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

Project:
Offshore Maryland Geophysical Survey

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Protected Species Observer Report

Survey Dates:
2nd June to 25th July 2015

Project Number:
10505

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EXECUTIVE SUMMARY

- Monitoring for marine mammals and sea turtles occurred during a high resolution geophysical (HRG) survey offshore Maryland, USA. This survey was conducted onboard the *R.V. Shearwater* from 2nd June to 25th July 2015.

- Weather conditions recorded during marine mammal and sea turtle monitoring were good, with predominately good visibility, slight seas and low swell (>2m). Beaufort wind force was between 0 and 6 and was mainly from a south-westerly direction.

- The survey was run in accordance with the mitigation requirements stipulated in the lease (OSC-A 0489 and OCS-A 490) 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 survey activities.

- Watches for marine mammals and sea turtles occurred on 44 days of the survey and resulted in 913 hours and 35 minutes of observer effort and 64 observations.

- Acoustic monitoring for marine mammals occurred on 42 days of the survey and resulted in 804 hours and 48 minutes of monitoring effort and 10 acoustic detections.

- There were no encounters of North Atlantic right whales, two encounters of other non-delphinid cetaceans, 39 encounters of delphinids and 29 sightings of 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 Zone or on entering a Seasonal Management Area.

- The geophysical survey utilised single beam echo sounder and chirper on 43 days to run a total of 373 lines (including reruns) and four tests.

- There were 42 ramp-ups of HRG equipment during the survey of which 37 were during daylight hours. All ramp-ups of HRG equipment were covered by full dedicated pre-start watches and acoustic monitoring.

- There were three delays to the start up of HRG equipment due to marine mammals or sea turtle encounters during the survey.

- There were 15 shut-downs of HRG equipment due to non-delphinid cetaceans or sea turtles during the survey. There were 12 power downs due to delphinid cetaceans during the survey.

- There were two reports of sightings of injured or dead protected species during the survey. All incidences were reported directly to the appropriate authorities within 24 hours.

SERVICE WARRANTY

USE OF THIS REPORT

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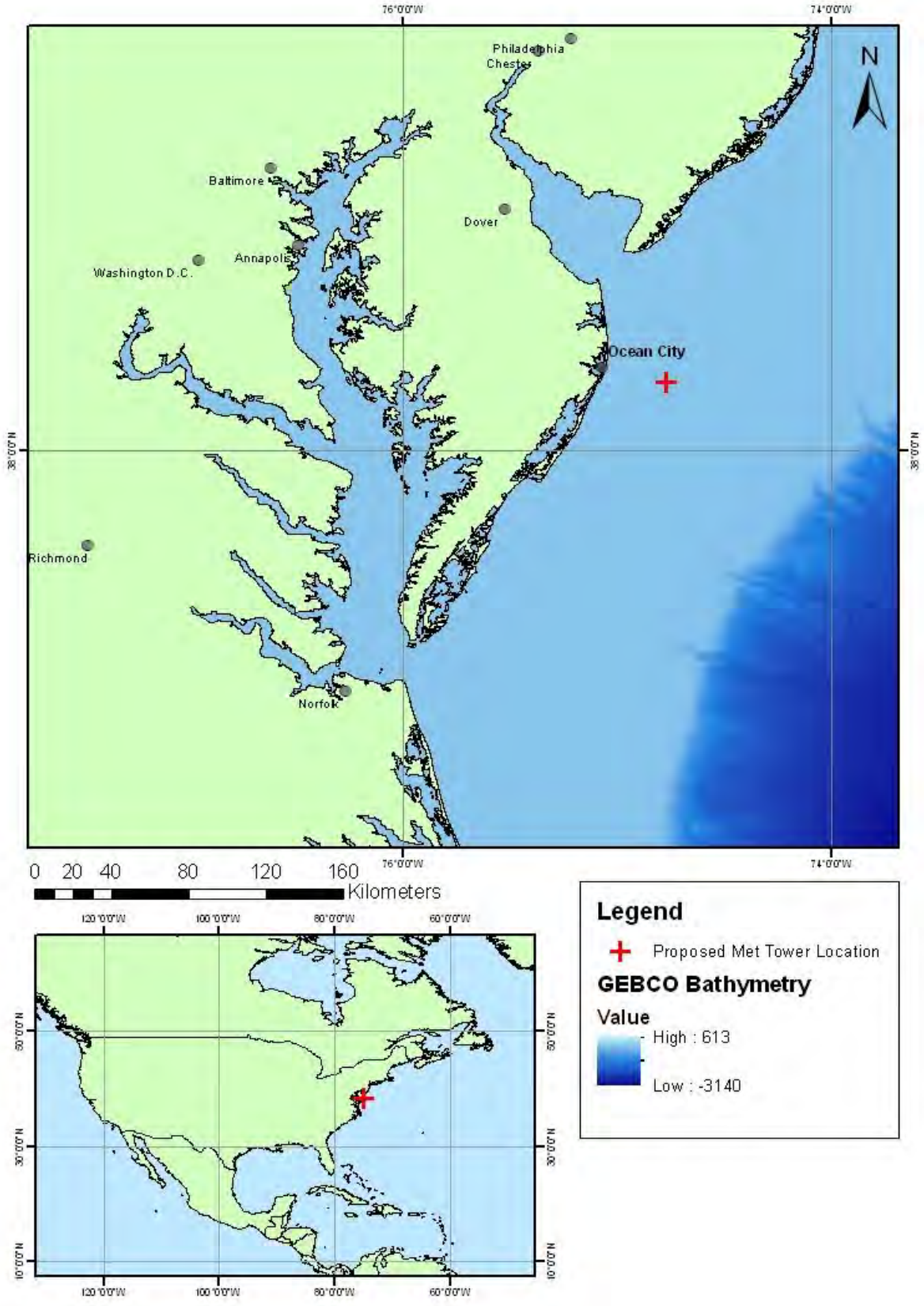
LOCATION MAP



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1. INTRODUCTION

1.1 Marine Geophysical Surveys

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

1.2 Sound and Marine Mammals and Sea Turtles

1.2.1 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 7 Hz and 180 kHz, with the large baleen whales using the lower frequencies while smaller toothed whales use higher frequencies (Southall *et al*., 2007) (Figure 1.1).

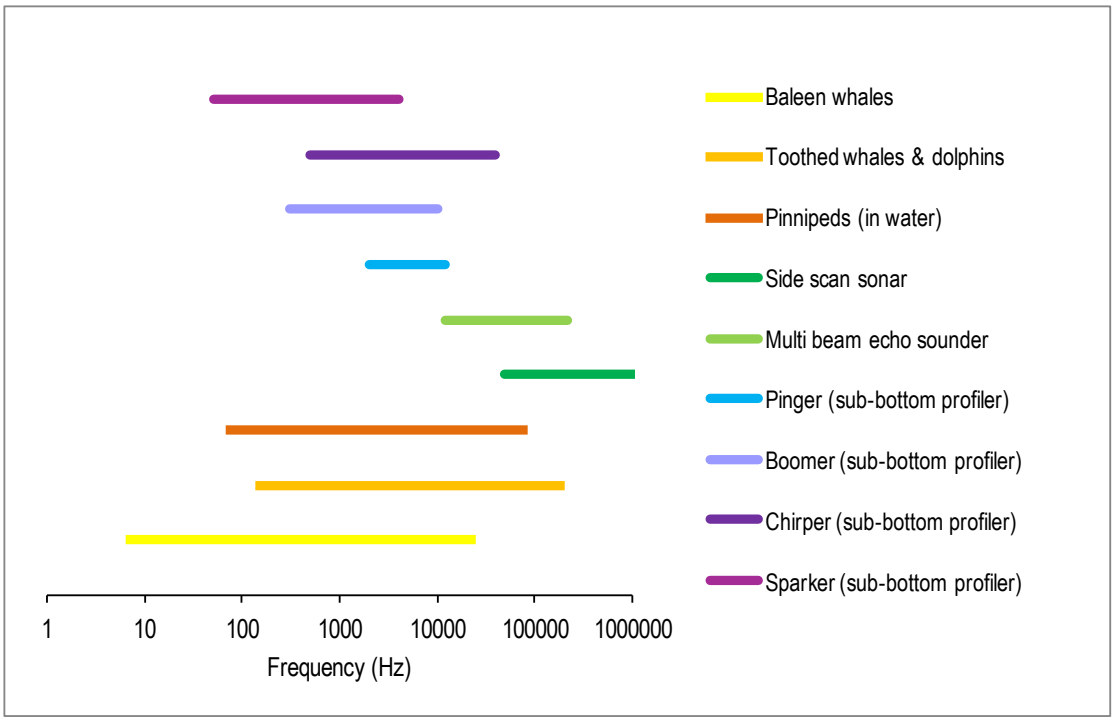

Figure 1.1 Auditory frequencies used by marine mammals and the main frequency range of analogue equipment (Based on Gotz *et al*., 2009 & Southall *et al*., 2007)

Anthropogenic sound can impact marine mammals in a number of ways from direct injury (physiological and auditory effects) and behavioural 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 metres, and although generally below harmful levels

could potentially affect the behaviour 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 multi beam echo sounder system (Southall *et al*., 2013).

It is clear that behavioural 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 behavioural 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 vocalisation rates and the frequencies used have been suggested to be compensatory behaviour to elevated background noise levels (Di Iorio & Clark, 2010).

1.2.2 Sea turtles

Sea turtles are another group potentially impacted by acoustic activity although their hearing sensitivity falls in the low frequency range (<1 kHz) (Bartol *et al*., 1999). McCauley *et al*. (2000) demonstrated avoidance behaviour 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.

1.3 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 behaviour of individual and species (Dolman *et al*., 2006; McKenna *et al*., 2015). In the north-west 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).

1.4 Legislation

There are two US Federal Legislations appropriate to marine mammals and sea turtles: the Marine Mammal Protection Act (MMPA) (1972, and 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 Authorisations (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 behavioural 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 minimise 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 activities and reporting (Appendix A).

1.5 Objective

This report presents the findings of dedicated marine mammal and sea turtle monitoring during a high resolution geophysical (HRG) 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 *R.V. Shearwater* from 2nd June to 25th July 2015.

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

2. THE MARINE ENVIRONMENT

2.1 Physical Environment 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 has 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 localised 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 behavioural, 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 sea 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.A, encompassing the waters surrounding Maryland. The site is located 9 nm offshore in an area of water approximately 27 m (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 50 m before quickly descending to depths of over 1000 m 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 catalysing or slowing the current from 0 – 40 cm 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 U.S.A. with areas close to freshwater inputs having productivity levels of approximately 430 gC m^{-2} a $year^{-1}$, and the outer shelf waters maintaining productivity of between 100 – 160 gC m^{-2} a $year^{-1}$ (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 are comprised of 149 species of polychaetes, crustaceans, molluscs 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, 1994). The waters surrounding Maryland are also inhabited by basking sharks (*Cetorhinus maximus*), which 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, comprising 19 odontocetes, five mysticetes and two pinniped species (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA 2014; IUCN 2015) (Table 2.1). All species of cetacean are listed under the Marine Mammal Protection Act (MMPA) (1972). Cetaceans listed as endangered or threatened under the Endangered Species Act (ESA) and found within the region include, humpback whale (*Megaptera novaeangliae*), 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 455 individuals in 2013, although the population is exhibiting a positive and slowly accelerating trend (Waring *et al*., 2009). 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 (*Tursiops truncatus*) is the most abundant species of odontocetes recorded off the Maryland coast. The north-west 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 harbour seal (*Phoca vitulina*) is the most common and is 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, although individuals occasionally stray further south and in to the survey area.

Table 2.1 below was created from strandings records completed in the last 20 years, NOAA stock assessments and extrapolated from species recorded in the mid-Atlantic bight south of south New England (Kenney *et al.,* 1997; Marine Mammal & Sea Turtle Stranding, 2014; NOAA 2014; IUCN 2015).

All species of sea turtle are listed on the Endangered ESA. Four species of turtle have been recorded in the area: the loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*) green (*Chelonia mydas*) and leatherback turtle (*Dermochelys coriacea*) (Marine Mammal & Sea Turtle Stranding, 2015). 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 truncates*	Least concern
Short-beaked common dolphin	*Delphinus delphis*	Least concern
Striped dolphin	*Stenella coeruleoalba*	Least concern
Pantropical spotted dolphin	*Stenella attenuate*	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 catodon*	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
Harbour seal	*Phoca vitulina*	Least concern
Grey seal	*Halichoerus grypus*	Least concern

3. METHODOLOGY

3.1 Survey Area

The HRG survey was carried out by Alpine Ocean Seismic Survey Inc. on behalf of US Wind Inc. The site was located offshore Maryland (see Location Map) in an area of water approximately 27 m deep and 15 km east from Ocean City. The position of the proposed Met Tower location, around which the survey was completed, can be found in Table 3.1.

Table 3.1 Survey location

Site	Latitude	Longitude	Coordinate System
Met Tower	38° 19.230" N	74° 46.309" W	UTM 18N

3.2 Survey Vessel

The HRG survey was carried out onboard the *R.V. Shearwater* from 2nd June to 25th July 2015. The vessel details are as displayed in Table 3.2.

Table 3.2 Vessel specifications

R. V. Shearwater	Specifications
Manager	Alpine Ocean Seismic Survey
Flag	United States of America
Type	Multi-Role Survey
Built	1981 (reconfigured 2011)
Length OA	110 ft (33.53 m)
Breadth OA	39 ft (11.89 m)
Draft	7 ft (2.13 m)
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 comprised of HRG data acquisition with survey speed approximately 4.5 knots.

The purpose of the survey was to characterise the seabed for the future construction of a wind farm. The survey is being conducted in an area covering 184 km^2 within the lease areas.

Shallow geophysical data were collected using single and multi beam echo sounders, side scan sonar and sub-bottom profiler (chirper). Details of the equipment used during the survey can be found in Table 3.3.

Table 3.3 Analogue survey equipment

Equipment	Sample model type	Frequency
Multi-beam depth sounder	R2Sonic 2024	200-400 kHz
Single beam depth sounder	ODOM Echotrac	200 kHz
Side scan sonar	Klein Dual 3900	450 and 900 kHz
Shallow-penetration sub-bottom profiler (chirper)	Teledyne Benthos CHIRP III	2-7 kHz

3.4 Operators Procedures

In line with the requirements stipulated in the lease (OSC-A 0489 and OCS-A 490) 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.

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 Dynamic Management Areas (DMAs) and Seasonal Management Areas (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 500 m was maintained between the vessel and any North Atlantic right whales encountered. If a North Atlantic right whale was encountered within 500 m, the vessel steered a course away from the whale at 10 knots or less until it was more than 500 m from the vessel. If North Atlantic right whales were encountered within 100 m 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 100 m away.
- Vessel then steered a course at 10 knots or less away from the individual/s until the 500 m minimum separation distance was established.

A minimum separation distance of 100 m was maintained between the vessel and any other non-delphinid cetaceans encountered. If individuals were encountered within 100 m, the vessel reduced

speed and shifted engines into neutral. Engines were only engaged once the individual/s was more than 100 m away.

For delphinid cetaceans a minimum separation distance of 50 m was maintained. If delphinids were encountered within 50 m 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 50 m from the vessel or they had moved abeam.

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

3.4.2 Reporting injured or 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 standardised incident report was also completed for all injured or dead protected species sighted (Appendix B).

3.4.3 Mitigation for the HRG survey

PSOs and PAMS Operators maintained dedicated monitoring for marine mammals and sea turtles for a minimum of 60 minutes prior to an acoustic source starting. Following a period with no marine mammal or sea turtle recorded within the 200 m mitigation zone the acoustic source commenced firing.

If a marine mammal or sea turtle was detected within the 200 m 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, or until the animals were successfully tracked outside of the mitigation zone.

A ramp-up of all acoustic survey equipment was conducted at the start and restart of all survey activities. The ramp-up began with the power of the smallest acoustic source at its lowest output. Power output was then increased gradually and other acoustic sources added so that the source level increased in steps not exceeding 6 dB per 5-minute period.

Once the acoustic equipment was active if a non-delphinid cetacean or sea turtle was detected within the 200 m mitigation zone the source was immediately shut-down. The acoustic source 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 200 m 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 vocalisations 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.

3.5 Observation Methods

The PSOs carried out dedicated watches for marine mammals and sea turtles during all operations, including transit to and from site. Watches were conducted 24-hours, with night–vision binoculars and thermal imaging technology utilised during the hours of darkness. The Joint Nature Conservation Committee (JNCC) standardised 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 C). 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 D. 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 C).

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 & x 10) (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 (Appendix E). Calibrations were conducted during mobilisation and at a minimum once a week throughout the survey.

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 70-300 mm lens.

The JNCC Marine Mammal Recording Forms were available to record sightings made by the PSOs (Appendix C). The information recorded included the date and time, the vessels position, course, depth and acoustic activity. The species, certainty of identification, number of animals, behaviour, 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

Passive Acoustic Monitoring (PAM) uses hydrophones (underwater microphones) to detect and monitor the presence of marine mammals through the detection of their vocalisations. Most cetaceans (whales, dolphins and porpoises) vocalise regularly and produce a variety of sounds ranging from low frequency vocalisations of baleen whales (down to about 15 Hz) to relatively high frequency echolocation clicks of some toothed whales (up to about 160 kHz) (Sturtivant *et al.*, 1994; Richardson *et al.*, 1995; Berchok *et al.*, 2006). This method of detection is only effective when mammals are vocalising.

During the Offshore Maryland Geophysical Survey a Passive Acoustic Monitoring System (PAMS) was used to acoustically monitoring for marine mammals 24-hours a day. 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 (Appendix C). Weather conditions were recorded every hour and whenever a change in conditions or source activity occurred. The used definitions of Beaufort wind force and sea state are provided in Appendix D. In addition the start and end times of dedicated pre-shoot monitoring and the start and end times of firing of the acoustic source was recorded on the JNCC Record of Operations Form (Appendix C).

The JNCC Sightings Form (Appendix C) was available to record detections made by the PAMS Operator. The information recorded included the date and time, the vessel's position, course, water 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 mobilisation and a minimum of once a week throughout the survey. The software used was optimised to minimise background noise from the vessel and HRG equipment – for example, the spectrogram resolution and thresholds adjusted, in order to maximise the chance of detecting vocalisations.

3.6.1 The PAMS

The PAMS comprised of 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 digitises 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 utilised low and broadband frequency hydrophones in order to cover the frequency range of vocalising marine mammals, from low frequency mysticete (baleen whale) moans to high frequency odontocete (toothed whale and dolphin) clicks. The signal receive 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 vocalising 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 data processing system comprises the following sub systems:

a) High frequency data acquisition for cetacean clicks up to 250 kHz (max sample rate 500 kHz).
b) Medium/low frequency data acquisition for cetacean click and whistles up to 48 kHz (max sample rate 96 kHz) and cetacean moans down to 10 Hz.
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 (vocalisation) to each hydrophone of the array.

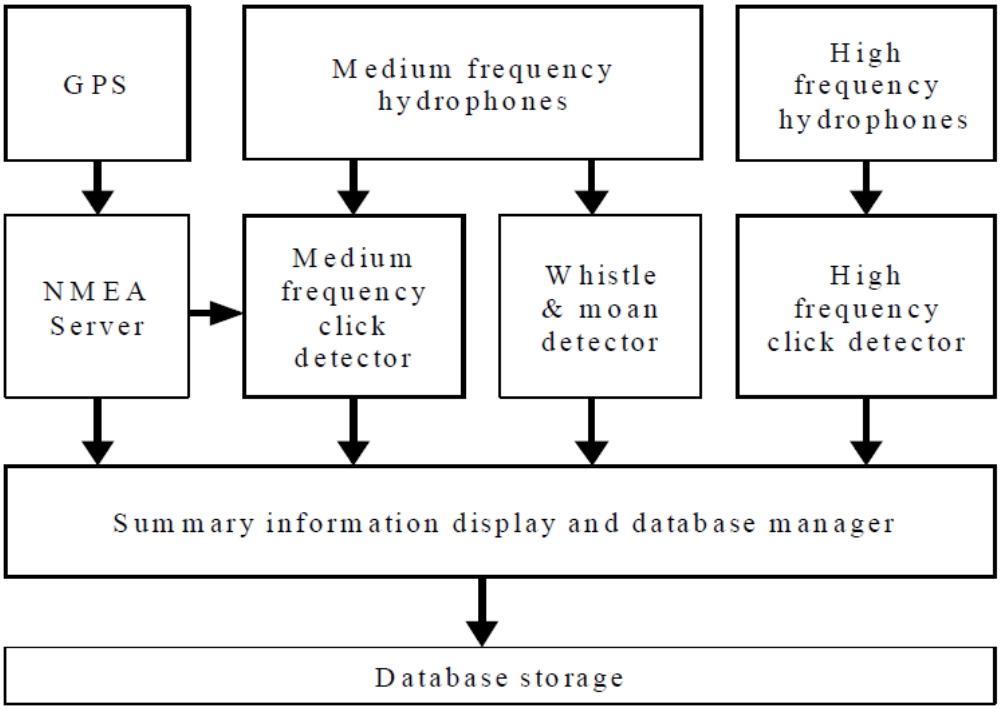

Figure 3.1 Schematic set up of PAMS

3.6.2 The hydrophone array

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

3.6.3 The monitoring system

The latest version of PAMGuard software Version (1.13.00 Beta) was utilised as a graphical display for sound acquisition, visualisation 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 Environmental Ltd. Using the most appropriate modules and specifications, a low/medium frequency and a high frequency data module configuration was utilised simultaneously using a single computer interface (Figure 3.2).

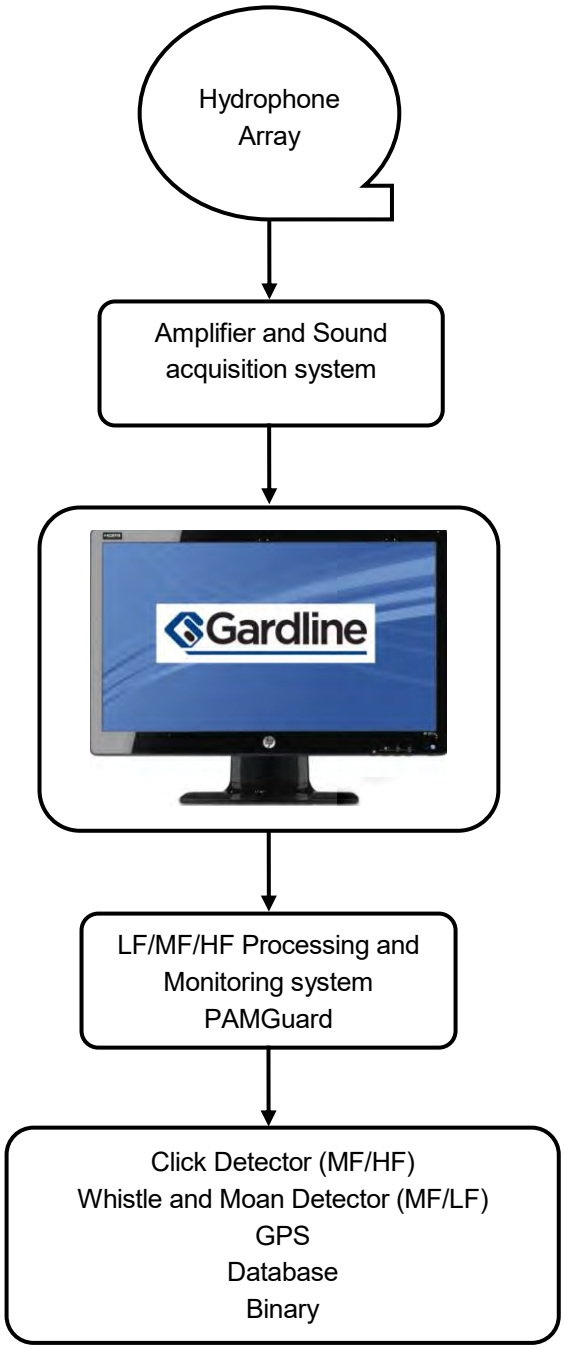

Figure 3.2 Schematic plug-in modules used in PAMGuard

The medium/low frequency configuration is programmed to specifically track and localise clicks, whistles and moans produced by cetaceans in the vicinity of the hydrophones. This includes odontocete clicks and whistles up to 48 kHz and mysticete moans down to 10 Hz.

The high frequency configuration is programmed to detect the clicks of odontocetes (including dolphins and porpoises) up to 250 kHz.

All of the detection modules were 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 *R.V. Shearwater* began mobilisation in Ocean City on 2nd June 2015. On 5th June the vessel left port and transited out to site at 15:15h (UTC). Upon arrival, calibrations of the geophysical equipment were undertaken and the noise assessment data was collected using PAMS. The vessel then began multi beam data acquisition before ramping up the sub-bottom profiler and single beam depth sounder and beginning the first line at 23:22h on 6th June. Operations continued until 19th June when the vessel headed to Ocean City for replenishment at 04:25h. On 22nd June the vessel returned to site and continued running HRG survey lines at 19:23h. Operations continued until another replenishment port call was required on 6th July. The vessel returned to site on 8th July and resumed running lines at 19:51h. Data acquisitions continued until 19:50h on 13th July when the PAMs cable became entangled in the propeller, and after replacing the array, survey operations resumed at 01:29h on 14th July. At 19:16h on 14th July operations were halted for adverse sea conditions and the vessel made a routine port call, arriving alongside in Ocean City at 13:20h on 15th July. The *R.V. Shearwater* transited back to site at 11:30h on 17th July and survey operations recommenced at 14:57h on the same day. The vessel continued running HRG survey lines until 12:55h on 22nd July when the USBL transceiver stopping transmitting. It was then decided to return to Ocean City to replace the equipment and the vessel arrived alongside at 16:00h on the same day. The vessel left port at 16:30h on 24th July and, following a USBL calibration, the geophysical survey continued at 21:05h on the same day. All HRG data acquisition was completed on 24th July. Environmental activities including shallow water camera work and grab samples were undertaken at 05:45h with the entire survey being completed at 14:00h on 25th July. At 16:30h on the same day the *R.V. Shearwater* arrived back in Ocean City for demobilisation.

During the survey a total of 373 HRG survey lines, including 87 reruns, were run over 43 days. In addition there were four tests conducted. Table 4.1 provides a summary of data acquisition during the survey.

Table 4.1 Summary of data acquisition for the geophysical survey

Data acquisition	Offshore Maryland geophysical survey
Number of lines (incl. reruns)	286 (373)
Number of tests	4
Total hours of acoustic equipment active (hrs:mm)	736:26
Number of ramp-ups	42
Number of daylight ramp-ups	37

4.2 Protected Species Observer Effort

A total of 913 hours and 35 minutes of dedicated marine mammal and sea turtle watches and 804 hours and 48 minutes of dedicated acoustic monitoring effort were carried out by the PSOs between 6th June and 25th July 2015. This included 42 hours of dedicated full pre-start watches and acoustic monitoring.

4.3 Weather Conditions

Weather conditions recorded during the survey were good. The sea state varied between glassy and choppy, but was primarily slight (Figure 4.1). Swell height was predominately low (<2 m) 95%

of the time and moderate (2 – 4 m) 5% of the time. Visibility was generally good although moderate and poor at times (Figure 4.2). Beaufort wind force varied between Force 0 and 6 (Figure 4.3) and was mainly either southerly or south westerly in direction (Figure 4.4).

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

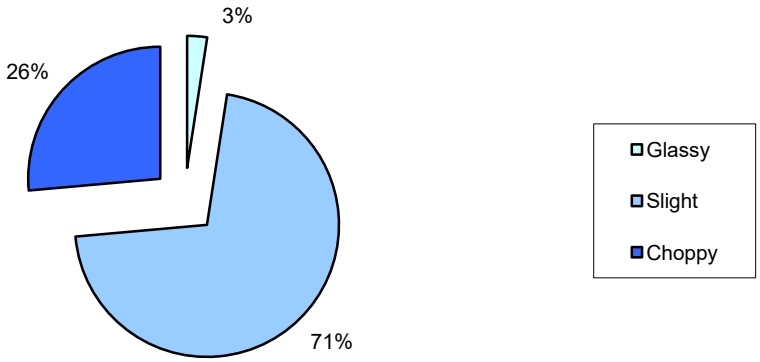

Figure 4.1 Sea state recorded during dedicated marine mammal and sea turtle monitoring during the geophysical survey

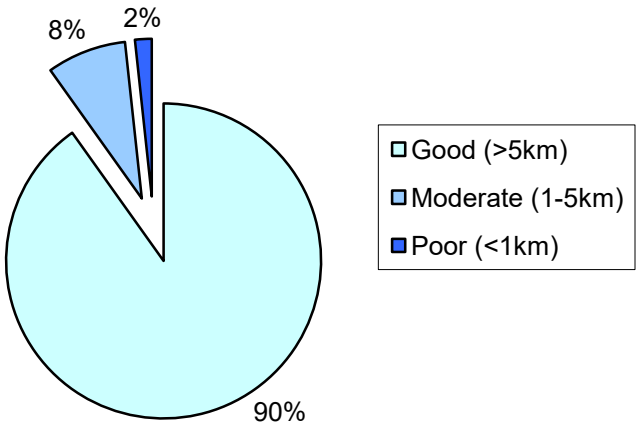

Figure 4.2 Visibility recorded during dedicated marine mammal and sea turtle monitoring during the geophysical survey

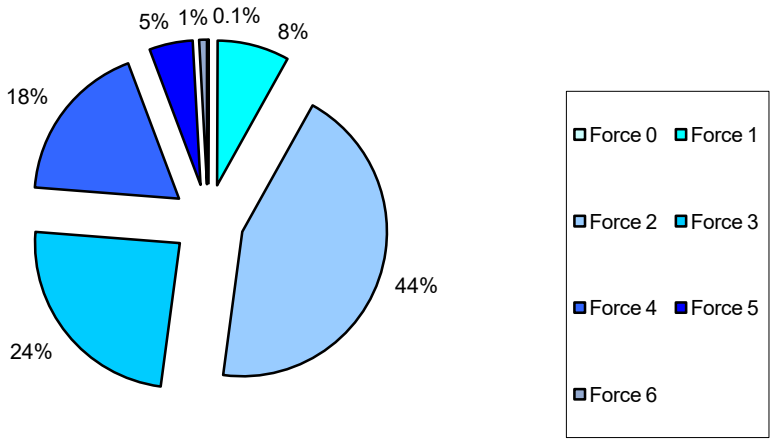

Figure 4.3 Beaufort wind force recorded during dedicated marine mammal and sea turtle monitoring during geophysical survey

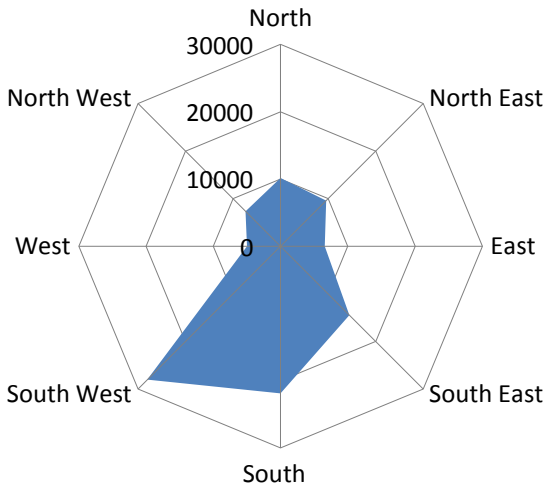

Figure 4.4 Wind direction recorded during dedicated marine mammal and sea turtle monitoring during the geophysical survey

4.4 *Compliance with Protected Species Mitigation Measures*

The Offshore Maryland Geophysical Survey was run in accordance with a specific mitigation measures stipulated in the lease (OSC-A 0489 and OSC-A 490). PSOs conducted dedicated watches and acoustic monitoring during all survey operations and visual monitoring during all transits to and from site.

There were no encounters with North Atlantic right whale during the survey.

There were two encounters with non-delphinid cetaceans during the survey. A minimum separation distance of 100 m was maintained during one encounter of an unidentified baleen whale on 29th

June 2015 sighted at 4000 m. On one occasion, non-delphinid cetaceans were encountered within 100 m of the vessel during transit to port: on 22nd July a mother and calf pair of pygmy sperm whale were sighted a minimum of 10 m from the vessel. The vessel speed remained below 10 knots throughout the encounter as the vessel was coming in to port, however there were a high number of vessels and fishing gear in the vicinity, therefore it was deemed unsafe to put the vessel into neutral. However, the vessel maintained a constant slow speed to minimise the risk of collision and the animals were passed safely.

There were 39 encounters with delphinid cetaceans during the survey. A minimum separation distance of 50 m was maintained during 31 encounters. On eight occasions delphinid cetaceans were encountered within 50 m of the vessel; on all such occasions the appropriate avoidance measures were implemented.

There were 29 encounters with sea turtles and no encounters with pinnipeds during the survey. A minimum separation distance of 50 m was maintained during 16 encounters. On 13 occasions marine turtles were encountered within 50 m of the vessel; on all such occasions the appropriate avoidance measures were implemented.

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

During the survey there were no incidences of vessel strikes with marine mammals or sea turtles. There were two sightings of dead, unidentified turtle species but no other sightings of injured or dead protected species. The first dead turtle was sighted on 14th June at 15:58h. It was floating belly up and was moderately decomposed (signs of bloating and muscle/ tissue degradation). The second sighting was on 11th July, when a dead turtle was sighted at 20:20h. It was also floating belly up and moderately decomposed. During both sightings, seabirds were seen feeding on the remains. Both sightings were reported to the NOAA NMFS Northeast Region Stranding Hotline within 24-hours and a full incident report completed (Appendix B).

Vessel speed was maintained at 4 - 5 knots throughout geophysical 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 for North Atlantic right whales.

The lease stipulated that the Early Warning System, Sighting Advisory System and Mandatory Ship Recording System must be used in Seasonal Management Areas 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.
During the survey there were 42 ramp-ups of the geophysical survey equipment, of which 37 occurred during daylight hours including one during lowlight hours at dusk; and five occurred during the hours of darkness. Full dedicated pre-start monitoring (visual and acoustic) was completed prior to all full ramp-ups of acoustic equipment. If a power-down was required due to a delphinid cetacean or pinniped entering the mitigation zone, then full monitoring would continue throughout the encounter.

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

During the survey there were three occasions where the start-up of geophysical equipment was delayed due to the close proximity of marine mammals or turtles. There were 15 occasions where

the active source was shut-down due to the close proximity of non-delphinid cetaceans and turtles, and there were 12 occasions when the active source was powered down due to the close proximity of a delphinid cetacean (Table 4.2).

Table 4.2 Summary of mitigation during the geophysical survey

Date dd/mm/yy	Time animal entered mitigation zone(UTC)	Species	Closest distance from source	Source activity	Action taken	Length of delay/shut down/power down / mins
07/06/15	12:22	Loggerhead turtle	50	Full power	Shut down	60
12/06/15	00:07	Atlantic spotted dolphin	5	Full power	Power down	9
12/06/15	17:08	Loggerhead turtle	5	Full power	Shut down	60
13/06/15	16:04	Unidentified turtle sp.	20	Full power	Shut down	60
16/06/15	15:09	Unidentified turtle sp.	100	Full power	Shut down	60
17/06/15	15:45	Unidentified turtle sp.	10	Full power	Shut down	60
17/06/15	16:37	Unidentified turtle sp.	100	Not active	Delay ramp up	52
17/06/15	19:13	Loggerhead turtle	75	Full power	Shut down	60
17/06/15	19:26	Loggerhead turtle	40	Not active	Delay ramp up	13
17/06/15	19:31	Loggerhead turtle	200	Not active	Delay ramp up	4
17/06/15	21:45	Unidentified turtle sp.	10	Full power	Shut down	60
24/06/15	20:55	Loggerhead turtle	50	Full power	Shut down	60
25/06/15	16:39	Unidentified dolphin sp.	180	Full power	Power down	4
29/06/15	17:21	Loggerhead turtle	60	Full power	Shut down	60
30/06/15	13:46	Bottlenose dolphin	2	Full power	Power down	22
30/06/15	19:27	Loggerhead turtle	20	Full power	Shut down	62
01/07/15	10:30	Bottlenose dolphin	100	Full power	Power down	30
01/07/15	17:42	Loggerhead turtle	50	Full power	Shut down	60
09/07/15	15:16	Unidentified turtle sp.	50	Full power	Shut down	62
09/07/15	22:25	Bottlenose dolphin	150	Full power	Power down	5

09/07/15	22:45	Bottlenose dolphin*	60	Ramp up	Power down	17
10/07/15	02:15	Atlantic spotted dolphin	10	Full power	Power down	7
10/07/15	02:29	Atlantic spotted dolphin *	15	Ramp up	Power down	10
10/07/15	10:25	Unidentified turtle sp.	150	Full power	Shut down	60
18/07/15	11:16	Atlantic spotted dolphin	5	Full power	Power down	6
18/07/15	12:03	Atlantic spotted dolphin	5	Full power	Power down	9
20/07/15	15:43	Unidentified turtle sp.	50	Full power	Shut down	60
21/07/15	15:37	Green turtle	30	Full power	Shut down	61
22/07/15	00:04	Bottlenose dolphin	150	Ramp up	Power down	4
22/07/2015	00:15	Bottlenose dolphin *	5	Ramp up	Power down	7

* denotes when the same animal/s re-entered the mitigation zone

4.5 *Marine Mammal and Sea Turtle Encounters*

There were 64 sightings of marine mammals and sea turtles, and 10 acoustic detections of marine mammals throughout the duration of the survey, from 5th June to 25th July 2015. Encounters included bottlenose dolphin, Atlantic spotted dolphin, unidentified dolphin species, pygmy sperm whale, unidentified baleen whale species, loggerhead turtle, leatherback turtle, green turtle and unidentified turtle species.

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

A summary of the species encountered is provided in Table 4.2; 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 G. Figure 4.5 shows a distribution map of the encounters.

Table 4.3 Summary of marine mammal and sea turtle encounters during the geophysical survey

Species	Daylight		Night time	
	Number of Sightings	Number of Acoustic Detections	Number of Sightings	Number of Acoustic Detections
Loggerhead turtle	12	0	0	0
Green turtle	1	0	0	0
Leatherback turtle	2	0	0	0
Unidentified turtle sp.	13	0	1	0
Bottlenose dolphin	27	3	0	0
Atlantic spotted dolphin	3	1	1	1
Pygmy sperm whale	1	0	0	0
Unidentified dolphin sp	2	0	0	5
Unidentified baleen whale sp.	1	0	0	0

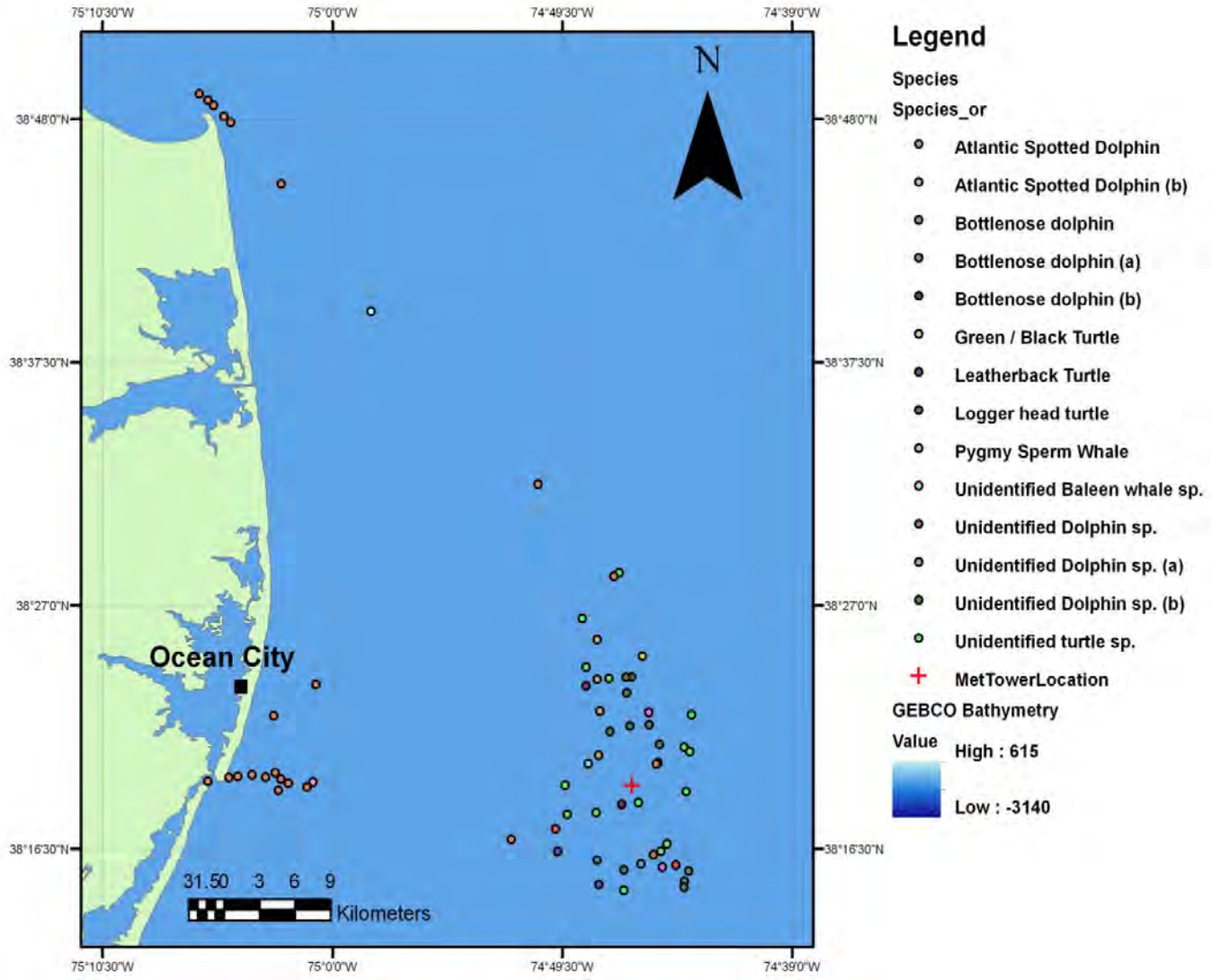

Figure 4.5 Distribution map of the marine mammals and sea turtles encountered during the geophysical survey. (a) denotes species acoustically detected whilst (b) denotes species detected both visually and acoustically. All other encounters were visual only.

4.6 Marine Mammal and Sea Turtle Sightings

4.6.1 Unidentified baleen whale

There was one sighting of a large baleen whale during the geophysical survey. On the 29th June at 10:29h a series of tall blows were sighted (Figure 4.6), although the body of the whale was not visible. At the time of the sighting, there was no acoustic output from the vessel and the individual remained 4000 m away and so mitigation action or vessel avoidance was not required.

Figure 4.6 Large baleen whale sighted on 29th June during the geophysical survey

4.6.2 Atlantic spotted dolphin (Stenella frontalis)

There were four sightings of Atlantic spotted dolphin (Figure 4.7) during the geophysical survey - these are summarised in the table below (Table 4.4).

Table 4.4 Summary of Atlantic spotted dolphin sightings/detections during the geophysical survey

Date (dd/mm/yy)	Start time of sighting (UTC)	End time of sighting (UTC)	Number of Individuals	Distance from vessel when first sighted / m	Bearing from North / degrees	Method of detection	Method first detected
12/06/15	00:07	00:18	17	150	160	Visual	N/A
10/07/15	02:14	02:38	10	10	265	Both*	Acoustic
18/07/15	11:16	11:16	3	10	160	Visual	N/A
18/07/15	11:58	11:58	20	250	180	Both	Visual

* denotes when the animals were seen with the night vision binoculars

Figure 4.7 Atlantic spotted dolphins sighted on 12th June during the geophysical survey

4.6.3 *Bottlenose dolphin (Tursiops truncatus)*

There were 27 sightings of bottlenose dolphins (Figure 4.8) during the geophysical survey - these are summarised in the table below (Table 4.5)

Table 4.5 Summary of bottlenose dolphin sightings/detections during the geophysical survey

Date (dd/mm/yy)	Start time of sight (UTC)	End Time of sighting (UTC)	No. of Individuals	Distance from vessel when first sighted / m	Bearing from North / degrees	Method of detection	Method first detected
09/06/15	01:00	01:05	2	50	280	Visual	N/A
09/06/15	20:25	20:30	12	900	260	Visual	N/A
09/06/15	21:13	21:15	1	1300	230	Visual	N/A
09/06/15	22:55	22:56	6	700	70	Visual	N/A
10/06/15	20:00	20:01	1	1000	150	Visual	N/A
19/06/15	14:46	14:47	10	10	315	Visual	N/A
22/06/15	15:10	15:13	10	200	60	Visual	N/A
22/06/15	15:26	15:33	40	350	117	Visual	N/A
26/06/15	19:39	19:41	7	400	225	Visual	N/A
26/06/15	20:20	20:23	1	1000	225	Visual	N/A
26/06/15	20:26	20:29	2	300	260	Visual	N/A
30/06/15	13:46	13:58	14	180	210	Both	Visual
01/07/15	10:25	10:42	100	1000	100	Visual	N/A
08/07/15	16:23	16:26	1	500	350	Visual	N/A
09/07/15	22:20	22:58	50	300	310	Both	Acoustic

14/07/15	22:34	22:35	3	600	340	Visual	N/A
14/07/15	23:19	23:23	2	200	165	Visual	N/A
15/07/15	10:48	10:51	1	50	340	Visual	N/A
15/07/15	12:35	12:32	4	100	270	Visual	N/A
17/07/15	12:30	12:32	4	100	70	Visual	N/A
21/07/15	14:21	14:23	1	1500	120	Visual	N/A
22/07/15	00:02	00:20	30			Both	Acoustic
22/07/15	16:27	16:32	6	500	230	Visual	N/A
24/07/15	16:52	17:06	3	600	30	Visual	N/A
24/07/15	17:22	17:25	8	500	10	Visual	N/A
24/07/15	18:46	18:49	1	500	125	Visual	N/A
25/07/15	16:42	16:44	1	300	180	Visual	N/A

Figure 4.8 Bottlenose dolphins sighted on 30th June during the geophysical survey

4.6.4 Unidentified dolphin species

There were two visual sightings of unidentified dolphin species during the geophysical survey.

At 16:39h on 25th June a pod of five unidentified dolphins were seen 180 m from the vessel. The sighting resulted in a 4-minute power-down of the acoustic source.

At 18:30h on the 3rd July a pod of seven unidentified dolphins were sighted 2000 m from the vessel. The sighting lasted for seven minutes and resulted in no mitigation action being required.

4.6.5 *Pygmy sperm whale (Kogia breviceps)*

There was one sighting of pygmy sperm whale during the geophysical survey (Figure 4.9). Between 15:11h and 15:15h on 22nd July a mother and calm pygmy sperm whale were seen 50 m off the port bow of the vessel. At the time of the sighting the vessel was transiting back to port therefore no mitigation action was required however the vessel kept in line with vessel strike avoidance measures where possible. Due to the number of vessels and fishing gear in the vicinity it was not possible to put the vessel into neutral however a constant speed below 10 knots was maintained to reduce the collision risk and the animals were passed safely.

Figure 4.9 Pygmy sperm whale sighted on 22nd July during the geophysical survey

4.6.6 *Loggerhead turtle (Caretta caretta)*

There were 12 confirmed sightings of loggerhead turtles during the geophysical survey (Figure 4.10), these are summarised in the table below (Table 4.6).

Table 4.6 Summary of loggerhead turtle sightings during the offshore Maryland geophysical survey

Date	Start Time of sighting (UTC)	End time of sighting (UTC)	Number of Individuals	Distance from vessel when first sighted / m	Bearing from North / degrees
07/06/15	12:22	12:23	1	50	340
10/06/15	11:36	11:37	1	250	193
11/06/15	00:12	00:14	1	200	212
12/06/15	17:08	17:10	1	10	300
17/06/15	19:13	19:16	1	100	42
17/06/15	19:26	19:28	1	80	128
17/06/15	19:31	19:33	1	200	215
24/06/15	20:55	20:58	1	75	68
29/06/15	17:20	17:22	1	230	33
30/06/15	19:27	19:28	1	20	313
01/07/15	17:42	17:42	1	75	191
22/07/15	13:13	13:14	1	250	15

Figure 4.10 Loggerhead turtle sighted on 30th June during the geophysical survey

4.6.7 Green turtle (Chelonia mydas)

There was one sighting of a probable green turtle during the geophysical survey. At 15:37h on 21st July 2015 a probable green turtle was recorded. The individual had a dark carapace, but pale flippers. The animal was seen 30 m from the vessel and initiated a shutdown of the acoustic source.

4.6.8 *Leatherback turtle*

There were two sightings of leatherback turtle during the geophysical survey.

At 20:27h on 24th July a single leatherback turtle was seen 500 m from the vessel. The individual was seen slowly swimming before taking a dive out of sight at 20:28h.

The second leatherback turtle sighting occurred at 21:11h on the same day. The turtle was sighted 500 m from the vessel and again performed a deep dive at 21:13h. On both occasions, no mitigation action was required.

Figure 4.11 Leatherback turtle sighted on 24th July during the offshore Maryland geophysical survey

4.6.9 *Unidentified turtle species*

There were 14 sightings of unidentified turtle species during the geophysical survey, including two dead specimens. Live sighting are summarised in the table below (Table 4.7).

Table 4.7 Summary of unidentified turtle sightings during the geophysical survey

Date	Start time of sighting (UTC)	End time of sighting (UTC)	Number of Individuals	Distance from vessel when first sighted / m	Bearing from North / degrees
10/06/15	21:08	21:09	1	300	60
10/06/15	21:58	21:59	1	215	280
*11/06/15	08:30	08:30	1	75	100
13/06/15	16:04	16:04	1	20	30
16/06/15	15:09	15:10	1	100	80
17/06/15	15:45	15:46	1	10	110
17/06/15	16:37	16:37	1	100	90
17/06/15	21:45	21:46	1	15	90
09/07/15	15:16	15:17	1	50	340
10/07/15	10:25	10:26	1	150	230
20/07/15	15:43	15:45	1	50	300
24/07/15	21:54	21:55	1	650	355

* denotes when the animals were seen with the night vision binoculars

4.7 Marine Mammal Acoustic Detections

4.7.1 Atlantic spotted dolphin (Stenella frontalis)

There were two detections of Atlantic spotted dolphin during the geophysical survey.

The first detection occurred at 02:14h on 10th July. The pod, estimated to be between 10 -15 individuals, was recorded for 24 minutes in total, and the species identity was confirmed visually using night vision binoculars. The dolphins were observed entering the mitigation zone twice at a minimum distance of 10 m from the equipment (Figure 4.12). The first time the animals entered the mitigation zone the equipment was at full power and a power down was initiated, the animals left the mitigation zone at 02:22h however the animals re-entered the mitigating zone during ramp up at 02:29h. Another power down was initiated until the PSOs and PAMS Operator on watch gave the all clear that the animals had left the mitigation zone at 02:38h.

The second detection occurred at 11:58h on 18th July. The detection lasted until 12:13h and was comprised of whistle, clicks and echolocation buzzes that ranged in frequency from 12 - 24 kHz. This sighting was confirmed visually at a distance of 250 m however the animals moved into the mitigation zone within 5 m of the vessel. The equipment was in operation during this time and a power down was initiated until the PSO and PAMs Operator on watch gave the all clear that the animals had left the mitigation zone and a ramp up to began at 12:13h.

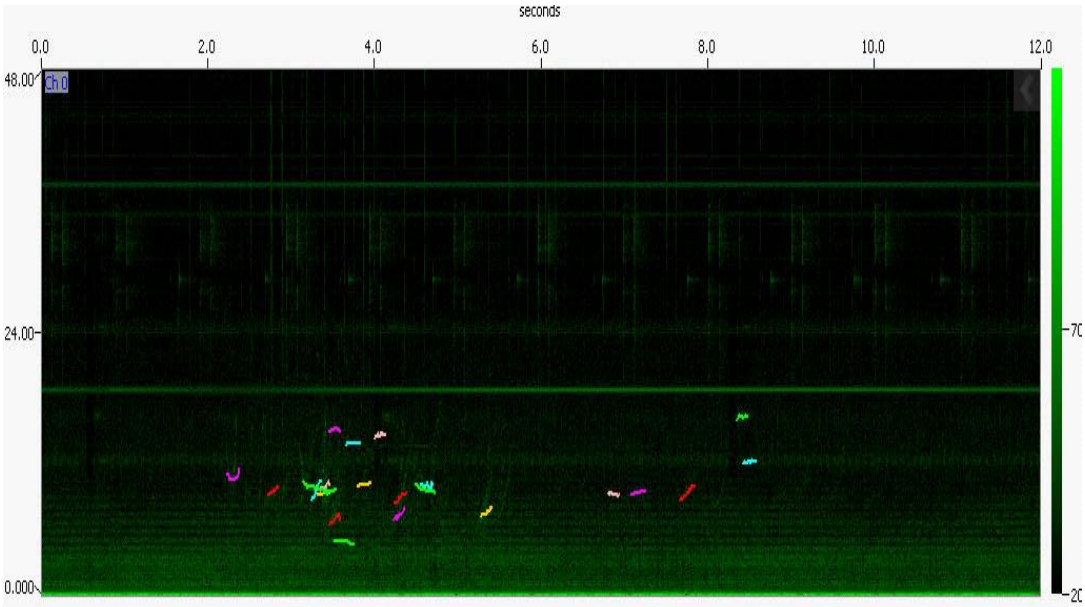

Figure 4.12 Acoustic detection of Atlantic spotted dolphins recorded on 10th July during the geophysical survey

4.7.2 Bottlenose dolphin (Tursiops truncatus)

There were three detections of bottlenose dolphin during the geophysical survey. On all three occasions the species identification was confirmed by the PSO on watch.

The first detection occurred at 13:46h on the 30th June and lasted for 12 minutes. The PSO on watch confirmed the identification and distance of the species at 180 m however the animals moved inside the mitigation zone to within 5 m of the vessel, a power down was initiated until the PSO and PAMS Operator on watch gave the all clear that the animals had left the mitigation zone at 13:59h, ramp up of equipment began at 14:08h.

The second detection occurred at 22:20h on the 9th July, the detection lasted for 20 minutes (Figure 4.13). The identification was confirmed by the PSO on watch and animals were sighted at 300 m, before entering the mitigation zone at 22:25h. A power down was initiated and the animals left the mitigation zone at 22:29 before re-entering at 22:45h during ramp up of equipment. The animals left the mitigation zone and 22:51h and the PSO and PAMS Operator on watch gave the all clear for ramp up procedures to begin.

The third detection occurred at 00:02h on 22nd July and lasted for 18 minutes. The detection comprised of regular whistles between 5 -18 kHz. The species was confirmed by the PSO on watch and the animals were observed entering the mitigation zone twice. The first time occurred at 00:04h during equipment ramp up, the animals left the mitigation zone at 00:08h. The animals then re-entered the mitigation zone at 00:15h during ramp up. A power down was initiated which lasted for 7 minutes, operations resumed following a ramp up after the PAMS Operator and PSO on watch gave the all clear.

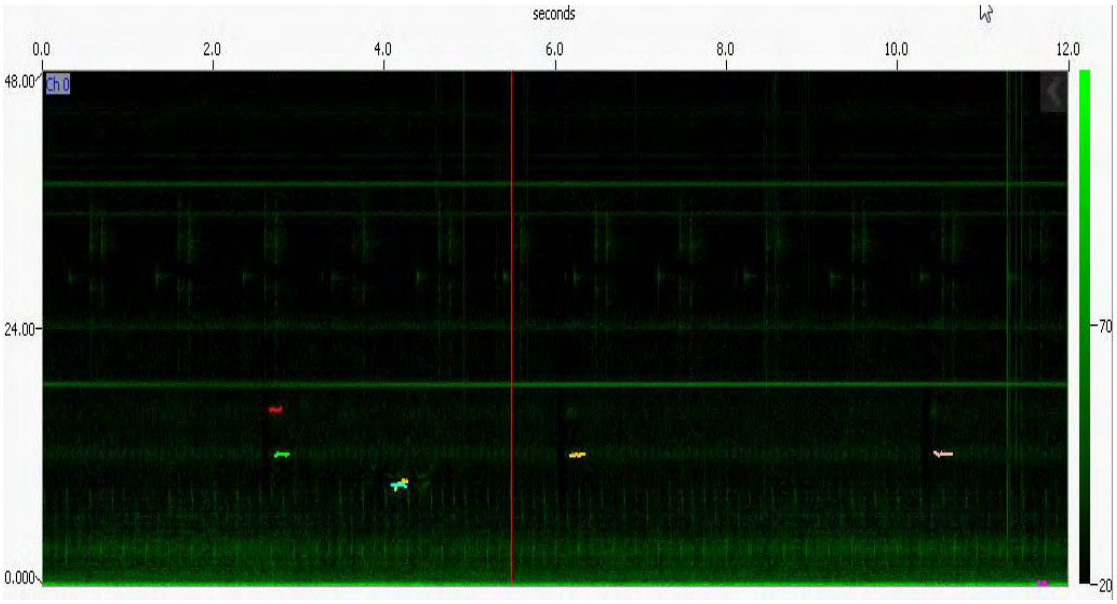

Figure 4.13 Acoustic detection of bottlenose dolphin recorded on 9th July during the geophysical survey

4.7.3 *Unidentified dolphin species*

There were five acoustic detections of unidentified dolphin species during the geophysical survey Table 4.8), these detections have been summarised in the table below. These were all during night time operations.

Table 4.8 Summary of unidentified dolphin species detections during the geophysical survey

Date	Start Time of encounter (UTC)	End time of encounter (UTC)	Number of Individuals	Distance from vessel when first sighted / m	Frequency range
01/07/15	02:52	03:07	1	500	Whistles: 5-10 kHz
12/07/15	02:04	02:10	1	1000	Whistles: 8–13 kHz
12/07/15	02:25	02:33	1	1500	Whistles: 8–13 kHz
12/07/15	04:22	04:24	1	1000	Whistles: 8–13 kHz
12/07/15	05:56	05:59	1	1500	Whistles: 8–13 kHz

4.8 *Comparison of Detection Methods*

During the geophysical survey, three different detection methods were used: PAMS was operated 24 hours a day to detect cetaceans acoustically, while reticule binoculars were used during the day to detect animals visually and at night, and night vision binoculars were used to detect animals visually during the hours of darkness.

There were 12 sightings of cetaceans (six bottlenose dolphin, four Atlantic spotted dolphin and two unidentified dolphin sp.) recorded when PAMS was deployed and four of these resulted in acoustic detections (Figure 4.14). There were also 23 sightings of cetaceans when PAMS was not deployed (due to the vessel waiting on weather or being in transit) (Figure 4.14). There was one sighting of Atlantic spotted dolphins that occurred at night with the night vision binoculars.

There were 12 sightings of loggerhead turtles, two sightings of leatherback turtle, one sighting of a probable green turtle and 14 sightings of unidentified turtle species, one of which occurred during the hours of darkness using night vision binoculars (Figure 4.15).

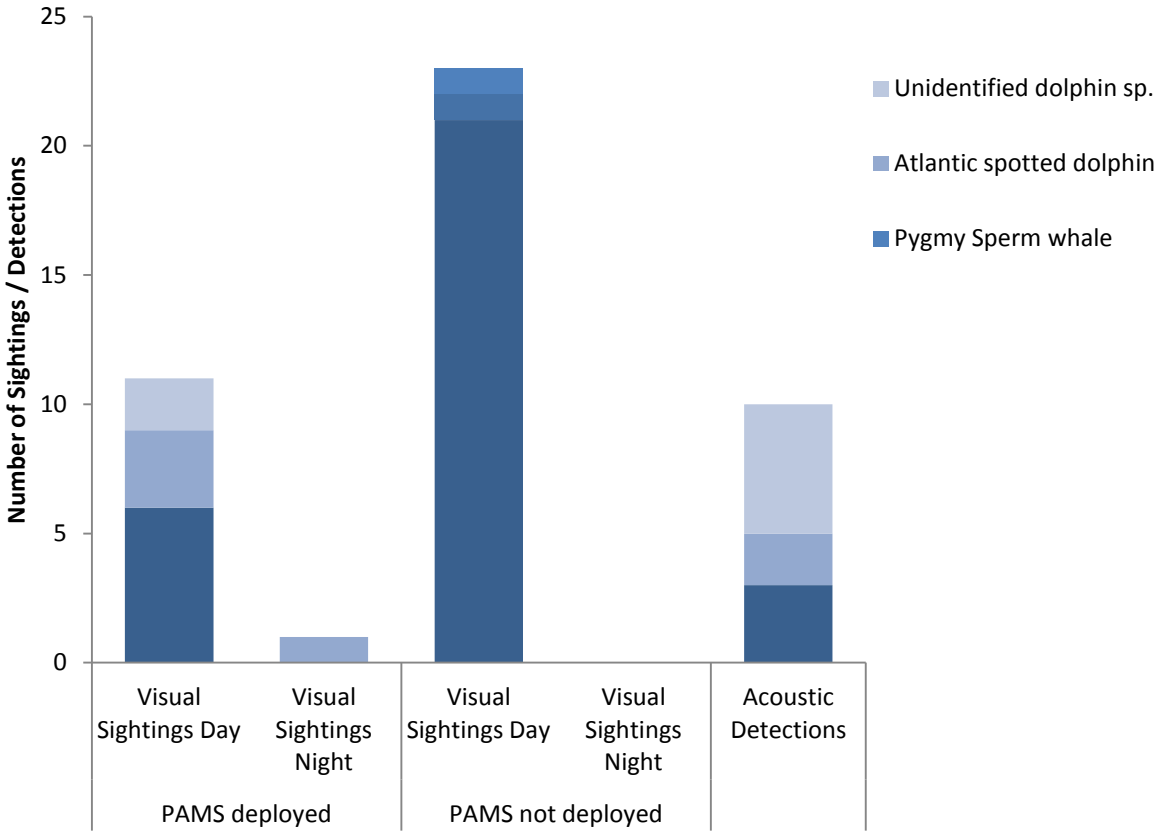

Figure 4.14 Number of visual sightings and acoustic detections of cetaceans during the geophysical survey

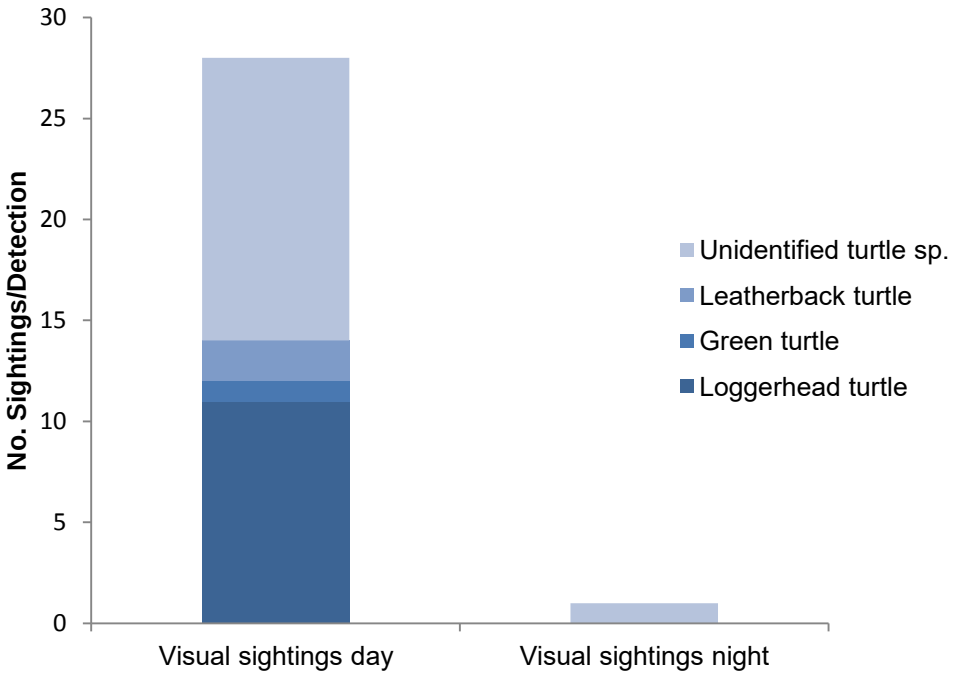

Figure 4.15 Number of visual sightings of sea turtles during both day and night during the geophysical survey

4.9 Accuracy of Distance Estimation Instruments

During the geophysical survey, the PSOs used two methods to estimate distance of animals from the vessel: 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 standardised form. The minimum distance that was used for calibration was 455 m - any objects observed closer to this to the *Shearwater* were too small to be detected by radar and therefore could not be used for calibration of the visual equipment. A table recording distances can be found in Appendix E.

A comparison of the average differences in the accuracy of distance estimation showed that the range finder stick tended to be more accurate, with an average percentage error of 12.3% compared to 21.1% with the reticule binoculars out to 6000 m, and nine accurate readings. Both pieces of equipment tended to underestimate distance rather than overestimate: 23 out of 43 measurements were overestimated using the range finder, and 24 out of 50 were overestimated using the reticule binoculars.

Both pieces of equipment were more accurate at estimating closer distances with average percentage error reducing to 7.1% for reticule binoculars and 6.0% for the range finder stick at a maximum distance of 1200 m. Figure 4.16 shows the comparison of distance using reticule binoculars and range finder sticks with the ships radar up to a distance of 1200 m. Few calibrations were possible within the mitigation zone (closest distance 460 m) however the percentage errors are expected to decrease further the closer the objects are to the observer.

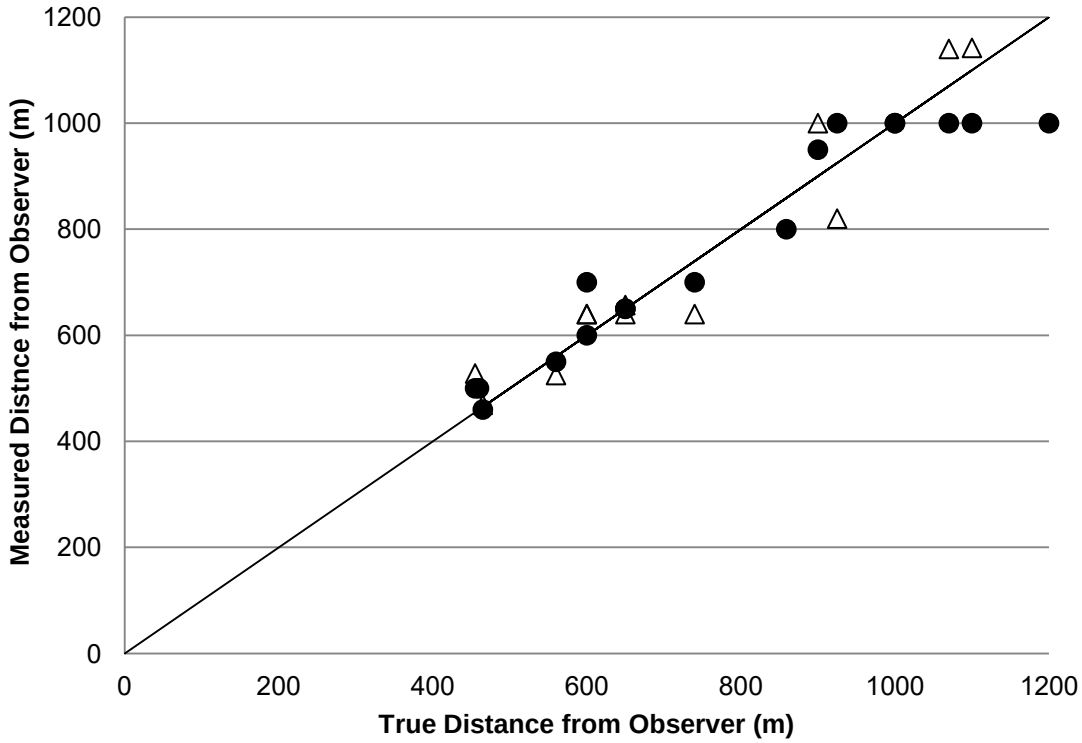

Figure 4.16 Comparison of distances using ship's radar (solid line), range finder stick (filled circles and reticule binoculars (open triangles) out to 1200 m

5. DISCUSSION

5.1 Marine Mammal and Sea Turtle Detection

Marine mammal and sea turtle research carried out previously within the waters of the eastern Atlantic off Maryland have recorded 24 cetacean species, two species of pinniped and four species of sea turtle occurring throughout the year (Kenney *et al.,* 1997; Marine Mammal and Sea Turtle Stranding, 2014; NOAA 2014; IUCN, 2015). While these species occur in spatially distinct areas (Kenney *et al.,* 1997; NOAA 2014; IUCN 2015), 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 2015). 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 behaviour such as the harbour porpoise (Palka, 1996). Weather conditions recorded during marine mammal and sea turtle monitoring were good, with wind force predominantly Force 2, slight seas and low swell (<2 m), however there were a few periods when wind force reached up to Force 6, and seas were choppy. It is likely that in these conditions some species would be very difficult to see, especially sea turtles.

5.2 Comparison of Detection Methods

During the HRG survey between 2nd June and 25th July 2015 there were 63 sightings of marine mammals and turtles and 10 acoustic detections of vocalising marine mammals. Of the visual sightings, 61 occurred during daylight and two during night time operations. Of the acoustic detections, three occurred during daylight and seven during night time operations.

Although there were 35 visual sightings of cetaceans, compared to only 10 acoustic detections, the majority of sightings (23) occurred when PAMs was not deployed, while the vessel was waiting on weather, or during transit to or from the survey area. Of the 10 acoustic detections, five detections were confirmed visually by the PSOs, although in four of these incidences, the animals were detected acoustically first.

The majority of sightings of marine animals occurred during daylight hours, with two sightings occurring at night using the night vision binoculars.

Night vision binoculars with COTI were seen to be most effective at close distances: their effectiveness is greatest within 300 m of the observer and decreases thereafter, however the 500 m range can still be patrolled effectively and the likelihood of detecting a large baleen whale at this distance is still high.

During the hours of darkness the observer is not able to scan the horizon with the naked eye, which has the potential to narrow the field of view for the observer, however this can be taken into account and observation methods altered accordingly to ensure that the mitigation area is scanned effectively.

The levels of background and ambient light did however make a difference to the application of night vision binoculars: PSOs reported that observed distances were greatest when facing the coastline due to residual light however scanning the horizon became more difficult in the presence of bright artificial light close to the observer (e.g lights from the vessel). In addition, weather conditions and the moon phase altered visibility using the night vision binoculars.

The night vision binoculars were particularly effective when utilised in conjunction with PAMS. If a detection was heard at night, the PSO could scan around the vessel to confirm the detection and range visually. This was evident during a detection of Atlantic spotted dolphin during the hours of darkness when the dolphins were initially detected acoustically - the PAMS Operator informed the PSO, and the PSO was able to locate the animals with the night vision binoculars and confirm their range, and provide additional information such as species, and number of animals.

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 behaviour such as the harbour porpoise (Palka, 1996). Weather conditions recorded during marine mammal and sea turtle monitoring were predominantly good. Sea states were generally slight with a low swell and good visibility during daylight hours therefore weather conditions were not likely to have significantly affected the visual detection of marine mammal or turtle species. As with daylight visual detection, poor weather conditions and high sea states have a negative effect on night vision detection ability.

The acoustic detection of marine mammals is generally not as restricted by the weather as visual observations, although the range of hydrophones is occasionally reduced during poor weather conditions due to increased levels of background noise from wave action, precipitation or swell noise. PAMS is a highly reliable technique for detecting marine mammals at night, however animals must be vocalising in order to be detected therefore it is ineffective at monitoring turtle and pinniped species which are not known to vocalise underwater. Over half of the visual sightings recorded by the PSOs were of turtles, therefore it is expected that during this survey PAMS will have a lower detection rate than visual observations.

For some species, particularly baleen whales, vocal activity may vary with season, location, behaviour and gender (Mellinger *et al*., 2007; Boisseau *et al*., 2008). Some species of cetacean are notoriously difficult to monitor acoustically, for example the beaked whales (Barlow & Gisner, 2006). Despite this, many species of cetacean are audible for a greater proportion of time than they are visible at the surface (Gordon *et al*., 2003). In general PAMS has the advantage of being able to detect elusive or small mammals, like the harbour porpoise, that can often be missed by observers during unfavourable weather conditions and the hours of darkness (O'Brien, 2009).

Despite the limitations discussed, night time monitoring did result in two visual sightings and six acoustic detections. The greatest distance of the acoustic detection was at 1500m whilst the furthest visual sighting was at 265 m however night vision binoculars are effective up to 500 m especially when detecting large animals such as north Atlantic right whales. This demonstrates that both are effective at detecting animals in the mitigation zone. Using both night-vision binoculars (for non-vocalising species) and PAMS (for vocalising species) therefore provided optimal monitoring during night time hours and allowed suitable mitigation to be applied during geophysical operations.

5.3 Marine Mammal and Sea Turtle Encounters

During the survey, three confirmed species of cetacean (bottlenose dolphin, Atlantic spotted dolphin and pygmy sperm whale), two confirmed species of sea turtle (loggerhead turtle and leatherback turtle) and one probable species (green turtle) were identified. 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 (NOAA, 2014). The sighting of a pygmy sperm whale mother and calf was the most unexpected sighting of the survey: they have been recorded along the eastern coast of North America, but sightings are rare, with most records coming from strandings (Baird *et al*., 1994). When this species is seen at sea, it is usually recorded around the edge of continental shelves, whereas the sighting during the offshore Maryland geophysical survey occurred in a shallow water depth of 27.6 m.

During the geophysical survey, no specific avoidance behaviour by marine mammals or sea turtles was recorded by the mitigation team. Delphinid cetaceans were commonly recorded exhibiting bow-riding behaviour whilst geophysical operations were underway, whilst turtle sightings were often brief and therefore observations on animal behaviour were not possible.

5.4 Recommendations

In order to minimise the impacts on marine mammals and sea turtles the geophysical 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 utilised. This will ensure that the risks to protected marine mammal and sea turtle species are minimised 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 Monitoring and Mitigation Plan

US Wind Inc. (US Wind) proposes to conduct marine Geophysical and Geotechnical (G&G) surveys as required by BOEM to file a Site Assessment Plan (SAP) 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 early-May, 2015.

US Wind submitted a formal survey plan, dated January 30, 2015, in accordance with the Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585 for these G&G activities to BOEM. In response to BOEM comments, US Wind submitted a revised survey plan on March 4, 2015. A pre-survey meeting was held at BOEM headquarters on March 11, 2015 in accordance with US Wind's lease. In response to comments received at that meeting, US Wind submitted a further revised SAP Survey Plan. This Marine Mammal Monitoring and Mitigation Plan is part of that revised plan.

DESCRIPTION OF PROPOSED G & G ACTIVITY

The G&G survey activity that will be conducted to support preparation of the SAP is described below. Additional detail can be found in the SAP 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, as the project will rely on existing data previously collected for the Lease Areas.[1] 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 47 days under 24-hour operations, not including weather or protected species down time.

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	450 and 900 kHz
Shallow-penetration Subbottom Profiler (chirp)	Teledyne Benthos CHIRP III	2-7 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[2] 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

[1] The Maryland Energy Administration commissioned a similar geophysical survey that acquired medium penetration subbottom data throughout the Project Area and therefore this equipment will not be utilized during the upcoming field program.

[2] 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.

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 Wind Energy Project[3], 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. Again, no higher impact medium penetration survey equipment is proposed for the US Wind HRG survey.

Geotechnical Survey

Following the completion of the HRG survey, a geotechnical program will be conducted. Approximately twelve sampling locations are proposed across the Project Area. These will be sampled using a combination a cone penetrometer and soil boring equipment. The Geotechnical sampling activities are estimated to take approximately 20 days to complete under 24-hour operations, not including weather or protected species down time.

EXCLUSION ZONES AND ALTERNATIVE MONITORING PLAN

As requested by BOEM, US Wind will staff and equip the SAP survey team to provide both 24-hour Passive Acoustic Monitoring System (PAMS) observations and 24-hour visual observations. The exclusion zones for G&G survey activities will be monitored by qualified Protected Species Observers (PSOs) and PAMS operators and all applicable conditions and procedures contained in the lease (e.g. clearance before start up, ramp up, shut down, etc.) will be implemented.

In order to continue operations at night or during periods of impaired visibility, US Wind will implement additional mitigation measures agreed upon by BOEM and US Wind. These will include supplemental monitoring technologies, as described below, to detect the presence of protected species.

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. 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 a towed system specifically designed around the survey vessel specifications provided in Appendix B of the SAP Survey Plan.

The PAMS system will be operated 24 hours per day during the 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).

Visual Observers

For night time operations, visual observers will use high performance night vision goggles, i.e., PVS-7-3AG. Observers will also test 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.

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

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 MMO/PAMS coverage 24-hours a day for the SAP survey, 4 professionals, each of whom is both a certified PSO and an experienced PAMS operator will be required. 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 both day time and night time operations. All of these professionals will have effective training and experience with using night vision optics. These personnel would do no more than 4 hours at each monitoring station (visual or acoustic) and after 4 hours of one discipline would change to another, i.e. change from visually monitoring the sea with binoculars to monitoring the PAMS laptops. Each operator will have a 12 hour break during each 24 hour period. Vessel crews will be available to cover short breaks in PSO coverage to allow the mitigation team to have sufficient meals and rest room breaks. Gardline will ensure that all vessel crew have a short training session prior to or during mobilization to enable them to cover the PSO duties for these short periods. This 4-person staffing program is consistent with berthing available on the survey vessels.

Protected Species Monitoring/Night Time Operations Mitigation Summary

- 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 for 24 hour operations.
- PSOs will be required to make night time observations from a platform with no visual barriers.
- The 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 and sea turtle species, as well as the 200 m exclusion zone during G&G surveys operating below 200 kHz, will be ensured and monitored by vessel operators, vessel crew and PSOs, in accordance with the standard operating conditions of the leases.
- 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 both day time and night time operations. All of these professionals will have effective training and experience with using night vision optics.
- Shut down or delaying operations will occur to maintain required exclusion zones when low frequency vocalizations are detected but are not possible to be localized on with the PAMS.
- A spectrum of frequencies will be analyzed in the empirical acoustic data collected by US Wind in order to cover vessel noise, biological noise and HRG equipment noise (i.e., 50, 100, 200, 500 Hz and 1, 2, 5, 7, 10, 20, 50, 100 and 150 kHz). A sub sample of acoustic, and corresponding visual observation, data will be provided to BOEM within 3 weeks after the commencement of HRG surveys.
- 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.

- Boring operations will be initiated during daytime and night vision optics will be used at night by PSOs throughout the operation to monitor the 200 m exclusion zone for protected species.
- US Wind will conduct a comparative assessment of protected species detection using PAM and visual monitoring during day and night time operations, including calibration exercises. The assessment and subsequent final report will be submitted to BOEM 30 days after the surveys are completed.

Protected Species Detection Comparison 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. This report will also include an assessment of the methods of detection, equipment, and recommendations.

Noise Assessment

To assess the operational sound signature produced by the survey vessel *Shearwater*, a sound assessment will be conducted. This assessment involves a two-step process:

1. A background noise measurement will be taken while the vessel is dead in the water (or as practicably as possible due to safety) with the towed PAMS cable deployed to collect .wav file data recordings for 30 minutes. Recordings do not need to be for 30 minutes continuously.

2. A vessel noise assessment will be taken with the towed PAMS cable deployed while the vessel is operating at normal survey speed(s) to collect .wav file data recordings for 30 minutes. Recordings do not need to be continuous.

Both sets of vessel noise assessments will be taken at multiple locations to cover variations in site conditions e.g. water depth, bottom conditions, etc. The acoustic signature will also be measured at various vessel RPMs over these site conditions. US Wind will also collect representative baseline and vessel signature data for the geotechnical vessel.

Once data is collected, an underwater noise analysis will be performed using Matlab. In this process, the noise level recorded from the vessel operation will be extracted from the acoustic data in terms of sound pressure level and then compared to the background noise level. This will provide an approximation of the vessel noise level without the contribution of any ambient noise. An acoustic spectrogram will be computed to visualize the vessel's acoustic signature. This will provide the relative received noise levels from the vessel at the hydrophone under various site conditions. US Wind expects to be able to provide preliminary acoustic data from the *Shearwater* to BOEM within two weeks after the start of the survey program. This timeframe should be sufficient to allow for the transfer of data from the offshore survey area to shore plus 7-10 days for processing once the data is received.

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[4]. However, with the monitoring and mitigation proposed by US Wind in

[4] 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.

this plane, 24-hour G&G survey operations can proceed 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 Lease Area is 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 Lease Area and Maryland does not have any primary turtle nesting sites or any reported 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 Lease Area during survey activities, the use of PAMS and night vision goggles 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 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 the use of PAMS and night vision goggles 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.

APPENDIX B INJURED OR DEAD PROTECTED SPECIES INCIDENT REPORTS

INCIDENT REPORT: PROTECTED SPECIES INJURY OR MORTALITY

Photographs and/or video footage should be taken of all injured or dead animals, if possible

Observer's full name and/or Reporter's full name: Sam Tufano / Sharon Doake
Date and Time animal observed: 14/06/2015 at 15:58 UTC
Date and Time animal/samples collected: N/A
Location of Incident (Latitude/Longitude): 38 19.24 N / 74 49.36 W
Species Identification (closest taxonomic level possible): Unidentified turtle species
Photograph/Video footage collected: **YES**/NO
If Yes, was the data provided to NMFS? **YES**/NO

Name of vessel, vessel speed at the times of incident, and activity ongoing at the time of observation (e.g. transit, survey, pile driving):
Sighted from the R.V. Shearwater, doing 4 knots while undertaking a geophysical survey in the area, the vessel was on line at the time. (Survey lease number OCS-A 0489)

Environmental conditions at time of observation (i.e. Beaufort sea state, cloud cover, wind speed, glare):
Wind south, Force 2, Sea state 1, cloud cover 0, glare – strong forward

Water temperature (°C) and depth at site of observation:
Depth 23m, Water temperature unknown

Describe location of animal and events leading up to, including, and after, the incident:
During a geophysical survey, a PSO onboard the vessel saw a dead turtle float past at about 100 m away while the vessel was running a line. The turtle was floating belly up and a number of seabirds were pecking at it, it appeared to have been dead for awhile, estimated at least a week.

Status of all sound-source use in the 24 hours preceding the incident:
In the past 24 hours the vessel has been on site collecting data, using analogue equipment such as side scan sonar, sub-bottom profiler and single beam depth sounder to map the seabed.

Describe all marine mammal, sea turtle, and sturgeon observations in the 24 hours preceding the incident:
In the past 24 hours a turtle of unknown species was sighted at 16:04 (UTC) on 13th June while the vessel was running a line. It was seen floating at the surface with its head up, about 20 m from the vessel and according to procedures documented in the lease for the survey, the analogue equipment was shut down for 60 mins before eamp up porcedures were followed.

Protected species Information:
Injuries observed: Dead
Condition/description of animal: turtle was belly up, brown/white shell. The flippers appeared to be absent and there may have been what look like shark bites to the shell, this could have occurred before or after death. It was in a good state of decompostion and had been dead for awhile.

Other remarks: –

–

Date and time of incident reported to NMFS Stranding Hotline: –

Sea Turtle Species Information (*Please designate cm/m or inches*):
Weight (kg or lbs):
Sex (circle): MALE FEMALE UNKNOWN How was sex determined?
Straight carapace length: Straight carapace width:
Curved carapace length: Curved carapace width:
Plastron length: Plastron width:
Tail length: Head width:
Condition of specimen/description of animal:

Existing Flipper Tag Information:
Left: Right:
PIT Tag #:
Miscellaneous:
Genetic biopsy taken: YES / NO
Photos taken: YES / NO
Turtle Release Information
Date: Time:
Latitude: Longitude:
State: County:

Remarks: (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propeller damage, papillomas, old tag locations, etc.):

INCIDENT REPORT: PROTECTED SPECIES INJURY OR MORTALITY

Photographs and/or video footage should be taken of all injured or dead animals, if possible

Observer's full name and/or Reporter's full name: Teresa Martin / Sharon Doake
Date and Time animal observed: 11/07/15 seen at 20:20 and 20:38 UTC
Date and Time animal/samples collected: N/A
Location of Incident (Latitude/Longitude): 38°18.05 N / 74°47.95 W and 38°18.42 N / 74°47.89 W
Species Identification (closest taxonomic level possible): Unidentified turtle species
Photograph/Video footage collected: **YES**/NO
If Yes, was the data provided to NMFS? **YES**/NO

Name of vessel, vessel speed at the times of incident, and activity ongoing at the time of observation (e.g. transit, survey, pile driving):
Sighted from the R.V. Shearwater, doing 4 knots while undertaking a geophysical survey in the area, the vessel was on line at the time. (Survey lease number OCS-A 0489)

Environmental conditions at time of observation (i.e. Beaufort sea state, cloud cover, wind speed, glare):
Wind south, Force 2, Sea state 1, cloud cover 3, glare – strong forward

Water temperature (°C) and depth at site of observation:
Depth 23.7m, Water temperature unknown

Describe location of animal and events leading up to, including, and after, the incident:
During a geophysical survey, a PSO onboard the vessel initially saw a dead turtle float past at 20:20 UTC, about 600 m away while the vessel was running a line. The turtle was floating belly up and a fewstorm petrels were pecking at it. Then the vessel turned around and headed back the same way and the PSO saw presumably the same dead turtle in roughly the same location at 20:38. about 1000 m from the vessel.

Status of all sound-source use in the 24 hours preceding the incident:
In the past 24 hours the vessel has been on site collecting data, using analogue equipment such as side scan sonar, sub-bottom profiler and single beam depth sounder to characterise the seabed.

Describe all marine mammal, sea turtle, and sturgeon observations in the 24 hours preceding the incident:
In the past 24 hours no marine mammals, sea turtles or sturgeon were sighted

Protected species Information:
Injuries observed: Dead
Condition/description of animal: turtle was belly up, brown/yellow/green shell. It appeared to be moderately decomposed(likely deceased several days, signs of bloating and muscular breakdown). The PSO reported seeing fishing line entangled around the carcass although this is not evident in the pictures.

Other remarks: –

–

Date and time of incident reported to NMFS Stranding Hotline: –

Sea Turtle Species Information (*Please designate cm/m or inches*):
Weight (kg or lbs):
Sex (circle): MALE FEMALE UNKNOWN How was sex determined?
Straight carapace length: Straight carapace width:
Curved carapace length: Curved carapace width:
Plastron length: Plastron width:
Tail length: Head width:
Condition of specimen/description of animal:

Existing Flipper Tag Information:
Left: Right:
PIT Tag #:
Miscellaneous:
Genetic biopsy taken: YES / NO
Photos taken: YES / NO
Turtle Release Information
Date: Time:
Latitude: Longitude:
State: County:

Remarks: (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propeller damage, papillomas, old tag locations, etc.):

APPENDIX C COMPLETED JNCC RECORDING FORMS

The completed JNCC forms can be found in the Excel document entitled 10505_US Wind_Shearwater_MMOforms

APPENDIX D 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 E MONITORING EQUIPMENT CALIBRATION FORMS

Calibration For Distance Estimation								
Week #	**Date**	**Name of Observer**	**Reticule Binoculars Distance (m)**	**Range Finder Distance (m)**	**Distance provided by the system onboard**	**Sea state (Beaufort Scale)**	**Wind force (Beaufort Scale)**	**Swell (m)**
1	06/06/2015	J. Allum	1140	1000	1070	1	1	1
1	06/06/2015	S. Doake	1147	n/a	1270	1	1	1
1	06/06/2015	S. Doake	n/a	2000	2960	1	1	1
1	07/06/2015	S. Doake	n/a	1000	1000	2	3	1
1	07/06/2015	S. Doake	1906	n/a	4310	3	3	2
1	07/06/2015	T. Martin	1898	2500	1560	3	3	2
1	08/06/2015	J. Allum	640	1000	1295	3	3	2
2	10/06/2015	S. Tufano	1147	1000	1295	3	3	2
2	10/06/2015	T. Martin	1898	n/a	5550	1	1	1
2	10/06/2015	T. Martin	n/a	2400	2300	1	1	1
2	11/06/2015	T. Martin	n/a	500	460	3	3	1
2	11/06/2015	S. Doake	1147	1500	1850	4	4	1
2	11/06/2015	T. Martin	1142	1300	1350	4	4	1
2	11/06/2015	S. Doake	1147	1560	1700	2	2	1
2	13/06/2015	S. Doake	824	1000	1500	2	2	1
2	13/06/2015	J. Allum	1140	1200	1850	1	2	0.5
2	13/06/2015	T. Martin	1898	2300	2270	1	2	0.5
2	14/06/2015	T. Martin	820	1000	925	2	3	0.5
2	14/06/2015	S. Doake	n/a	800	859	2	3	0.5
2	15/06/2015	T. Martin	1898	1900	1850	2	3	0.5
2	16/06/2015	R. Counihan	2500	2000	2300	2	2	0.5
2	16/06/2015	R. Counihan	5000	5000	5550	2	2	0.5
2	17/06/2015	J. Allum	640	700	740	3	4	1
2	17/06/2015	T. Martin	n/a	1850	1850	3	4	1
2	19/06/2015	R. Counihan	1000	950	900	2	2	1
3	24/06/2015	T. Martin	1898	2450	2400	2	1	0.5
3	25/06/2015	S. Doake	824	1500	1700	2	2	1
3	25/06/2015	T. Martin	657	650	650	1	2	0.5
4	30/06/2015	T. Martin	640	650	650	3	3	0.5
4	02/07/2015	J. Allum	640	700	600	3	3	0.5
4	03/07/2015	T. Martin	1682	1875	1850	2	1	0.25
4	03/07/2015	S. Doake	1147	1500	1500	2	2	0.5

4	03/07/2015	T. Martin	1142	1700	1600	2	2	0.5
4	03/07/2015	S. Doake	528	500	455	2	2	0.25
5	05/07/2015	S. Tufano	1147	2000	1500	3	2	0.5
5	05/07/2015	T. Martin	469	460	465	2	1	0.25
6	06/07/2015	S. Tufano	1147	1500	1500	2	2	0.25
6	08/07/2015	T. Martin	525	550	560	4	4	0.5
6	09/07/2015	T. Martin	640	600	600	2	1	0.25
6	11/07/2015	T. Martin	n/a	n/a	1820	2	1	0.25
6	13/07/2015	S. Doake	1906	3000	2730	1	1	0.25
7	15/07/2015	S. Tufano	1800	2000	2000	2	3	0.5
7	15/07/2015	L. Slater	1800	2000	2000	2	3	0.5
7	17/07/2015	T. Martin	1898	2000	2180	2	3	0.5
7	18/07/2015	S. Tufano	n/a	n/a	3300	2	2	0.5
7	18/07/2015	L. Slater	n/a	2500	1800	2	3	0.5
7	18/07/2015	L. Slater	n/a	4500	5000	2	2	0.5
7	18/07/2015	S. Doake	n/a	1000	1200	2	2	0.5
7	18/07/2015	L. Slater	n/a	1000	1000	2	2	0.5
7	19/07/2015	S. Tufano	n/a	n/a	3000	2	2	0.5
7	19/07/2015	L. Slater	1850	2000	2400	2	2	0.5
7	19/07/2015	R. Lee	1300	2000	1420	2	2	0.5
7	20/07/2015	R. Lee	1940	2000	2500	2	2	0.3
7	20/07/2015	S. Tufano	n/a	2000	2500	2	2	0.3
7	20/07/2015	T. Martin	1142	1000	1100	2	2	0.25
8	21/07/2015	T. Martin	1142	1250	1230	2	2	0.5

APPENDIX F PASSIVE ACOUSTIC MONITORING SYSTEM SPECIFICATIONS

General	
Manufacturer	Gardline Environmental Ltd
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 Environmental Limited 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 G SPECIES DESCRIPTIONS

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. Colour 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 colouration 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 4.1 m, and weigh between 150 and 650 kg (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, 2015).

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 (<200 m) and continental slope (200-2000 m) 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. Colouration 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 1.6 and 2.3 m and weigh between 100 and 143 kg (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, 2015).

Pygmy Sperm Whale (Kogia breviceps)

Pygmy sperm whales are widely distributed in tropical and temperate seas, and are usually encountered in waters off the continental shelf (Culik, 2011). This is a small, inconspicuous animal that rarely shows demonstrative behaviour making it hard to spot, as a result is rarely recorded alive at sea, but is one of the most frequently stranded odontocetes in certain parts of the world (Shirihai & Jarrett, 2006). This species has a blunt head with a narrow underslung lower jaw. The overall body is counter shaded and can vary between dark to light grey across the spine, typically with a pinkish tone on the underside. There is a light coloured bracket shape that runs from the eyes to the pectoral fins (dubbed the "false gill"), although variability among the cheek and eye markings make the false gill possibly less prominent. The overall body length is 2.7 m to 3.4 m and adults may weigh up to 450 kg (Jefferson et al., 2008; Shirihai & Jarrett, 2006). The dorsal fin is hooked shaped and set low along the spine, it is the primary characteristic that visually differentiates the pygmy and dwarf sperm whale (Kogia sima). The diet of pygmy sperm whales is primarily comprised of deep-

water cephalopods, with stomach content analysis showing that they also occasionally feed on fish and crustacean species (Santos et al., 2006). Group size is usually small, ranging from single individuals up to groups of 10 (McAlpine, 2009). There are no global estimates of abundance with population trends unknown and the species is listed as 'Data Deficient' on the IUCN Red List (IUCN, 2015).

Green Turtle (Chelonia mydas)

Green turtles are widely distributed throughout tropical and subtropical waters, near continental coasts and around islands. They usually remain within the 20°C isotherms and follow seasonal latitudinal changes in these limits, although they are occasionally reported in temperate waters (Márquez, 1990). The green turtle has a slightly depressed oval shaped, smooth carapace which ranges in colour from shades of black, grey, green, brown and yellow (NOAA, 2012). Records of maximum size are of 139.5 cm and 235 kg, with males generally smaller than females (Márquez, 1990). Green turtles are highly migratory, using a range of habitats during their lifecycle. On leaving the nesting beach, hatchlings begin an oceanic phase (Carr, 1987) floating passively in major current systems which serve as open-ocean development grounds. Once the turtles reach 30 to 40 cm in length they settle in neritic developmental areas rich in seagrass and or marine algae, such as tropical tidal and sub-tidal coral and rocky reefs. Here they forage and remain until maturity (Musick & Limpus, 1997), when then commence breeding migrations between foraging grounds and nesting areas, often traversing oceanic zones, every few years. Nesting occurs in over 80 countries worldwide (Hirth, 1997). During non-breeding periods adults remain at coastal neritic feedings areas that may coincide with juvenile development habitats. There is substantial variability in the proportion of the population that nests in any given year (Seminoff, 2004). Analysis of subpopulation changes indicates a 48% to 67% decline in the number of mature females nesting annually as a result of over exploitation of eggs and adult females at nesting sites, juveniles and adults in foraging areas and to a lesser extent Incidental mortality relating to marine fisheries and degradation of habitat (Seminoff, 2004). The species is listed under Appendix I of the Convention on International Trade in Endangered Fauna and Flora (CITES) and under Appendix II of the Convention on Migratory Species (CMS). It is listed as 'Endangered' on the IUCN Red List (IUCN, 2015).

Loggerhead Turtle (Caretta caretta)

Loggerhead turtles are widely distributed in coastal tropical and subtropical waters ranging between 16 and 20°C, although it is also commonly recorded in temperate waters at the boundaries of warm currents (Márquez, 1990). The heart-shaped carapace is reddish brown in colour. Adults reach between 82 and 105.3 cm, with a mean weight of approximately 75 kg (Márquez, 1990). The species is distinguished by its large head and strong jaws. Adult loggerhead turtles are known to undertake long distance migrations between nesting beaches and foraging grounds (Polovina et al., 2004; Nichols et al., 2000). Loggerhead hatchlings and juveniles are frequently associated with sea fronts, down-wellings and eddies where they feed on epipelagic animals. Between 7 and 12 years old juveniles migrate from oceanic habitats to neritic zones to continue maturing until adulthood. The neritic zone also provides crucial foraging, inter-nesting and migratory habitat for adult loggerheads (NOAA, 2012). Recent reviews indicate only two loggerhead nesting aggregations have more than 10,000 females nesting annually. Intermediate sized nesting aggregations occur in the US, Mexico, Brazil, the Cape Verde Islands and Western Australia (US Fish & Wildlife, 2012). The primary threat to loggerhead populations is incidental capture in marine fisheries gear (NOAA, 2012). The species is listed under Appendix I CITES and under Appendices I and II of the CMS, and is listed as 'Endangered' on the IUCN Red List (IUCN, 2015).

Leatherback Turtle (Dermochelys coriacea)

The leatherback turtle is the largest marine turtle, with the largest specimen recorded at 256.5 cm (Márquez, 1990). The body is large and spindle shaped, with a leathery, unscaled carapace. The colour is essentially black with scattered white patches (Márquez, 1990). Adult leatherbacks are adapted to colder water due to their protective thick and oily skin. Therefore the species is more widely distributed, with numerous records from higher latitudes in waters between 10°C and 20°C (Márquez, 1990). Leatherback turtles nest on sandy beaches in tropical waters, with hatchlings remaining in warm tropical coastal waters until they are more than

100 cm in length. As adults leatherbacks are pelagic, ranging widely in the open ocean although they will often forage in coastal habitats also (Sarti Martinez, 2000; NOAA, 2012). Leatherbacks are carnivorous, feeding on jellyfish and other soft-bodied animals. They are the deepest diving reptile, reaching depths of over 1200 m (Spotila, 2004) although in temperate regions dives tend to be shallower (McMahon & Hays, 2006; James et al., 2006). Global population size was estimated to be between 20,000 and 30,000 adult females in 1996, an estimated 78% reduction compared to previous estimations in 1982 (Sarti Martinez, 2000). The largest nesting populations are found within the eastern and western Atlantic and the Caribbean (Spotila et al., 1996). The species is listed under Appendix I of both CITES and CMS, and are listed as 'Vulnerable' on the IUCN Red List (IUCN, 2015).

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