates are provided for undifferentiated (short vs. long-finned) pilot whales. In the mid-Atlantic, pilot whale bycatch rates are attributed primarily to short-finned pilot whales based on genetic data collected in the region (Hayes et al., 2019). Between 2014 and 2016, more fisheries interactions were observed further north along the southern Georges Bank. Due to the higher water temperatures recorded during the surveys, they were estimated to have a 90% probability of being short-finned species (Hayes et al., 2019). Based on these observations and the expected distribution of short-finned pilot whales, the mean annual fishery-related mortality and serious injury from 2012 to 2016 was estimated to be 168 whales (Hayes et al., 2019).

Like long-finned pilot whales, short-finned pilot whales are also susceptible to mass strandings, and it is estimated that between 2 and 168 pilot whales have stranded annually along the U.S. east coast since 1980. Between 2012 and 2016, there were approximately 39 reported strandings of short-finned pilot whales between Massachusetts and Florida, although the precise cause of these strandings is uncertain. Habitat contamination is also a concern for this stock, although the population level effects of the observed concentrations of contaminants in their habitat are unknown (Hayes et al., 2019).

Short-finned pilot whales fall into the same MF auditory category as the long-finned species, but recorded vocalizations for this species are slightly higher. Burst-pulse sounds had a frequency range from 1 to greater than 30 kHz (vs. long-finned pilot whale burst-pulses which ranged from 100 to 22,000 Hz), and foraging clicks had a peak frequency between 8 and 39 kHz (Erbe et al., 2016).

4.2.4 Long-finned Pilot Whale (*Globicephala melas melas*)

Long-finned pilot whales attain a body length between 5.7 and 6.7 m (18 and 22 ft) (Jefferson et al., 2011; Waring et al., 2015). There are two species of pilot whale in the western North Atlantic; long-finned (*G. melas*) and short-finned (*G. macrorhynchus*) (**Section 4.2.3**). The species overlap, are difficult to tell apart, and parameters that define their distributions are not well differentiated. The best distinguishing characteristic of the long-finned pilot whale are the long, slender flippers, which are typically not visible during aerial or shipboard surveys (Jefferson et al., 2011). However, it is generally accepted that pilot whale sightings above approximately 42° N are most likely long-finned pilot whales (Waring et al., 2015). Additionally, in the northern extent of the ranges, long-finned pilot whales are thought to occupy inshore areas, so the pilot whales that occur within the Project Area are most likely long-finned pilot whales that are part of the western North Atlantic stock. Long-finned pilot whales are not listed as threatened or endangered, and the Western North Atlantic stock is not considered strategic under the MMPA. The best population estimate for the western North Atlantic stock of long-finned pilot whales is 5,636 individuals (Hayes et al., 2019).

Long-finned pilot whales occur over the continental slope in high densities during winter and spring then move inshore and into shelf waters during summer and autumn following prey populations of squid and mackerel (Reeves et al., 2012). They will also readily feed on other fish, cephalopods, and crustaceans. Long-finned pilot whales are common in central and northern Georges Bank, Great South Channel, Stellwagen Bank, and Gulf of Maine during the summer and early fall (May and October) (Hayes et al., 2019). Long-finned pilot whales are highly social and vocal and are typically observed in groups of 10 to 20 surface-active individuals.

A source of mortality and injury to long-finned pilot whales is through bycatch during gillnet fishing, pelagic trawling, longline fishing, and purse seine fishing. For the period between 2012 and 2016, the observed average fishery-related mortality or serious injury was 27 long-finned pilot whales per year. The highest observed bycatch rate for all pilot whales occurred in the pelagic longline fishery with peak bycatch occurring during September and October along the mid-Atlantic coast. However, based on biopsy data, the majority, if not all, of the bycatch whales were short-finned. Other fisheries mortalities (i.e., bottom trawls, mid-water trawls, gillnet) are more frequently observed north of 40° N; therefore, these fisheries likely have a higher proportional impact on long-finned pilot whales.

Long-finned pilot whales also demonstrate a propensity to mass strand; however, the role that human activities play in these strandings is not known. From 2008 to 2012, 37 long-finned and 7 undetermined pilot whale species stranded between Maine and Florida. Bioaccumulated toxins are also a potential source of human-caused source of mortality in all pilot whales. Polychlorinated biphenyls and chlorinated pesticides (DDT, DDE, dieldrin, etc.) have been found in pilot whale blubber (Muir et al., 1988; Weisbrod et al., 2000); and bioaccumulation levels of these toxins were more similar in whales from the same stranding group than from animals within the same sex or age category (Weisbrod et al., 2000).

Long-finned pilot whales are acoustic MF specialists with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al., 2007). All pilot whales echolocate and produce tonal calls. Long-finned pilot whales produce burst-pulses which ranged from 100 to 22,000 Hz. The primary tonal calls of the long-finned pilot whale range from 1 to 8 kHz with a mean duration of about 1 second. The calls can be varied with seven categories identified (level, falling, rising, up-down, down-up, waver, and multi-hump) and are likely associated with specific social activities (Vester et al., 2014).

4.2.5 Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*)

The Atlantic white-sided (AWS) dolphin is robust and attains a body length of approximately 2.8 m (9 ft) (Jefferson et al., 2008; Waring et al., 2015). It is characterized by a strongly “keeled” tail stock and distinctive color pattern. The AWS dolphin occurs primarily along the 100-m (328-ft) depth contour within temperate and subpolar waters of the North Atlantic. Seasonally, AWS dolphins occupy northern, inshore waters during summer and southern, offshore waters in the winter. AWS dolphins that potentially occur in the Project Area are all part of the western North Atlantic stock, which inhabit waters from central West Greenland to North Carolina (about 35° N) (Waring et al., 2015). There is some evidence supporting the division of the Western Atlantic population into three separate stocks; however, this has not been clearly established (Hayes et al, 2019) The estimated average annual human-related mortality does not exceed the PBR for this stock and the AWS dolphin is not listed as threatened or endangered;

therefore, the stock is not considered strategic under the MMPA. The best abundance estimate for the western North Atlantic AWS dolphin stock is 48,819 (Hayes et al., 2019).

Mortality to AWS dolphins resulting from fisheries interactions averaged 30 dolphins per year between 2012 and 2016. This number was comprised of recorded mortality or serious injury from gillnets (4.6 per year), bottom trawls (24 per year), and mid-water trawls (1.9 per year) (Hayes et al., 2017).

AWS dolphins feed on a variety of fish such as herring, hake, smelt, capelin, and cod as well as squid and shrimp. Like many dolphins, this species is highly gregarious and will often travel in groups of 100 or more and are highly vocal when in these aggregations. Breeding takes place between May and August with most calves born in June and July. Recordings from Pacific white sided dolphins show that this *Lagenorhynchus* species produces echolocation clicks that were centered at 115 kHz and up to 15 whistle types between 7 and 16 kHz (Rasmussen and Miller, 2002).

The Virginia and North Carolina observations appear to represent the southern extent of the species range. Prior to the 1970s, white-sided dolphins in U.S. waters were found primarily offshore on the continental slope, while white-beaked dolphins (*L. albirostris*) were found on the continental shelf. During the 1970s, there was an apparent switch in habitat use between these two species. This shift may have been a result of the decrease in herring and increase in sand lance in the continental shelf waters (Katona et al., 1993; Kenney et al., 1996). White-sided dolphins are opportunistic feeders and their diet is based on available prey (Waring et al., 2007; Craddock et al., 2009).

Atlantic white-sided dolphins are in the MF functional hearing group with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al., 2007). Their vocalizations range from 6 to 15 kHz (DoN, 2008).

4.2.6 Common Dolphin (*Delphinus delphis*)

The common dolphin may be one of the most widely distributed species of cetaceans, as it is found worldwide in temperate, tropical, and subtropical seas (Waring et al., 2015). Two species were previously recognized: the long beaked common dolphin (*Delphinus capensis*) and the short-beaked common dolphin; however, Cunha et al. (2015) summarized the relevant data and analyses, along with additional molecular data and analysis, and recommended that *D. capensis* not be further used for the Atlantic stock. This taxonomic convention is used by the Society for Marine Mammalogy. The best population estimate for this stock is 70,184. The species is not listed as threatened or endangered under the ESA, and the stock is not classified as a strategic or depleted stock (Hayes et al., 2019).

Common dolphins are distributed in waters off the eastern U.S. coast from Cape Hatteras northeast to Georges Bank (35° to 42° N) during mid-January to May and move as far north as the Scotian Shelf from mid-summer to autumn (CETAP, 1982; Hayes et al., 2019; Hamazaki, 2002; Selzer and Payne, 1988). Primarily occurring at the shelf and shelf break along the Gulf Stream, however, common dolphins are known to occur in many water depths including coastal waters. A total of 270 common dolphin were recorded during the 2012 to 2014 MABS surveys. These recorded sightings occurred in all seasons (Williams et al., 2015a, b).

Common dolphins aggregate in large schools numbering in the hundreds, although the typical group size is 30 or fewer (Reeves et al., 2012). The common dolphin feeds on small schooling fish and squid; as such, common dolphins are subject to bycatch in gillnets, pelagic trawls, and longline fisheries. During 2012 to 2016, an estimated average of 406 common dolphins were taken each year in fisheries activities.

Common dolphins are in the MF functional hearing group with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al., 2007). Their vocalizations range widely from 200 Hz to 150 kHz (DoN, 2008).

4.2.7 Atlantic Spotted Dolphin (*Stenella frontalis*)

Atlantic spotted dolphins are widely distributed in tropical and warm temperate waters of the western North Atlantic (Leatherwood et al., 1976). They range from southern New England, south through the Gulf of Mexico, and the Caribbean to Venezuela (Leatherwood et al., 1976; Perrin et al., 1994). They regularly occur in the inshore waters south of Chesapeake Bay and near the continental shelf edge and continental slope waters north of this region (Payne et al., 1984; Mullin and Fulling, 2003). Atlantic spotted dolphins north of Cape Hatteras also associate with the north wall of the Gulf Stream and warm-core rings (Waring et al., 2007). Four sightings of Atlantic spotted dolphins were recorded between 2012 and 2014 during the summer MABS surveys (Williams et al., 2015a, b).

Atlantic spotted dolphins are not listed as threatened or endangered under the ESA. Atlantic species of spotted dolphins were not differentiated during surveys, resulting in insufficient data to determine the population trends. The stock status is also unknown (Waring et al., 2007).

The best estimate of abundance for the western North Atlantic stock of Atlantic spotted dolphins is 44,715, derived from the 2011 surveys (Hayes et al., 2019). The minimum population estimate for these Atlantic spotted is 31,610.

Atlantic spotted dolphins are in the MF functional hearing group with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al., 2007). Vocalizations typically range from 100 Hz to 130 kHz (DoN, 2008).

4.2.8 Common Bottlenose Dolphin (*Tursiops truncatus*)

Adult common bottlenose dolphins range in length from 1.8 to 3.8 m (5.9 to 12.5 ft). Within the western North Atlantic, including the Project Area, there are two distinct bottlenose dolphin forms, or morphotypes: coastal and offshore. The two forms are genetically and morphologically distinct although regionally variable (Jefferson et al., 2008; Waring et al., 2015). Both inhabit waters in the western North Atlantic Ocean (Hersh and Duffield, 1989; Mead and Potter, 1995; Curry and Smith, 1997) along the U.S. Atlantic coast. The common bottlenose dolphin is not listed as threatened or endangered under the ESA.

Analysis of stranding data, satellite tagging, and genetic studies resulted in the western North Atlantic stock being divided into five geographic stocks: The Central Florida, Northern Florida, South Carolina-Georgia, Southern Migratory Coastal, and Northern Migratory Coastal stocks (Rosel et al., 2009; Waring et al., 2010). All coastal stocks are listed as depleted (Waring et al., 2010). The northern migratory stock range is listed as upper New Jersey to lower Maryland. There is likely some interaction between the northern and southern migratory stocks but the bottlenose dolphins in the Project Area are expected to be from the northern migratory stock (Hayes et al., 2019).

The best abundance estimates for the Northern Migratory Coastal stock of common bottlenose dolphin is 6,639 (Hayes et al., 2019). Total U.S. fishery-related mortality and serious injury for these stocks cannot be directly estimated because of spatial overlap of several stocks in North Carolina. Best estimates of annual average mortality and serious injury for 2007 through 2011 was 3.8 to 5.8 individuals per year.

The western North Atlantic offshore common bottlenose dolphin is not listed as depleted under the MMPA, or as threatened or endangered under the ESA. Stock status within U.S. Atlantic waters is unknown and data are insufficient to determine population trends. The best available abundance estimate for offshore morphotype common bottlenose dolphins in the western North Atlantic is 77,532 (Hayes et al., 2019).

The offshore stock is distributed primarily along the OCS and continental slope, from Georges Bank to Cape Hatteras during the spring and summer (CETAP, 1982; Kenney, 1990). North of Cape Hatteras, there is separation of the two morphotypes across bathymetric contours during summer months. Aerial surveys flown from 1979 through 1981 indicated a concentration of common bottlenose dolphins in waters <25 m deep that corresponded with the coastal morphotype, and an area of high abundance along the shelf break that corresponded with the offshore stock (Hayes et al., 2018). Torres et al. (2003) found a statistically significant break in the distribution of the morphotypes at 34 km from shore. During the winter months, bottlenose dolphins are rarely observed north of the North Carolina-Virginia border, and their northern distribution appears to be limited by water temperatures <9.5°C (<49°F) (Garrison et al., 2003; Kenney, 1990).

Coastal and offshore stocks of bottlenose dolphins are in the MF functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al., 2007). Bottlenose dolphin vocalization frequencies range from 3.4 to 130 kHz (DoN, 2008).

4.2.9 Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise is the only porpoise species found in the Atlantic. It is a small, stocky cetacean with a blunt, short-beaked head. There are four subspecies, with *P. phocoena* residing in the North Atlantic (Committee on Taxonomy, 2018). This subspecies reaches a body length of 1.9 m (6 ft) (Jefferson et al., 2011). They commonly occur throughout Massachusetts Bay from September through April. During the fall and spring, harbor porpoises are widely distributed along the east coast from New Jersey to Maine. During the summer, the porpoises are concentrated in the Northern Gulf of Maine and Southern Bay of Fundy in water depths <150 m (<492 ft). In winter, densities increase in waters off New Jersey to North Carolina and decrease in the waters from New York to New Brunswick, however, specific migratory timing or routes are not apparent. Although still considered uncommon, harbor porpoises were regularly detected offshore of Maryland during winter and spring surveys (Wingfield et al., 2017).

The harbor porpoises that occur in the Project Area comprise the Gulf of Maine/Bay of Fundy stock. This stock is not considered strategic under the MMPA because they are not listed as threatened or endangered and the annual human-related mortality rates do not exceed the PBR. In 2001, NMFS conducted a status review for the stock, mainly due to the level of bycatch in fisheries (66 *FR* 53195). The determination from the review was that listing the harbor porpoise under the ESA was not warranted and the species was removed from the candidate list.

Harbor porpoise feed on small schooling fish such as mackerel, herring, and cod, as well as worms, squid, and sand eels. Their foraging habits and habitats make this species particularly susceptible to mortality in bottom-set gill nets (Waring et al., 2015). The average estimated human-caused mortality or serious injury for this stock is 255 harbor porpoises per year, derived from both U.S. and Canadian fisheries observer records. In 2010, a final rule was published for the existing Harbor Porpoise Take Reduction Plan (75 *FR* 7383) to address closure areas and timing based on bycatch rates.

Population trends for this species are unknown. The best, and most recent, abundance estimate for harbor porpoise in the Gulf of Maine/Bay of Fundy stock is 79,833 (Hayes et al., 2019).

The harbor porpoise is the only potentially affected species in the Project Area within the HF hearing group; it is an HF specialist using ultrasonic echolocation clicks to navigate and hunt prey. The click frequency is between 110 and 150 kHz, which is consistent with harbor porpoise hearing sensitivity centered between 100 and 120 kHz (Thompson et al., 2013). Click trains can have very short inter-click intervals when close to a prey item which results in a "feeding buzz" due to the rapid succession of individual clicks, making them highly identifiable in acoustic surveys.

4.3 PHOCIDS

4.3.1 Harbor Seal (*Phoca vitulina*)

The harbor seal is found in all nearshore waters of the Atlantic Ocean and adjoining seas north of 30°N (Hayes et al., 2019). In the western North Atlantic, they are distributed from eastern Canada to southern New England and New York, and occasionally to the Carolinas (Payne and Selzer, 1989). Harbor seals are the most abundant seals in the eastern U.S.; they are not listed as threatened or endangered. The harbor seals within the Project Area are part of the single Western North Atlantic stock, which is not considered strategic under the MMPA. The best population estimate of harbor seals for this stock is 75,834 (Hayes et al., 2019).

Harbor seals will exploit a variety of available food sources and will feed both in shallow coastal habitats and offshore (Waring, 2015). Typical prey items include squid and small schooling fish (i.e., herring, alewife, flounder, redfish, cod, yellowtail flounder, sand eel, hake) and spend up to 85% of the day diving, presumably foraging.

Fisheries interactions are common, and harbor seals are legally killed in Canada, Norway, and the United Kingdom to protect fish farms or local fisheries (Reeves et al., 2013). They are also susceptible to bycatch in gillnets, trawls, and purse seines. For the period from 2012 to 2016, the average human-caused mortality and serious injury to harbor seals was 345 per year, of which 333 (96.5%) occurred in fisheries interactions

Male harbor seals produce underwater vocalizations during mating season to attract females and defend territories (Sabisnky et al., 2012). These calls are comprised of "growls" or "roars" with a peak energy at 1.2 kHz (Sabinsky et al., 2012). Captive studies have shown that harbor seals have good (>50%) sound detection thresholds between 0.1 and 80 kHz, with primary sound detection between 0.5 and 40 kHz (Kastelein et al., 2009).

4.3.2 Gray Seal (*Halichoerus grypus*)

The gray seal ranges from Canada to New York; however, there are stranding records as far south as Cape Hatteras, North Carolina (Gilbert et al., 2005). Gray seals within the Project Area are part of the Western North Atlantic stock. They are not listed as threatened or endangered and the stock is not considered strategic under the MMPA. The best population estimate of gray seals for this stock is 27,131 (Hayes et al., 2019). A U.S. population estimate for this species is not available, however, the Canadian gray seal population was estimated to be 505,000 (Waring et al., 2015).

Gray seals will aggregate in large numbers to breed, molt, and rest. Gray seals will exploit a variety of available food sources and will feed both in shallow coastal habitats and offshore (Waring, 2015). Typical prey items include cephalopods, sessile organisms, small schooling fish (i.e., herring, alewife, flounder, redfish, cod, yellowtail flounder, sand eel, hake), and crustaceans. Gray seals will go on extensive dives to depths to 475 m (1,558 ft) to capture food (Waring, 2015). Gray seals are susceptible to bycatch and fisheries interactions and, like the harbor seal, are legally killed in some countries to protect fisheries resources. The gray seal is also taken commercially outside the U.S. In the U.S., the average estimated human-caused mortality and serious injury of gray seals between 2012 and 2016 was 5,688 seals per year (Hayes et al., 2019).

Gray seals, as with all pinnipeds, are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al., 2007). Vocalizations range from 100 Hz to 3 kHz (DoN, 2008).

5.0 Type of Incidental Take Requested

The Applicant requests an IHA pursuant to Section 101 (a)(5)(D) of the MMPA for incidental take of small numbers of marine mammals by Level B harassment during geophysical surveys conducted as part of site characterizations activities within the Project Area. Proposed activities, as outlined in **Section 1.0**, have the potential to impact marine mammals within the Project Area from sounds generated by the vessel and survey equipment.

For impulsive and non-impulsive intermittent sources, the maximum range to a Level A threshold is less than 5 m and Level A take is not anticipated during HRG surveys. The calculations for Level A (and Level B) assumed that all 200 days of geophysical surveys conducted during the survey window will use the source producing the largest acoustic isopleths (GeoSource 800J Sparker and AA Dura-Spark). This assumption is conservative and provides a cautious approach to predicting active survey operations and their potential impact on marine mammal species.

The most likely Level B take is expected to result from minor behavioral reactions such as avoidance and temporary displacement for some individuals or groups of marine mammals near the proposed activities. It is expected that the severity of behavioral effects will vary with the duration of operations, the behavior of the animal at the time of reception of the sound, and the distance and received SPL_{rms} of the sound. The Level B take is unlikely to be manifested as a TTS (Southall et al., 2007) but has the potential in the immediate vicinity (several meters) of the sound source where the received SPLs might be high enough to cause a temporary loss of hearing sensitivity (Holt, 2008). No permanent hearing loss or physiological damage (such as PTS) or injury is expected to occur to marine mammals by the survey equipment or vessels during proposed surveys.

Potential impacts will be mitigated through a visual monitoring program and associated vessel activity management program, both of which are fully described in **Section 11.0**.

6.0 Take Estimates for Marine Mammals

The Applicant is seeking authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of NMFS in the proposed region of activity, as described in **Section 2.0**. The 16 species potentially taken are described in **Section 4.0**. Each species has a geographic distribution that encompasses the Project Area and has at least a minimal potential to occur.

Authorization for Level B harassment is sought for the following 16 species:

1. North Atlantic right whale (*Eubalaena glacialis*);
2. Humpback whale (*Megaptera novaeangliae*);
3. Fin whale (*Balaenoptera physalus*);
4. Sei whale (*Balaenoptera borealis*);
5. Minke whale (*Balaenoptera acutorostrata*);
6. Sperm whale (*Physeter microcephalus*);
7. Risso's dolphin (*Grampus griseus*);
8. Long-finned pilot whale (*Globicephala melas*);
9. Short-finned pilot whale (*Globicephala macrorhynchus*)
10. Atlantic white-sided dolphin (*Lagenorhynchus acutus*);
11. Common dolphin (*Delphinus delphis*);
12. Atlantic spotted dolphin (*Stenella frontalis*);
13. Common bottlenose dolphin (*Tursiops truncatus*);
14. Harbor porpoise (*Phocoena phocoena*);
15. Harbor seal (*Phoca vitulina*); and
16. Gray seal (*Halichoerus grypus*).

The only anticipated impacts to marine mammals are associated with noise and are limited to the use of geophysical survey equipment. The potential activities are not expected to take more than a small number of marine mammals or have more than a negligible effect on their populations based on their seasonal density and distribution and their known reactions to exposure to such underwater sound sources. The source activity is described in **Section 1.2**.

6.1 BASIS FOR ESTIMATING NUMBERS OF MARINE MAMMALS THAT MIGHT BE TAKEN BY HARASSMENT

Estimating exposures of marine mammal species assumes that exposure of an animal to a specified noise level within a region of ensonification will result in a take of that animal. The ensonified area is calculated based on the SL and operational mode of the equipment (**Sections 6.1.1** and **6.1.2**). Potential Level B take exposures are estimated within the area ensonified as an SPL_{rms} exceeding 160 dB re 1 µPa for non-impulsive intermittent sources (e.g., sonar, Chirps) and impulsive sources (e.g., sparkers, boomers) within an average day of activity. The potential number of exposed animals is estimated from the mean monthly densities (animals km^{-2}) of a given species expected within the Project Area. These densities are then multiplied by the maximum number of survey days. These calculations result in unmitigated take estimates for each affected species over the entire survey period.

6.1.1 Zone of Influence Calculations

The zone of influence (ZOI) is a representation of the maximum extent of the ensonified area around a sound source over a 24-hour period. The ZOI for each piece of equipment operating below 200 kHz was calculated per the following formulae:

Stationary Source: ZOI = πr^2

Mobile Source: ZOI = (Distance/day × 2r) + πr^2

Where r is the linear distance from the source to the isopleth for Level A or Level B thresholds and day =1.

The estimated potential daily active survey distance of 110 km (68 mi), was used as the estimated areal coverage over a 24-hour period. This distance accounts for the vessel traveling at roughly 4 knots and accounts for non-active survey periods. The corresponding Level A and Level B ZOIs for each source for a 24-hour period are provided in **Table 7**.

Table 7. Zone of Influence encompassing Level A and Level B thresholds for each sound source or comparable sound source category.†

Source	Level A ZOI (km^2)				Level B ZOI (km^2)
Hearing Group[a]	LF	MF	HF	PW	All
Shallow SBP (Chirps)					
TB Chirp III	0.2	0	0.2	0.1	10.6
ET 216 Chirp	0	0	0	0	2.0
ET 424 Chirp	0	0	0	0	0.9
ET 512i Chirp	0	0	0	0	1.3
GeoPulse 5430	0.1	0	0.1	0	4.6
Parametric SBP					
Innomar Parametric SBPs	0.1	0.1	0.3	0.1	0.2
Medium SBP (Boomers and Sparkers)					
AA Triple plate S-Boom (700-1000J)	0.1	0	0.6	0	7.5
AA Dura-Spark 400	0	0	0.6	0	31.1
GeoSource 400J Sparker	0	0	0.4	0	12.3
GeoSource 600J Sparker	0	0	0.7	0	24.7
GeoSource 800J Sparker	0	0	0.8	0	31.1
Acoustic Corers					
Pangeo Acoustic Corer (LF Chirp)	0	0	0	0	0
Pangeo Acoustic Corer (HF Chirp)	0	0	0	0	0
Acoustic Positioning					
All USBL & GAPS	0	0	0.2	0	11

†The Level A and B isopleths were calculated to comprehensively assess the potential impacts of the predicted source operations as required for this Application. However, as described in Section 5.0, Level A takes are not expected.
AA = Applied Acoustics; ET = EdgeTech; GAPS = Global Acoustic Positioning System; HF = high frequency; J = joules; LF = low frequency; PG = PanGeo; SBP = sub-bottom profilers; SEL_{cum} = cumulative sound exposure level; TB = teledyne benthos; USBL = ultra-short baseline.
[a]As defined in National Marine Fisheries Service (2018b): LF= low-frequency; MF = mid-frequency; HF = high-frequency; PI = phocid pinnipeds in water.

The Level A and Level B threshold isopleths were calculated to comprehensively assess the potential impacts of the predicted maximum practicable source operations as required for this Application. However, as described in **Section 5**, Level A takes are not expected. A conservative approach to estimate the Level B take distances for the survey was done by using the equipment that produced the greatest Level B isopleth distance from apparent or measured SL to define the impact radii of all proposed equipment within that group. The maximum estimated distance from a geophysical source to the Level B threshold (SPL_{rms} of 160 dB re 1 µPa) were for the GeoSource 800J Sparker and the AA Dura-Spark 400, both which produced a 141 m threshold range.

6.1.2 Marine Mammal Density Calculation

The density calculation methodology applied to take estimates for this application is derived from the model results produced by Roberts et al. (2016) and draft model results produced by Roberts (2018) for the East Coast region. In order to determine cetacean densities for take estimates, the density coverages that included any portion of the Project Area were selected for all survey months (**Figure 4**). These files were retrieved as raster files from the website http://cetsound.noaa.gov/cda or directly from Roberts (2018) with permission for use. These estimates are considered to be the best information currently available for calculating marine mammal densities in the U.S. Atlantic by NMFS (**Table 8**).

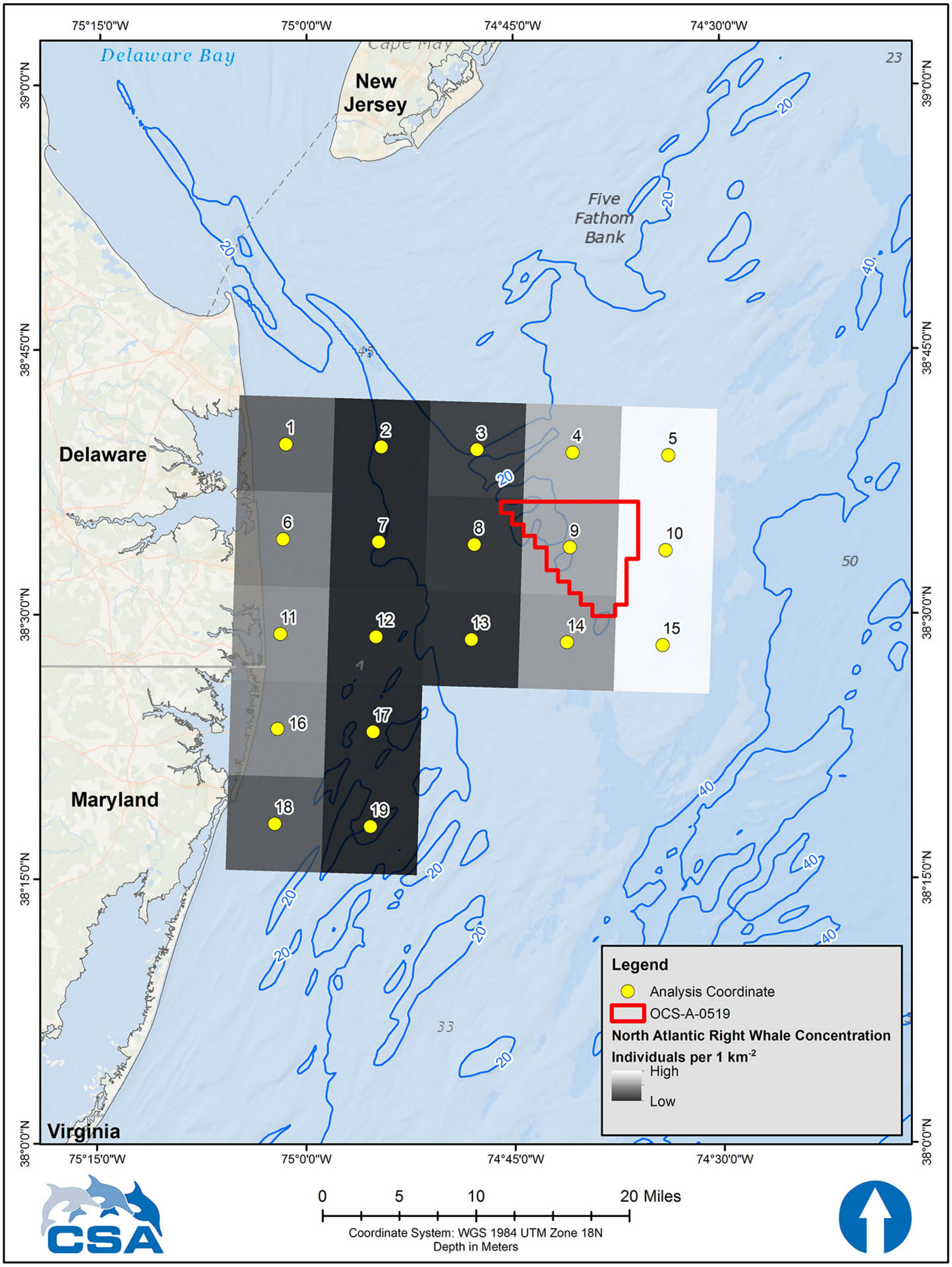

Figure 4. Sample density blocks (Roberts et al., 2016; Roberts 2018) from models used to determine monthly marine mammal densities within the project area.

Table 8. Estimated monthly and average annual density (animals km^{-2}) of potentially affected marine mammals within Lease Area OCS-A-0519 and export cable routes based on monthly habitat density models (Roberts et al., 2016; Roberts 2018).

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average Annual Density (km^{-2})
Low-Frequency Cetaceans													
Fin whale	0.0011	0.0009	0.0016	0.0022	0.0019	0.0014	0.0005	0.0005	0.0012	0.0015	0.0011	0.0009	**0.0012**
Sei whale	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0000**
Minke whale	0.0002	0.0002	0.0002	0.0010	0.0011	0.0005	0.0001	0.0001	0.0001	0.0004	0.0001	0.0001	**0.0003**
Humpback whale	0.0012	0.0006	0.0005	0.0006	0.0005	0.0004	0.0001	0.0001	0.0002	0.0004	0.0005	0.0012	**0.0005**
North Atlantic right whale	0.0010	0.0010	0.0010	0.0006	0.0003	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0010	**0.0005**
Mid-Frequency Cetaceans													
Sperm Whale	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0001	0.0000	0.0001	0.0000	0.0000	**0.00004**
Atlantic white sided dolphin	0.0020	0.0010	0.0014	0.0033	0.0040	0.0025	0.0007	0.0004	0.0010	0.0030	0.0042	0.0040	**0.0023**
Atlantic spotted dolphin	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	**0.0012**
Common bottlenose dolphin (Offshore)	0.0311	0.0267	0.0427	0.0826	0.5114	0.4138	0.5288	0.5976	0.2254	0.1905	0.1295	0.0459	**0.2355**
Common bottlenose dolphin (Migratory)	0.0311	0.0267	0.0427	0.0826	0.5114	0.4138	0.5288	0.5976	0.2254	0.1905	0.1295	0.0459	**0.2355**
Short-finned pilot whale	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	**0.0003**
Long-finned pilot whale	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	**0.0003**
Risso’s dolphin	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0000**
Common dolphin	0.0084	0.0041	0.0047	0.0106	0.0197	0.0131	0.0149	0.0170	0.0128	0.0128	0.0233	0.0180	**0.0133**
High-Frequency Cetaceans													
Harbor porpoise	0.0256	0.0273	0.0259	0.0106	0.0029	0.0000	0.0000	0.0000	0.0000	0.0006	0.0157	0.0446	**0.0128**
Pinnipeds[1]													
Gray seal	0.0005	0.0005	0.0005	0.0005	0.0005	0.0014	0.0014	0.0014	0.0005	0.0005	0.0005	0.0005	**0.0007**
Harbor seal	0.0005	0.0005	0.0005	0.0005	0.0005	0.0014	0.0014	0.0014	0.0005	0.0005	0.0005	0.0005	**0.0007**

OCS = outer continental shelf.
[1]Seal densities are not given by individual month, instead, seasons are divided as Summer (June, July, August) and Winter (September – May); as a result, reported seasonal densities for spring and fall are the same (Roberts 2018).
Roberts, J.J. 2018. Revised habitat-based marine mammal density models for the U.S. Atlantic and Gulf of Mexico. Unpublished data files received with permission to use September, 2018.
Roberts, J.J., L. Mannocci, P.N. Halpin. 2016. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2016-2017 (Opt. Year 1). Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC. Document version 1.4. 76 pp.

6.1.3 Take Calculation

Based on the average annual densities for each species (**bolded** numbers in **Table 8**), the estimated number of marine mammal takes per equipment type was determined. Calculations were based on vessel-towed or mounted geophysical survey equipment operating for 200 days.

Estimates of take are calculated according to the following formula:

Estimated Take = D × ZOI × # of Days

Where: D = average species density (km^{-2}); and ZOI = maximum ensonified area that equates to NMFS thresholds for noise impact criteria. To estimate take, the density of marine mammals within the Project Area (animals km^{-2}) was multiplied by the daily ensonified area (km^2). That result is then multiplied by the number of survey days (rounded to the nearest whole number) to arrive at the estimated take. This final number equals the instances of take for the entire operational period. The result is an estimate of the maximum potential number of instances that marine mammals could be exposed to sounds above the Level A or Level B harassment thresholds over the duration of survey activities. The Applicant has agreed to extensive mitigation measures to reduce any potential Level B harassment and eliminate the possibility of any Level A harassment.

6.2 ESTIMATED NUMBERS OF MARINE MAMMALS THAT MIGHT BE TAKEN BY HARASSMENT

The Applicant is requesting approval for the incidental harassment takes of marine mammals associated with geophysical surveys. Take estimates were projected based on marine mammal presence, calculated density estimates, and activity-specific noise source propagation characteristics.

6.2.1 Estimated Level A Harassment of Marine Mammals

Level A exposures are not expected to occur for any of the hearing groups during operation of geophysical impulsive sources. Estimated SPL_{pk} threshold distances extend to a maximum of 3.5 m from one source only for HF cetaceans (i.e. harbor porpoise); therefore, no Level A ZOIs or exposures are calculated based on SPL_{pk} linear distances. Level A ZOIs are based upon the SEL_{cum} linear threshold distances which are less than 6 m for all geophysical sources. Maximum potential Level A take calculations, without mitigation applied, are provided in **Table 9**. Although two takes were calculated for harbor porpoises with the SBP Sparkers, the impact radius for this source was less than 4 m, and the SEL_{cum} metric used to calculate Level A takes assumes animals are exposed to sound levels that could result in injury for 24 hours. Given the intermittent nature of this equipment, and because it is a non-impulsive source, it is unlikely that any marine mammals will receive noise at levels which could cause injury. Therefore, Level A takes are not being requested by the Applicant and will not be discussed further.

Table 9. Maximum potential Level A take exposures for each equipment category operating for 200 days between August 30, 2019 and August 29, 2020 without mitigation applied.

Species	Abundance	Geophysical Equipment Category						Max % Population
		SBP chirps	Parametric SBP	SBP Boomers	SBP Sparkers	Acoustic Corers	USBL & GAPS	
Low-Frequency Cetaceans								
Fin whale	1,618	0	0	0	0	0	0	0.000
Sei whale	357	0	0	0	0	0	0	0.000
Minke whale	2,591	0	0	0	0	0	0	0.000
Humpback whale	896	0	0	0	0	0	0	0.000
North Atlantic right whale	451	0	0	0	0	0	0	0.000
Mid-Frequency Cetaceans								
Sperm whale	2,288	0	0	0	0	0	0	0.000
Atlantic white sided dolphin	48,819	0	0	0	0	0	0	0.000
Atlantic spotted dolphin	44,715	0	0	0	0	0	0	0.000
Common bottlenose dolphin (offshore stock)	77,532	0	0	0	0	0	0	0.000
Common bottlenose dolphin (migratory stock)	6,639	0	0	0	0	0	0	0.000
Short-finned pilot whale	28,924	0	0	0	0	0	0	0.000
Long-finned pilot whale	5,636	0	0	0	0	0	0	0.000
Risso’s dolphin	18,250	0	0	0	0	0	0	0.000
Common dolphin	70,184	0	0	0	0	0	0	0.000
High-Frequency Cetaceans								
Harbor porpoise	79,833	0	0	0	2	0	0	<1
Pinnipeds								
Gray seal	27,131	0	0	0	0	0	0	0.000
Harbor seal	75,834	0	0	0	0	0	0	0.000

GAPS = Global Acoustic Positioning System; SBP = sub-bottom profilers; USBL = ultra-short baseline.

6.2.2 Estimated Level B Harassment of Marine Mammals

Level B exposures were estimated by multiplying the average annual density of each species (**Table 8**) (Roberts et al., 2016; Roberts, 2018) by the daily ZOI area that was estimated to be ensonified to an SPL_{rms} exceeding 160 dB re 1 µPa, times the number of operating days (200) that is expected for the survey.

Table 10 summarizes the Level B take estimates for all species having a density estimate in the Project Area that was considered common, uncommon, or regular. As described previously, NMFS has defined the received thresholds for impulsive and non-impulsive sound sources using the SPL_{rms} metric. A marine mammal exposed to the thresholds results in a Level B take regardless of the exposure duration (unlike Level A takes where the SEL_{cum} includes an exposure duration).

Because specific equipment (**Table 4**) and survey needs are not yet fully defined, the requested take was estimated based on the operation of the equipment in **Table 4** that produced the largest threshold isopleths (i.e., the GeoSource 800J Sparker and AA Dura-Spark 400) for the entire 200 days of survey. These estimates provide conservative (maximum) estimates of the potential Level B exposures to any of the species stocks expected to occur within the Project Area.

The Applicant is planning to conduct site characterization surveys for up to 200 days; however, the maximum output source (sparker) is not expected to be used during 100% of the survey. It is likely that up to 120 days of survey may only include operation of the MBES and/or USBL. Unexploded ordnance surveys are planned between January 1 and July 30, 2020 in which only a USBL will be operated. Bathymetric survey may also be performed at any point throughout the survey period, with a vessel using only a hull-mounted USBL and MBES. Because of the short threshold radii of the USBL this would minimize the potential for Level B exposures, as the ZOI for the USBL is substantially smaller than the maximum estimate used to calculate the takes (10.6 vs. 31.1 km^2). Regardless of these periods of USBL-only usage, the total 200 survey days (including the 120 UXO survey days) were assumed as us using the sparker source

It is assumed that an animal will only be taken once over a 24-hour period; however, an activity may result in multiple takes of the same animal over a period of time. Therefore, both the number of takes and the affected population percentages represent the maximum potential take numbers. In actuality, a limited number of marine mammals may realize behavioral modification. The numbers of individuals in the take calculations range from 0 to 1,465 (**Table 10**). Mitigation will be effective to fully eliminate Level A takes and will minimize the potential for Level B takes. Maximum linear distance for Level B threshold levels is 141 m, allowing for effective mitigation.

Although mitigation will effectively reduce the potential for Level B exposures, the Applicant is using a conservative approach for this exposure assessment (i.e., assuming equipment that produces the largest threshold isopleths, surveys with this equipment over all 200 days, and no animal aversion). Therefore, the requested takes will follow the maximum number of estimated Level B exposures (**Table 10**). For species where no takes were estimated but are reasonably expected to occur in the Project Area based on records from previous surveys, requested takes (numbers in parentheses) are based on mean group size derived from published literature (**Table 10**). For species that have habitat densities for only a single guild (i.e., pilot whales, seals, common bottlenose dolphin) (Roberts et al., 2016; Roberts, 2018), take estimates were computed for each guild and applied to the individual species or stocks within each guild. For estimated takes of pilot whales (2) and seals (4), we assumed an equal probability of either species being encountered and therefore, requested the total estimated takes for each species within the guild. For the common bottlenose dolphin, the offshore stock is primarily found in waters >34 m; while the migratory stock is primarily found in waters <25 m (Hayes et al., 2018). The mean water depth of the Lease Area is 28 m; therefore, it is expected that all bottlenose dolphin will be from the northern migratory stock and none from the offshore stock.

Table 10. Summary of maximum potential Level B take exposures resulting from 100% usage of the GeoSource 800J Sparker and/or AA Dura-Spark 400 during all 200 days of surveys in both nearshore and offshore areas. Estimates are without mitigation or aversion behavior applied, for marine mammal species. Exposures with numbers in parentheses indicate those species for which no takes were estimated but takes are requested due to low densities, records in the Project Area during previous surveys, and wide distributions within the western North Atlantic†.

Species	Abundance	Requested Level B Takes	Max % Population
Low-Frequency Cetaceans			
Fin whale	1,618	8	0.49%
Sei whale	357	0 (1)	0.28%
Minke whale	2,591	2	0.08%
Humpback whale	896	3	0.37%
North Atlantic right whale	451	3	0.60%

Table 10. (Continued).

<table>
<tr><th colspan="2">Species</th><th>Abundance</th><th>Requested Level B Takes</th><th>Max % Population</th></tr>
<tr><td colspan="5">Mid-Frequency Cetaceans</td></tr>
<tr><td colspan="2">Sperm whale</td><td>2,288</td><td>0 (3)</td><td>0.13%</td></tr>
<tr><td colspan="2">Atlantic white-sided dolphin</td><td>48,819</td><td>14</td><td>0.03%</td></tr>
<tr><td colspan="2">Atlantic spotted dolphin</td><td>44,715</td><td>8</td><td>0.02%</td></tr>
<tr><td colspan="2">Common bottlenose dolphin (offshore stock)[1]</td><td>77,532</td><td rowspan="2">1,465</td><td>1.89 %</td></tr>
<tr><td colspan="2">Common bottlenose dolphin (migratory stock)[1]</td><td>6,639</td><td>22.06%</td></tr>
<tr><td rowspan="2">Pilot Whales[1]</td><td>Short-finned pilot whale</td><td>28,924</td><td>2</td><td><0.01%</td></tr>
<tr><td>Long-finned pilot whale</td><td>5,636</td><td>2</td><td>0.03%</td></tr>
<tr><td colspan="2">Risso's dolphin</td><td>18,250</td><td>0 (30)</td><td>0.16%</td></tr>
<tr><td colspan="2">Common dolphin</td><td>70,184</td><td>83</td><td>0.12%</td></tr>
<tr><td colspan="5">High-Frequency Cetaceans</td></tr>
<tr><td colspan="2">Harbor porpoise</td><td>79,833</td><td>79</td><td>0.10%</td></tr>
<tr><td colspan="5">Pinnipeds</td></tr>
<tr><td colspan="2">Gray seal[1]</td><td>27,131</td><td>5</td><td>0.02%</td></tr>
<tr><td colspan="2">Harbor seal[1]</td><td>75,834</td><td>5</td><td>0.01%</td></tr>
</table>

[1] Roberts (2018) only provides density estimates for "generic" pilot whales and seals; and does not separate stocks of bottlenose dolphins; therefore an equal potential for takes has been assumed for of either species or stocks within the larger group.
† Changes from calculated takes are as follows:
0 (#) = No takes were calculated for these species; however, due to very low positive densities in some density blocks and general variability in the movements of these species Level B takes are requested based on mean group sizes derived from the following references:
Sei whale: Kenney and Vigness-Raposa, 2010.
Sperm whale: Barkaszi, M.J. and C.J. Kelly. 2019 (In Press). Seismic Survey Mitigation Measures and Protected Species Observer Reports: Synthesis Report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2018-XXX. 141 pp + apps.
Risso's dolphin: NOAA Fisheries species directory: Risso's dolphin (https://www.fisheries.noaa.gov/species/rissos-dolphin).
Kenney, R.D. and K.J. Vigness-Raposa. 2010. Marine Mammals and Sea Turtles of Narragansett Bay, Block Island Sound, Rhode Island Sound, and Nearby Waters: An Analysis of Existing Data for the Rhode Island Ocean Special Area Management Plan. In: RICRMC (Rhode Island Coastal Resources Management Council). 2010. Rhode Island Ocean Special Area Management Plan (OceanSAMP), volumes 1 and 2.

7.0 Effects on Marine Mammal Species or Stocks

Marine mammals exposed to natural or man-made sound may experience non-auditory and auditory impacts, which range in severity (Southall et al., 2007; Southall et al., 2019; NMFS, 2018a; Wood et al., 2012). The potential exists for small numbers of marine mammals to be exposed to underwater sound associated with survey activities. These impacts are likely to affect individual species but have only negligible effects on the marine mammal stocks and, therefore, will not adversely affect the population of any species.

7.1 MITIGATION AND AVERSION

Mitigation and aversion are not considered in the take estimates. The inclusion of mitigation and aversion would reduce the take estimates. Although the proposed mitigation (**Section 11.0**) is implemented to eliminate the potential for Level A takes, it will also serve to reduce the exposure of animals to SLs that could constitute Level B takes. In the BOEM RI-MA EA (2013), the modeled area of ensonification for some geophysical survey equipment showed potential Level B thresholds at distances beyond what BOEM considered could be effectively visually monitored for the presence of marine mammals. However, NMFS determined that with the SOCs and RPMs, the proposed geophysical surveys may adversely affect but are not likely to jeopardize the continued existence of North Atlantic right, humpback, fin, sei, or sperm whales. This suggests that geophysical survey operations would not jeopardize the sustainability of other cetaceans, particularly other LF and MF species that occupy the same acoustic habitat. Theoretically, an animal entering the Level A exclusion zone has already received a Level B exposure; however, for many of the sources, the Lease-stipulated 200-m (656-ft) exclusion zone will eliminate Level B exposures, thus reducing the actual number of Level B takes.

7.2 MULTIPLE EXPOSURES AND SEASONALITY

The estimated exposures to most species' stocks are expected to be a significant over-estimate of the actual proportion of the stock potentially affected by the survey activities. For example, in the case of the migratory common bottlenose dolphin stock, Level B exposures likely include the same individuals across multiple days and not exposures to the entire stock; therefore, they can be considered instances of exposurerather than a discrete count of individuals that have received regulatory-level sound exposures. The acoustic metric used to establish Level B isopleths (SPL_{rms}) does not consider a duration of exposure (SEL_{cum}) in its calculations. The SPL_{rms} assumes that an animal within the Level B isopleth, regardless of the length of time, is taken by exposure. The take estimates assume that an animal will only be taken once over a 24-hour period; however, an activity may result in multiple takes of the same animal over a period of time. It is only the multiplication of the same animals being exposed over 200 days that numbers become inflated and hence, a conservative approach to the population-level exposure. Animals in an area of exposure may move location depending on their acoustic sensitivity, life stage, and acclimation (Wood et al., 2012) and may or may not demonstrate behavioral responses. Specifically related to the northern migratory bottlenose dolphin stock found in the project area, the seasonal movement places the stock south of the project area almost entirely during the months of January and February; however, due to the evolution of survey schedules, it is not possible to determine what proportion of the surveys would be conducted during those months. Therefore, while the number of takes and the affected population percentages represent the maximum potential take numbers, in actuality a limited number of marine mammals may realize behavioral modification.

7.3 VOLUMETRIC DENSITY CALCULATIONS

Particularly for HRG sources that have narrow bandwidths, the linear distances to impact isopleths are typically over-estimations of the actual three-dimensional sound field produced and the resultant volume of water in which species densities should be applied. Using a volumetric calculation for highly directional sources, such as those used during wind lease site characterization surveys, the sound fields for exposure densities will significantly reduce the number of Level B exposures. As increased information for individual geophysical sources is acquired, a volumetric approach will become applicable.

7.4 NEGLIGIBLE IMPACTS

Animals in an area of exposure may move location depending on their acoustic sensitivity, life stage, and acclimation (Wood et al., 2012) and may or may not demonstrate behavioral responses. Therefore, while the number of takes and the affected population percentages represent the maximum potential take numbers, in actuality a limited number of marine mammals may realize behavioral modification.

Under the requirements of 50 CFR § 216.104, NMFS has defined negligible impact as an impact that is not reasonably expected to adversely affect a species or stock through effects on annual rates of recruitment or survival. The small numbers requirement is not based on take estimates alone; rather, for NMFS to make a negligible impact determination, small numbers must denote that the portion of a marine mammal species or stock in the take estimates will have a negligible impact on that species or stock.

As discussed in **Sections 9.0** and **10.0**, physical auditory effects, vessel strikes, PTS or TTS, and long-term impacts to habitat or prey species are not expected to occur. Temporary masking may occur in localized areas for short periods of time when an animal is in proximity to the survey. Masking occurs when an animal's acoustic "space" (i.e. auditory perception and discrimination) is covered up by noise of similar frequency but at higher amplitudes of biologically important sounds. However, due to movement of the sources masking effects are expected to be negligible and not contribute significantly to other noise sources operating in the region.

The primary potential impact on marine mammals from exposure to survey-related underwater sound is behavioral responses, which do not necessarily constitute significant changes in biologically important behaviors. The National Research Council (2005) noted that an action or activity becomes biologically significant to an individual animal when it affects the ability of the animal to grow, survive, and reproduce, wherein an impact on individuals can lead to population-level consequences and affect the viability of the species. The reasonably expected impacts from the proposed activities are based on noise exposure thresholds that can potentially elicit a behavioral response and are categorized as Level B takes under the MMPA. Here, due to the variability in species reaction to sound sources, short time period of the survey operations, and use of mitigation measures, any behavioral reactions are expected to be **minor**, **localized**, **short term**, and have **negligible** effects on individuals and stocks. It is expected that behavioral reactions will mainly comprise a temporary shift in spatial use. No long-term or population effects are expected from the behavioral reactions to the proposed surveys.

8.0 Minimization of Adverse Effects to Subsistence Uses

This section addresses NFMS' requirement to identify methods to minimize adverse effects of the proposed activity on subsistence uses.

There are no current subsistence hunting areas in the vicinity of the proposed Project Area, and there are no activities related to the proposed surveys that may affect the availability of a species or stock of marine mammals for subsistence uses. Consequently, there are no available methods to minimize potentially adverse effects to subsistence uses.

9.0 Anticipated Impacts on Habitat

This section addresses NFMS' requirement to characterize the short- and long-term impacts of the proposed activity on marine mammals associated with the predicted loss or modification of habitat and to address available methods and likelihood of restoration of lost or modified habitat. The site characterization surveys will include geophysical surveys between August 30, 2019 and August 29, 2020. Therefore, long-term impacts are not expected. Anticipated impacts to marine mammal habitat have been summarized in the following sections.

9.1 SHORT-TERM IMPACTS

The proposed activity has the potential to affect marine mammal habitat primarily through short-term impacts from increases in ambient noise levels from vessel activities. These impacts arise from a variety of impact producing factors (i.e., noise, discharges, physical presence, lights, turbidity) with the potential to temporarily affect marine mammal prey availability. Various pelagic and benthic fish species, cephalopods, and crustaceans are expected to occur in the Project Area. Elevated noise levels may cause these species to leave the immediate area of operations, temporarily disrupting feeding behavior. Displaced individuals are expected to return shortly after work is completed. Sediment disturbance is expected during geotechnical sampling and coring within the immediate area (<1 m [<3 ft] diameter) around the core, drill, or grab sampler. This disturbance and associated increase in water turbidity is expected to be short-term and temporary with minimal effects on habitat.

Discharges of contamintants (e.g. oil), if any, will be localized near their source and are not expected to adversely affect fish or squid. While the physical presence of vessels, and deployed equipment may produce avoidance behavior, night lighting may serve to attract fishes and squid. Neither physical presence nor night lighting are expected to adversely affect prey species.

9.2 LONG-TERM IMPACTS

Due to the short duration of the potential activities and the minimal acoustic disturbance expected, no long-term impacts associated with loss or modification habitat are anticipated.

10.0 Anticipated Effects of Habitat Impacts on Marine Mammals

This section addresses the NFMS requirement to characterize the short- and long-term impacts of the proposed activity on predicted habitat loss or modification. Loss or modification of marine mammal habitat could arise from alteration of benthic habitat, degradation of water quality, or effects of noise. These impacts could be short- or long-term in nature. However, no significant short- or long-term impacts on marine mammals or their habitat are expected. The predicted impacts to marine mammal habitat have been summarized in **Sections 10.1** and **10.2**.

10.1 SHORT-TERM IMPACTS

Marine mammals use sound to navigate, communicate, find open water, avoid predators, and find food. Acoustic acuity within the habitat must be available for species to conduct these ecological processes. If noise levels within critical frequency bands preclude animals from accessing the acoustic properties of that habitat, then availability and quality of that habitat has been diminished. The sounds that marine mammals hear and generate will vary in terms of dominant frequency, bandwidth, energy, temporal pattern, and directionality. The same variables in ambient noise will, therefore, determine a marine mammal's acoustic resource availability. In the case of marine mammals, anthropogenic noise can be viewed as a form of habitat fragmentation resulting in a loss of acoustic space that could otherwise be occupied by vocalizations or other acoustic cues (Rice et al., 2014). Primary acoustic habitat for a species will be focused within the vocal ranges for that species; therefore, habitat impact assessment should be conducted within those vocal ranges. The functional extent of the ensonified space around specific vessel operations will require an understanding of the distribution of SPLs by their spectral probability density and knowledge of received exposure levels with coordinated species densities. Therefore, marine mammals may experience some short-term loss of acoustic habitat, but the nature and duration of this loss is not expected to represent a significant loss of habitat.

Reduction of prey availability might indirectly affect marine mammals by altering prey abundance, behavior, and distribution. Rising sound levels could affect fish populations (McCauley et al., 2003; Popper and Hastings, 2009; Slabbekoorn et al., 2010). Marine fish are typically sensitive to the 100 to 500 Hz range, which is below the primary operating frequencies of most HRG survey sources. However, several studies have demonstrated that seismic airguns and other impulsive sources might affect the behavior of at least some species of fish. For example, field studies by Engås et al. (1996) and Whitlock and Schluter (2009) showed that the catch rate of haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*) significantly declined over the five days following seismic airgun operation, after which the catch rate returned to normal. Other studies found only minor responses by fish to seismic surveys, such as a small decline in lesser sand eel (*Ammodytes marinus*) abundance that quickly returned to pre-seismic levels (Hassel et al., 2004) or no permanent changes in the behavior of marine reef fishes (Wardle et al., 2001). Squid (*Sepioteuthis australis*) are an extremely important food chain component for many higher order marine predators, including sperm whales. McCauley et al. (2000) recorded caged squid responding to airgun signals. Given the generally low SPLs produced by expected geophysical sources in comparison to sources such as airguns, no short-term impacts to potential prey items (fishes, cephalopods, crustaceans) are expected from the proposed survey activities.

Due to the small footprint of any sediment disturbance caused by acoustic coring or geotechnical activities combined with the temporary nature of the activities and likely availability of similar benthic habitat around the sampling location, it is expected that acoustic coring or geotechnical activities would have negligible benthic effects that could impact marine mammals.

10.2 LONG-TERM IMPACTS

Due to the short duration of the potential activities and the minimal acoustic disturbance expected, no long-term impacts to marine mammals associated with loss or modification habitat are anticipated.

11.0 Mitigation Measures

This section addresses NMFS' IHA requirement to assess the availability and feasibility (economic and technological), methods, and manner of conducting this survey activity and the means of effecting the least practicable impact upon effected species or stock, their habitat, and their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

The Applicant has demonstrated a strong commitment to minimizing impacts to marine mammal species through a comprehensive and progressive mitigation and monitoring program, described here. This program provides the protocols for both mitigation and monitoring during all proposed activities. The Applicant has committed to engaging in ongoing consultations with the NMFS and following a comprehensive set of mitigation measures during site characterization surveys. These measures include the following components which are described in detail below:

- Vessel strike avoidance procedures.
- Seasonal right whale monitoring requirements
- Establishment of exclusion zones;
- Visual monitoring; including low visibility monitoring tools
- Area clearance;
- Ramp-up procedures;
- Source minimization during turns;
- Operational shutdowns and delays;
- Communication of sightings between vessels; and
- Utilization of Whale Alert as able for monitoring for Dynamic Management Areas (DMAs)

The mitigation protocols have been designed to provide protection to marine mammals, both individual species, and by extension, species' stocks where designated, by minimizing exposure to potentially disruptive noise levels during site characterization activities. The mitigation measures will also reduce any potential ship strikes to large whales in the area.

Project-specific training will be conducted for all vessel crew prior to the start of a survey and during any changes in crew such that all survey personnel are fully aware and understand the mitigation, monitoring and reporting requirements. Prior to implementation with vessel crews, the training program will be provided to NOAA Fisheries for review and approval. Confirmation of the training and understanding of the requirements will be documented on a training course log sheet. Signing the log sheet will certify that the crew members stipulate their understanding and will comply with the necessary requirements throughout the survey activities.

11.1 VESSEL STRIKE AVOIDANCE PROCEDURES

The Applicant will ensure that vessel operators and crew maintain a vigilant watch for cetaceans, pinnipeds, and slow down or stop their vessels to avoid striking these protected species. Survey vessel crew members responsible for navigation duties will receive site-specific training on marine mammal detection and identification, sighting/reporting, and vessel strike avoidance measures. Vessel strike avoidance measures will include, but are not limited to, the following, except under extraordinary circumstances when complying with these requirements would put the safety of the vessel or crew at risk:

- All vessel operators and crew will maintain vigilant watch for cetaceans, pinnipeds and slow down or stop their vessel to avoid striking an animal;

- All vessel operators will comply with 10 knot (<18.5 km h^{-1}) speed restrictions in any DMA.

- All vessels 65 ft (19.8 m) or greater operating from November 1 through July 31 will operate at speeds of 10 knots (<18.5 km/h) or less;

- All vessel operators will reduce vessel speed to 10 knots or less when mother/calf pairs, pods, or larger assemblages of non-delphinid cetaceans are observed near an underway vessel;

- All survey vessels will maintain a separation distance of 1640 ft (500 m) or greater from any sighted North Atlantic right whale (62 *FR* 6729);

- If underway, vessels must steer a course away from any sighted North Atlantic right whale at 10 kn (<18.5 km h^{-1}) or less until the 1640-ft (500-m) minimum separation distance has been established. If a North Atlantic right whale is sighted in a vessel's path, or within 330 ft (100 m) to an underway vessel, the underway vessel must reduce speed and shift the engine to neutral. Engines will not be engaged until the North Atlantic right whale has moved outside of the vessel's path and beyond 330 ft (100 m). If the whale is stationary, the vessel must not engage engines until the North Atlantic right whale has moved beyond 330 ft (100 m);

- All vessels will maintain a separation distance of 330 ft (100 m) or greater from any sighted non-delphinid cetacean. If sighted, the vessel underway must reduce speed and shift the engine to neutral and must not engage the engines until the non-delphinid cetacean has moved outside of the vessel's path and beyond 330 ft (100 m). If a survey vessel is stationary, the vessel will not engage engines until the non-delphinid cetacean has moved out of the vessel's path and beyond 330 ft (100 m);

- All vessels will maintain a separation distance of 164 ft (50 m) or greater from any sighted delphinid cetacean. Any vessel underway should remain parallel to a sighted delphinid cetacean's course whenever possible, and avoid excessive speed or abrupt changes in direction. Any vessel underway reduces vessel speed to 10 knots or less when pods (including mother/calf pairs) or large assemblages of delphinid cetaceans are observed. Vessels may not adjust course and speed until the delphinid cetaceans have moved beyond 164 ft (50 m) and/or the abeam of the underway vessel;

- All vessels underway will not change course to approach any delphinid cetacean or pinniped. Any vessel underway will avoid excessive speed or abrupt changes in direction to avoid injury to the sighted delphinid cetacean or pinniped; and

- All vessels will maintain a separation distance of 164 ft (50 m) or greater from any sighted pinniped.

11.2 SEASONAL RIGHT WHALE OPERATING REQUIREMENTS

Members of the monitoring team will consult NOAA Fisheries North Atlantic right whale reporting system and Whale Alert as able for the presence of North Atlantic right whales throughout survey operations. Survey vessels may transit SMAs.

Throughout all survey operations, the monitoring team will monitor NOAA Fisheries North Atlantic right whale reporting system and Whale Alert as able for the establishment of a DMA. If NOAA Fisheries should establish a DMA in the Lease Areas under survey, the vessels will abide by speed restrictions in the DMA per the lease conditions.

11.3 MONITORING, EXCLUSION, AND LEVEL B HARASSMENT ZONES

We have defined three distinct zones to better describe the monitoring activities and mitigation actions associated with the detection of a marine mammals during the survey:

- **Monitoring zone:** the monitoring zone will encompass the exclusion zone, Level B Harassment (Level B) zone, and general waters surrounding the vessel out to a distance that can be visually monitored with the naked eye. The monitoring zone is continuously scanned by protected species observers (PSOs) in order to conduct observations of marine mammals within the immediate area of the survey. There are no visibility requirements or mitigation requirements associated with the monitoring zone but all observation conditions and marine mammal detections within this zone are recorded.

- **Level B zone:** the Level B zone is the distance to which a SPL_{rms} of 160dB re 1 μPa extends from a source whereby marine mammals may be exposed to sound pressure levels of sufficient amplitude to result in potential behavioral harassment. Animals detected within the Level B zone while geophysical sources with frequencies <200 kHz are in operation may constitute take under the MMPA. PSO will note visibility of the Level B zone but there is no visibility requirement for this zone to proceed with the survey. The Level B zone may not be visible in its entirety and in such cases, the Applicant will apply NMFS-accepted alternatives for calculating potential Level B exposures.

- **Exclusion zone (EZ)**: the exclusion zone is a species-specific zone around the geophysical source. The exclusion zone only delineates the area in which mitigation actions (ramp up delay, operational shutdown) are required for species entering the zone. The exclusion zone may or may not encompass the Level B zone and an animal's entry into the exclusion zone does not necessarily represent a take. Species' exclusion zones inside the Level B zone must be visible at all times. Species' exclusion zones outside of the Level B zone may have intermittent visibly without affecting survey operations.

The Applicant will employ the following zones during all HRG survey activities (**Figure 5**):

- **Monitoring zone:**
  - Waters surrounding the sound sources and the vessel. All marine mammals detected will be recorded.
- **Level B zone:**
  - 141 m (463 ft) for all marine mammals around active geophysical sound sources that have operating frequencies less than 200 kHz.
- **Exclusion zones:**
  - North Atlantic Right Whale exclusion zone: 500 m (1,640 ft) for North Atlantic right whale
  - Marine Mammal exclusion zone: 100 m (328 ft) for all non-delphinid cetaceans, seals, and porpoises
  - No exclusion zone for dolphins; however a 100-m (328 ft) pre-clearance zone will be incorporated prior to start of HRG sources.

Figure 5. Graphical representation of monitoring, North Atlantic right whale (NARW) exclusion, Level B and non-delphinid marine mammal exclusion zones (not to scale).

11.4 VISUAL MONITORING

Visual monitoring of the established exclusion zones and monitoring zone will be performed by the NOAA Fisheries-approved PSOs.

PSOs will be stationed on all survey vessels and will work in shifts such that observers obtain adequate rest periods between active watch periods. For all HRG survey segments with sources operating at <200kHz, PSOs will work in shifts as stipulated above, such that one PSO will be on watch during all daylight hours; and two PSOs, equipped with nighttime monitoring devices, will be on watch during all hours of reduced visibility, including night time. During PSO observations, the following guidelines shall be followed:

- Other than brief alerts to bridge personnel of maritime hazards and the collection of ancillary wildlife data, no additional duties may be assigned to the PSO during his/her visual observation watch;
- No PSO will be allowed more than four consecutive hours on watch before being allocated a break from visual watch;
- No person on watch as a PSO will be assigned a combined watch schedule of more than 12 hours in a 24-hour period.
- The PSOs will stand watch in a suitable location that will not interfere with the navigation or operation of the vessel and affords an optimal view of the sea surface.

- PSOs will adjust their positions appropriately to ensure coverage of the entire exclusion zone
- Position data will be recorded using hand-held or vessel GPS units for each sighting
- The PSOs will begin observation of the monitoring zone at least 30 minutes prior to any HRG survey operations; PSOs will continue observations throughout the survey activity while sources operating below 200 kHz are in use.
- The PSOs will be responsible for visually monitoring and identifying marine mammals approaching or entering the established zones (**Figure 5**) during survey activities. It will be the responsibility of a senior-level PSO who has supervisory capacity over the PSO team (Lead PSO) to communicate the presence of marine mammals as well as to communicate and enforce the action(s) that are necessary to ensure mitigation and monitoring requirements are implemented as appropriate.
- PSOs will share sighting data between project survey vessels as able

Each PSO will be equipped with reticled binoculars that have an internal compass in order to estimate range and bearing to detected marine mammals Digital single-lens reflex camera equipment will be used to record sightings and assist in subsequent verification of species identification.

11.4.1 Nighttime Monitoring

During night operations, night-vision equipment (night-vision goggles with thermal clip-ons) and infrared/thermal technology will be used. Recent studies have concluded that the use of IR (thermal) imaging technology allow for the detection of marine mammals at night (Verfuss et al., 2018; Guazzo et al., 2019). Guazzo et al (2019) showed that probability of detecting a large whale blow by the infrared camera (commercial, off-the shelf *FLIR F-606* model) was the same at night as during the day; and camera monitoring distance was 2.1 km from an elevated vantage point versus 3 km for daylight visual monitoring from the same location. The Applicant finds that use of thermal camera systems for mitigation purposes warrants additional application in the field as both a standalone tool and in conjunction with other alternative monitoring methods (e.g., night vision binoculars).

Towed passive acoustic monitoring (PAM) systems will be available on the 24-hour vessels for use at night to assist in clearing the 100-m marine mammal clearance zone. Deployment of the PAM array will be at the discretion of the lead PSO and vessel captain to determine if PAM can be safely deployed and effectively monitored given the *in situ* noise conditions.

11.4.2 Data Recording

PSOs will record all sightings of marine mammals while monitoring during day or night. Data on all PSO observations will be recorded based on standard PSO collection requirements. This will include dates and locations of construction operations; time of observation, location and weather; details of the sightings (e.g., species, age classification [if known], numbers, behavior); and details of any observed behavioral disturbances or injury/mortality. The data sheet will be provided to both NOAA Fisheries and BOEM for review and approval prior to the start of survey activities. Visual detections will be shared between vessels in near-real time, to the most practicable extent possible, via radio, phone, or other methods, thus increasing situational awareness.

11.5 PRE-CLEARANCE OF THE EXCLUSION ZONES

The Applicant will implement a 30- minute clearance period of the exclusion zones prior to the initiation of ramp-up (**Section 11.6**). During this period the marine mammal exclusion zone must be visible. After 30 minutes of monitoring, if any marine mammal has entered their respective exclusion zone, ramp up will not be initiated until the animal is confirmed outside the exclusion zone or until the following time has elapsed since the last sighting of the animal in the exclusion zone:

- 30 minutes for whales, including the North Atlantic right whale
- 15 minutes for dolphins, porpoises, seals

11.6 RAMP-UP PROCEDURES

Where technically feasible, a ramp-up procedure will be used for HRG survey equipment capable of adjusting energy levels at the start or re-start of HRG survey activities. A ramp-up would begin with powering up of the HRG equipment that has the lowest source level output and start it at its lowest practical power appropriate for the survey. The ramp up will proceed by either adding equipment with higher source levels, increasing the power output of the operating equipment, or a combination of both.

A ramp-up procedure will be used, to the extent practicable, at the beginning of HRG survey activities in order to provide additional protection to marine mammals near the survey by allowing them to vacate the area prior to the commencement of survey equipment use.

The ramp-up procedure will not be initiated (i.e. equipment will not be started) during periods of inclement conditions when the marine mammal exclusion zone cannot be adequately monitored by the PSOs for a 30-minute period, using the appropriate visual technology. If any marine mammal enters the exclusion zone, ramp up will not be initiated until the animal is confirmed outside the marine mammal exclusion zone or until the appropriate time (30 minutes for whales, 15 minutes for dolphins, porpoises and seals) has elapsed since the last sighting of the animal in the exclusion zone.

11.7 SHUT-DOWN PROCEDURES

An immediate shut-down of the HRG survey equipment operating at frequencies less than 200 kHz will be required if a whale, porpoise, or seal is sighted at or within the 100- m marine mammal exclusion zone or if a North Atlantic right whale is observed within the 500-m right whale exclusion zone. Survey equipment will not be shut down for dolphins. The vessel operator must comply immediately with any call for shut-down by the Lead PSO. Any disagreement between the Lead PSO and vessel operator should be discussed only after shut-down has occurred. Subsequent restart of the survey equipment can be initiated if the animal has been observed exiting its respective exclusion zone or has not been re-sighted within their respective exclusion zone for the appropriate time period (30 minutes for whales, 15 minutes for dolphins, porpoises and seals). The PSOs will make a judgment determining if the marine mammal is inside or outside the respective exclusion zone.

If another marine mammal enters the respective exclusion zone during this shutdown period, the equipment may not restart until that animal is confirmed outside the marine mammal exclusion zone as above or until the appropriate time listed below has elapsed since the last sighting of the animal in the exclusion zone.

If the acoustic source is shut down for reasons other than mitigation (e.g., mechanical difficulty) for less than 30 minutes, it may be activated again without ramp-up as long as PSOs have maintained constant observation and no detections of any marine mammal have occurred within the respective exclusion zones. If these conditions are not met, standard ramp up conditions apply.

11.8 SURVEY COMMUNICATION AND COORDINATION FOR SIGHTINGS

The Applicant will utilize radios and available software to communicate sightings between all vessels. This will allow all PSOs and vessel crew to maintain awareness of marine mammal observations and adjust activities accordingly. The Applicant will also utilize the Whale Alert application, https://apps.apple.com/us/app/whale-alert-reducing-ship/id911035973?ls=1 , to report all North Atlantic right whale detections and monitor for DMAs. The Whale Alert will be checked at least once every hour by the PSOs.

12.0 Arctic Plan of Cooperation

This requirement is applicable only for activities that occur in Alaskan waters north of 60° N latitude. The proposed survey activities will not take place within the designated region and, therefore, will not have an adverse effect on the availability of marine mammals for subsistence uses. As such, there is no need to form such a plan.

13.0 Monitoring and Reporting

As required in Lease OCS-A 0519, The Applicant will comply with the marine mammal reporting requirements for site characterization activities detailed below.

Reporting Injured or Dead Species. The Applicant will ensure that sightings of any injured or dead marine mammals are reported to the Greater Atlantic (Northeast) Region Marine Mammal and Sea Turtle Stranding & Entanglement Hotline (866-755-NOAA [6622]) within 24 hours of a sighting, regardless of whether the injury or death is caused by a vessel. In addition, if the injury or death was caused by a collision with a project-related vessel, the Applicant will ensure that BOEM is notified of the strike within 24 hours. The notification of such strike will include the date and location (latitude/longitude) of the strike, the name of the vessel involved, and the species identification or a description of the animal, if possible. If the project activity is responsible for the injury or death, the Applicant will supply a vessel to assist in any salvage effort as requested by NMFS.

Reporting Observed Impacts to Species. The observers will report any observations concerning impacts on marine mammals to BOEM and NMFS within 48 hours. Any observed takes of listed marine mammals resulting in injury or mortality must be reported within 24 hours to BOEM and NMFS.

Report of Activities and Observations. The Applicant will provide BOEM and NMFS with a report within 90 calendar days following the commencement of survey activities, including a summary of the survey activities and an estimate of the number of marine mammals taken during these survey activities.

Report Information. Data on all marine mammal observations will be recorded and based on standards of marine mammal observer collection data by the PSOs. This information will include dates, times, and locations of survey operations; time of observation, location and weather; details of marine mammal sightings (e.g., species, numbers, behavior) and details of any observed taking (e.g., behavioral disturbances or injury/mortality).

14.0 Suggested Means of Coordinated Research

This section addresses the IHA requirement to suggest means of learning of, encouraging, and coordinating research opportunities, plans, and activities related to reducing incidental take and evaluating its effects.

While no direct research on marine mammals or marine mammal stocks is expected from the project, there is the opportunity for the proposed activity to contribute greatly to the noise characterization in the region and to specific sound source measurements.

Data acquired during the mitigation and monitoring may provide valuable information to direct or refine future research on marine mammal species present in the area. Sightings data (e.g., date, time, weather conditions, species identification, approximate sighting distance, direction, heading in relation to sound sources, behavioral observations) may be useful in designing the location and scope of future marine mammal survey and monitoring programs.

The applicant will immediately share all North Atlantic right whale sightings with NOAA.

All marine mammal data collected by the Applicant during marine characterization survey activities will be provided to NMFS, BOEM, through the reporting processes. In addition, the data, upon request, may be made available to educational institutions and environmental groups.

15.0 List of Preparers

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- Mary Jo Barkaszi, Marine Mammal Programs Manager
- Kayla Hartigan, Project Scientist
- Ashley Lawson, Project Scientist
- Melanie Cahill, Project Scientist
- Jeffrey Martin, Project Scientist
- Mark Fonseca, Science Reviewer
- Teresa Thorpe, Technical Editor

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- Stephanie Wilson, Manager of Permitting & Environmental Affairs
- Aileen Kenney, Vice President of Permitting & Environmental Affairs

59 *Federal Register* (*FR*) 28805. 1994. Designated Critical Habitat; Northern Right Whale. June 3, 1994.

62 *Federal Register (FR)* 39157. 1997. Taking of Marine Mammals Incidental to Commercial Fishing Operations; Atlantic Large Whale Take Reduction Plan Regulations. July 22, 1997.

66 *Federal Register (FR)* 53195. 2001. Threatened Fish and Wildlife; Status Review of the Gulf of Maine/Bay of Fundy Population of Harbor Porpoise Under the Endangered Species Act (ESA). October 19, 2001.

69 *Federal Register (FR)* 69536. 2004. Regulations Governing the Approach to North Atlantic Right Whales.
November 30, 2004.

73 *Federal Register (FR)* 60173. 2008. Endangered Fish and Wildlife; Final Rule to Implement Speed Restrictions to Reduce the Threat of Ship Collisions with North Atlantic Right Whales. October 10, 2008.

75 *Federal Register (FR)* 61690. 2010. Endangered and Threatened Wildlife and Designating Critical Habitat for the Endangered North Atlantic Right Whale. October 6, 2010.

75 *Federal Register (FR)* 7383. 2010. Taking of Marine Mammals Incidental to Commercial Fishing Operations; Harbor Porpoise Take Reduction Plan Regulations. February 19, 2010.

77 *Federal Register (FR)* 2494. 2012. Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf. February 3,2012.

78 *Federal Register (FR)* 73726. 2013. Endangered Fish and Wildlife; Final Rule to Remove the Sunset Provision of the Final Rule Implementing Vessel Speed Restrictions to Reduce the Threat of Ship Collisions with North Atlantic Right Whales. December 9, 2013.

81 *Federal Register (FR)* 4838. 2016. Endangered and Threatened Species; Critical Habitat for Endangered North Atlantic Right Whale. January 27, 2016.

81 *Federal Register (FR)* 62259. 2016. Endangered and threatened species; Identification of 14 distinct population segments of the humpback whale (*Megaptera novaengliae*) and revision of species-wide listing. September 8, 2016.

Aguilar Soto, N., M.P. Johnson, P.T. Madsen, F. Díaz, I. Domínguez, A. Brito, and P. Tyack. 2008. Cheetahs of the deep sea: deep foraging sprints in short-finned pilot whales off Tenerife (Canary Islands). Journal of Animal Ecology, 77(5):936-947.

Baird, R.W., and P.J. Stacey. 1991. Status of the Risso's dolphin, *Grampus griseus*, in Canada. Canadian Field-Naturalist 105:233-242.

Barco, S.G., W.A. McLellan, J.M. Allen, R.A. Asmutis-Silvia, R. Mallon-Day, E.M. Meagher, D.A. Pabst, J. Robbins, R.E. Seton, W.M. Swingle, M.T. Weinrich, and P.J. Clapham. 2002. Population identity of humpback whales (*Megaptera novaeangliae*) in the waters of the U.S. Mid-Atlantic states. Journal of Cetacean Research Management 4(2):135-141.

Baumgartner, M.F., S.M. Van Parijs, F.W. Wenzel, C.J. Tremblay, H.C. Esch, and A.M. Warde. 2008. Low frequency vocalizations attributed to sei whales (*Balaenoptera borealis*). Journal of the Acoustical Society of America 124(2):1339-1349.

Best, B.D., P.N. Halpin, A.J. Read, E., Fujioka, C.P. Good, E.A. LaBrecque, R.S. Schick, J.J. Roberts, L.J. Hazen, S.S. Qian, D.L. Palka, L.P. Garrison, and W.A. McLellan. 2012. Online Cetacean Habitat Modeling System for the U.S. East Coast and Gulf of Mexico. Endangered Species Research 18:1-15.

Bettridge, S., C.S. Baker, J. Barlow, P.J. Clapham, M. Ford, D. Gouveia, D.K. Mattila, R.M. Pace III, P.E. Rosel, G.K. Silber, and P.R. Wade. 2015. Status Review of the Humpback Whale (*Megaptera novaeangliae*) Under the Endangered Species Act. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Memorandum NMFS Southwest Fisheries Science Center-540. 263 pp.

Bort, J., S.M. Van Parijs, P.T. Stevick, E. Summers, and S. Todd. 2015. North Atlantic right whale *Eubalaena glacialis* vocalization patterns in the central Gulf of Maine from October 2009 through October 2010. Endangered Species Research 26:271-280.

Bureau of Ocean Energy Management (BOEM). 2012. Commercial wind lease issuance and site assessment activities on the Atlantic outer continental shelf offshore New Jersey, Delaware, Maryland, and Virginia. Final Environmental Assessment. U.S. Department of the Interior, BOEM Office of Renewable Energy Programs. OCS EIS/EA BOEM 2012-003. 366 pp.

Bureau of Ocean Energy Management (BOEM). 2013. Commercial wind lease issuance and site assessment activities on the Atlantic outer continental shelf offshore Rhode Island and Massachusetts. Revised Environmental Assessment. U.S. Department of the Interior, BOEM Office of Renewable Energy Programs. OCS EIS/EA BOEM 2013-1131. 417 pp.

Bureau of Ocean Energy Management (BOEM). 2014. Atlantic OCS Proposed Geological and Geophysical Activities: Mid-Atlantic and South Atlantic Planning Areas; Final Programmatic Environmental Impact Statement. Volume I: Chapters 1-8, Figures, Tables, and Keyword Index. Prepared by CSA Ocean Sciences Inc. for U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS EIS/EA BOEM 2014-001. 788 pp.

Bureau of Ocean Energy Management (BOEM). 2015. Guidelines for providing geophysical, geotechnical, and geohazard information pursuant to 30 CFR Part 585. U.S. Department of the Interior, BOEM Office of Renewable Energy Programs. July 2, 2015. 30 pp.

Bureau of Ocean Energy Management (BOEM). 2017. Gulf of Mexico OCS Proposed Geological and Geophysical Activities. Final Programmatic Environmental Impact Statement. Prepared by CSA Ocean Sciences Inc. for U.S. Department of the Interior, BOEM Gulf of Mexico OCS Region. OCS EIS/EIA BOEM 2017-051. 792 pp + app.

Brown, M.W., P.K. Hamilton, R.D. Kenney, A.R. Knowlton, M.K. Marx, C.A. Mayo, C.K. Slay, S.D. Kraus, and S. Brault. 2001. Sighting heterogeneity of right whales in the western North Atlantic: 1980-1992. Journal of Cetacean Research Management (Special Issue) 2:245-250.

Cetacean and Turtle Assessment Program (CETAP). 1982. A Characterization of Marine Mammals and Turtles in the Mid- and North-Atlantic Areas of the U.S. Outer Continental Shelf. Kingston, Rhode Island: University of Rhode Island, Sponsored by the U.S. Department of the Interior, Bureau of Land Management. Contract #AA552-CT8-48. 576 pp.

Charif, R.A., D.K. Mellinger, K.J. Dunsmore, K.M. Fristrup, and C.W. Clark. 2002. Estimated source levels of fin whale (*Balaenoptera physalus*) vocalizations: Adjustments for surface interference. Marine Mammal Science 18(1):81-98.

Clark, C.W. and P.J. Clapham. 2004. Acoustic monitoring on a humpback whale (*Megaptera novaeangliae*) feeding ground shows continual singing into late spring. Proceedings of the Royal Society B: Biological Sciences 271:1051-1057.

Clark, C.W., W.T. Ellison, B.L. Southall, L. Hatch, S.M. Van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. Marine Ecology Progress Series 395:201-222.

Cole, T.V.N, P. Hamilton, A.G. Henry, P. Duley, R.M. Pace III, B.N. White, and T. Frasier. 2013. Evidence of a North Atlantic right whale *Eubalaena glacialis* mating ground. Endangered Species Research 21(1):55-64.

Committee on Taxonomy. 2018. List of marine mammal species and subspecies. Society for Marine Mammalogy. Internet website: https://www.marinemammalscience.org/species-information/list-marine-mammal-species-subspecies/. Accessed 1 July 2019.

Craddock, J.E., P.T. Polloni, B. Hayward, and F. Wenzel. 2009. Food habits of Atlantic white-sided dolphins (*Lagenorhynchus acutus*). Fisheries Bulletin 107:384-394.

Crocker, S.E., and F.D Fratantonio. 2016. Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys. Naval Undersea Warfare Center Division, Newport, RI. For U.S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Assessment Division and U.S. Geological Survey. OCS Study BOEM 2016-044. NUWC-NPT Technical Report 12,203, 24 March 2016. 266 pp.

Cunha H.A., R.L. de Castro, E.R. Secchi, E.A. Crespo, J. Lailson-Brito, A.F. Azevedo, C. Lazoski, and A.M. Solé-Cava. 2015. Correction: Molecular and Morphological Differentiation of Common Dolphins (*Delphinus* sp.) in the Southwestern Atlantic: Testing the Two Species Hypothesis in Sympatry. PLoS One 10(11):e0140251.

Curry, B. E., and J. Smith. 1997. Phylogeographic structure of the bottlenose dolphin (*Tursiops truncatus*): Stock identification and implications for management. Molecular Genetics of Marine Mammals Special Publication 3:327-247.

Davis, G.E., M.F. Baumgartner, J.M. Bonnell, J. Bell, C. Berchok, J.B. Thornton, S. Brault, G. Buchanan, R.A. Charif, D. Cholewaik, C.W. Clark, P. Corkeron, J. Delarue, K. Dudzinski, L. Hatch, J. Hildebrand, L. Hodge, H. Klinck, S. Kraus, B. Martin, D.K. Mellinger, H. Moors-Murphy, S. Nieukirk, D.P. Nowacek, S. Parks, A.J. Read, A.N. Rice, D. Risch, A. Širović, M. Soldevilla, K. Stafford, J.E. Stanistreet, E. Summers, S. Todd, A. Warde, and S.M. Van Parijs. 2017. Long-term passive acoustic recordings track the changing distribution of North Atlantic right whales (*Eubalaena glacialis*) from 2004 to 2014. Scientific Reports 7:13460.

Dominion Resources Inc. 2013. Virginia Offshore Wind Technology Advancement Project (VOWTAP) Site Characterization Survey Marine Mammal and Sea Turtle Harassment Avoidance Summary Report.

Dominion Resources Inc. 2014. Virginia Offshore Wind Technology Advancement Project (VOWTAP) Site Characterization Survey Marine Mammal and Sea Turtle Harassment Avoidance Nearshore Marine Geophysical and Geotechnical Surveys Summary Report.

Department of the Navy (DoN). 2008. Request for Letter of Authorization for the incidental harassment of marine mammals resulting from Navy training activities conducted within the northwest training range complex. Prepared by Commander, U.S. Pacific Fleet for U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service Office of Protected Resources. September 2008. 322 pp.

DONG Energy. 2016. Bay State Wind Offshore Wind Farm – Request for the Taking of Marine Mammals Incidental to the Site Characterization of the DONG Energy Bay State Wind OffshoreWind Farm Lease Area. 60 pp.

Engås, A., S. Løkkeborg, E. Ona, and A. Vold Soldal. 1996. Effects of seismic shooting on local abundance and catch rates of cod ((*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*)). Canadian Journal of Fisheries and Aquatic Sciences 53(10):2238-2249.

Erbe, C., C. Reichmuth, K. Cunningham, K. Lucke, and R. Dooling. 2016. Communication masking in marine mammals: A review and research strategy. Marine pollution bulletin 103(1-2):15-38.

Garrison, L.P., P.E. Rosel, A.A. Hohn, R. Baird, and W. Hoggard. 2003. Abundance of the coastal morphotype of bottlenose dolphin *Tursiops truncatus* in U.S. continental shelf waters between New Jersey and Florida during winter and summer 2002. National Marine Fisheries Service, Southeast Fisheries Science Center, report prepared and reviewed for the Bottlenose Dolphin Take Reduction Team. Available from Southeast Fisheries Science Center, Miami, FL.

Gilbert, J.R., G.T. Waring, K.M. Wynne, and N. Guldager. 2005. Changes in abundance and distribution of harbor seals in Maine, 1981-2001. Marine Mammal Science 21:519-535.

Glass, A.H., T.V.N. Cole, and M. Geron. 2009. Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian Maritimes, 2003–2007. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center. Document 09-04. 18 pp.

Hamazaki, T. 2002. Spatiotemporal prediction models of cetacean habitats in the mid-western North Atlantic Ocean (from Cape Hatteras, North Carolina, U.S.A. to Nova Scotia, Canada). Marine Mammal Science 18:920-939.

Hassel, A., T. Knutsen, J. Dalen, K. Skaar, S. Løkkeborg, O.A. Misund, Ø. Østensen, M. Fonn, and E.K. Haugland. 2004. Influence of seismic shooting on the lesser sandeel (*Ammodytes marinus*). ICES Journal of Marine Science: Journal du Conseil 61(7):1165-1173.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2017. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2016. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NOAA Technical Memorandum NMFS-NE-241. 282 pp.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2018. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2017. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NOAA Technical Memorandum NMFS-NE-245. 378 pp.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds). 2019. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2018. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NOAA Technical Memorandum NMFS-NE-258. 306 pp.

Hersh, S.L. and D.A. Duffield. 1989. Distinction between northwest Atlantic offshore and coastal bottlenose dolphins based on hemoglobin profile and morphometry. In: Leatherwood S., and R.R. Reeves (Eds.), The bottlenose dolphin. San Diego, CA: Academic Press. pp. 129-140.

Hodge, K.B., C.A. Muirhead, J.L. Morano, C.W. Clark, and A.N. Rice. 2015. North Atlantic right whale occurrence near wind energy areas along the mid-Atlantic US coast: implications for management. Endangered Species Research 28(3):225-234.

International Organization for Standardization (ISO). 2017. ISO 18405 Underwater Acoustics – Terminology. International Organization for Standardization, Geneva, Switzerland. 62 pp.

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

Jefferson, T.A., M.A. Webber, and R.L. Pitman. 2011. Marine mammals of the world: a comprehensive guide to their identification. London, UK: Elsevier. 576 pp.

Jensen, A.S. and G.K. Silber. 2003. Large Whale Ship Strike Database. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Memorandum NMFS-OPR-. 37 pp.

Khan, C.B., A. Henry, L. Crowe, P. Duley, J. Gatzke, and T.V. Cole. 2018. North Atlantic Right Whale Sighting Survey (NARWSS) and Right Whale Sighting Advisory System (RWSAS) 2016 Results Summary. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NEFSC Reference Document 18-01. 18 pp.

Kastelein, R.A., P.J. Wensveen, L. Hoek, W.C. Verboom, and J.M. Terhune. 2009. Underwater detection of tonal signals between 0.125 and 100 kHz by harbor seals (*Phoca vitulina*). The Journal of the Acoustical Society of America 125(2):222-1229.

Katona, S. K., V. Rough, and D.T. Richardson. 1993. A Field Guide to Whales, Porpoises, and Seals from Cape Cod to Newfoundland. Washington, DC: Smithsonian Institution Press. 336 pp.

Kenney, R.D., 1990. Bottlenose dolphins off the northeastern United States. In: Leatherwood, S., and R.R. Reeves (Eds.), The bottlenose dolphin. San Diego, CA: Academic Press. pp. 369-386.

Kenney, R. D., H.E. Winn and M.C. Macaulay 1995. Cetaceans in the Great South Channel, 1979-1989: right whale (*Eubalaena glacialis*). Continental Shelf Research 15:385-414.

Kenney, R.D., P.M. Payne, D.W. Heinemann, and H.E. Winn. 1996. Shifts in Northeast Shelf cetacean distributions relative to trends in Gulf of Maine/Georges Bank finfish abundance. In: Sherman, K., N.A. Jaworski, and T.J. Smayda (Eds.), The Northeast Shelf ecosystem: assessment, sustainability, and management. Cambridge, MA: Blackwell Science, Inc. pp. 169-196.

Kenney, R.D., C.A. Mayo, and H.E. Winn. 2001. Migration and foraging strategies at varying spatial scales in western North Atlantic right whales: a review of hypotheses. Journal of Cetacean Research and Management (Special issue) 2:251-260.

Leatherwood, S., D.K. Caldwell, and H.E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic: a guide to their identification. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Report NMFS Circular 396. 183 pp.

Martin, B, J. MacDonnell, N.E. Chorney, and D. Zeddies. 2012. Sound Source Verification of Fugro Geotechnical Sources: Final Report: Boomer, Sub-Bottom Profiler, Multibeam Sonar, and the R/V Taku. Technical report by JASCO Applied Sciences for Fugro GeoServices Inc. JASCO Document 00413, Version 1.0 DRAFT. 31 pp.

Matthews, L.P., J.A. McCordic, and S.E. Parks. 2014. Remote acoustic monitoring of North Atlantic right whales (*Eubalaena glacialis*) reveals seasonal and diel variations in acoustic behavior. PloS one 9(3):e91367.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys—a study of environmental implications. APPEA Journal 40(1):692-708.

McCauley R.D., J. Fewtrell, and A.N. Popper. 2003. High-intensity anthropogenic sound damages fish ears. Journal of the Acoustical Society of America 113:638-42.

McDonald, M.A., J.A. Hildebrand, S.M. Wiggins, D. Thiele, D. Glasgow, and S.E. Moore. 2005. Sei whale sounds recorded in the Antarctic. Journal of the Acoustical Society of America. 118(6):3941-3945.

Mead, J.G., and C.W. Potter. 1995. Recognizing two populations of the bottlenose dolphin (*Tursiops truncatus*) of the Atlantic coast of North America-morphologic and ecologic considerations. IBI Reports 5:31-44.

Morano, J.L., A.N. Rice, J.T. Tielens, B.J. Estabrook, A. Murray, B.L. Roberts, and C.W. Clark. 2012. Acoustically Detected Year-Round Presence of Right Whales in an Urbanized Migration Corridor. Conservation Biology 26(4):698-707.

Muir, D.C.G., R. Wagemann, N.P. Grift, R.J. Norstrom, M.A. Simon, and J. Lien. 1988. Organochlorine chemical and heavy metal contaminants in white-beaked dolphins (*Lagenorhynchus albirostris)* and pilot whales (*Globicephala melaena*) from the coast of Newfoundland, Canada. Archives of Environmental Contamination and Toxicology 17(5):613-629.

Mullin, K.D., and G.L. Fulling. 2003. Abundance of cetaceans in the southern US North Atlantic Ocean during summer 1998. Fishery Bulletin 101(3):603-613.

NMFS (National Marine Fisheries Service). 2010. Recovery plan for the fin whale (*Balaenoptera physalus*). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources. Silver Spring, MD. 121 pp.

National Marine Fisheries Service (NMFS). 2011. 5-year review: summary and evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. 23 pp.

National Marine Fisheries Service (NMFS). 2012. Marine Mammal Acoustic Thresholds. Internet website: https://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html. Accessed 1 July 2019.

National Marine Fisheries Service (NMFS). 2013. Final Biological Opinion for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf in Massachusetts, Rhode Island, New York, and New Jersey Wind Energy Areas. NER-2012-9211. 10 April 2013. 256 pp.

National Marine Fisheries Service (NMFS). 2018a. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. NOAA Technical Memorandum NMFS-OPR-59. 167 pp.

National Marine Fisheries Service (NMFS). 2018b. Manual for Optional User Spreadsheet Tool (Version 2.0) for: 2018 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Silver Spring, MD. 109 pp.

National Marine Fisheries Service (NMFS). 2019a. 2016-2019 Humpback whale unusual mortality event along the Atlantic coast. https://www.fisheries.noaa.gov/national/marine-life-distress/2016-2019-humpback-whale-unusual-mortality-event-along-atlantic-coast Accessed 1 July 2019.

National Marine Fisheries Service (NMFS). 2019b. Short-finned Pilot Whale *Globicephala macrorhynchus* Species Overview. https://www.fisheries.noaa.gov/species/short-finned-pilot-whale. Accessed 1 July 2019.

National Research Council. 2005. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. Committee on Characterizing Biologically Significant Marine Mammal Behavior. Washington, D.C.: The National Academies Press. 142 pp.

Palka, D. 2012. Cetacean Abundance Estimates in US Northwestern Atlantic Ocean Waters from Summer 2011 Line Transect Survey. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NEFSC Reference Document 12-29. 43 pp.

Pangeo Subsea. 2018. Acoustic corer sound source analysis and environmental impact for South Fork Wind Farm. RPT-08082-1. April 2, 2018. 56 pp.

Parks, S.E. and P.L. Tyack. 2005. Sound production by North Atlantic right whales (*Eubalaena glacialis*) in surface active groups. Journal of the Acoustical Society of America 117(5):3297-3306.

Parks, S.E., P.K. Hamilton, S.D. Kraus, and P.L. Tyack. 2005. The gunshot sound produced by male North Atlantic right whales (*Eubalaena glacialis*) and its potential function in reproductive advertisement. Marine Mammal Science 21(3):458-475.

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

Payne, P.M., and D.W. Heinemann. 1990. A distributional assessment of cetaceans in the shelf and shelf edge waters of the northeastern United States based on aerial and shipboard surveys, 1978-1988. Report to the National Marine Fisheries Service. Northeast Fisheries Science Center, Woods Hole, MA 02543.

Payne, P.M. and L.A. Selzer. 1989. The Distribution, Abundance and Selected Prey of the Harbor Seal, *Phoca Vitulina Concolor*, in Southern New England. Marine Mammal Science 5:173-192.

Payne PM, Selzer LA, Knowlton AR. 1984. Distribution and density of cetaceans, marine turtles, and seabirds in the shelf waters fo the northeastern United States, June 1980 - December 1983, based on shipboard observations. U.S. Department of Commerce, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NOAA/NMFS Contract No. NA-81-FA-C-00023. 294 pp.

Payne, P.M., J.R. Nicholas, L. O'Brien, and K.D. Powers. 1986. The distribution of the humpback whale, *Megaptera novaeangliae*, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, *Ammodytes americanus*. Fisheries Bulletin 84:271-277.

Pendleton, D.E., A. Pershing, M.W. Brown, C.A. Mayo, R.D. Kenney, N.R. Record, and T.V. Cole. 2009. Regional-scale mean copepod concentration indicates relative abundance of North Atlantic right whales. Marine Ecology Progress Series 378:211.

Perrin, W.F., D.K. Caldwell, and M.C. Caldwell. 1994. Atlantic spotted dolphin *Stenella frontalis* (G. Cuvier, 1829). Handbook of marine mammals 5:173-190.

Popper, A.N., and M.C. Hastings. 2009. The effects of human-generated sound on fish. Integrative Zoology 4(1):43-52.

Rankin, S., and J. Barlow. 2005. Source of the North Pacific "boing" sound attributed to minke whales. The Journal of the Acoustical Society of America 118(5):3346-3351.

Rankin, S., and J. Barlow. 2007. Vocalizations of the sei whale (*Balaenoptera borealis*) off the Hawaiian Islands. Bioacoustics 16:137-145.

Rasmussen, M.H., and L.A Miller. 2002. Whistles and clicks from white-beaked dolphins, *Lagenorhynchus albirostris*, recorded in Faxaflói Bay, Iceland. Aquatic Mammals 28(1):78-89.

Reeves, R.R. 2001. Overview of catch history, historic abundance and distribution of right whales in the western North Atlantic and in Cintra Bay, West Africa. Journal of Cetacean Research and Management 2:187-192.

Reeves, R.R., C. Rosa, J.C. George, G. Sheffield, and M. Moore. 2012. Implications of Arctic industrial growth and strategies to mitigate future vessel and fishing gear impacts on bowhead whales. Marine policy, 36(2):454-462.

Reeves, R.R., K. McClellan, and T.B. Werner. 2013. Marine mammal bycatch in gillnet and other entangling net fisheries, 1990 to 2011. Endangered Species Research, 20(1):71-97.

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

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. San Diego, CA: Academic Press. 575 pp.

Risch, D., M. Castellote, C.W. Clark, G.E. Davis, P.J. Dugan, L.E. Hodge, S.M. Van Parijs. 2014. Seasonal migrations of North Atlantic minke whales: novel insights from large-scale passive acoustic monitoring networks. Movement Ecology 2(24):1-17.

Roberts, J.J. 2018. Revised habitat-based marine mammal density models for the U.S. Atlantic and Gulf of Mexico. Unpublished data files received with permission to use September, 2018.

Roberts, J.J., L. Mannocci, P.N. Halpin. 2016. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2016-2017 (Opt. Year 1). Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC. Document version 1.4. 76 pp.

Rolland, R.M., S.E. Parks, K.E. Hunt, M. Castellote, P.J. Corkeron, D.P. Nowacek, S.K. Wasser, and S.D. Kraus. 2012. Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society B: Biological Sciences 279(1737):2363-2368.

Rosel, P.E., L. Hansen and A.A. Hohn. 2009. Restricted dispersal in a continuously distributed marine species: common bottlenose dolphins *Tursiops truncatus* in coastal waters of the western North Atlantic. Molecular Ecology 18:5030–5045.

Sabinsky, P.F., J. Tougaard, M. Wahlberg, and O.N. Larsen. 2012. Seasonal, diel, tidal, and geographical variation in male harbour seal (*Phoca vitulina*) vocalizations in southern Scandinavia. In: 26th Annual Conference of the European Cetacean Society. 26-28 March 2012, Galway, Ireland.

Salisbury, D.P., Clark, C.W. and Rice, A.N. 2016. Right whale occurrence in the coastal waters of Virginia, USA: Endangered species presence in a rapidly developing energy market. Marine Mammal Science, 32(2):508-519.

Selzer, L.A., and P.M. Payne. 1988. The distribution of white-sided, *Lagenorhynchus acutus* and common dolphins, *Delphinus delphis* vs. environmental features of the continental shelf of the northeastern United States. Marine Mammal Science 4(2):141-153.

Slabbekoorn, H., N. Bouton, I. van Opzeeland, A. Coers, C. ten Cate, and A.N. Popper. 2010. A noisy spring: the impact of globally rising underwater sound levels on fish. Trends in Ecology & Evolution 25(7): 419-427.

Southall, B.J., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(44):411-521.

Southall, B.L., J.J. Finneran, C. Rcichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek and P.L Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 45(2):125-232.

Tetra Tech. 2014. Hydroacoustic Survey Report of Geotechnical Activities Virginia Offshore Wind Technology Advancement Project (VOWTAP) September.

Thompson, P.M., G.D. Hastie, J. Nedwell, R. Barham, K.L. Brookes, L.S. Cordes, H. Bailey, and N. McLean. 2013. Framework for assessing impacts of pile-driving noise from offshore wind farm construction on a harbour seal population. Environmental Impact Assessment Review 43:73-85.

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

U.S. Fish and Wildlife Service (USFWS). 2019. West Indian manatee *Trichechus manatus*. https://www.fws.gov/southeast/wildlife/mammals/manatee/. Accessed 1 July 2019.

van Der Hoop, J.M., M.J. Moore, S.G. Barco, T.V.N. Cole, P.Y. Daoust, A.G. Henry, D.F. McAlpine, W.A. McLellan, T. Wimmer, and A.R. Solow. 2013. Assessment of management to mitigate anthropogenic effects on large whales. Conservation Biology 27(1):121-133.

Vester, H., K. Hammerschmidt, M. Timme, and S. Hallerberg. 2014. Bag-of-calls analysis reveals group-specific vocal repertoire in long-finned pilot whales. Quantitative Methods arXiv:1410.4711.

Vu, E., D. Risch, C. Clark, S. Gaylord, L. Hatch, M. Thompson, D. Wiley, and S. Van Parijs. 2012. Humpback whale song occurs extensively on feeding grounds in the western North Atlantic Ocean. Aquatic Biology 14(2):175–183.

Wardle, C., T. Carter, G. Urquhart, A. Johnstone, A. Ziolkowski, G. Hampson, and D. Mackie. 2001. Effects of seismic air guns on marine fish. Continental Shelf Research 21(8):1005-1027.

Waring, G.T., C.P. Fairfield, and K. Maze-Foley (eds.). 2007. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments – 2006. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Wood Hole, MA. NOAA Technical Memorandum. NMFS-NE-201, 378p.

Waring, G.T., E. Josephson, C.P. Fairfield-Walsh, and K. Maze-Foley (eds.). 2008. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2007. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Wood Hole, MA. NOAA Technical Memorandum NMFS-NE-205. 426 pp.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2010. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2010. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Wood Hole, MA. NOAA Technical Memorandum NMFS-NE-219. 609 pp.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2015. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments – 2014. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NOAA Technical Memorandum NMFS-NE-231. 370 pp.

Watkins, W.A., M.A. Daher, G.M. Reppucci, J.E. George, D.L. Martin, N.A. DiMarzio, and D.P. Gannon. 2000. Seasonality and distribution of whale calls in the North Pacific. Oceanography 13:62-67.

Weisbrod, A.V., D. Shea, M.J. Moore, and J.J. Stegeman. 2000. Organochlorine exposure and bioaccumulation in the endangered Northwest Atlantic right whale (*Eubalaena glacialis*) population. Environmental Toxicology and Chemistry 19(3):654-666.

Whitlock, M.C. and D. Schluter. 2009. The analysis of biological data. Greenwood Village, Colorado: Roberts and Company Publishers. 704 pp.

Whitt, A.D., K. Dudzinski, and J.R. Laliberté. 2013. North Atlantic right whale distribution and seasonal occurrence in nearshore waters off New Jersey, USA, and implications for management. Endangered Species Research 20(1):59-69.

Wiley, D.N., R.A. Asmutis, T.D. Pitchford and D.P. Gannon. 1995. Stranding and mortality of humpback whales, *Megaptera novaeangliae*, in the Mid-Atlantic and southeast United States, 1985-1992. Fisheries Bulletin 93:196-205.

Williams K.A., E.E. Connelly, S.M. Johnson, I.J. Stenhouse (eds.). 2015a. Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Outer Continental Shelf: Final Report to the Department of Energy EERE Wind & Water Power Technologies Office. Biodiversity Research Institute, Portland, ME. Report BRI 2015-11, Award Number: DE-EE0005362. 715 pp.

Williams K.A., E.E. Connelly, S.M. Johnson, and I.J. Stenhouse (eds.). 2015b. Baseline Wildlife Studies in Atlantic Waters Offshore of Maryland: Final Report to the Maryland Department of Natural Resources and the Maryland Energy Administration, 2015. Biodiversity Research Institute, Portland, ME. Report BRI 2015-17. 437 pp.

Wingfield, J.E., M. O'Brien, V. Lyubchich, J.J. Roberts, P.N. Halpin, A.N. Rice, H. Bailey. 2017. Year-round spatiotemporal distribution of harbour porpoises within and around the Maryland wind energy area. PLoS One 12(5):e0176653.

Winn, H.E., C.A. Price, and P.W. Sorensen. 1986. The distributional ecology of the right whale *Eubalaena glacialis* in the western North Atlantic. Reports of the International Whaling Commission, Special Issue 10:129–138.

Wood, J., B.L. Southall, and D.J. Tollit. 2012. PG&E offshore 3-D Seismic Survey Project EIR – Marine Mammal Technical Draft Report. SMRU Ltd. SMRUL-NA0611ERM. 124 pp.