Survey Report for
Alpine Ocean Seismic Survey on behalf of US Wind Inc.

Project:
Offshore Maryland Geophysical and Geotechnical Survey: Phase 2

Description:
Protected Species Observer Report

Survey Dates:
23-Aug-2016 to 15-Sept-2016

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10849

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EXECUTIVE SUMMARY

- Monitoring for marine mammals and sea turtles occurred during a high resolution geophysical (HRG) and geotechnical survey offshore Maryland, USA on board the *(RV) Shearwater.* This survey was conducted from 23-Aug-2016 to 15-Sept-2016.

- Weather conditions recorded during marine mammal and sea turtle monitoring were good, with predominantly slight seas, low swell (< 2m) and good visibility (> 5km). Wind force ranged between Force 1 and 5 from a south easterly direction.

- The survey was run in accordance with the mitigation requirements stipulated in the lease (OCS_A0489 and OCS_A0490) and mitigation plan submitted to the Bureau of Ocean Energy Management (BOEM). Mitigation measures covered mitigation for vessel strike avoidance and for the avoidance of disturbance and harm from geophysical and geotechnical survey activities.

- Watches for marine mammals and sea turtles occurred on 15 days of the survey and resulted in 232 hours and 4 minutes of observer effort and 18 observations.

- Acoustic monitoring for marine mammals occurred on seven days of the survey and resulted in 62 hours and 30 minutes of monitoring effort and one acoustic detection.

- There were no encounters of North Atlantic right whales, one encounter of a non-delphinid cetacean, 17 encounters of delphinids (including one acoustic detection) and one sighting of a marine turtle.

- All appropriate separation distances and avoidance measures were maintained and implemented during the survey.

- There were no occasions where vessel speed was reduced to 10 knots or less due to large assemblages, mother/calf pairs, designation of a Dynamic Management Area (DMA) or upon entering a Seasonal Management Area (SMA).

- The geophysical survey utilized a sub bottom profiler (SBP; chirp) on seven days to run a total of 198 lines (including reruns).

- The geotechnical survey used a vibracore on five days and collected 58 samples at 34 sites.

- There were eight ramp-ups of the SBP (not including those following power-downs for dolphins) during the survey, of which four were during daylight hours. All daylight start-ups were covered by full, dedicated pre-start watches whilst all night time start ups were covered by full, dedicated pre-start watches and acoustic monitoring.

- All start-ups of the vibracore were covered by full, dedicated pre-start watches during daylight hours, no operations took place at night.

- There were no delays to the start up of HRG equipment and two delays to the start up of geotechnical equipment due to marine mammal or sea turtle encounters during the survey.

- There was one shut-down of HRG equipment due to non-delphinid cetaceans or sea turtles and four power downs due to delphinid cetaceans during the survey. There was one sighting of dolphins within the 200m mitigation zone which did not have a power down.

- There were no reports of sightings of injured or dead protected species during the survey.

SERVICE WARRANTY

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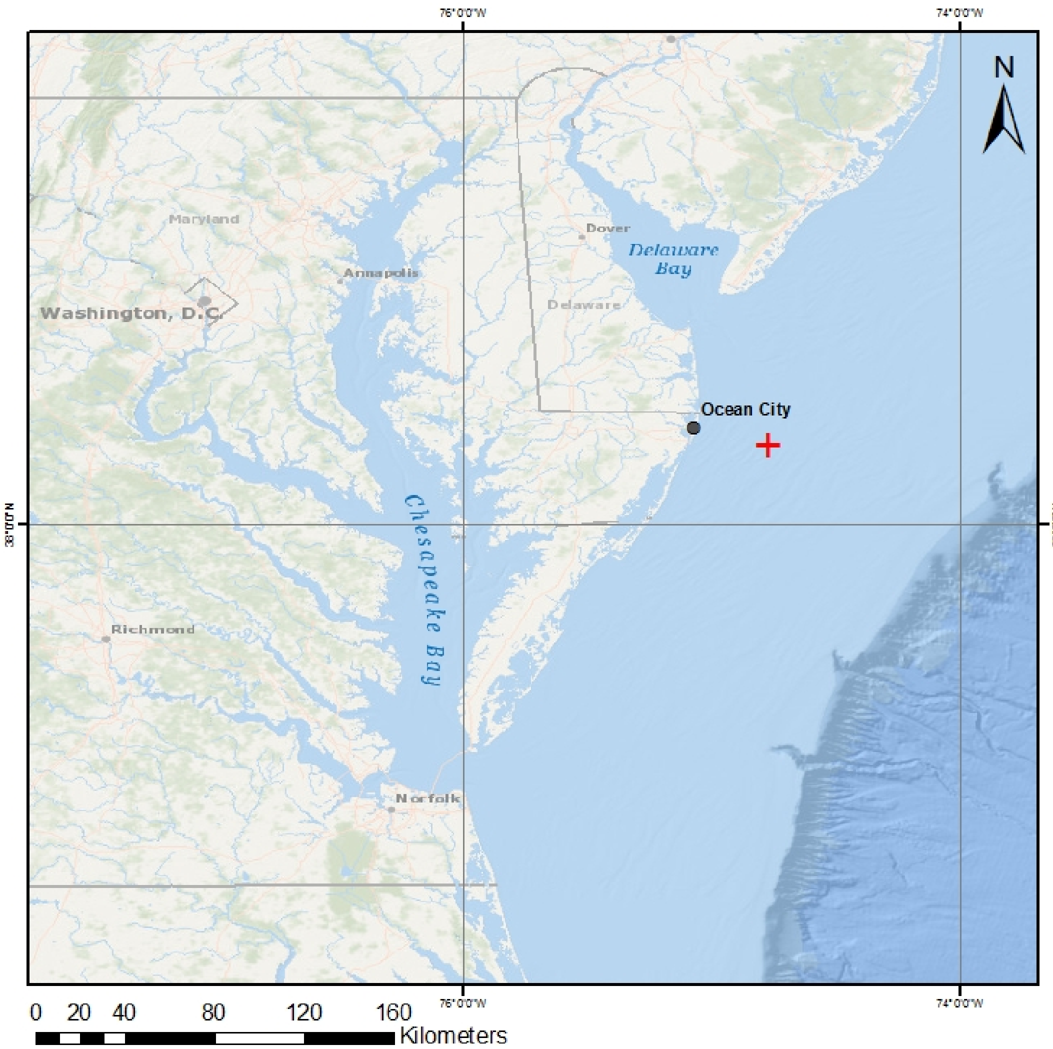
LOCATION MAP



Key

+ Proposed Met Tower Location

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

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GLOSSARY OF TERMS AND ABBREVIATIONS

BOEM	Bureau for Ocean Energy Management
COTI	Clip on thermal imaging
DMAs	Dynamic Management Areas
ESA	Endangered Species Act
EZ	Exclusion Zone
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization
HRG	High resolution geophysical
JNCC	Joint Nature Conservation Committee
MBES	Multi-beam echo sounder
MMMP	Marine Mammal Mitigation Plan
MMPA	Marine Mammal Protection Act
MSRS	Mandatory Ship Recording System
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PAM	Passive Acoustic Monitoring
PAMS	Passive Acoustic Monitoring System
PMPS	Protected Species Mitigation Protocol
PSO	Protected Species Observer
SBP	Sub-bottom profiler
SBES	Single-beam echo sounder
SMA	United States Seasonal Management Areas
SSS	Side scan sonar
UHRS	Ultra high resolution seismic
USBL	Ultra-short baseline

1 INTRODUCTION

1.1 Marine Geophysical Surveys

Marine geophysical surveys are performed to establish and investigate seabed conditions, water depths and oceanographic and environmental conditions within an area. Shallow geophysical survey equipment such as sub-bottom profilers (SBPs), multi-beam echo sounders (MBES) and side scan sonar (SSS) are used to characterize the sediments and layers just below the seabed. Such equipment predominantly produces sound between 0.4 and 30kHz with source levels between 200 and 230dB re 1 µPa2 m^2 (Richardson *et al.*, 1995).

1.2 Marine Geophysical Surveys

Marine geotechnical surveys are performed to characterize and investigate seabed conditions in the area to aid planning and development of a potential wind farm sites. Little is known about sound levels produced by equipment such as vibracores, soil boring equipment and cone penetrometer equipment. Noise measurements recorded during a geotechnical survey in the Chucki Sea presented threshold distances of 1800m for 120dB re 1 µPa although this accounted for dynamic positioning systems onboard as well as coring activity (Hartin *et al*., 2011).

1.3 Sound and Marine Mammals and Sea Turtles

1.3.1 Marine Mammals

Sound is conducted through water approximately 4.5 times faster than through air and is the most important sense for many marine organisms. This is especially true for marine mammals, which use sound to communicate, navigate, forage, and for predator avoidance (Richardson *et al.,* 1995). The functional frequency range used by marine mammals varies between 7Hz and 180kHz, with the large baleen whales using the lower frequencies while smaller toothed whales use higher frequencies (Southall *et al.,* 2007; Figure 1.1).

Anthropogenic sound can impact marine mammals in a number of ways from direct injury (physiological and auditory effects) and behavioral responses, to perceptual and indirect effects (Gotz *et al*., 2009; Southall *et al*., 2007). While the operating frequency of analogue equipment is generally above the hearing range of marine mammals, their operation can generate sound that falls within the functional hearing range of marine mammals. Therefore such sources may be detectable over distances of several hundred meters, and although generally below harmful levels could potentially affect the behavior of marine mammals within close proximity (Deng *et al*., 2014). Recent investigations into a mass stranding of melon-headed whale (*Peponocephala electra*) indicate the event was primarily triggered by a MBES system (Southall *et al*., 2013).

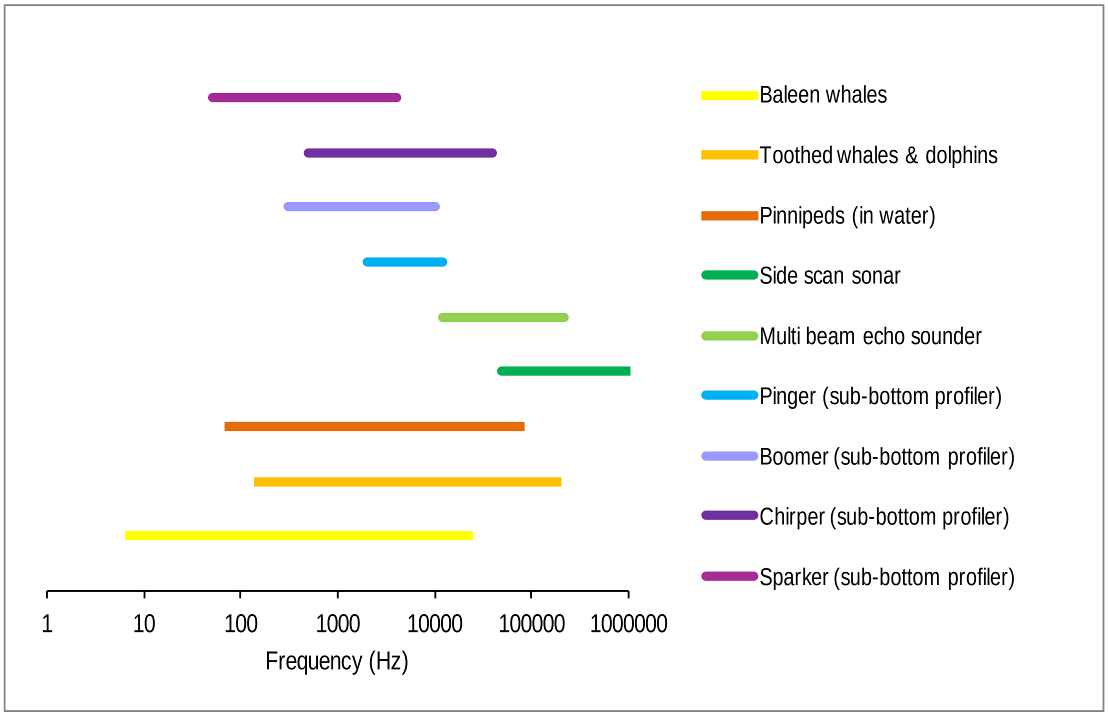

Figure 1.1 Auditory frequencies used by marine mammals and the main frequency range of analogue equipment (Based on Gotz *et al*., 2009 & Southall *et al*., 2007)

It is clear that behavioral responses to sound are highly variable and context specific, with spatial and temporal relationship, habitat quality, previous experience and similarity to biologically significant sounds, as well as the species, gender, age and behavioral state of the individual influencing the type and severity of the response or even if one is observed at all (Southall *et al*., 2007; Ellison *et al*., 2012).

The ability to perceive biologically important sounds is critical to marine mammals (Richardson *et al*., 1995). Masking by increased sound levels in the natural environment can reduce the range over which signals are perceived and reduced the signal's quality of information, which can have implications for survival, reproduction and foraging (Weilgart, 2007). In many cases changes in vocalization rates and the frequencies used have been suggested to be compensatory behavior to elevated background noise levels (Di Iorio & Clark, 2010).

1.3.2 Sea Turtles

Sea turtles are another group potentially impacted by acoustic activity although their hearing sensitivity falls in the low frequency range (< 1kHz; Bartol *et al*., 1999). McCauley *et al*. (2000) demonstrated avoidance behavior in two species exposed to a single airgun source. Strong site fidelity to nesting sites, specific feeding grounds and migratory routes (Broderick *et al*., 2007) could mean sea turtles are unable to avoid particular areas and consequently acoustic activity.

1.4 Vessel Strikes

There is increasing evidence that collisions between vessels and cetaceans (whales, dolphins and porpoises) is occurring more frequently than previously thought, and that in some cases this may pose a significant conservation threat particularly for geographically isolated and endangered populations (Dolman *et al.,* 2006; Van Waerebeek *et al*., 2007; Knowlton & Kraus, 2001). There are several variables which may either make a collision more likely or influence the kind of injuries inflicted or whether the collision is fatal. These include vessel speed, with speeds > 11 knots more likely to cause a fatality (Vanderlaan & Taggart, 2007), type and size of vessel, visibility, condition and behavior of individual and species (Dolman *et al*., 2006; McKenna *et al*., 2015). In the northwest Atlantic, the North Atlantic right whale (*Eubalaena glacialis*) is particularly vulnerable to vessel strikes (Knowlton & Kraus, 2001), and as such a number of mitigation measures have been implemented in order to reduce the number of vessel strikes offshore of the northeast coast of the USA (Laist *et al*., 2014; NOAA, 2008).

1.5 Legislation

There are two US Federal Legislations appropriate to marine mammals and sea turtles: the Marine Mammal Protection Act (MMPA; 1972, last amended in 2007) and the Endangered Species Act (ESA; 1973).

The MMPA was established to prevent species and populations from 'declining to the point where they cease to be significant functioning elements of the ecosystems of which they are a part'. The Act established a moratorium on the *taking* of marine mammals, with the word *take* defined as 'to hunt, harass, capture or kill any marine mammal or attempt to do so'. Under the MMPA, Incidental Harassment Authorizations (IHAs) were established to allow incidental 'takes' of small numbers of marine mammals by harassment. There are two levels of harassment defined under the IHAs: Level A covers any act with the potential to injure and Level B covers any act with the potential to disturb by causing disruption of behavioral patterns.

The ESA protects endangered and threatened species, which includes 22 species of marine mammal and all sea turtles, and their habitats by prohibiting the take of listed animals.

The Bureau of Ocean Energy Management (BOEM) considers all permit applications for geological and geophysical activities throughout the Mid-Atlantic and South Atlantic Planning Areas. Such permits are then subject to mitigation measures for avoidance of disturbance and injury to marine mammals and turtles. Such measures include, but are not limited to, guidance for vessel strike avoidance and measures to minimize disturbance and injury from acoustic surveys.

In accordance with the lease issued by BOEM the current survey was run in accordance with mitigation measures that cover vessel strike avoidance, reducing disturbance and harm from geophysical and geotechnical activities and reporting (Appendix A).

1.6 Objective

This report presents the findings of dedicated marine mammal and sea turtle monitoring during a high resolution geophysical (HRG) survey and geotechnical survey, offshore Maryland, USA (see Location

Map). This survey was conducted by Alpine Ocean Seismic Survey Inc. on behalf of US Wind Inc. onboard the (*RV*) *Shearwater* from 23-Aug-2016 to 15-Sep-2016.

The report provides a summary of HRG and geotechnical survey activities as well as compliance with measures implemented to reduce the risk of vessel strikes and disturbance and harm from such survey activities. The report also includes an assessment of the methods of detection equipment and includes any recommendations for future work.

2 THE MARINE ENVIRONMENT

2.1 Physical and Oceanographic Features

The ocean is a highly heterogeneous environment with large, intermediate and small-scale spatial and temporal patterns in physical, chemical and biological processes (Hunt & Schneider, 1987). Variation in such processes have an effect on primary production and therefore the abundance and distribution of plankton (Mackas *et al*., 1985), which in turn affects marine populations at higher trophic levels (Thompson & Ollason, 2001). Physical processes such as circulatory patterns may also have large-scale implications on the dispersion of marine life. Equally important small-scale features or localized episodes will also have an effect (Hunt & Schneider, 1987). Seasonal fluctuations in temperature, salinity and the formation of fronts will also influence dispersion and primary production (Le Fèvre, 1986; Ellett & Blindheim, 1992).

The distribution of marine animals is primarily related to the movement and abundance of their food source (*e.g.* Evans, 1990; Macleod *et al*., 2004; Friedlaender *et al*., 2006). Other behavioral, morphological and energetic constraints will also have an influence on the movement and distribution of marine species. For example many species of baleen whale migrate to low latitude breeding grounds during winter (Stern, 2002) while marine turtles migrate between feeding, nesting and developmental areas (Plotkin, 2003; Bolten, 2003). Such seasonal patterns in biology are likely to have evolved to take advantage of oceanographic conditions. As the distribution and abundance of marine animals is influenced by oceanographic characteristics, it is important to describe the marine processes in the survey area.

The survey area is located off the coast of the eastern coast of the U.S, encompassing the waters surrounding Maryland. The site is located 9nm offshore in an area of water approximately 27m (90 feet) deep. The bathymetry of the study site and surrounding area is comprised of a gently sloping outer continental shelf (the mid-Atlantic bight), that attains depths of up to 50m before quickly descending to depths of over 1000m past the shelf break (Firestone *et al*., 2010; Grothe *et al*., 2010).

The hydrographical regime of the waters off Maryland reflects the currents that affect the Mid-Atlantic Bight further north (Vincent *et al*., 1981). The currents along the New York Bight (a northern subsection of the Mid-Atlantic Bight) and surrounding waters generally flow in a south-westerly direction, although this is modulated by storm induced flows along the continental shelf (Vincent *et al*., 1981).The waters off the continental shelf are also highly affected by the gulf stream, with the direction of the gulf stream catalyzing or slowing the current from 0 – 40cm S^{-1} (Bane *et al.,* 1988).

2.2 Marine Communities

There is a strong correlation with phytoplankton productivity and depth in the Atlantic Ocean off the eastern USA with areas close to freshwater inputs having productivity levels of approximately 430g C m^{-2} $year^{-1}$, and the outer shelf waters maintaining productivity of between 100g C m^{-2} $year^{-1}$ and 160g C m^{-2} $year^{-1}$ (Malone, 1978). The density of phytoplankton and zooplankton is also seasonally driven, with annual spring blooms occurring throughout the Mid-Atlantic Bight (Flagg *et al.,* 1994).

The benthic communities of the Mid-Atlantic Bight comprised of 149 species of polychaetes, crustaceans, mollusks and echinoderms *(*Maurer *et al.,* 1976)*.* There is a seasonal shift in the abundance and biomass of species within the area, with polychaetes such as *Goniadella gracilis* and *Lumbrineris acuta* dominating in May, but *Polygordius sp.* dominating in November (Maurer *et al.,* 1976). The species that have been recorded in the area are typical of those that are commonly recorded in clean sand areas along the inner continental shelf of the Mid-Atlantic Bight (Maurer *et al.,* 1976).

The pelagic fish assemblages of the Mid-Atlantic Bight are comprised of over 300 species (Martin *et al.,* 1978). This primarily includes the Percifromes (perch (*Percidae*), mackerel (*Scombridae*), tuna and bass (*Serranidae*)) and especially the commercially viable skipjack (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), albacore (*Thunnus alalunga*) and Atlantic mackerel (*Scomber scombrus*). The most numerous benthic fish species in the area include spotted hake (*Urophycis regius*), fourspot flounder (*Hippoglossina oblonga*) and butterfish (*Stromateidae sp.;* Gabriel, 1992). The waters surrounding Maryland are also inhabited by Basking sharks (*Cetorhinus maximus*), they have been recorded in the area from both boat & aerial surveys (Kenney *et al*., 1985) and through tagging experiments (Skomal *et al*., 2004).

There have been 26 species of marine mammal recorded along the Maryland coast (this is comprised of 19 Odontocetes, five Mysticetes and two Pinniped species; Kenney *et al.,* 1997; NOAA, 2014; IUCN, 2016; Table 2.1). All species of cetacean are listed under the MMPA (1972). Cetaceans listed as endangered or threatened under the ESA and found within the region include fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*) and the North Atlantic right whale (*Eubalaena glacialis*). Of particular concern is the North Atlantic right whale, whose population numbered at a minimum of 444 individuals in 2009, although the population is exhibiting a positive and slowly accelerating trend (Waring *et al*., 2007). The north Atlantic right whale is most likely to be seen on transit as the waters of Maryland form part of the bi-annual migratory corridor used by this species (Brown and Marx, 2000) The bottlenose dolphin (*Lagenorhynchus acutus*) is the most abundant species of Odontocete recorded off the Maryland coast. The northwest Atlantic stock is estimated to be around 77,500 (NOAA, 2014).

There are two species of Pinniped that have been recorded in the area. The harbor seal (*Phoca vitulina*) is the most common and are often found in near shore waters year round off Maine and seasonally off southern New England to Virginia (Thompson & Härkönen, 2008). Grey seals (*Halichoerus grypus*) range from New York to Labrador, with three established breeding colonies off Maine and Massachusetts, these individuals occasionally stray further south and in to the survey area.

All species of sea turtle are listed on the ESA. Five species of turtle have been recorded in the area including the loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*) green (*Chelonia mydas*) and leatherback turtle (*Dermochelys coriacea;* NEFSC, 2015*).* Hawksbill turtle *(Eretmochelys imbricata)* has also been sighted however this is rare in the region (NMFS, 2014). All turtle species are migrants that come to forage along the coastal shelves (Shoop, 1987).

Table 2.1 Marine mammal species recorded off the Maryland coast

Species	Scientific Name	IUCN Status
Humpback whale	*Megaptera novaeangliae*	Least concern
North Atlantic right whale	*Eubalaena glacialis*	Endangered
Minke whale	*Balaenoptera acutorostrata*	Least concern
Sei whale	*Balaenoptera borealis*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Gervais' beaked whale	*Mesoplodon europaeus*	Data deficient
Cuvier's beaked whale	*Ziphius cavirostris*	Least concern
Sowerby's beaked whale	*Mesoplodon bidens*	Data deficient
Blainville's Beaked whale	*Mesoplodon densirostris*	Data deficient
True's beaked whale	*Mesoplodon mirus*	Data deficient
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Least concern
Bottlenose dolphin	*Tursiops truncatus*	Least concern
Short-beaked common dolphin	*Delphinus delphis*	Least concern
Striped dolphin	*Stenella coeruleoalba*	Least concern
Pantropical spotted dolphin	*Stenella attenuata*	Least concern
Atlantic spotted dolphin	*Stenella frontalis*	Data deficient
Spinner dolphin	*Stenella longirostris*	Data deficient
Pygmy sperm whale	*Kogia breviceps*	Data deficient
Dwarf sperm whale	*Kogia sima*	Data deficient
Sperm whale	*Physeter macrocephalus*	Vulnerable
Long-finned pilot whale	*Globicephala melas*	Data deficient
Short-finned pilot whale	*Globicephala macrorhynchus*	Data deficient
False killer whale	*Pseudorca crassidens*	Data deficient
Risso's dolphin	*Grampus griseus*	Least concern
Harbor seal	*Phoca vitulina*	Least concern
Grey seal	*Halichoerus grypus*	Least concern

3 METHODOLOGY

3.1 Survey Area

The geophysical and geotechnical survey is being carried out by Alpine Ocean Seismic Survey Inc. on behalf of US Wind Inc. The site is located offshore Maryland in the eastern North Atlantic (see Location Map) in an area of water approximately 20 – 30m deep and 27km east of Ocean City. The position of the proposed wind farm location, around which the survey is being completed, can be found in Table 3.1.

Table 3.1 Survey Location

Site	Latitude	Longitude	Coordinate system
Meteorology (Met) Tower	38^{o}19.230 N	74^{o}46.309 W	UTM 18N

3.2 Survey Vessel

The geophysical and geotechnical survey was carried out on board the *(RV) Shearwater*. The vessel details are as displayed in Table 3.2.

Table 3.2 Vessel specifications

R.V. Shearwater	Specifications
Owner	Alpine Ocean Seismic Survey
Flag	United States of America
Type	Multi-Role Survey
Built	1981 (reconfigured 2011)
Length Overall	110ft (33.53m)
Breadth Overall	39ft (11.89m)
Draft	7ft (2.13m)
Main Engine	2 x 526 HP John Deere Model 6125AFM
Thrusters	2 x Hydraulically driven “Z” Drives (360 degree steering)
Endurance	14 days
Accommodation	20 berths

3.3 Survey Parameters

The survey was comprised of geophysical, geotechnical and environmental data acquisition with survey speed approximately 4.5 knots and geotechnical sampling.

The purpose of the survey was to characterize the seabed for the future construction of a wind farm and subsequent cable laying from the offshore site to the proposed sub-station.

Shallow geophysical data was collected using MBES, SSS and SBP (chirp). Details of the equipment used during the survey can be found in Table 3.3.

Geotechnical work involved the use of a vibracore to take samples from the seabed at specific locations.

Additionally environmental work was carried out using a camera and day grab but no mitigation was required.

Table 3.3 Analogue survey equipment

Equipment	Sample Model type	Frequency	Mitigation required
Multi-beam echo sounder	R2Sonic 2024	200 – 400kHz	No
Side scan sonar	Klein Dual 3900	500 and 900kHz	No
Shallow-penetration sub-bottom profiler (chirp)	Teledyne Benthos CHIRP III	2 – 7kHz	Yes

3.4 Operators Procedures

In line with the requirements stipulated in the lease (OCS_A0489 and OCS_A0490) the survey was run in accordance with a number of mitigation measures which covered vessel strike avoidance, the reduction of the risk of disturbance and injury from geophysical survey operations and reporting requirements. Full details can be found in Appendix A.

3.4.1 Vessel strike avoidance

In order to avoid causing injury or death to marine mammals and sea turtles the following measures were implemented.

Protected Species Observers (PSOs) and the vessel operator maintained a vigilant watch for marine mammals and turtles, and either slowed down or stopped the vessel in order to avoid striking any sighted individuals.

Vessel speed was reduced to 10 knots or less when groups including mother and calf pairs or large groups of cetaceans were encountered. Vessel speed was also reduced to 10 knots or less in any DMAs and SMAs implemented for North Atlantic right whales.

During the survey the National Marine Fisheries Service (NMFS) North Atlantic Right Whale Reporting Systems were monitored for the presence of North Atlantic right whales within or adjacent to the survey area. This includes the following:

- Early Warning System
- Sightings Advisory System
- Mandatory Ship Reporting System

A minimum separation distance of 500m was maintained between the vessel and any North Atlantic right whales encountered. If a North Atlantic right whale was encountered within 100 – 500m, the vessel steered a course away from the whale at 10 knots or less until it was more than 500m from the vessel. If North Atlantic right whales were encountered within 100m of the vessel the following avoidance measures were taken:

Vessel speed was reduced and the vessel engine shifted to neutral. Engines were not engaged until the whale was more than 100m away. Vessel then steered a course at 10 knots or less away from the individual(s) until the 500m minimum separation distance was established.

A minimum separation distance of 100m was maintained between the vessel and any other non-delphinid cetaceans encountered. If individuals were encountered within 100m, the vessel reduced speed and shifted engines into neutral. Engines were only engaged once the individual(s) were more than 100m away.

For delphinid cetaceans a minimum separation distance of 50m was maintained. If delphinids were encountered within 50m the vessel maintained a parallel course with the group wherever possible, avoiding abrupt changes in direction and excessive speed. Course and speed were only adjusted once the animals moved more than 50m from the vessel or they had moved abeam.

For all marine turtle and pinniped encounters a minimum distance of 50m was maintained.

3.4.2 Reporting injured of dead protected species

During the survey, PSOs reported any sightings of dead or injured protected species (including all marine mammals, sea turtles and sturgeon) immediately regardless of whether the injury or death was caused by the survey vessel. All such incidences were reported to BOEM and the NMFS Northeast Regional Stranding Hotline (866-755-6622) within 24-hours. Any sightings of dead, injured or entangled North Atlantic right whales were also reported to the US Coast Guard via CHF Channel 16. A standardized incident report was also completed if any injured or dead protected species were sighted.

3.4.3 Mitigation for the HRG survey

PSOs maintained dedicated monitoring for marine mammals and sea turtles for a minimum of 60 minutes prior to an acoustic source starting during daylight hours. Dedicated monitoring during hours of darkness or poor visibility was aided by passive acoustic monitoring (PAM). Following a period with no marine mammal or sea turtle recorded within the 200m mitigation zone the acoustic source commenced firing.

If a marine mammal or sea turtle was detected within the 200m mitigation zone surrounding the acoustic source during the 60 minute pre-shoot period, a delay to the activation of the acoustic source was implemented. Start up was delayed by 60 minutes from the last time the marine mammal or sea turtle was detected within the mitigation zone.

A ramp-up of the SBP was conducted at the start and restart of all survey activities. Power output of the SBP was increased gradually in steps not exceeding 6dB per 5-minute period until the required power was reached.

Once the SBP was active if a non-delphinid cetacean or sea turtle was detected within the 200m mitigation zone the source was immediately shut-down. The SBP resumed firing with a ramp-up after at least 60 minutes had passed since they were last detected within the mitigation zone.

If a delphinid cetacean or pinniped was detected within the 200m mitigation zone the acoustic source was powered down to its lowest possible power output. Subsequent power up followed a ramp-up procedure and only occurred once the mitigation zone was clear of delphinid cetaceans or pinnipeds or after 10 minutes of observations it was clear that the animals were approaching voluntarily to bow-ride or chase towed equipment.

If low frequency vocalizations were detected by the PAMS but range could not be determined and the animal not detected visually then a shut-down or delay was implemented as a precautionary measure.

No HRG survey operations were conducted in any established DMAs.

Any breaks in acoustic activity of less than 20 minutes (other than those caused by a non-delphinid or sea turtle shut-down) resumed at operational levels straight away providing the PSO and PAMS Operator had been conducting monitoring during the break and no marine mammals or sea turtles were detected within the mitigation zone. Breaks of more than 20 minutes resumed, following full dedicated pre-shoot monitoring and a full ramp-up procedure.

3.4.4 Mitigation for the geotechnical survey

PSOs maintained dedicated monitoring for marine mammals and sea turtles for a minimum of 60 minutes prior to the acoustic source (i.e. vibracore) starting during daylight hours. PAM was available to aid dedicated monitoring during periods of poor visibility; geotechnical operations were not carried out at night. Following a 60 min period with no marine mammal or sea turtle recorded within the 200m mitigation zone, operations commenced.

If a marine mammal or sea turtle was detected within the 200m mitigation zone surrounding the acoustic source during the 60 minute pre-shoot period, a delay to the activation of the acoustic source was implemented. Start up was delayed by 60 minutes from the last time the marine mammal or sea turtle was detected within the mitigation zone.

Once the acoustic equipment was active no shutdowns or power downs were implemented, as this was not possible for operational reasons.

After any breaks in vibracore activity operations were allowed to resume as long as the PSO was on watch during the time.

3.5 Observation Methods

The PSOs carried out dedicated watches for marine mammals and sea turtles during all operations, including transit to and from site. During the HRG survey, watches were conducted 24-hours, with night-vision binoculars and thermal imagining technology during the hours of darkness. During the geotechnical survey watches were conducted during the hours of daylight. The Joint Nature Conservation Committee (JNCC) standardized recording forms were completed by the PSOs during all operations and transit.

Watches were carried out from the bridge and bridge wings. Prior to beginning a watch, the time (UTC) and weather conditions were recorded on the JNCC Location and Effort Form (Appendix B). Weather conditions (Beaufort wind force and direction, sea state, swell height and visibility) were noted every hour and whenever a change in conditions occurred. The used definitions of Beaufort wind force and sea state are provided in Appendix C. In addition, the start and end times of marine mammal and sea turtle watches and the start and end times of the firing of the acoustic sources were recorded each day on the JNCC Record of Operations Form (Appendix B).

The primary observation technique used to detect marine mammals and sea turtles during daylight hours was to scan the visible area of sea using the naked eye, and scanning areas of interest with binoculars (magnification x 8 and x10) (e.g. waves going against the prevailing direction, white water during calm periods, bird activity, bird transiting direction etc.). This technique gave both a wide field of view and the ability to have a sufficient range of 3-4 km in ideal conditions. Reticule binoculars and a range-finder stick (Heinemann, 1981) were used to establish the distance to all marine mammal and sea turtles sighted.

During the hours of darkness the PSOs used night-vision binoculars (PVS-7 night vision goggle Generation 3 Pinnacle) with additional clip-on thermal imaging (COTI) technology. All watches with night-vision optics were carried out from a platform with no visual barriers.

PSOs calibrated reticule binoculars and range finder sticks using standard methods. Calibrations were conducted at a minimum once a week throughout the survey, where possible. Effectiveness of night vision equipment was also tested where possible.

Identifications were based on a combination of the observer's previous experience, aided by the field guide "Whales, Dolphins and Seals: A field guide to the marine mammals of the world" by Shirihai and Jarrett (2006).

PSOs were also equipped with bearing finding equipment and a stills camera with 70 - 300mm lens.

The JNCC Marine Mammal Recording Forms were available to record sightings made by the PSOs (Appendix B). The information recorded included the date and time, the vessels position, course, depth and acoustic activity. The species, certainty of identification, number of animals, behavior, distance from the vessel and direction of travel were also recorded. Any additional information, such as details on the features used to identify the animals and the reaction of the animals to the acoustic source was also noted.

3.6 Acoustic Monitoring Methods

PAM uses hydrophones (underwater microphones) to detect and monitor the presence of marine mammals through the detection of their vocalizations. Most cetaceans (whales, dolphins and porpoises) vocalize regularly and produce a variety of sounds ranging from low frequency vocalizations of baleen whales (down to about 15Hz) to relatively high frequency echolocation clicks of some toothed whales (up to about 160kHz; Sturtivant *et al*., 1994; Richardson *et al*., 1995; Berchok *et al*., 2006). It should be noted that PAM is only effective when animals are vocalizing, and cannot detect animals which are not producing sound.

During the geophysical survey a Passive Acoustic Monitoring System (PAMS) was used to acoustically monitor for marine mammals at night and during periods of poor visibility. Details of the PAMS used during the survey are provided below.

Prior to commencing monitoring the time (UTC) and weather conditions were recorded on the JNCC Location and Effort Form. Weather conditions were recorded every hour and whenever a change in conditions or source activity occurred. In addition the start and end times of dedicated pre-start monitoring and the start and end times of activity of the acoustic source were recorded on the JNCC Record of Operations Form.

The JNCC Sightings Form (Appendix B) was available to record detections made by the PAMS Operator. The information recorded included the date and time, the vessel's position, course, depth, acoustic source activity, range and bearing to marine mammals and a description of the detection. Where possible the species and number of individuals were also recorded.

PAMS Operators calibrated the PAMS using standard methods, including dry tap tests on deck, and wet tests with the cable in the water. Calibrations were conducted during mobilization and a minimum of once a week throughout the survey. The software used was optimized to minimize background noise from the vessel and HRG equipment – for example, the spectrogram resolution and thresholds adjusted, in order to maximize the chance of detecting vocalizations.

3.6.1 The PAMS

The PAMS comprises a towed hydrophone array connected to a data processing system, enabling the acquired sound to be inspected both aurally and visually. The hydrophones are connected to dry-end hardware which digitizes the analogue signal allowing it to then be read by the laptop computers. The computers run analysis software which highlights the number of varied clicks and whistles produced by different species of marine mammals.

The system utilizes low and broadband frequency hydrophones in order to cover the frequency range of vocalizing marine mammals, from low frequency Mysticetes (baleen whale) moans to high frequency Odontocetes (toothed whale and dolphin) clicks. The signal received by the hydrophones is then monitored in real-time by the dedicated software PAMGuard, which through the use of click detectors, whistle and moan detectors, and filters allows the automatic detection of the presence of marine mammals. Detectors and filters can be adjusted manually by the PAMS Operator in order to increase positive detections. The detections were then stored in a database (Figure 3.1). The PAMS equipment was sensitive to noise between 10kHz and 250kHz, this meant it was an appropriate tool for both marine mammal monitoring and acoustic noise assessments.

The data processing system comprises the following sub systems:

a) High frequency data acquisition for cetacean clicks up to 250kHz (max sample rate 500kHz).
b) Medium/low frequency data acquisition for cetacean click and whistles up to 48kHz (max sample rate 96kHz) and cetacean moans down to 10Hz.
c) Depth data acquisition.
d) Computer based sound acquisition, display and analysis software.

The directionality and range of the marine mammal is determined by the time difference of the arrival of the acoustic signal (vocalization) to each hydrophone of the array.

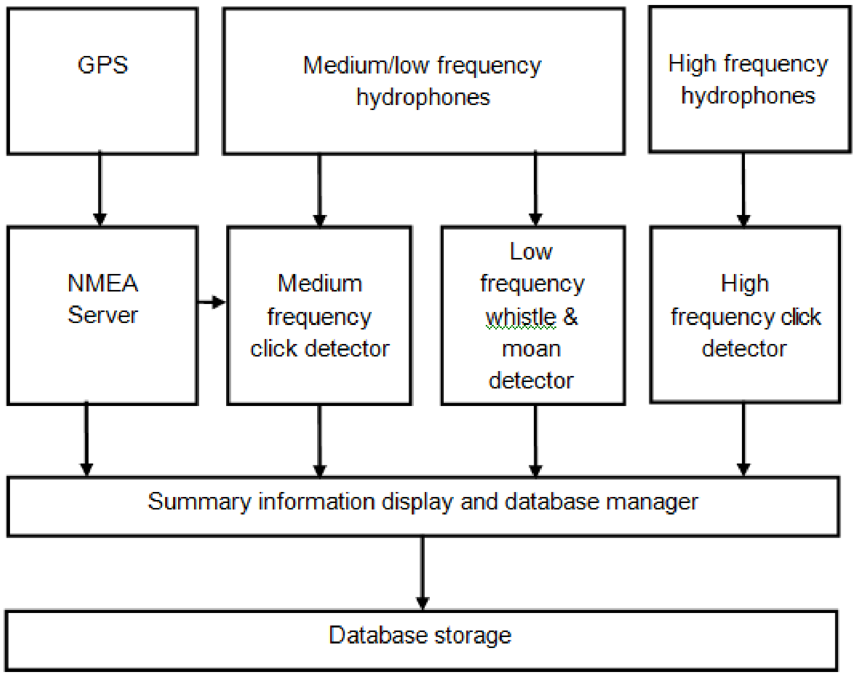

Figure 3.1 Schematic set-up of PAMS

3.6.2 The hydrophone array

The PAMS used during the survey was a Gardline MK4 system which consisted of six hydrophones; three medium frequency and three high frequency. The manufacturer's specification for the PAMS system can be found in Appendix D. The hydrophone array was wired into a tow cable, an electric cable of 250m in length, and towed behind the vessel

3.6.3 The monitoring system

The latest version of PAMGuard software (Version 1.15.03) was utilized as a graphical display for sound acquisition, visualization and detection of marine mammal vocalisations. PAMGuard is an open-source software, that is platform-independent (e.g. Windows or Linux), flexible and built in a modular architecture.

For mitigation purposes, during the current survey the PAMS used a specific data model configuration created by Gardline. Using the most appropriate modules and specifications, a low/medium frequency and a high frequency data module configuration utilized simultaneously using a Captec rack mount computer.

The medium/low frequency configuration is programmed to specifically track and localize clicks, whistles and moans produced by cetaceans in the vicinity of the hydrophones. This includes Odontocete clicks and whistles up to 48kHz and Mysticetes (baleen whale) moans down to 10Hz.

The high frequency configuration is programmed to detect the clicks of Odontocetes (toothed whales including dolphins and porpoises) up to 250kHz. Harbor porpoise for example echolocate using high frequency clicks which are undetectable by the human ear so the PAMS relies entirely on automated detection of these clicks.

All of the detection modules are run in real time and monitored by a dedicated PAMS Operator, with audio recordings and screenshots taken for any detections during the survey.

4 RESULTS

4.1 Survey Coverage

The *(RV) Shearwater* began mobiliation in Ocean City, Maryland on 23-Aug-2016. On 25-Aug-2016 the vessel sailed for site at 20:30h (UTC). After running calibrations SBP data acquisition started on 26-Aug-2016 at 08:32h. All survey lines were completed by 04:01h (UTC) on 01-Sep-2016 and the vessel transited back to port in Ocean City to mobilize for the geotechnical work.

After a period of waiting on weather and completing mobilization the vessel began transit to site at 18:30h on 08-Aug-2016. The first core was obtained at 22:26h however due to technical issues the vessel switched to environmental work for the following two days. The camera and benthic grab sampling was completed on 09-Aug-2016 and after resolving the technical issues, the vessel resumed geotechnical operations at 20:30h.

A break in operations occurred due to weather between 17:55h on 10-Sep-2016 and 11:58 on 13-Sep-2016. Geotechnical operations continued until 22:14h on 14-Sep-2016 when operations were deemed completed and the vessel began transit into port arriving on 15-Sep-2016 for demobilization.

During the survey a total of 198 HRG survey lines (including reruns) were run over seven days. Table 4.1 provides a summary of data acquisition during the survey.

Additionally 34 geotechnical sampling stations were completed over five days. Table 4.2 provides a summary of geotechnical data acquisition during the survey.

Table 4.1 Summary of HRG data acquisition for the offshore Maryland survey

	Offshore Maryland
Number of lines (inc reruns)	198
Total hours of acoustic equipment active (hrs:mm)	134:13
Number of full ramp-ups	8
Number of ramp-ups following power-downs	4

Table 4.2 Summary of geotechnical data acquisition for the offshore Maryland survey

	Offshore Maryland
Number of sampling stations	34
Number of cores	58
Total hours of geotechnical equipment active (hrs:mm)	6:26
Number of start-ups	58
Number of start-ups in poor visibility	0

4.2 Protected Species Observer Effort

A total of 232 hours and 4 minutes of dedicated marine mammal and sea turtle watches and 62 hours and 30 minutes of dedicated acoustic monitoring effort were carried out by the PSOs between 25-Aug-2016 and 14-Sep-2016.

4.3 Weather Conditions

Weather conditions recorded during the survey were good; sea state was predominately slight (Figure 4.1) although occasionally choppy and rarely glassy. Swell was consistently low (< 2m) and visibility was good (> 5km; Figure 4.2) for the majority of the survey however this ranged to poor at times (including during night time watches). Beaufort wind force varied between Force 1 – 5, but was predominantly Force 2 - 3 (Figure 4.3) and was mainly south-easterly in direction (Figure 4.4).

It should be noted that weather observations were only made during dedicated marine animal monitoring and hence may not fully reflect weather throughout the entire survey.

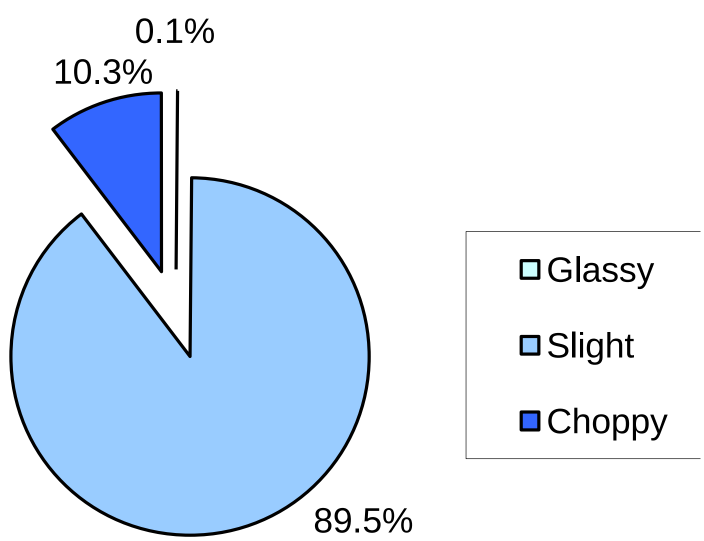

Figure 4.1 Sea state recorded during dedicated marine mammal and sea turtle monitoring during the offshore Maryland survey

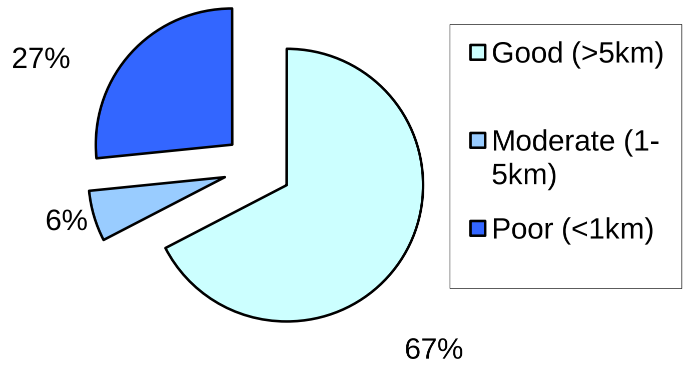

Figure 4.2 Visibility during dedicated marine mammal and sea turtle monitoring during the offshore Maryland survey

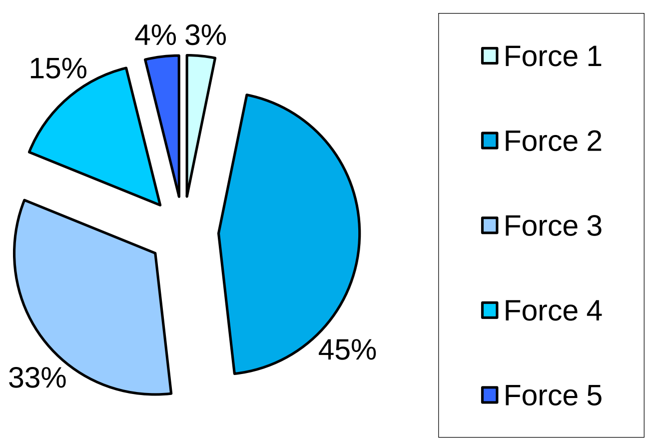

Figure 4.3 Wind force during dedicated marine mammal and sea turtle monitoring during the offshore Maryland survey

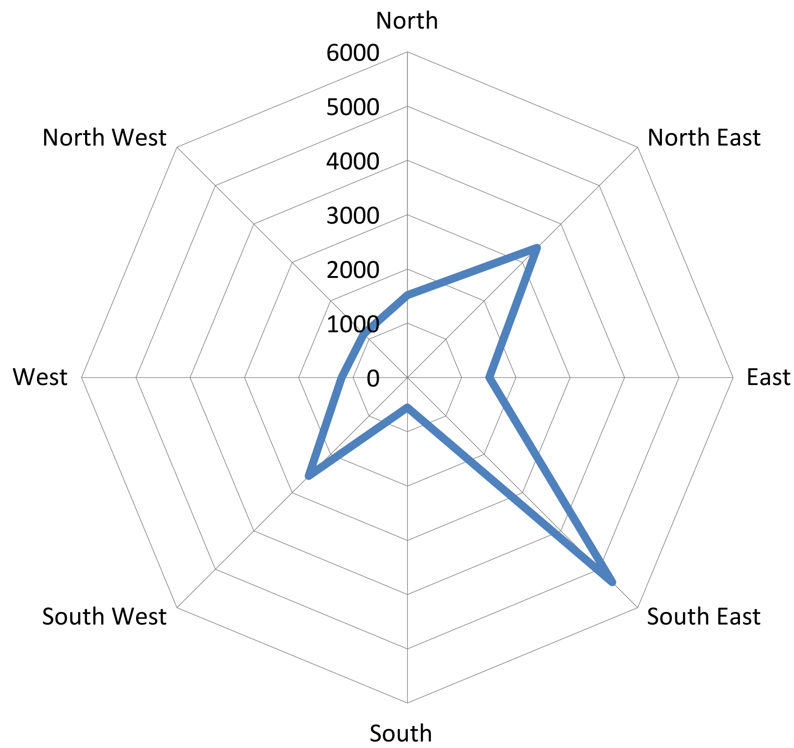

Figure 4.4 Wind direction during dedicated marine mammal and sea turtle monitoring during the offshore Maryland survey

4.4 Compliance with the Protected Species Mitigation Measures

The Offshore Maryland geophysical and geotechnical survey was run in accordance with a specific mitigation measures stipulated in the leases (OCS-A 0489 and 0490). PSOs conducted dedicated watches and acoustic monitoring (where required) during all survey operations and visual monitoring during all transits to and from site.

4.4.1 Ramp-ups and breaks

During the HRG survey there were eight ramp-ups of equipment (not including those after power downs for dolphin sightings), of these, four were during daylight hours. All ramp-ups of equipment were covered by full dedicated pre-shoot monitoring.

All breaks in firing (for reasons other than shut-down due to non-delphinid cetaceans or turtles) were covered by the appropriate pre-shoot monitoring and ramp-ups where appropriate.

4.4.2 Delays, power downs and shut downs

During the HRG survey, there were no delays to ramp-up due to marine mammal or marine turtles, there were four power-downs of equipment due to delphinids and one shut-down of equipment due to a turtle sighting. A summary is provided in Table 4.3.

There was one instance, on 31-Aug-2016, where the equipment was not powered down when dolphins entered the mitigation zone 150m from the source. Dolphins were seen inside the mitigation zone at 12:24h, at which point the PSO asked the Officer on Watch to call the survey crew and inform them of the dolphins. The officer called the survey crew but did not specify that the dolphins were inside the mitigation zone. The survey crew called back to ask where the dolphins were but by the time the PSO responded, the dolphins had left the mitigation zone (at 12:25h) and there was no further need to implement a power down. Upon review of this incident it was decided that the PSO should contact the survey crew directly to avoid any confusion in the future.

Table 4.3 Summary of HRG mitigation action implemented during the offshore Maryland survey

Date	Species	Type of detection	Number of Individuals	Closest Distance (m)	Time Observed Within Mitigation Zone (UTC)	Mitigation Implemented	Time Ramp-up Resumed (UTC)
26/08/2016	Atlantic spotted dolphin	Visual	8	1	11:05 – 11:19	Power-down	11:16 (after 10 mins)
28/08/2016	Unidentified dolphin sp.	Visual	3	200	15:08 - 15:11	Power-down	15:21
28/08/2016	Bottlenose dolphin	Visual	2	150	17:03 – 17:09	Power-down	17:10
28/08/2016	Bottlenose dolphin	Visual	7	150	17:56 – 17:59	Power-down	17:59
28/08/2016	Unidentified turtle	Visual	1	30	19:40 - 19:41	Shut-down	20:41

During the geotechnical survey, there were two delays to start up of equipment, due to marine mammal or turtle sightings. A summary is provided in Table 4.4.

Table 4.4 Summary of geotechnical mitigation action implemented during the offshore Maryland survey

Date	Species	Type of detection	Number of Individuals	Distance (m)	Time Within Mitigation Zone (UTC)	Mitigation Implemented	Time Operations Resumed (UTC)
08/09/2016	Bottlenose dolphin	Visual	3	200	21:11 -12:18	Delay to start	22:26
14/08/2016	Unidentified dolphin sp.	Visual	4	170	13:09 - 13:10	Delay to start	14:15

4.4.3 Sightings of a dead or injured protected species

There were no sightings of dead or injured protected species during the survey.

4.4.4 Vessel strike avoidance

There were a total of no incidences of vessel strikes during the survey.

Vessel speed was maintained at approximately 4 – 6 knots throughout geophysical and geotechnical survey operations. During transit, there were no occasions where vessel speed was reduced to less than 10 knots due to the presence of mother and calf pairs, large groups of cetaceans or due to the designation of a DMA or SMA for North Atlantic right whales.

There were no encounters with North Atlantic right whale during the survey. The lease stipulated that the Early Warning System, Sighting Advisory System and Mandatory Ship Recording System must be used in SMAs in the designated period of 1st November to 30th April. Although the survey did not take place during this period, this system was still monitored for the presence of North Atlantic right whales throughout operations and transit.

There was one encounter with a non-delphinid cetacean during the survey. On this occasion no ship strike avoidance measures were necessary as the whale was more than 500m away from the vessel.

A minimum separation distance of 50m was maintained during 13 encounters of delphinids (including one acoustic detection). On three occasions delphinid cetaceans were encountered within 50m of the vessel; on all such occasions the vessel maintained course and speed until the animals were beyond 50m.

On one occasion a marine turtle was encountered within 50m of the vessel; the turtle surfaced 30m away but was not on a collision course and quickly disappeared.

Full details of all the marine mammal and sea turtle encounters during the survey are provided in sections 4.5 and 4.6 below.

4.5 Marine Mammal and Sea Turtle Encounters

There were 18 sightings of marine mammals and sea turtles, and one acoustic detection of marine mammals throughout the duration of the survey, from 25-Aug-2016 to 15-Sep-2016. All sightings occurred during daylight hours. Encounters comprised humpback whale, Atlantic spotted dolphin, bottlenose dolphin, unidentified dolphin species and an unidentified turtle.

During the geophysical and geotechnical survey there were no sightings of North Atlantic right whales.

A summary of the species encountered is provided in Table 4.5; full details of the sightings and acoustic detections are provided in the sections below while a general description of each species encountered is provided in Appendix E. Figure 4.5 shows a distribution map of the encounters.

Table 4.5 Summary of marine mammal and sea turtle encounters during the offshore Maryland survey

Species	Daylight	Night time	
	Number of Sightings	Number of Sightings	Number of Acoustic Detections
Humpback whale	1	0	0
Atlantic spotted dolphins	1	0	0
Bottlenose dolphins	8	0	0
Unidentified dolphin sp.	7	0	1
Unidentified turtle sp.	1	0	0

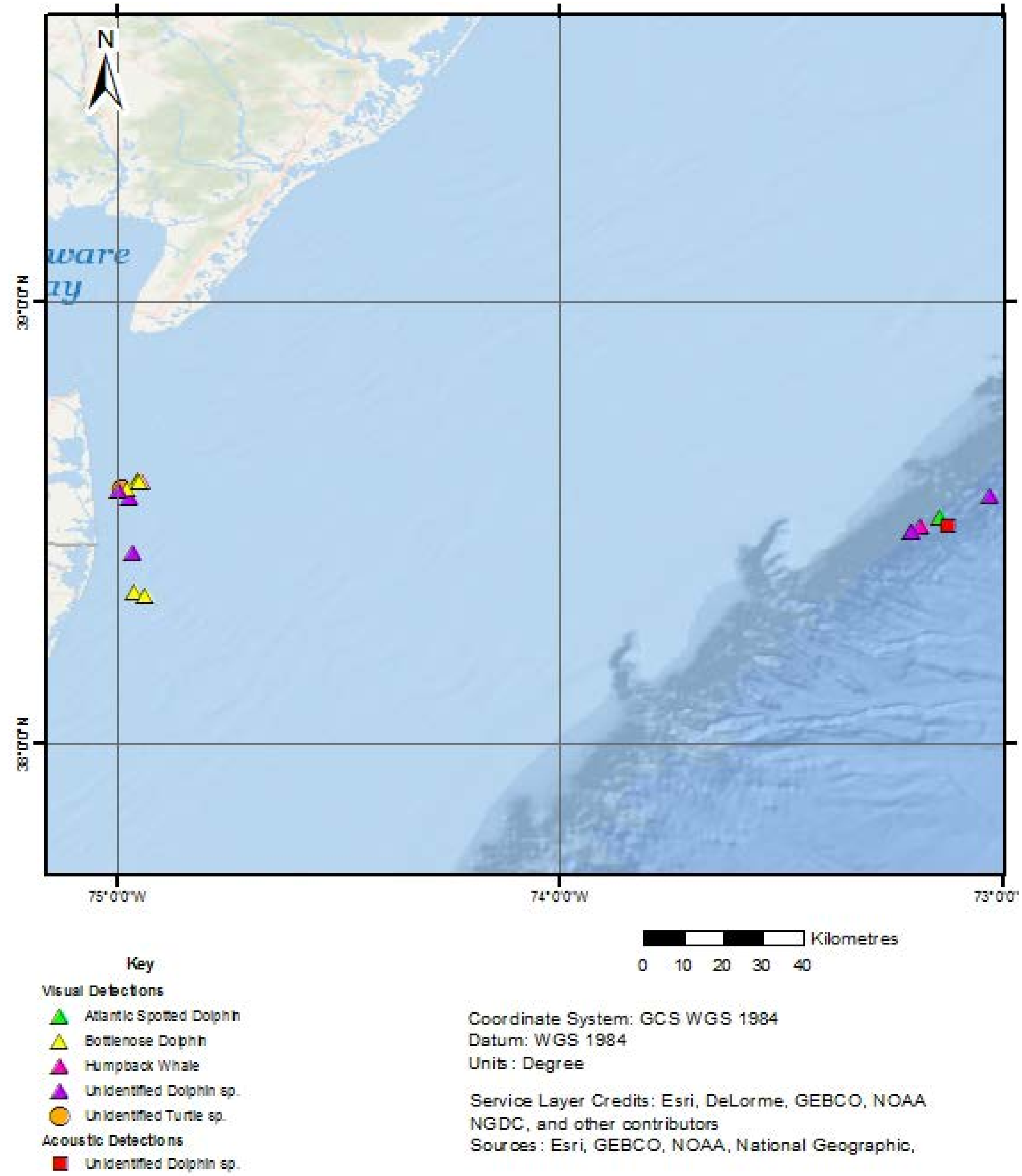

Figure 4.5 Distribution map of the marine mammals and sea turtles encountered during the geophysical survey.

4.6 Marine Mammal and Sea Turtle Sightings

4.6.1 Humpback whale (*Megaptera novaeangliae)*

A single humpback whale was sighted on 29-Aug-2016 at 16:59h, at a distance of 1140 m from the vessel (Figure 4.6). The whale was observed surfacing a few times before fluking and diving twice. The animal was last sighted at 17:05h. Due to the distance of the sighting no mitigation was required.

Figure 4.6 Humpback whale sighted on 29-Aug-2016

4.6.2 Atlantic spotted dolphin (*Stenella frontalis)*

A group of 10 individuals including two juveniles were sighted on 26-Aug-2016 at 11:05h (UTC) approximately 30m from the vessel (Figure 4.7). The animals came within 1m of the vessel and were bow riding and swimming quickly before disappearing at 11:19h. A power-down was implemented as the animals entered the mitigation zone.

Figure 4.7 Atlantic spotted dolphin sighted on 26-Aug-2016

4.6.3 Bottlenose dolphin *(Tursiops truncatus)*

There were eight sightings of bottlenose dolphins during the survey, these are summarized in Table 4.6.

Table 4.6 Summary of bottlenose dolphin sightings during the offshore Maryland survey

Date	Time start of encounter (UTC)	Time end of encounter (UTC)	Behavior	Initial Distance from vessel (m)	Number of Individuals	Mitigation Required
28/08/2016	17:03	17:09	Fast swimming towards shore	150	2	Yes
28/08/2016	17:55	18:06	Slow swimming, logging	150	7	Yes
29/08/2016	10:41	10:45	Fast swimming	400	8	No
01/09/2016	11:32	12:06	Fast swimming, split into sub groups	500	15	No
01/09/2016	12:14	12:19	Social behavior	280	20	No
07/09/2016	21:11	21:43	Fast swimming, porpoising	200	3	No
08/09/2016	11:00	11:02	Slow swimming	300	3	No
08/09/2016	13:55	14:12	Slow swimming	500	2	No

4.6.4 Unidentified dolphin species

There were seven sightings of unidentified dolphins during the survey, these are summarized in Table 4.7.

Table 4.7 Summary of unidentified dolphin sightings during the offshore Maryland survey

Date	Time start of encounter (UTC)	Time end of encounter (UTC)	Behavior	Distance from vessel (m)	Number of animals (no. of Calves)	Mitigation Required
26/08/2016	14:47	14:57	Feeding	1000	14	No
28/08/2016	15:07	15:11	Fast swimming across bow	340	3	Yes
31/08/2016	12:24	12:25	Slow swimming	50	2	No
07/09/1016	20:41	20:44	Fast swimming, porpoising	1000	5	No
13/09/2016	13:24	13:27	Fast swimming, porpoising	350	2	No
14/09/2016	11:34	11:38	Fast swimming, porpoising	400	30	No
14/09/2016	13:09	13:10	Feeding, circling bait ball	170	4	No

4.6.5 Unidentified turtle species

On 28-Aug-2016 a turtle was sighted 30m from the vessel at 19:40h, it was large and had a brownish coloured shell. Two small sharks were seen following the animal. All animals were last sighted at 19:41h. Due to the distance of the sighting a shut-down was required.

4.7 Marine Mammal Acoustic Detections

4.7.1 Unidentified dolphin species

On 28-Aug-2016 a detection of dolphins was recorded using a PAM system (PAMS; Figure 4.8). Whistles were first detected at 01:35h and lasted until 01:46h. The whistles were mostly upsweeps around 12kHz but a number of whistles were long and ranged in frequency from 9kHz – 25kHz. Distance from the vessel was estimated at approximately 400m and the animals were not seen with the night vision binoculars therefore no mitigation action was implemented.

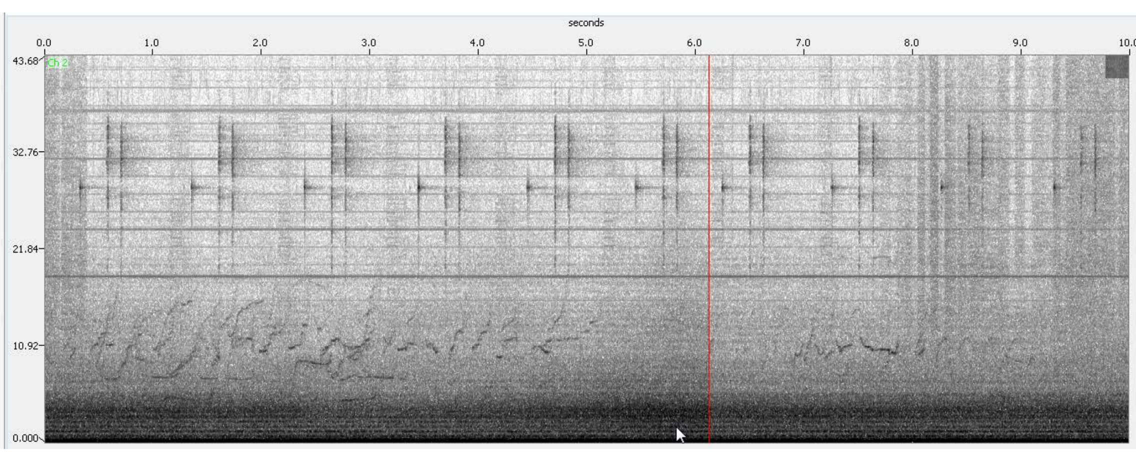

Figure 4.8 Dolphin whistles detected on 28-Aug-2016

4.8 Comparison of Detection Methods

During the geophysical and geotechnical survey, three different detection methods were used: PAMS was operated during hours of darkness or periods of low visibility to detect cetaceans acoustically, while reticule binoculars and sighting by eye were used during the day to detect animals visually. At night,

night-vision binoculars with thermal imaging technology were used to detect animals visually during the hours of darkness.

All sightings of marine mammals and turtles occurred during daylight hours, no animals were sighted at night. PAMS was only monitored at night and during the survey there was one detection of dolphins however they were not observed using the night vision binoculars (Figure 4.9).

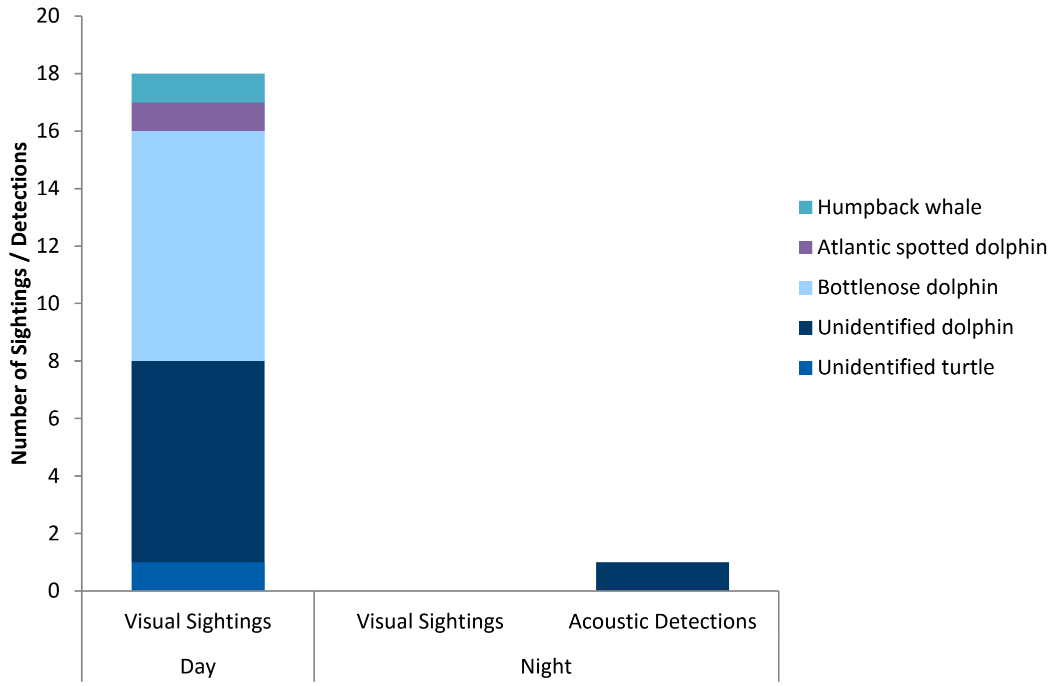

Figure 4.9 Number of visual sightings and acoustic detections of marine mammals and turtles during the offshore Maryland survey (PAMS only deployed at night).

4.9 Comparison of Distance Estimation Methods

During the geophysical and geotechnical survey, the PSOs used two methods to estimate distance of marine mammals or sea turtles from the vessel during daylight hours: reticule binoculars and range finder sticks. Both instruments were calibrated regularly against the vessel's radar with objects such as other vessels and the results were recorded in a standardized form, details of these calibrations can be found in Appendix F. A table detailing the recorded distances can be found in Table 4.8.

An initial comparison of the average differences in the accuracy of distance estimation showed that the range finder stick tended to be more accurate, having an average percentage error of 29%, compared with 40% for the reticule binoculars (Table 4.8). Both pieces of equipment were more accurate at shorter distances; when examining objects on the ship's radar within 1000m or less, percentage error of the ranger finder stick was reduced to 17% whilst percentage error of reticule binoculars was reduced to 27%. Figure 4.10 shows the errors of the range finders and reticule binoculars out to a distance of

1000m compared against the true values taken from the vessel's radar. The majority of measurements for both pieces of equipment, ranges were underestimated.

Table 4.8 Comparison of the accuracy of distance estimation equipment used during offshore Maryland survey

Equipment	Average % Error	Number Underestimated	Number Overestimated	Number Accurate
All Measurements				
Range Finder Stick	29.35	12	4	0
Reticule Binoculars	40.01	11	1	0
<1000m				
Range Finder Stick	16.62	5	3	0
Reticule Binoculars	26.74	3	1	0

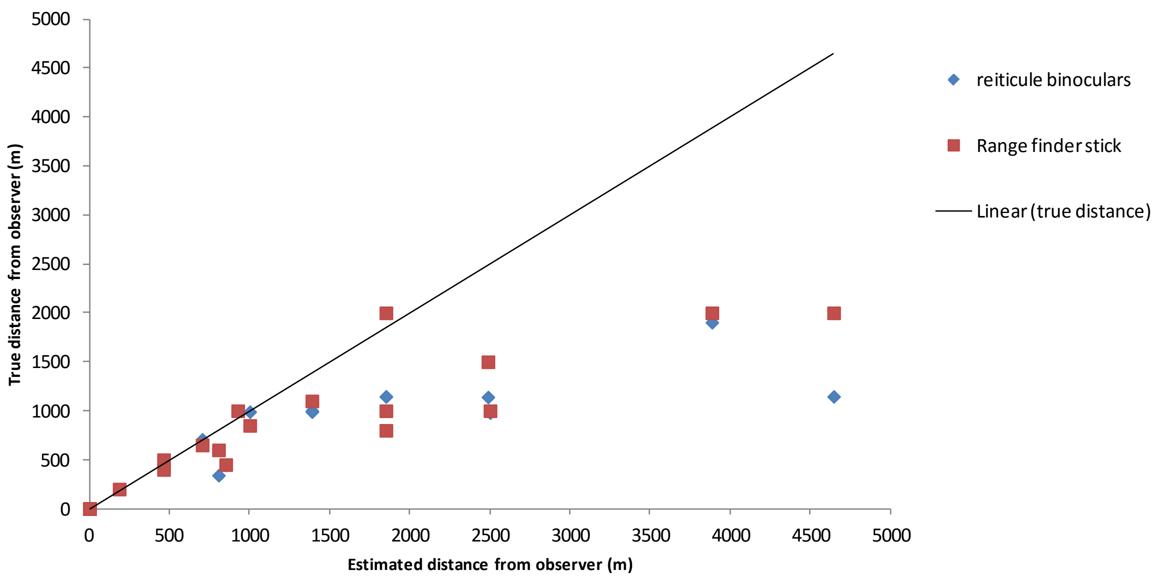

Figure 4.10 Comparison of distances measured using ship's radar (true distance), range finder stick and reticule binoculars

4.10 Estimated Take during Survey Operations

Table 4.9 summarizes the number of listed marine mammals, sea turtles and sturgeon observed during the survey between 25-Aug-2016 and 15-Sep-2016. The Endangered Species Act (1973) makes it unlawful for a person to take a listed animal without a permit. "Take" is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct". During the Maryland Offshore survey, no deceased animals were observed.

Of the number sightings of live animals, no behavior was observed which was consistent with a response to harassment (for example, rapid swimming away from the sound source or vessel; repeated fin slaps or breaches; notable changes in behavior as a result of vessel approach), and no animals demonstrated signs of physical harm. There was one occasion where a power-down was not correctly performed during a sighting of unidentified dolphin. The animal was only sighted in the mitigation zone for 1 minute with a closest distance of 150m. Although the animal was within the mitigation zone the sighting was very short and it is estimated that the approximate distance to the 160dB Level B harassment threshold is 10m for the chirp (ESS Group Inc., 2012) and therefore any potential harm to the animal was unlikely.

Table 4.9 Summary of listed species visually observed or acoustically detected during the geophysical survey

Species	Sum Total of Sightings and Acoustic Detections	Number of Individuals
Humpback whale	1	1
Atlantic spotted dolphin	1	10
Bottlenose dolphin	8	60
Unidentified dolphin spp.	8	61
Unidentified turtle spp.	1	1

5 DISCUSSION

5.1 Marine Mammal and Sea Turtle Detection

Marine mammal and sea turtle research carried out previously within the waters of offshore Maryland have recorded 24 cetacean species, two species of pinniped and four species of sea turtle occurring throughout the year. While these species occur in spatially distinct areas (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA, 2014; IUCN, 2016), and not necessarily in the current survey area, it must be remembered that marine mammals and sea turtles are highly mobile. It was therefore anticipated that marine mammal and sea turtle encounters were possible, and as such visual and acoustic monitoring was conducted during all operations including transit to and from site.

The spatio-temporal distribution and high mobility of marine mammals and sea turtles may also have had an effect on detection. Many species of marine animal migrate at certain times of the year, primarily in relation to prey abundance and distribution, breeding opportunities and availability of space (Stern, 2002; Plotkin, 2003). In the survey area the distribution of marine mammals and turtles is seasonally variable (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA, 2014; IUCN, 2016). Therefore certain species may not have been present, or present in abundance, in the area during the survey period.

Weather can affect the ability to detect marine animals in a number of ways, with increasing sea state, wind force and decreasing visibility reducing the detection probability of marine animals (Forney, 2000) particularly those with inconspicuous surfacing behavior such as the harbor porpoise (Palka, 1996). The weather was predominately good throughout monitoring, with low swell, slight seas, good visibility and wind force 2 – 3, however on occasions, the wind force rose to force 5 with choppy seas, and it is likely that in these conditions some species would be very difficult to see, especially sea turtles.

5.2 Comparison of Detection Methods

Of the 18 visual sightings recorded during the offshore Maryland survey, all occurred during daylight hours and none were visually observed at night. There was one acoustic detection during the survey. This suggests that the best method for sighting marine mammals and sea turtles is visually during daylight hours.

PAMS was only used at night, therefore there was less opportunity to detect mammals and no comparison can be made with daytime sightings. PAMS is limited in that it can only detect animals when they vocalize and there is also the potential for masking of calls by ship engine noise etc. Furthermore PAMS cannot detect sea turtles, which have limited underwater vocalizations. The potential to detect animals at night using night vision binoculars is limited due to blind spots caused by the ships lighting and the narrow field of view of the binoculars.

Although there was only one detection and no sightings at night during this survey, previous surveys have shown that using night vision in conjunction with the PAMS system can still provide effective mitigation (Gardline Environmental Limited, 2015). Using the night vision binoculars while being guided by the PAM operator could help pinpoint animals and confirm presence in the mitigation zone as well as potentially identifying the species.

5.3 Marine Mammal and Turtle Encounters

During the survey three different species were encountered, humpback whale, Atlantic spotted dolphin and bottlenose dolphin, as well as a number of unidentified dolphin sightings and one unidentified turtle species. Bottlenose dolphins are the most frequently recorded dolphin species in the area while Atlantic spotted dolphin are less frequent however not uncommon. Although there are four sea turtle species that can occur in the area, loggerhead turtles are the most commonly recorded however it is unclear which species was sighted (NOAA, 2014). The presence of these species in the area was not unexpected (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA, 2014; IUCN 2016). No obvious avoidance behavior to the vessel was observed and on a number of occasions dolphins were seen approaching the vessel during survey operations, in one instance they were observed bow riding.

5.4 Recommendations

In order to minimize the impacts on marine mammals and sea turtles the geophysical and geotechnical survey was run in accordance with dedicated protection species mitigation measures. The measures implemented during the survey successfully achieved a high standard of mitigation suitable for the project. The success relied on the use of experienced and dedicated observers, who were available and operational on a 24/7 basis to provide both acoustic and visual monitoring for protected species, and able to communicate effectively with the survey crew and each other.

Using a number of detection methods in conjunction with each other increases the effectiveness of detection of all animals in the area. All methods available (daylight visual, night-time visual, and acoustic) have some limitations, however using a combination of methods provides a complementary approach. It is therefore recommended that in order to enable the continued use of 24-hour geophysical survey operations for further projects in the region, the same mitigation measures as were employed during this survey are utilized. This will ensure that the risks to protected marine mammal and sea turtle species are minimized in the most cost effective manner.

Finally, it is recommended that data regarding marine mammal and sea turtle presence in an area is shared between developers, as this can assist with designing suitable mitigation measures for survey operations, particularly in areas where little information on the abundance and distribution of protected species is available.

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APPENDICES

Appendix A MARINE MAMMAL MITIGATION PLAN

Marine Mammal and Sea Turtle Monitoring and Mitigation Plan

US Wind Inc. (US Wind) proposes to conduct marine Geophysical and Geotechnical (G&G) surveys of an export cable interconnection corridor as required by BOEM to file a Construction and Operation Plan (COP) for offshore wind facility development on leases OCS-A 0489 and OCS-A 0490. The Project team intends to begin these site characterization studies in May 2016.

DESCRIPTION OF PROPOSED G & G ACTIVITY

The G&G survey activity that will be conducted to support preparation of the COP is described below. Additional detail can be found in the COP Easement Survey Plan.

High Resolution Geophysical Survey

US Wind proposes to conduct an HRG survey utilizing the following acoustic survey equipment: multi beam and single beam depth sounders, side scan sonar, and shallow penetration subbottom profiler. Medium penetration equipment will not be used. The equipment systems (or equivalent) proposed for use during the HRG surveys are included in Table 1 below. The HRG Survey is estimated to last approximately 6 days offshore with 24-hour operations and 18 days in Indian River Bay, not including weather or protected species down time, which could be as much as 25 – 38%.

Table 1. Equipment to be utilized (or equivalent) during HRG Survey

Survey Task	Sample Equipment Model Type	Frequency (kilohertz)
Multi Beam Depth Sounder	R2Sonic 2024	200 – 400 kHz
Single Beam Depth Sounder	ODOM Echotrac CVM	200 kHz
Side Scan Sonar	Klein Dual 3900	500 and 900 kHz
Shallow-penetration Subbottom Profiler (chirp)	Teledyne Benthos CHIRP III Edgetech 3100	2-7 kHz 2-16 kHz
Ultra-Short Baseline Positioning	Wideband Sub Mini	19-36 kHz

Sound emitted by the HRG survey equipment proposed for use by US Wind is as indicated in Table 1. This proposed equipment meets industry standards and is consistent with equipment previously evaluated for acoustic impacts by BOEM and National Marine Fisheries Service (NMFS) in the PEIS[1] and for other offshore renewable energy projects.

The proposed side scan sonar equipment operates at frequencies above the hearing threshold of marine mammals (7 Hz to 180 kHz) and sea turtles (<1,600 Hz) and therefore should have no adverse impact on these protected species. Similarly, the multibeam, which will only be used at the MET tower location, will be operated at its highest frequencies (400 kHz) to achieve the highest resolution possible; therefore, the sounds from the multibeam will also be above the hearing threshold of the species of concern.

The single beam depth sounder and shallow-penetration subbottom profiler (chirp) emit sound within the hearing threshold of marine mammals. However, during pre-construction surveys conducted for the Cape

[1] Bureau of Ocean Energy Management. 2014. Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement.

Wind Energy Project[2], field testing performed by JASCO Applied Sciences to determine sound pressure levels (SPL) showed that neither the single beam nor the subbottom profiler exceeded 180 dB harassment threshold for protected species, and that the distance to the 160 dB isopleth was 2m and 10m, respectively.

The Sonardyne Wideband Sub Mini (MF Omnidirectional) 8071-000-03 ultra short baseline (USBL) acoustic positioning system is a commonly used system for various marine operations. This is anticipated to be a non-continuous sound source (190 dB re 1 µPa @ 1 m), operating at 19-36 kHz, as per specifications provided in the SAP Survey Plan and on Sonardyne's website (http://www.sonardyne.com/products/all-products/superseded/158-wideband-sub-mini-8070-8071.html). Considering, spherical spreading, which is a reasonable assumption for shallower water depths (30 m), the sound levels will dissipate to 158 dB within 40 m from the sound source, which is within the 200 m exclusion zone for HRG operations, therefore impacts to protected species are not anticipated.

Vibracore & Benthic Surveys

Following the completion of the HRG survey, a vibracore and benthic sampling program will be conducted. Approximately forty-two sampling locations are proposed across the Project Area. These will be sampled via vibracore and benthic grabs. These sampling activities are estimated to take approximately 14 days to complete, not including weather or protected species down time. Each vibracore is expected to be completed within a matter of minutes.

EXCLUSION ZONES AND ALTERNATIVE MONITORING PLAN

The exclusion zones for offshore G&G survey activities will be monitored by qualified Protected Species Observers (PSOs) during daylight operations and by Passive Acoustic Monitoring System (PAMS)) and PSOs during nighttime operations. Furthermore, all applicable conditions and procedures contained in the lease (e.g. clearance before start up, ramp up, shut down, etc.) will be implemented.

Within Indian River Bay, the extremely shallow water conditions require a small vessel with limited space and capacity where the addition of PSOs creates a safety concern. Due to the limited time frame of the survey and low potential for protected species in the bay, US Wind is proposing to train survey crews on PSO protocols and species identification to provide the necessary mitigation. Furthermore, Indian River Bay survey crews will be provided with contact information for NMFS certified PSOs to provide on-call support in the event of a protected species sighting. All PSO protocols will be adhered to; including pre-survey watches, exclusion zones, and post-survey watches.

In order to continue operations at night or during periods of impaired visibility while operating offshore, US Wind will implement the additional mitigation measures agreed upon by BOEM and US Wind during the development of the SAP Survey Plan and implemented during the 2015 SAP surveys. This additional mitigation included implementation of Passive Acoustic Monitoring System (PAMS) in addition to visual observations when surveys were conducted at night and in low visibility conditions. Results of the marine mammal and sea turtle monitoring conducted during the surveys in 2015 suggest that when the monitoring technologies included in the additional mitigation measures are used in conjunction with each other, they provide a complimentary approach which will ensure that the risks to marine mammals and sea turtles are minimized[3] during 24-hour operations. The same supplemental monitoring technologies are proposed for the COP easement survey, as described below, to detect the presence of protected

[2] http://www.nmfs.noaa.gov/pr/pdfs/permits/capewind_iha_application_renewal.pdf

[3] Gardline Offshore Maryland Geophysical Survey – Shearwater Protected Species Report and Discovery Protected Species Report

species. In Indian River Bay, and along the coast where PAMS equipment cannot be towed due to shallow water conditions, survey operations will be conducted in daylight hours only.

Passive Acoustic Monitoring System

US Wind is teaming with Alpine Ocean Seismic Survey and its parent company Gardline to operate the PAMS system during the G&G program nighttime and low visibility operations. Gardline has been providing underwater acoustic monitoring and mitigation services to the offshore energy industry since 2002. For US Wind, the HRG survey team will use the same towed system used in the SAP surveys. Details regarding this system, which has been specifically designed around the survey vessel specifications, provided in Appendix B of the COP Easement Survey Plan.

The PAMS system will be operated 24 hours per day during nighttime and low visibility survey to provide a range and bearing to any marine mammals in the vicinity of the survey vessel. Visual observations will be conducted to confirm protected species sightings. US Wind will engage multiple PAMS operators onboard allowing relief to prevent fatigue (see below). PAMS will not be deployed in nearshore areas due to shallow water conditions.

Visual Observers

For night time operations, visual observers will use high performance night vision goggles, i.e., PVS-7-3AG. Observers will also use clip-on thermal imaging (COTI) technology, the specifications for which were provided by BOEM. Due to the potential for reflectivity from bridge windows that could interfere with the use of the night vision optics, PSOs will be required to make night time observations from a platform with no visual barriers. Results of the 2015 SAP survey show that night vision goggles with COTI are most effective at less than 300 meters; however, the 500 meter range can still be patrolled effectively and the likelihood of detecting a large baleen whale at this distance is still high[4].

Gardline will employ standard techniques to calibrate the visual observation equipment. This will include observations of known objects at set distances and under various lighting conditions. This calibration will be performed during mobilization and periodically throughout the survey operation.

Observers will document their sighting results throughout survey operations in accordance with Addendum C, Appendix B of the Lease. Where applicable, a notation will be included regarding the type(s) of equipment in use during the observations.

Protected Species Monitoring Logistics

To provide PSO coverage 24-hours a day and PAMS coverage at night and in low visibility conditions, during the COP Easement Survey, 4-5 professionals, all of whom are both a certified PSO and an experienced PAMS operator, will be required. At night and under low visibility conditions, two of these PSO/PAMS professionals will work simultaneously on each watch - one on PAMS, the other on visual - on an alternating basis. All of these professionals will have effective training and experience with using night vision optics.

The watch schedule for PSO/PAMS operators will follow the guidance provided on page 24 of NOAA Technical Memorandum NMFS-OPR-49, *National Standards for a Protected Species Observer and Data Management Program*, November 2013[5]:

> *The Working Group recommends that PSOs not be required to be on watch for more than 4 consecutive hours. Watch duties of 2 consecutive hours are further suggested to reduce errors due to*

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[4] Gardline Offshore Maryland Geophysical Survey – Shearwater Protected Species Report and Discovery Protected Species Report

[5] Available at: http://www.nmfs.noaa.gov/pr/publications/techmemo/observers_nmfsopr49.pdf

observer fatigue. A "break" time of at least 2 hours should be allowed before an observer begins another visual monitoring watch rotation ("break" time means no assigned observational duties). If necessary (e.g., an assigned PSO is unable to stand watch due to illness), shorter breaks may be allowed, though not less than 1 hour. No PSO should be assigned a combined watch schedule of more than 12 hours in a 24-hour period.

The PSO/PAMS personnel will stand watch no more than 4 consecutive hours at each monitoring station (visual or acoustic) and after 4 hours will have a break of 2 hours. Each operator will have a combined watch schedule of no more than 12 hours during each 24 hour period. This 4-5 person staffing program is consistent with berthing available on the survey vessels.

Protected Species Monitoring/Night Time Operations Mitigation Summary

1. US Wind will ensure that no night time operations take place without both night vision and PAM systems being fully operational. Redundancy planning will be implemented to achieve this coverage.

2. PSOs will be required to make night time observations from a platform with no visual barriers.

3. The vessel strike separation distance of 500 m for North Atlantic right whales, 100 m separation distance for all non-delphinoid species and the 50 m separation distance for delphinoid, pinniped, and sea turtle species will be ensured and monitored by vessel operators, vessel crew and PSOs, in accordance with the standard operating conditions of the leases. Furthermore, approved PSOs will monitor the 200 m exclusion zone during G&G surveys, except in Indian River Bay as summarized below.

4. Two certified PSO professionals who are also trained PAMS operators will work simultaneously on each watch - one on PAMS, the other on visual - on an alternating basis during night time operations. All of these professionals will have effective training and experience with using night vision optics.

In Indian River Bay the survey vessel crew will be trained in PSO protocols and species identification to provide protected species mitigation in an area where vessel capacity and safety concerns do not permit additional crew members. Furthermore, Indian River Bay survey crews will be provided with contact information for NMFS certified PSOs to provide on-call support in the event of a protected species sighting.

5. Shut down or delaying operations will occur to maintain applicable exclusion zones (see item 3) when low frequency vocalizations are detected but are not possible to be localized on with the PAMS.

6. All vessel operators will be required to monitor the NMFS North Atlantic right whale reporting systems (e.g., the Early Warning System, Sighting Advisory System, and Mandatory Ship Reporting System for the presence of North Atlantic right whales during HRG survey operations.

7. Vibracore operations will be conducted only during daytime hours. To ensure protective measures, vibracores will not be initiated until the 200 m exclusion zone is cleared by PSOs. Given that vibracoring lasts only minutes, shutdown actions are not practicable[6].

Protected Species Detection Report

US Wind will provide BOEM with a post-survey report that will include presentation, analysis, and discussion of the marine mammal detections and methods during the survey.

[6] Due to the very brief, continuous, nonimpulsive sound associated with vibracores, combined with the small number of days the source will be used overall, it is unexpected that vibracore operations will result in the take of marine mammals, as explained by NMFS in the *Federal Register* (Volume 81, No. 24, dated February 5, 2016).

POTENTIAL IMPACT TO PROTECTED SPECIES

The US Wind Lease includes specific terms, conditions, and stipulations (Addendum C) that apply to the site characterization studies proposed by US Wind and its team of subcontractors. US Wind understands that these lease conditions, which include exclusion zones for G&G activities and limit nighttime and low visibility activities, were developed as a result of extensive environmental analysis by BOEM and the National Marine Fisheries Service[7]. However, with the monitoring and mitigation proposed by US Wind in this plan, 24-hour HRG survey operations can proceed offshore in a manner that will maintain compliance with exclusion zones as specified in the Lease.

In addition, while protected species may be present in the project vicinity during the G&G activities, the area along the survey corridor and within Indian River Bay are not considered critical habitat to any Endangered Species Act (ESA)-listed whale species and the closest Right Whale Seasonal Management Area is located several nautical miles to the north of the Lease Area. Similarly, none of the ESA-listed sea turtles, have critical habitats within the survey area and Delaware and Maryland do not have any primary turtle nesting sites (PEIS). All vessel operators will be required to monitor the NMFS North Atlantic right whale reporting systems (e.g., the Early Warning System, Sighting Advisory System, and Mandatory Ship Reporting System for the presence of North Atlantic right whales during HRG survey operations.

For those animals that are in the vicinity of the cable corridor during survey activities, the use of PSOs during the day and the use of PAMS and night vision technologies at night should provide sufficient supplemental information for trained observers to detect the presence of protected species so that exclusion zones can be maintained and applicable operating procedures regarding avoidance, reduction in survey activity, shutdown and ramp up can be implemented as required.

In addition, for the HRG survey activities, the 200m exclusion zone specified to mitigate sound impacts is highly conservative relative to the low-impact types of equipment proposed for the US Wind COP Easement Survey. Based on operational data collected by JASCO as cited above, the US Wind team estimates that the approximate distance to the 160 dB Level B harassment threshold during the HRG survey will be only 10 meters from the chirp and 2 meters from the single beam. The use of the proposed equipment, combined with 24-hour PSOs, and the additional use of PAMS and night vision technologies at night, should ensure that protected species are not exposed to level A or level B harassment sound levels from this activity. US Wind is confident that following BOEM's required monitoring and mitigation measures will ensure that no marine mammals or sea turtles will be harassed during the survey program, and therefore, US Wind does not intend to request Incidental Harassment Authorization from NMFS.

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[7] Bureau of Ocean Energy Management. 2014. Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement.

National Marine Fisheries Service. 2013. Biological Opinion.

Bureau of Ocean Energy Management. 2012. Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas, Biological Assessment.

Appendix B COMPLETED JNCC RECORDING FORMS

The completed JNCC forms can be found in the Excel document entitled 10849_USWind_ MMO forms

Appendix C BEAUFORT WIND, SEA CONDITIONS AND VISIBILITY

WIND SPEED			
Beaufort Scale	Name	Knots	Metres/second
0	Calm	0 – 1	0 - 0.2
1	Light air	1 – 3	0.3 - 1.5
2	Light breeze	4 – 6	1.6 - 3.3
3	Gentle breeze	7 – 10	3.4 - 5.4
4	Moderate breeze	11 – 16	5.5 - 7.9
5	Fresh breeze	17 – 21	8.0 - 10.7
6	Strong breeze	22 – 27	10.8 - 13.8
7	Near gale	28 – 33	13.9 - 17.1
8	Gale	34 – 40	17.2 - 20.7
9	Strong gale	41 – 47	20.8 - 24.4
10	Storm	48 – 55	24.5 - 28.4
11	Violent storm	56 – 63	28.5 - 32.6
12	Hurricane	64+	32.7+

SEA STATE		
Symbol	Name	Height in metres
0	Calm (glassy)	0
1	Calm (rippled)	0 – 0.10
2	Smooth (wavelets)	0.10 – 0.50
3	Slight	0.50 – 1.25
4	Moderate	1.25 – 2.50
5	Rough	2.50 – 4.00
6	Very rough	4.00 – 6.00
7	High	6.00 – 9.00
8	Very high	9.00 – 14.00
9	Phenomenal	14.00+

VISIBILITY	
Name	Visibility (nautical miles)
Fog or dense snow fall	Less than 0.5
Poor visibility	0.5 – 2.0
Moderate visibility	2.0 – 5.0
Good visibility	5.0 – 25.0
Very good visibility	More than 25.0

Appendix D PASSIVE ACOUSTIC MONITORING SYSTEM SPECIFICATIONS

General	
Manufacturer	Gardline
Model	MK4
Towed streamer section	
Length	N/A integrated into tow cable
Section diameter	14mm over cable, 24mm over mouldings
Number of Hydrophones	6
Hydrophone type	Custom built by Gardline 3 low frequency, 3 broadband
Receive sensitivity (dB re 1 V/µPa)	-204
Hydrophone separation	Hydrophone 1 and 2 1.2m Hydrophone 2 and 3 1.2m Hydrophone 3 and 4 1.2m Hydrophone 4 and 5 3.15m Hydrophone 5 and 6 6.75m
Preamplifiers	6 broadband
Preamplifier type	Sensor Technology SA-03
Depth sensor manufacturer	SensorTechnics
Tow cable	
Length	250 m
Diameter	14 mm
Termination	37 pin CEEP Connectors
Deck cable	
Length	100 m
Diameter	14 mm
Termination	37 pin CEEP Connectors

Appendix E SPECIES DESCRIPTIONS

E.1 Humpback whale (*Megaptera novaeangliae*)

The humpback whale is a widely distributed species, occurring seasonally in all oceans worldwide, with distinct populations located in virtually every sea. All populations except one (in the Arabian Sea) undertake migrations between breeding and feeding grounds (Fleming & Jackson, 2011). This is a familiar whale, with a stout, robust body and very long pectoral fins (up to 1/3 of the body length) that have a series of bumps known as tubercles on them. The head is rounded and flat and also covered in tubercles. The dorsal fin is located 2/3 along the back and is low, often sitting on a raised hump of tissue and is highly variable in shape and size (Jefferson et al.*, 2008). Flukes are large, with a serrated trailing edge and are often raised high during diving (Shirihai & Jarrett, 2006). The humpback whale is black to blue-black in color, with pale to white undersides that show black markings that vary according to the individual. They measure between 11-17m in length, with the females generally larger than the males, and they weigh up to 35 tonnes (Jefferson* et al.*, 2008). The blow is bushy but visible, reaching 2.5 to 3m (Shirihai & Jarrett, 2006). Humpback whales are 'gulp' feeders; although unlike other species have many varied methods of feeding, including lunge feeding, tail flicking and bubble-netting (Fleming & Jackson, 2011). Humpback whales often congregate in large, loose groups for breeding and feeding (Shirihai & Jarrett, 2006). The mating system is thought to be male-dominance polygyny, where males compete for individual females and exhibit competitive behavior. The 'song' of male humpback whales is a long, complex vocalization produced usually on the winter breeding grounds, but also on migration and seasonally on feeding grounds. Studies suggest the song is used to advertize for females and to establish dominance amongst males (Fleming & Jackson, 2011). Available population estimates total more than 60,000 animals with populations continuing to increase; therefore the species is listed as 'Least Concern' on the IUCN Red List (IUCN, 2016). However concern does remain about apparent discrete and small subpopulations for which information remains lacking*

E.2 Common bottlenose dolphin (*Tursiops truncatus*)

The common bottlenose dolphin is widely-distributed occurring in coastal and continental shelf waters of tropical and temperate regions. Although population density appears higher in near-shore areas, there are also pelagic populations (Culik, 2011). The common bottlenose dolphin is a large, robust dolphin, with a moderate stocky beak sharply demarcated from the melon. The dorsal fin is tall and falcate, set near the middle of the back. Color varies from light grey to nearly black on back and sides fading to white on the belly. There is however extensive geographical variation in size, shape, appendages and coloration of this species, and confusion remains as to its taxonomy. In many areas markedly differentiated inshore and offshore populations occur in close proximity (Jefferson et al.*, 2008). Common bottlenose dolphins range in size from 1.9 to 4.1m, and weigh between 150 and 650kg (Shirihai & Jarrett, 2006). The species is found in a range of habitats, from rocky reefs, to calm lagoons and open waters. They are generalist feeders, preying on a wide variety of prey, mostly fish and squid, and are known to feed cooperatively (Jefferson* et al.*, 2008). Group size is commonly between two and 15 animals, although they can be encountered individually and in groups of several hundred to thousands offshore. They commonly associate with other species of cetacean, although some interactions are reported to be aggressive (Culik, 2011). Based on regional population estimates, the* *world-wide population is estimated to be a minimum 600,000 (Hammond* et al.*, 2012). The species is listed as 'Least Concern' on the IUCN Red List (IUCN, 2016).*

E.3 Atlantic spotted dolphin (*Stenella frontalis*)

Atlantic spotted dolphins are distributed in the tropical and warm temperate waters of the Atlantic Ocean, where they primarily occur in continental shelf (< 200m) and continental slope (200 − 2000m) waters. Some populations are known to inhabit shallow, coastal waters or deep, oceanic waters (Culik, 2011). Atlantic spotted dolphins have a moderately long, stocky beak and fairly robust body, with a tall, falcate dorsal fin. Juveniles are unspotted, with spots developing with age, although there is much variation in the amount of spotting and adults in some offshore populations remain unspotted. Coloration otherwise is generally light grey sides, dark dorsal cape and white belly. There is also a distinct spinal blaze, which sweeps up into the dorsal cape (Jefferson et al.*, 2008). Adults range between 1.6m and 2.3m and weigh between 100kgand 143kg (Shirihai & Jarrett, 2006). Group size tends to be small to moderate, generally less than 50 individuals, with coastal groups tending to be smaller with five to 15 individuals. Groups are often segregated by sex and age, with studies indicating a very fluid social structure (Jefferson* et al.*, 2008). Atlantic spotted dolphins are generalist feeders, taking a variety of epi- and mesopelagic fish and squid and have been reported to feed using coordinated feeding techniques (Culik, 2011). Fast swimmers, Atlantic spotted dolphins are known to breach frequently and often approach to bow-ride vessels (Shirihai & Jarrett, 2006). No global population estimate exists and although the species is widespread it is listed as 'Data Deficient' on the IUCN Red List (IUCN, 2016).*

E.4 References

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Appendix F CALIBRATION FOR DISTANCE ESTIMATION

Calibration For Distance Estimation										
Date	Name of Observer	Reticule Binoculars Distance (m)	Range Finder Distance (m)	Distance provided by the system onboard (m)	Sea state (Beaufort Scale)	Wind force (Beaufort Scale)	Swell (m)	Location of measurement (bridge, monkey island etc.)	Height of Platform (m)	Description of object e.g. Large/small vessel, platform etc.
26/08/2016	J. Allum	-	500	462	s	1	1	Bridge	5.74	Small boat
26/08/2016	S. Doake	1146	1000	1850	s	2	1	Bridge	5.74	Small boat
27/08/2016	S. Doake	1903	2000	3885	c	4	1	Bridge	5.74	Small boat
27/08/2016	S. Doake	1146	800	1850	c	4	1	Bridge	5.74	Small boat
27/08/2016	S. Doake	1146	2000	4645	c	4	1	Bridge	5.74	Large ship
27/08/2016	S. Doake	447	500	-	c	4	1	Bridge	5.74	Small boat
28/08/2016	J. Allum	-	2000	1850	s	3	1	Bridge	5.74	Small boat
28/08/2016	J. Allum	-	1000	925	s	2	0.5	Bridge	5.74	Small boat
28/08/2016	F. Shaw	1140	1500	2487	s	2	0.5	Bridge	5.74	Small boat
28/08/2016	F. Shaw	980	1000	2500	s	2	0.5	Bridge	5.74	Small boat
28/08/2016	F. Shaw	445	450	850	s	2	0.5	Bridge	5.74	Small boat
28/08/2016	F. Shaw	341	600	805	s	2	1	Bridge	5.74	Medium boat
29/08/2016	J. Allum	-	400	462	s	2	0.3	Bridge	5.74	Small boat
29/08/2016	J. Allum	1000	-	1388	s	2	0.5	Bridge	5.74	Medium boat
30/08/2016	J. Allum	-	200	185	s	2	0.3	Bridge	5.74	Small boat
30/08/2016	S. Ponting	990	1100	1388	s	2	0.2	Bridge	5.74	Small boat
31/08/2016	S. Ponting	990	850	1000	s	2	0.3	Bridge	5.74	Small boat
31/08/2016	S. Ponting	708	650	703	c	3	0.3	Bridge	5.74	Small boat