Environmental Evaluation

International Ocean Discovery Program Expedition 369 from the R/V *JOIDES Resolution* off Western Australia, September–November 2017

Prepared for

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LIST OF ACRONYMS

~	approximately
asl	above sea level
dB	decibels
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMR	Commonwealth Marine Reserve
DPS	Distinct Population Segment
EE	Environmental Evaluation
EEZ	Exclusive Economic Zone
EPBC	Environmental Protection and Biodiversity Conservation (Act)
ESA	(U.S.) Endangered Species Act
GoM	Gulf of Mexico
Hz	Hertz
IFAW	International Fund for Animal Welfare
IODP	International Ocean Discovery Program
IOS	Indian Ocean Sanctuary
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
JRSO	JOIDES Resolution Science Operator
L-DEO	Lamont-Doherty Earth Observatory of Columbia University
m	meter
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
NMFS	(U.S.) National Marine Fisheries Service
NSF	National Science Foundation
OBIS	Ocean Biogeographic Information System
PEIS	Programmatic Environmental Impact Statement
pk	peak
PSO	Protected Species Observer
ROD	Record of Decision
rms	root-mean-square
SEL	sound exposure level
SPL	sound pressure level
TAMU	Texas A&M University
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
U.S.	United States of America
USIO	United States Implementing Organization
USGS	U.S. Geological Survey
VSP	Vertical Seismic Profiling
WCMC	World Conservation Monitoring Centre

1. INTRODUCTION

The International Ocean Discovery Program (IODP) is an international research program that explores the history and structure of the earth as recorded in seafloor sediments and rocks. Within the structure of the IODP, the United States (U.S.) is responsible for operating the riserless drilling vessel *JOIDES Resolution*, with funding from the National Science Foundation (NSF). Texas A&M University (TAMU) has been selected by NSF to be the IODP *JOIDES Resolution* Science Operator (IODP-JRSO). Before October 2014, the science operator was known as the United States Implementing Organization (USIO). In June 2008, USIO-IODP prepared a Programmatic Environmental Impact Statement (PEIS) for its IODP operations and issued a Record of Decision (ROD) on 30 June 2008. Additionally, in June 2011, NSF and the U.S. Geological Survey (USGS) issued a Final Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey (NSF and USGS 2011), and NSF issued the associated ROD in June 2012 (NSF 2012); both documents are referred to herein as the NSF/USGS PEIS.

IODP-JRSO proposes to core, log, and drill at up to 8 sites (3 primary and 5 alternate) at water depths 850–3120 m in the area ~33.0–34.0°S, 112.4–114.5°E off the west coast of Western Australia (Fig. 1) during the Australia Cretaceous Climate and Tectonics Expedition 369 from 26 September to 26 November 2017. A 9th proposed drill site is located at a water depth of 3035 m off the south coast of Western Australia at ~34ºS, 128ºE (Fig. 1). The study area is located in the southeastern Indian Ocean, within the exclusive economic zone (EEZ) of Australia, but outside of territorial waters. This document is an evaluation of the vertical seismic profiling (VSP) that is planned at the 8 sites off the west coast of Western Australia (no seismic surveys are proposed, and no VSP is planned for the site off the south coast) with a view to assessing whether there are any extraordinary circumstances associated with the activity and if any additional mitigation procedures could be required to meet Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) requirements.

According to the Commonwealth of Australia (2012), 42 cetacean species occur in the South-west Marine Region of Australia; 33 of these occur there regularly, and the other 9 species occur there infrequently. A total of 39 of the 42 cetaceans (29 odontocetes and 10 mysticetes) and 6 pinnipeds (see following paragraph) could be encountered near the proposed drill sites off Western Australia (Appendix A). Five of the 45 species are listed under the U.S. ESA as ***Endangered***: the southern right (*Eubalaena australis*), fin (*Balaenoptera physalus*), sei (*B. borealis*), blue (*B. musculus*), and sperm (*Physeter macrocephalus*) whales. An additional 9 marine mammal species that occur in Australia, including 4 of the species listed by the Commonwealth of Australia (2012) for the South-west Marine Region of Australia, are extremely unlikely to be encountered near the proposed drill sites and are not discussed further. They occur in (1) more southerly waters of Australia or its Antarctic Territory (spectacled porpoise *Phocoena dioptrica* and hourglass dolphin *Lagenorhynchus cruciger*); (2) more northerly waters (Longman's beaked whale *Indopacetus pacificus*, Fraser's dolphin *Lagenodelphis hosei*, rough-toothed dolphin *Steno bredanensis*, Australian humpback dolphin *Sousa sahulensis*, Australian snubfin dolphin *Orcaella heinsohni*, and dugong *Dugong dugon*); or (3) only shallow, coastal waters (Indo-Pacific bottlenose dolphin *Tursiops aduncus*). Although strandings of spectacled porpoise have been reported for Tasmania and South Australia, these records are associated with anomalies in water temperature (Evans et al. 2001). One stranding of Fraser's dolphin has also been reported for Western Australia (Groom and Coughran 2012b). It is uncertain whether the spade-toothed beaked whale (*Mesoplodon traversii*) occurs in Australia; thus, it is also not discussed further.

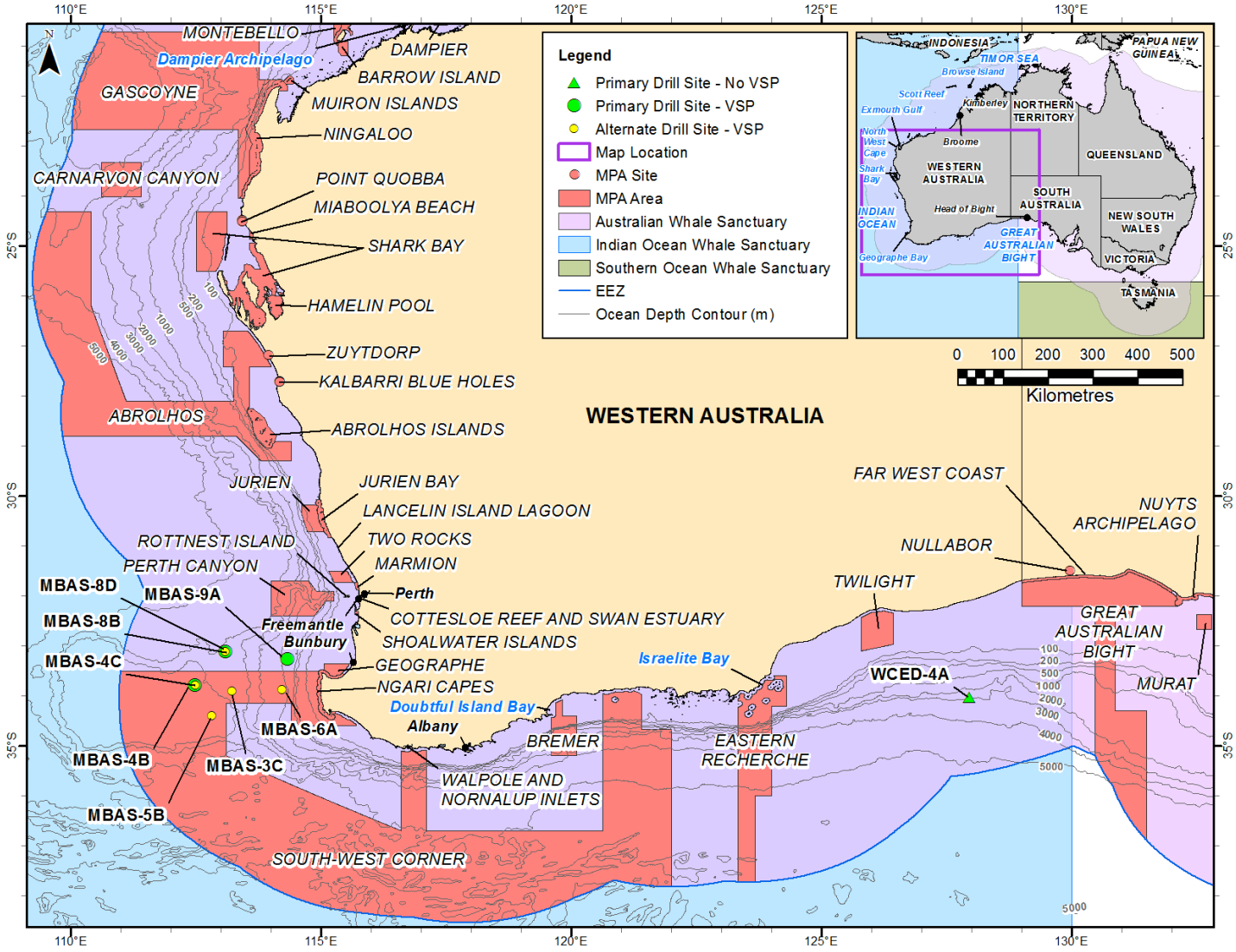

FIGURE 1. Proposed drill sites for IODP-JRSO Expedition 369 off Western Australia during September–November 2017, with locations of marine protected areas (MPAs) shown. Further information on MPAs can be found in Appendix A.

Ten species of pinnipeds are known to occur in Australian waters (Commonwealth of Australia 2016). Of these, 3 are commonly found in southern Australian waters: the Australian sea lion (*Neophoca cinerea*), New Zealand fur seal (*Arctocephalus forsteri*), and Australian fur seal (*A. pusillus*); the Australian fur seal only occurs in southeastern Australia and is not discussed further. The other 7 species occur in Australia's Antarctic Territory, although vagrants of the southern elephant seal (*Mirounga leonina*), leopard seal (*Hydrurga leptonyx*), crabeater seal (*Lobodon carcinophagus*), and Subantarctic fur seal (*A. tropicalis*) have been reported for the mainland of Australia. The Antarctic fur seal (*A. gazelle*), Weddell seal (*Leptonychotes weddellii*), and Ross seal (*Ommatophoca rossii*) will not be discussed further, as they are rarely reported outside of Australia's Antarctic Territory. Six pinniped species—2 from southern Australia and 4 from Australia's Antarctic Territory—are described in Appendix A.

In addition to ESA-listed marine mammal species, 3 ESA-listed sea turtle species could occur near the proposed drill sites, including the ***Endangered*** leatherback turtle (*Dermochelys coriacea*) and the ***Threatened*** loggerhead turtle (*Caretta caretta*; Southeast Indo-Pacific Ocean DPS) and green turtle (*Chelonia mydas;* East Indian-West Pacific DPS). The ***Endangered*** hawksbill (*Eretmochelys imbricata*), ***Threatened*** olive ridley (*Lepidochelys olivacea*), and flatback (*Natator depressus*) turtles likely do not occur near the proposed drill sites, but have been reported in the region as vagrants. No ESA-listed sea snakes occur in the South-west Marine Region. It is possible, although unlikely, that one ESA-listed seabird species, the ***Endangered*** Amsterdam albatross (*Diomedia amsterdamensis*), could be encountered near the drill sites off the coast of Western Australia.

Marine mammals, sea turtles, and seabirds that could be found near the proposed drill sites are described in Appendix A.

2. VSP Details and Mitigation Measures

2.1 Airgun Size and Configuration

The airgun source that would be used for VSP during the proposed expedition is made up of two 250-in^3 Sercel G guns in parallel cluster 1 m apart, attached to a buoy and suspended from the aft port crane ~15 m from the ship at a depth of 2–7 m. In IODP VSP operations, a downhole tool containing a geophone is anchored against the borehole wall at regularly spaced intervals to record the acoustic waves generated by the source positioned just below the sea surface. The source would be fired 5–15 times while the geophone is at each depth station, with a minimum shot interval of 18 s. During this expedition, stations would be spaced at 25-m depth intervals. A single G gun would be used during mitigation measures (see below).

2.2 Airgun Source Levels

Airgun Specifications

Energy Source	One or two 250-in^3 G airguns
Source output (downward) (1 × 250 in^3)	0–pk is 3.1 bar-m (229.8 dB re 1 µPa·m$_p$); pk–pk is 6.4 bar-m (236.2 dB re 1 µPa·m$_{p-p}$)
Source output (downward) (2 × 250 in^3)	0–pk is 5.2 bar-m (234.3 dB re 1 µPa·m$_p$); pk–pk is 10.8 bar-m (240.7 dB re 1 µPa·m$_{p-p}$)
Deployment depth of energy source	2–7 m
Air discharge volume	250 or 500 in^3
Dominant frequency components	0–256 Hz

The rms[1] (root mean square) received levels that are used as impact criteria for marine mammals are not directly comparable to the peak (p or 0–p) or peak to peak (p–p) values normally used to characterize source levels of airgun arrays. The measurement units used to describe airgun sources, peak or peak-to-peak decibels, are always higher than the "root mean square" (rms) decibels referred to in biological literature. For example, a measured received level of 160 dB re 1 μPa_{rms} in the far field would typically correspond to ~170 dB re 1 μPa_{p} and ~176–178 dB re 1 $\mu Pa_{p\text{-}p}$, as measured for the same pulse received at the same location (Greene 1997; McCauley et al. 1998, 2000). The precise difference between rms and peak or peak-to-peak values depends on the frequency content and duration of the pulse, among other factors. However, the rms level is always lower than the peak or peak-to-peak level for an airgun-type source. Using the approximations given above, the maximum rms sound level at the source in a downward direction would be ~226 dB re 1 $\mu Pa \cdot m$ for the G-gun cluster and ~220 dB re 1 $\mu Pa \cdot m$ for one G gun.

2.3 Exclusion Zones for Marine Mammals, Sea Turtles, and Endangered Species

In July 2016, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) released new technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (NMFS 2016). The new guidance established new thresholds for permanent threshold shift onset, or Level A Harassment (injury), for marine mammal species. The new guidance incorporates marine mammal auditory weighting functions and dual metrics of cumulative sound exposure level (SEL_{cum}) and peak sound level. The new guidance, however, did not alter the current threshold, 160dB re 1μPa_{rms}, for Level B Harassment (behavior).

During the planning phase, mitigation zones for the proposed seismic source were calculated based on modeling by Lamont-Doherty Earth Observatory of Columbia University (L-DEO). Received sound levels have been modeled for a number of airgun configurations, including two 250-in^3 G airguns and one 250-in^3 G gun, in relation to distance and direction from the source. This modeling approach uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). In addition, propagation measurements of pulses from the research vessel (R/V) *Marcus G. Langseth's* 36-airgun array at a tow depth of 6 m have been reported in deep water (~1600 m), intermediate-water depth on the slope (~600–1100 m), and shallow water (~50 m) in the Gulf of Mexico (GoM) in 2007–2008 (Tolstoy et al. 2009; Diebold et al. 2010).

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

[1] The rms (root mean square) pressure is an average over the pulse duration.

from the maximum SPL through the entire water column at varying distances from the source array—is the most relevant. The results are summarized below.

In deep water, comparisons at short ranges between sound levels for direct arrivals recorded by the calibration hydrophone and model results for the same array tow depth are in good agreement (Fig. 12 and 14 in Appendix H of the NSF/USGS PEIS). As a consequence, the L-DEO model can reliably predict isopleths falling within this domain, although they could be imperfectly sampled by measurements recorded at a single depth. At larger distances, the calibration data show that seafloor-reflected and sub-seafloor-refracted arrivals dominate, whereas the direct arrivals become weak and/or incoherent (Fig. 11, 12, and 16 in Appendix H of the NSF/USGS PEIS). Aside from local topography effects, the region around the critical distance (~5 km in Fig. 11 and 12, and ~4 km in Fig. 16 in Appendix H of the NSF/USGS PEIS) is where the observed levels rise very close to the mitigation model curve. However, the observed sound levels are found to fall almost entirely below the mitigation model curve (Fig. 11, 12, and 16 in Appendix H of the NSF/USGS PEIS). Thus, analysis of the GoM calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for estimating mitigation radii.

The NSF/USGS PEIS describes the procedures for operations for which incidental take of marine mammals is not anticipated or authorized for low-energy sources. A low-energy source is defined as any towed acoustic source whose received level is ≤180 dB (the Level A threshold under the former NMFS acoustic guidance) at 100 m, including a single pair of clustered airguns with individual volumes of ≤250 in^3 and any single airgun with a volume ≤425 in^3. In § 2.4.2 of the NSF/USGS PEIS, Alternative B (the Preferred Alternative) conservatively applies a 100-m exclusion zone for all low-energy acoustic sources in water depths >100 m. Under the no-take scenario, shut downs would occur at the Level B zone, 160 dB re 1$\mu Pa_{rms,}$ which as noted above, was not affected by the new guidance released by NMFS. However, no fixed 160-dB zones were defined for the same suite of low-energy sources in the NSF/USGS PEIS; therefore, L-DEO model results are used here to determine the 160-dB radii in deep and intermediate-water for the two 250-in^3 G-gun cluster and the single 250-in^3 G gun. Specifically, the radii for intermediate-water depths are derived from the deep-water (>1000 m) ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (Fig. 16 in Appendix H of the NSF/USGS PEIS).

The deep-water L-DEO model results are shown as SEL in decibels (dB) re 1 $\mu Pa^2 \cdot s$ for the two 250-in^3 G-airgun cluster (Fig. 2) and the single 250-in^3 G airgun (Fig. 3). The proposed expedition off Western Australia would acquire VSP data at up to 8 drill sites in water depths 850–3120 m. The mitigation distances provided in Table 1 are for a 7-m cluster or single gun depth, which is the deepest of the depths that could be used (2–7 m). With a deeper source, the sound level is greater at a given distance. Therefore, using the deepest source depth is a conservative criterion because the distances to various sound levels overestimate the distances for the cluster if it is deployed at a shallower depth.

SEL is a measure of the received energy in the pulse and represents the SPL that would be measured if the pulse energy were spread evenly across a 1-s period. Because actual seismic pulses are less than 1 s in duration in most situations, this means that the SEL value for a given pulse is usually lower than the SPL calculated for the actual duration of the pulse (see Appendix H of the NSF/USGS PEIS). The advantage of working with SEL is that the SEL measure accounts for the total received energy in the pulse, and biological effects of pulsed sounds are believed to depend mainly on pulse energy (Southall et al. 2007). In contrast, SPL for a given pulse depends greatly on pulse duration. A pulse with a given SEL can be long or short depending on the extent to which propagation effects have "stretched"

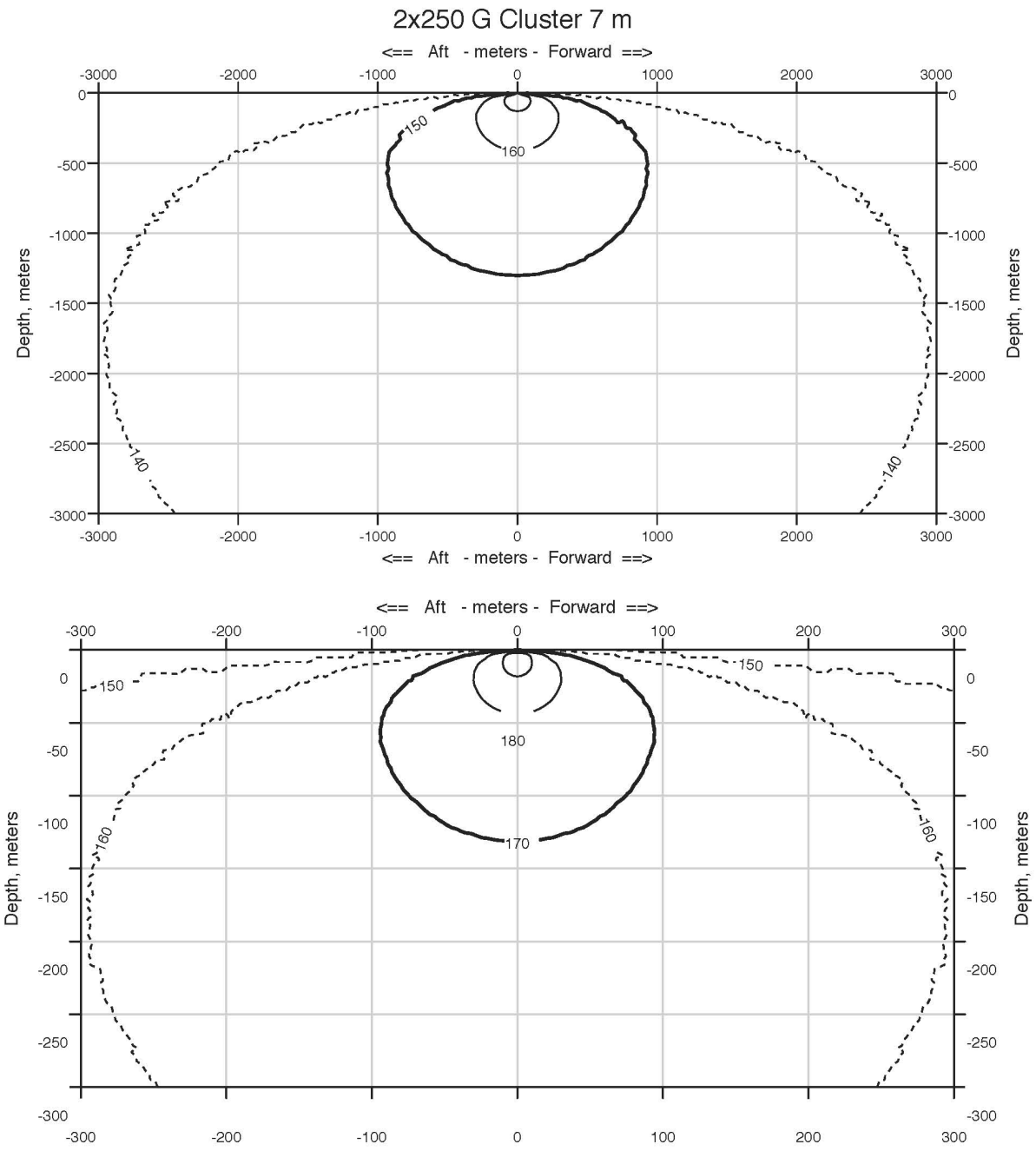

FIGURE 2. Modeled received sound levels from the two 250-in^3 G-gun cluster that would be used for VSP operations at the drill sites during IODP-JRSO Expedition 369 off Western Australia, September–November 2017, shown in cross-section. Scale is different in the two panels. Model results provided by L-DEO in SEL, so the 150-dB contour in the upper panel is 160 dB rms (see text), the shut-down threshold for VSP operations.

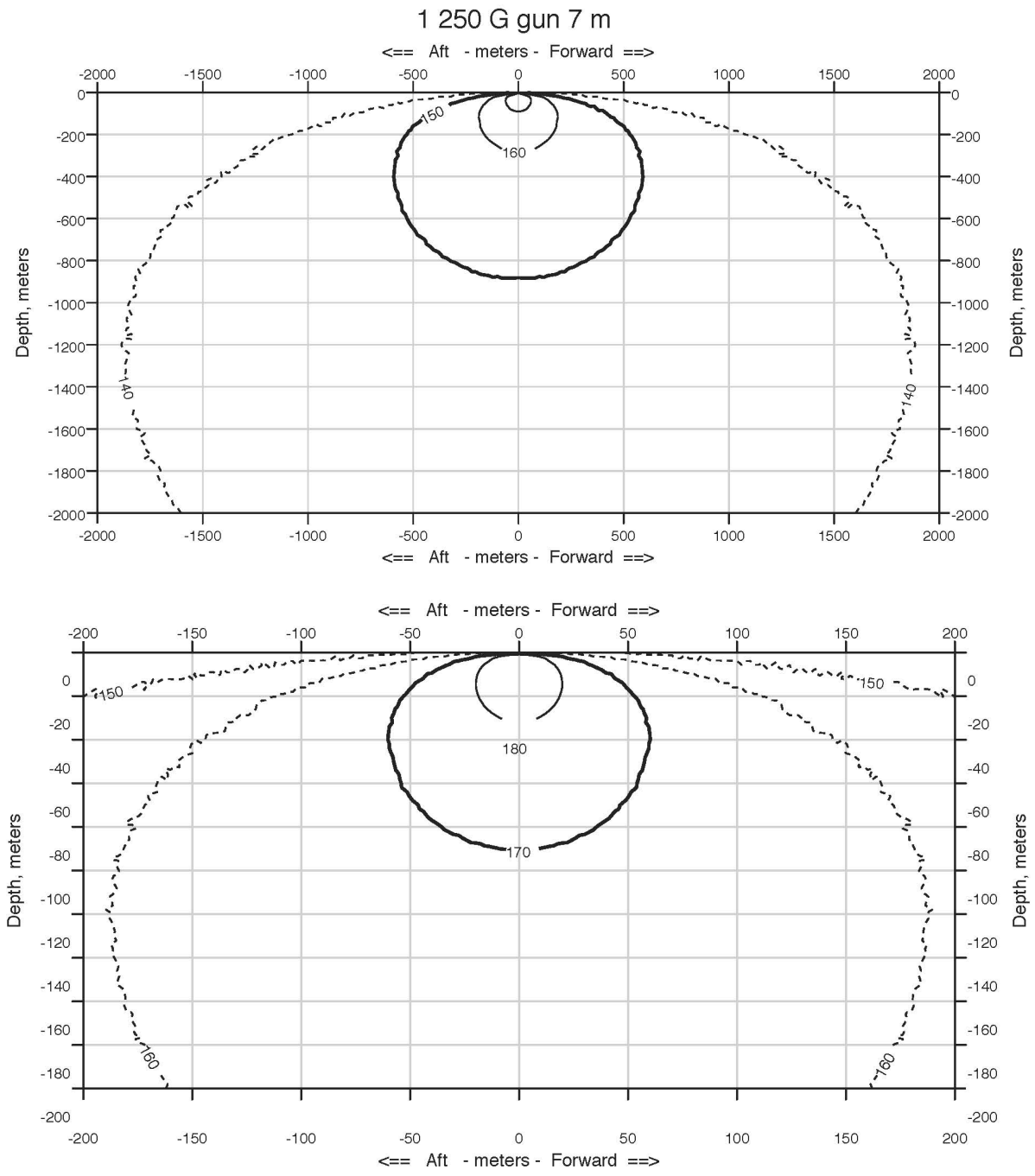

FIGURE 3. Modeled received sound levels from the one 250-in^3 G gun that would be used for ramp up for VSP operations at the drill sites during IODP-JRSO Expedition 369 off Western Australia, September–November 2017, shown in cross-section. Scale is different in the two panels. Model results provided by L-DEO in SEL, so the 150-dB contour in the upper panel is 160 dB rms (see text), the shut-down threshold for VSP operations.

the pulse duration. The SPL will be low if the duration is long and higher if the duration is short, even though the pulse energy (and presumably the biological effects) are the same.

Although SEL is now believed to be a better measure than SPL when dealing with biological effects of pulsed sound and is incorporated into NMFS' new guidance for Level A thresholds, SPL is a measure that has been commonly used in studies of marine mammal reactions to airgun sounds and is still used by NMFS concerning Level B take. SPL is often referred to as rms pressure, averaged over the pulse duration. As noted above, the rms received levels that are used as impact criteria for marine mammals are not directly comparable to pulse energy (SEL). At the distances where rms levels are 160–190 dB re 1 µPa, the difference between the SEL and SPL values for the same pulse measured at the same location usually average ~10–15 dB, depending on the propagation characteristics of the location (Greene 1997; McCauley et al. 1998, 2000; Appendix H of the NSF/USGS PEIS). In this document, we assume that rms pressure levels of received seismic pulses will be 10 dB higher than the SEL values predicted by L-DEO's model. Thus, we assume that 170 dB SEL ≈ 180 dB re 1 μPa_{rms}.

Table 1 shows the distances at which the Level B sound levels are expected to be received for the G-gun cluster and single G gun in deep and intermediate-water depths, and the fixed 100-m Level A distance per the NSF/USGS PEIS. During seismic operations, the seismic sources would be shut down immediately when marine mammals or sea turtles are detected within or about to enter the Level B zone (160-dB re 1 μPa_{rms}). The Level B shut-down criterion is considerably more conservative (precautionary) than the Level A shut-down criteria that have been previously used for cetaceans and pinnipeds, respectively, by NMFS (2000) and more recent NMFS (2016) guidelines. As shut downs of the seismic source would occur before any behavioral or physical impacts could occur, the proposed activities are not expected to affect marine mammals and "takes" are not anticipated. The fixed 100-m Level A threshold would be used as the exclusion zone for diving or foraging ESA-listed seabirds, as has been used during previous seismic surveys. Table 2 summarizes information about the drill sites, including the applicable Level B zone.

2.4 Protected Species Observers

Protected species observers (PSOs) would watch for marine mammals, sea turtles, and diving ESA-listed seabirds. PSOs would be a Ship's Officer (Mate on watch), a Laboratory or Assistant Laboratory Officer, or a marine technician. At least two PSOs would monitor the Level B zone during seismic operations, normally working in shifts of 4-h duration or less. The vessel crew would also be instructed to assist in detecting marine mammals and sea turtles. IODP PSOs are supervised by Brad Julson, Supervisor of Technical Support. Mr. Julson received his B.S. in aquatic biology from UC Santa Barbara. Before starting with scientific ocean drilling, he underwent a 3-week PSO training program and worked as a marine mammal observer for three years out of the NMFS Southwest Fisheries Science Center in La Jolla, CA. Mr. Julson trains each of the PSOs and runs a briefing session specific to the species identified in this EE prior to the start of each operation.

The *JOIDES Resolution* is a suitable platform for marine mammal, sea turtle, and seabird observations. The forward observer (Mate on watch) would be stationed on the bridge deck, with eye level ~14.5 m above sea level (asl). The aft observer (Laboratory or Assistant Laboratory Officer or a marine technician) would be stationed on the helideck, with eye level ~12 m asl. Figure 4 indicates the approximate position of each observer. All seismic activities would be conducted during daytime. The PSO(s) would scan the area around the vessel systematically with reticle binoculars (e.g., 7×50 Fujinon), deck-mounted Big-Eye (25×150) binoculars, and the naked eye.

TABLE 1. Radii distances of the Level A and B (160 dB re 1 μPa_{rms}) zones received from the one or two 250-in^3 G airguns that would be used for VSP operations during IODP-JRSO Expedition 369 off Western Australia, September–November 2017. Level B distances are based on model results provided by L-DEO in SEL converted to rms by adding 10 dB (see text) and is the shut-down threshold for VSP operations. The Level A distance is the conservative exclusion zone for all low-energy acoustic sources in water >100 m deep defined in the NSF/USGS PEIS.

Airgun(s) at a 7-m tow depth	Water Depth (m)	Level B Modeled Radii Distances (m)	Level A Radii Distances (m)
Two 250-in^3 G airguns	100–1000	1410[1]	141[1,2]
Two 250-in^3 G airguns	>1000	940	100
One 250-in^3 G airgun	100–1000	900[1]	100
One 250-in^3 G airgun	>1000	595	100

[1] Distance is based on L-DEO model results with a 1.5 x correction factor between deep and intermediate water depths.

[2] The modeled distance exceeds the fixed 100-m Level A zone in intermediate water.

TABLE 2. Summary of information on drill sites for the proposed IODP-JRSO Expedition 369 off Western Australia, September–November 2017.

Site	Location	Water depth (m)	Level B Exclusion Zone (m)
Primary			
WCED-4A*	34.027ºS, 127.963ºE	3035	N.A.
MBAS-8D	33.121ºS, 113.091ºE	2990	940
MBAS-4B	33.797ºS, 112.469ºE	2790	940
MBAS-9A	33.270ºS, 114.322ºE	850	1410
Alternate			
MBAS-8B	33.119ºS, 113.091ºE	2990	940
MBAS-4C	33.793ºS, 112.486ºE	2790	940
MBAS-6A	33.883ºS, 114.225ºE	1200	940
MBAS-3C	33.913ºS, 113.212ºE	3120	940
MBAS-5B	34.399ºS, 112.817ºE	2700	940

* No VSP is planned for this site. N.A. = not applicable. Note: Operations are planned using two airguns. If a single airgun is used, the zone for the single G airgun indicated in Table 1 would be used.

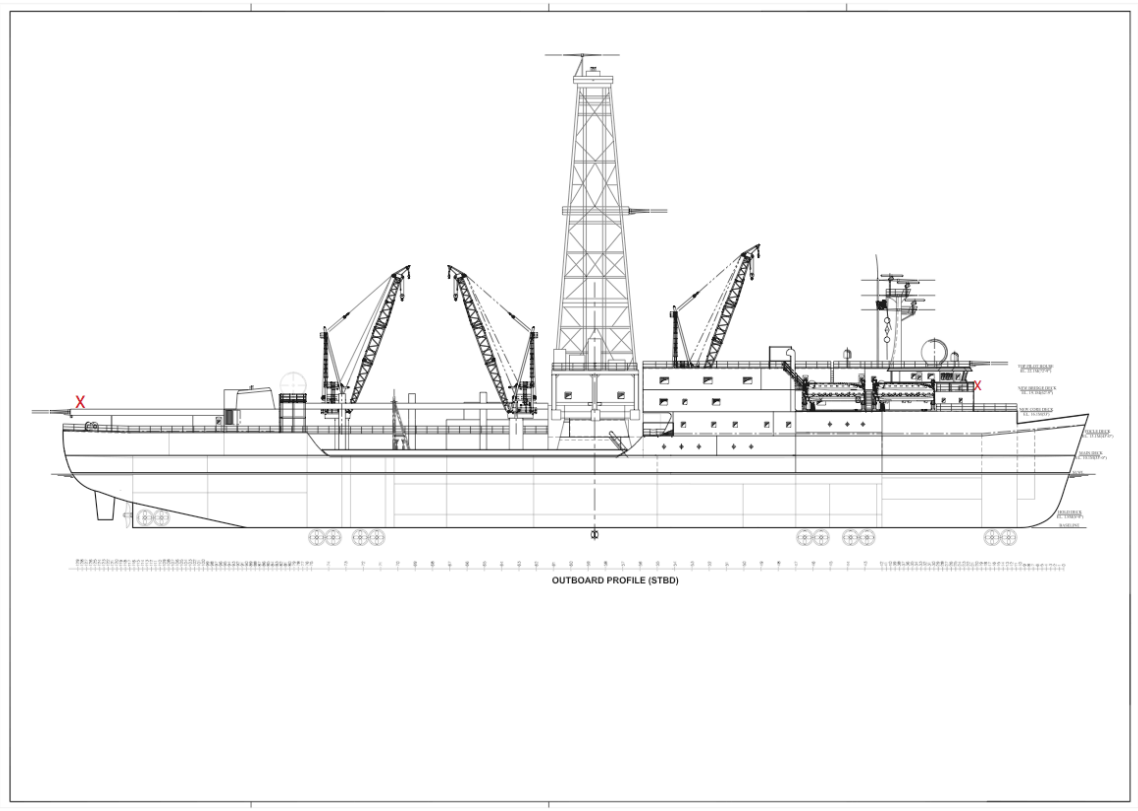

FIGURE 4. *JOIDES Resolution*, with positions of the protected species visual observers indicated by red x.

The observers would be in direct or wireless communication with ship's officers on the bridge and scientists in the vessel's operations laboratory, so they could advise promptly of the need for seismic source shut down. One hour before the use of seismic sources, the PSOs would begin observations for marine mammals, sea turtles, and ESA-listed seabirds. Observations would continue until the seismic operations are completed.

2.5 Times of Day for Seismic Operations

A VSP could be obtained at all 8 drill sites. During the expedition, the stations would be spaced at ~25-m depth intervals. Planned VSP operations would require ~5–10 hrs. All seismic operations would be conducted during daylight hours.

2.6 Ramp-up and Shut-down Procedures

Ramp-up procedures

A ramp-up procedure would be followed when the G-gun cluster begins operating after any 30-min period without operations during VSP. Beginning at a pressure of 500 psi, each of the two guns would be fired in succession at 30-sec intervals gradually increasing the pressure to the operational pressure over a ~30-min period. If the complete Level B zone has not been visible for at least 60 min prior to the start of operations, ramp up would not commence. Ramp up of the airguns would not be initiated if a marine mammal or sea turtle is sighted within or near the applicable Level B zone; ramp up would be delayed

until the animal has left the exclusion zone. Additionally, ramp up would not commence if an ESA-listed seabird is seen diving within the Level A zone (100 m).

Shut-down procedures

If a marine mammal or sea turtle is detected outside the Level B zone but is likely to enter it, the seismic source would be shut down before the animal is within the zone. Likewise, if a mammal or turtle is already within the Level B zone when first detected, the seismic source would be shut down immediately. Additionally, a shut down would be implemented if an ESA-listed seabird is seen diving within the Level A zone. All shut downs would be noted in the operational report. Following a shut down, seismic activity would not resume until the marine mammal or turtle has cleared the Level B zone, and no ESA-listed seabirds are observed in the Level A zone. A marine mammal or turtle would be considered to have cleared the Level B zone if it is visually observed to have left the zone or has not been seen within the zone for 60 min.

3. CONCLUSION

This EE assesses the VSP that is planned during the proposed expedition with a view to determine whether there are extraordinary circumstances associated with the activity and if any additional mitigation procedures could be necessary to meet MMPA and ESA requirements. Although several ESA-listed marine mammal and sea turtle species could occur in the area (Appendix A), only blue and sperm whales could be common in the area at the time of the expedition; other ESA-listed species are likely to be uncommon or rare. Humpback whales are also likely to be common in the study area. No critical habitat has been designated for ESA-listed species in the eastern Indian Ocean. The evaluation finds that standard monitoring and mitigation measures (as described in § 2.6) are appropriate and that there are no extraordinary circumstances associated with the activity that would warrant additional measures.

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APPENDIX A:

MARINE SPECIES AND PROTECTED AREAS WITHIN THE STUDY AREA

Commercial whaling severely depleted all the large whale populations in the Indian Ocean, and in 1979, the International Whaling Commission (IWC) declared the Indian Ocean north of 55ºS a whale sanctuary (IFAW 2002). Thus, the proposed expedition area is located within the Indian Ocean Sanctuary (IOS). In a United Nations Environment Programme (UNEP) report, Leatherwood and Donovan (1991) summarized cetacean research in the IOS, and de Boer et al. (2003) compiled sightings for the entire IOS in a report produced by the Whale and Dolphin Conservation Society.

Based on patterns of marine mammal species richness, Kaschner et al. (2011) predicted that marine mammal biodiversity in the Southern Hemisphere would be greatest in temperate waters, particularly south of 30°S. In addition, MacLeod and Mitchell (2006) reported that waters off southwestern Australia (between 32.08–34.54°S and 115.74–118.90°E and as far south as 44.75°S, 109.25°E) are a key area for beaked whales, as one or more species are regularly sighted there.

A total of 39 cetaceans (29 odontocetes and 10 mysticetes) and 6 pinnipeds could occur near the proposed drill sites off Western Australia (Table A-1). Five of the 45 species are listed under the U.S. ESA as ***Endangered***: the southern right, fin, sei, blue, and sperm whales. Under the Environmental Protection and Biodiversity Conservation (EPBC) Act of Australia, the southern right and blue whales are listed as *Endangered*; and the sei and fin whales are listed as *Vulnerable*. Although the humpback whale (*Megaptera novaeangliae*) is also listed as *Vulnerable* under the EPBC Act, the population that comprises the West Australia Distinct Population Segment (DPS) was recently delisted by NMFS (2016a). Biologically important areas have been identified in the South-west Marine Region for humpback, pygmy blue, southern right, and sperm whales. The Subantarctic fur seal, Australian sea lion, and southern elephant seal are all listed as *Vulnerable* under the EPBC Act. Information on the occurrence near the proposed drill sites in September–November, habitat, and conservation status for each of the 45 marine mammal species is presented in Table A-1.

In addition to ESA-listed marine mammal species, three ESA-listed sea turtles could also occur near the proposed drill sites, including the ***Endangered*** leatherback turtle and the ***Threatened*** loggerhead (Southeast Indo-Pacific Ocean DPS) and green (East Indian-West Pacific DPS) turtles. The ***Endangered*** hawksbill (*Eretmochelys imbricata*) and ***Threatened*** olive ridley (*Lepidochelys olivacea*) turtles are unlikely to occur near the proposed drill sites. Under the EPBC Act, the green and hawksbill turtles are listed as *Vulnerable*, and the leatherback, loggerhead, and olive ridley turtles are listed as *Endangered*. No ESA-listed sea snake species occur in the South-west Marine Region. It is possible, although unlikely, that one ESA-listed seabird species, the ***Endangered*** Amsterdam albatross, could be encountered near the drill sites off the coast of Western Australia.

Marine Protected Areas

The proposed drill sites are located within the Australian Whale Sanctuary and the IOS. Commercial whaling is prohibited in the IOS and adjacent waters (Commonwealth of Australia 2016b; IWC 2016a). The Australian Whale Sanctuary is year-round, seasonal or migratory habitat for ~44 species of cetaceans and provides protection for those species within Australian waters; it includes the entire EEZ of Australia as well as external territories (Commonwealth of Australia 2016c). Cetaceans are also protected in all state and territorial waters within 3 n.mi. of shore (Commonwealth of Australia 2016c). All whales, dolphins, and porpoises are protected under the EPBC Act 1999 (Commonwealth of

TABLE A-1. Habitat, occurrence and conservation status of marine mammals that could occur near the drill sites off Western Australia, during September–November 2017.

Species	Occurrence	Habitat	EPBC Act[1]	U.S. ESA[2]	IUCN[3]	CITES[4]
Mysticetes						
Southern right whale	Rare	Coastal	EN, MI	EN	LC	I
Pygmy right whale	Rare	Pelagic, coastal	MI	NL	DD	I
Humpback whale	Common	Pelagic, coastal	VU, MI	NL	LC	I
Dwarf minke whale	Common	Pelagic, coastal	NCA	NL	LC	I
Antarctic minke whale	Common?	Pelagic, coastal	MI	NL	DD	I
Bryde's whale	Common	Pelagic, coastal	MI	NL	DD	I
Omura's whale	Rare	Shelf, coastal	NCA	NL	DD	I
Sei whale	Uncommon	Pelagic, coastal	VU, MI	EN	EN	I
Fin whale	Uncommon	Pelagic, coastal	VU, MI	EN	EN	I
Blue whale	Common	Pelagic, shelf, coastal	EN, MI	EN	EN	I
Odontocetes						
Sperm whale	Common	Deep seas, slope	MI, K*	EN	VU	I
Pygmy sperm whale	Uncommon	Shelf, slope	NCA	NL	DD	II
Dwarf sperm whale	Uncommon	Shelf, slope	NCA	NL	DD	II
Cuvier's beaked whale	Uncommon	Deep, steep slope	NCA	NL	LC	II
Arnoux's beaked whale	Rare	Pelagic	NCA	NL	DD	I
Shepherd's beaked whale	Rare	Pelagic	NCA	NL	DD	II
Southern bottlenose whale	Uncommon	Pelagic	NCA	NL	LC	I
Hector's beaked whale	Rare	Pelagic	NCA	NL	DD	II
True's beaked whale	Rare	Pelagic	NCA	NL	DD	II
Gray's beaked whale	Uncommon	Pelagic	NCA	NL	DD	II
Andrew's beaked whale	Rare	Pelagic	NCA	NL	DD	II
Ginkgo-toothed beaked whale	Rare	Pelagic	NCA	NL	DD	II
Strap-toothed beaked whale	Uncommon	Pelagic	NCA	NL	DD	II
Blainville's beaked whale	Uncommon	Pelagic, slope	NCA	NL	DD	II
Common bottlenose dolphin	Uncommon	Pelagic, coastal	NCA	NL	LC	II
Pantropical spotted dolphin	Uncommon?	Pelagic, coastal, slope	MI, NCA	NL	LC	II
Spinner dolphin	Uncommon?	Pelagic, coastal	MI, K*	NL	DD	II
Striped dolphin	Uncommon?	Pelagic, shelf edges	NCA	NL	LC	II
Short-beaked common dolphin	Uncommon?	Pelagic, coastal	NCA	NL	LC	II
Long-beaked common dolphin	Uncommon?	Coastal	NCA	NL	DD	II
Dusky dolphin	Rare	Pelagic	MI	NL	DD	II
Southern right whale dolphin	Rare	Pelagic	NCA	NL	DD	II
Risso's dolphin	Common?	Deep slope, seamounts	NCA	NL	LC	II
Melon-headed whale	Uncommon?	Pelagic	NCA	NL	LC	II
Pygmy killer whale	Uncommon?	Pelagic	NCA	NL	DD	II
False killer whale	Common?	Pelagic	NCA	NL	DD	II
Killer whale	Common?	Pelagic, coastal	MI	NL	DD	II
Short-finned pilot whale	Common?	Pelagic, shelf, slope	NCA	NL	DD	II
Long-finned pilot whale	Common?	Pelagic, shelf, coastal	NCA	NL	DD	II
Pinnipeds						
Subantarctic fur seal	Rare	Pelagic, coastal	VU	NL	LC	II
New Zealand fur seal	Uncommon	Primarily coastal	NCA	NL	LC	II
Australian sea lion	Uncommon	Primarily coastal	VU	NL	EN	NL
Southern elephant seal	Rare	Pelagic, coastal	VU	NL	LC	II
Crabeater seal	Rare	Pelagic, coastal	NCA	NL	LC	NL
Leopard seal	Rare	Pelagic, coastal	NCA	NL	LC	NL

? Indicates uncertainty.
[1] EPBC Act of Australia (Commonwealth of Australia 2016a) unless noted otherwise. EN = Endangered; VU = Vulnerable; NCA = No Category Assigned; MI = Migratory. * Category K (Insufficiently Known) assigned by Bannister et al. (1996) and Ross (2006).
[2] Endangered Species Act (NMFS 2016b). EN = Endangered; NL = Not listed.
[3] Codes for IUCN classifications (IUCN 2016): EN = Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient.
[4] Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2016): Appendix I = Threatened with extinction; Appendix II = Not necessarily now threatened with extinction but may become so unless trade is closely controlled; NL = Not Listed.

Australia 2016a); under the EPBC Act it is an offence to kill, injure, or interfere with a cetacean. Activities within the Australian Whale Sanctuary that might affect cetaceans could require a permit (Commonwealth of Australia 2016c). However, the proposed activities are not expected to affect marine mammals because shut downs of the seismic source would occur before any behavioral or physical impacts could occur. As illustrated in Figure 1, there are numerous marine protected areas (MPAs) off southwestern Australia (Wood 2007; Hoyt 2011; Government of South Australia 2014; Commonwealth of Australia 2016d; IUCN and UNEP-WCMC 2016). Four of those are located within 100 km of the drill sites (Table A-2). One primary (MBAS-4B) and four alternate (MBAS-3C, -4C, -5B, -6A) drill sites are located within the South-west Corner Commonwealth Marine Reserve (CMR). Ngari Capes Marine Park and Geographe CMR are located ~60 km east of primary drill site MBAS-9A and alternate drill site MBAS-6A. Perth Canyon CMR is located ~95 km north of primary drill site MBAS-9A.

The marine bioregional plan for the South-west Marine Region aims to aid in biodiversity conservation and marine resource management (Commonwealth of Australia 2012a). In addition, a management plan is being prepared for the South-west CMR Network, which includes the South-west Corner CMR (Commonwealth of Australia 2016d). Previously approved activities are permitted within the CMR while the management plan is being prepared; these activities include mining operations, commercial fishing, recreational fishing, commercial tourism, commercial vessel transit, aquaculture, commercial media activities, commercial image capture, erecting structures, carrying out works, and carrying on excavation. The management plan will adopt a zoning scheme, including a Multiple Use Zone in which primary drill site MBAS-4B and alternate drill sites MBAS-3C, MBAS-4C, and MBAS-5B are located; research and mining operations would be allowed in this zone, along with most other activities. Alternate drill site MBAS-6A is located in the Special Purpose Zone (Oil & Gas Exclusion); research would be allowed in this zone, but mining operations, including exploration, development, and other activities, would not be permitted.

Marine Reptiles

Of the marine turtles, the green, loggerhead, and leatherback turtles are known to occur in the South-west Marine Region of Australia (Commonwealth of Australia 2012b). The leatherback and loggerhead turtles are listed under the EPBC Act as *Endangered*, whereas the green turtle is listed as *Vulnerable*; they are all listed as migratory species (Commonwealth of Australia 2012b). None of these species nest along the coast of southwestern Australia, but nesting sites for green and loggerhead turtles are located along the northwest coast (Marsh et al. 1994; Commonwealth of Australia 2012b; SWOT 2016). Hatchlings from the northern nesting sites are dispersed to the South-west Marine Region via currents that flow along the coast (Commonwealth of Australia 2012b). However, the extent of use of the South-west Marine Region is uncertain (Commonwealth of Australia 2012b).

Table A-2. Summary of Marine Protected Areas (MPAs) within 100 km of the proposed drill sites off Western Australia.

MPA Name	Major Conservation Values and Protected Species	Marine Area (km^2)	Location[1]		Source
			Lat. (°S)	Long. (°E)	
Perth Canyon CMR	Globally important seasonal feeding aggregation area for blue whale. Foraging area for sperm whale, soft-plumaged petrel, and wedge-tailed shearwater. Migratory area for humpback whale. Diverse demersal slope fish communities and meso-scale eddies (high productivity & feeding).	7,431	32.1	114.5	2, 3
Geographe CMR	Foraging area for soft-plumaged petrel and wedge-tailed shearwater. Pre-migration aggregation area for migratory flesh-footed shearwater. Migratory habitat for humpback and blue whales. High benthic productivity, biodiversity, feeding, nesting, breeding and nursery aggregations. Habitat for western rock lobster and seagrass.	977	33.5	115.3	2, 3
Ngari Capes Marine Park	Coral reefs & the *HMAS Swan* shipwreck. Migratory habitat for humpback, southern right, and blue whales. Habitat for dhufish, salmon, blue groper, snapper, tailor, skippy, western rock lobster, and abalone.	1,234	34.0	115.1	3, 4
South-West Corner CMR	Migratory area for humpback and blue whales. Foraging area for migratory sperm whale, Australian sea lion, white shark, Indian yellow-nosed albatross, soft-plumaged petrel, flesh-footed and short-tailed shearwaters, and Caspian tern. Seasonal calving habitat for southern right whale. Protects Albany Canyon group (high productivity, feeding aggregations), Cape Mentelle upwelling (high productivity), and Diamantina Fracture Zone and Naturaliste Plateau (support deepwater communities, high species diversity, and endemism). Protects western rock lobster habitat (species with important ecological role) and Commonwealth marine environment surrounding Recherche Archipelago (high biodiversity, breeding, and resting aggregations, including most extensive areas of reef on shelf within South-west Marine Region).	272,448	36.8	118.4	2, 3

[1] Location presented as approximate central coordinates for each MPA, in decimal degrees (WGS84).
[2] Commonwealth of Australia (2016d).
[3] IUCN and UNEP-WCMC (2016).
[4] Department of Parks and Wildlife (2014).

The leatherback turtle is occasionally sighted at sea off southwestern Australia (Commonwealth of Australia 2012b; Limpus 2009). The South-west Marine Region is an important feeding area, where leatherbacks are known to forage in the Leeuwin and West Australian currents (Commonwealth of Australia 2012b). Leatherback bycatch in fisheries have been reported for the proposed expedition area (Riskas et al. 2016). Loggerhead turtles are one of the most frequently sighted turtle species in coastal waters of the South-west Marine Region, which is considered to be a nesting migration pathway (Commonwealth of Australia 2012b). Resident turtles are known to occur in the Perth region (Commonwealth of Australia 2012b). Green turtles regularly occur in the South-west Marine Region; foraging juveniles as well as adults have been sighted around Rottnest Island off Perth (Commonwealth of Australia 2012b).

Although there are nesting sites of olive ridley, hawksbill, and flatback turtles on the northern or northwestern coasts of Australia (Marsh et al. 1994; SWOT 2016), these species are unlikely to be encountered near the proposed drill sites as they are only known to occur infrequently in the South-west Marine Region (Commonwealth of Australia 2012b). Nonetheless, hawksbill and flatback turtles have stranded along the southwest coast of Australia, but are considered vagrants in the region (Prince and Crane 1996). Olive ridley turtles are listed as *Endangered* under the EPBC, whereas the flatback and hawksbill turtles are listed as *Vulnerable*; all 3 turtles are listed as migratory (Commonwealth of Australia 2012b).

The yellow-bellied sea snake (*Pelamis platurus*) is pelagic and may occur in the South-west Marine Region (Commonwealth of Australia 2012b). There are numerous records of these snakes washed ashore along the coast of Western Australia (Commonwealth of Australia 2012b). Other species that could infrequently be carried down to the South-west Marine Region by currents include the elegant (*Hydrophis elegans*), spotted (*H. ocellatus*), olive-headed (*Disteira major*), and Shark Bay (*Aipysurus pooleorum*) seasnakes (Commonwealth of Australia 2012b).

Seabirds

The Amsterdam albatross could occur infrequently in the South-west Marine Region; it is listed as *Endangered* as the EPBC Act (Commonwealth of Australia 2012c). Non-breeding adults were tracked to waters of the Naturaliste Plateau (~112°E) near the proposed drill sites off the west coast of Australia, and at least one travelled through the Great Australian Bight as far as the Tasman Sea (Theibot et al. 2014). Some immatures were tracked to southwestern Australia and the Great Australian Bight and occasionally ventured closer to shore over the continental shelf (Theibot et al. 2014). Tracked birds did not show a consistent seasonal pattern; however, the majority of non-breeding adults were found in the eastern part of their range from late November to early February (Theibot et al. 2014).

Marine Mammals

Conservation Listed Species

Mysticetes

Southern Right Whale (*Eubalaena australis*)

The southern right whale is listed as ***Endangered*** under the ESA (NMFS 2016b) and the EPBC Act of Australia (Commonwealth of Australia 2016a). It is listed as ***Least Concern*** on the IUCN Red List of Threatened Species (IUCN 2016), and it is listed in CITES Appendix I (UNEP-WCMC 2016). The

southern right whale occurs throughout the Southern Hemisphere between ~20°S and 60°S (Kenney 2009). In Australia, it is distributed along the southern coastline from Perth, Western Australia, to Sydney, New South Wales, and Tasmania (Bannister et al. 1996; Commonwealth of Australia 2016e); most sightings are concentrated from west of Albany, Western Australia, to the Head of Bight, South Australia (Bannister 2001). Biologically important habitat areas and habitat critical to the survival of the species are located along the south coast of Australia (Allen and Bejder 2003; Commonwealth of Australia 2012d,e).

There are two stocks of southern right whales in Australia: the Southwest and Southeast stocks (Carroll et al. 2011). The main winter calving grounds for the Southwest Stock include Doubtful Bay and east of Israelite Bay, on the south coast of Western Australia; and Head of the Bight, South Australia (Bannister et al. 1996; Commonwealth of Australia 2012e; 2016e). Smaller numbers of calving females are also found at several other areas in Western Australia, including Flinders Bay, Twilight Cove, Albany/Cape Riche, and Yokinup Bay/Cape Arid; and at Encounter Bay and Fowlers Bay in South Australia (Commonwealth of Australia 2012e, 2016e). Along the western and central southern coast, calving females prefer shallow northeast oriented bays over sandy bottoms and are generally found <1 km from shore (Bannister et al. 1996). The Southeast Stock is known to calve in Victoria, mainly near Warrnambool, but numbers of calving females are smaller here than in Western Australia (Commonwealth of Australia 2012e, 2016e). Carroll et al. (2015) showed significant genetic differentiation between the calving grounds. The total Australian population is estimated at ~3500 individuals (Commonwealth of Australia 2012e). Peak abundance along the Australian coast occurs in August–September, but animals are commonly seen from late June to early October (Bannister 2001).

Dawbin (1986) suggested that southern right whales migrate along the south coast of Australia during austral winter along two different paths: north along the east coast of Tasmania and east coast of Australia; and north along the west coast of Tasmania and westward along the south and west coast of Australia. The migration along the south and west coast is known as the 'counter-clockwise' migratory pattern (Burnell 2001). During austral spring, southern right whales then move from the coastal winter calving grounds to offshore summer feeding grounds that are located at higher latitudes (Carroll et al. 2011). The main feeding area for Australian southern right whales is thought to be south of Australia at 40–60°S (Commonwealth of Australia 2012e). Summer feeding concentrations have been sighted ~900 km south of Albany at 42–43°S during December–January (Kato et al. 2007), but they likely occur farther south during February–March (Bannister et al. 1996).

Kasuya and Wada (1991) reported on Japanese sighting records in the southern Indian Ocean during October–April 1965–1985; survey coverage included coastal, shelf, slope, and offshore waters off Western Australia. Within a 5°x5° grid surrounding the expedition area (30–35°S, 110–115°E) off Western Australia, southern right whales were only sighted during November at a sighting rate of 2/10,000 n.mi. surveyed; sighting rates adjacent to the expedition area (in a 5°x5° grid to the northwest) ranged up to 8/10,000 n.mi. surveyed during November. No sightings were made along the south coast of Western Australia, between 30–35°S and 115–130°E.

Allen and Bejder (2003) reported 5 sightings between 1993 and 2002 along the west coast of Australia: 1 in Exmouth Gulf, 2 in Shark Bay, and 2 near Perth. There are 10 distinct southern right whale sighting records in the Australian National Whale and Dolphin Sightings and Strandings Database for Western Australia: 3 to the northeast of the proposed drill sites between 32.2–32.7°S and ~116°E (during August and September), 3 to the southeast of the drill sites between 34–35°S and 118–120°E (during April, August, and September), and 4 on the south coast during August–November at ~34°S and

between 121–123°E (OBIS 2016). Kemper et al. (2008) reported 44 records of right whale mortalities or human interaction events (i.e., entanglements, shootings, vessel collisions) for Australia between 1950 and 2006; records were reported throughout the year except January, with most reports during July–October. Twelve of the 44 events occurred in Western Australia, including strandings and entanglements in fishing gear (Kemper et al. 2008; Groom and Coughran 2012a,b).

The available information suggests that southern right whales could be encountered off Western Australia at the time of the expedition (September–November), although sightings in offshore waters of the study area likely would be rare.

Sei Whale (*Balaenoptera borealis*)

The sei whale is listed as ***Endangered*** under the ESA (NMFS 2016b) and on the IUCN Red List of Threatened Species (IUCN 2016). It is listed as ***Vulnerable*** under the EPBC Act of Australia (Commonwealth of Australia 2016a), and it is listed in CITES Appendix I (UNEP-WCMC 2016). The sei whale migrates from higher latitudes in summer, where most feeding takes place, to temperate zones in winter (Gambell 1985). In the Southern Hemisphere, it migrates into and out of the Antarctic somewhat later than blue and fin whales and does not migrate as far south (Gambell 1985; Horwood 2009).

In the Indian Ocean, sei whales from the Southern Hemisphere winter as far north as 25°S, including the west coast of Australia (Bannister et al. 1996; Rudolph and Smeenk 2009). Sei whales are seen infrequently off Australia, but records exist for Western Australia, Great Australian Bight, Tasmania, and Queensland (Bannister et al. 1996). Sei whales have also been seen off southern Australia (South Australia and Victoria) in November–February during aerial surveys conducted from 2002 to 2013 (Gill et al. 2015) and during vessel surveys in December 1993 (Kato et al. 2007).

During surveys of the southern Indian Ocean, Kasuya and Wada (1991) reported a concentration area for sei whales south of Australia during November–February. Sei whales were only seen in the expedition area during November, at a sighting rate of 21/10,000 n.mi. surveyed. Sighting rates in the areas adjacent to the expedition area ranged up to 235/10,000 n.mi. to the southeast during November; areas immediately to the east and west of the expedition area did not have any sightings. In the Australian National Whale and Dolphin Sightings and Strandings Database, 2 sei whale sightings were reported in May 1979 just to the north of the proposed drill sites at 30.6°S, 113.1°E and 30.1°S, 113.3°E; another sighting was reported at 19.2°S, 113.9°E during August 1997 (OBIS 2016).

Sei whales could be encountered near the proposed drill sites at the time of the expedition.

Fin Whale (*Balaenoptera physalus*)

The fin whale is listed as ***Endangered*** under the ESA (NMFS 2016b) and on the IUCN Red List of Threatened Species (IUCN 2016). It is listed as ***Vulnerable*** under the EPBC Act of Australia (Commonwealth of Australia 2016a), and it is listed in CITES Appendix I (UNEP-WCMC 2016). The fin whale is widely distributed in all the world's oceans, but is most abundant in temperate and cold waters (Aguilar 2009). It occurs most commonly outside the continental slope (Aguilar 2009), but can also occur closer to shore, especially where deeper waters approach the coast (Jefferson et al. 2015).

Fin whales in the Southern Hemisphere migrate seasonally between temperate waters, where they breed in austral winter, and polar waters, where they feed in austral summer (Aguilar 2009). In the Indian Ocean, Southern Hemisphere fin whales winter off South Africa, Madagascar, and Western Australia (Rudolph and Smeenk 2009). Fin whale records exist for Western Australia, South Australia, Victoria,

and Queensland; their migration path is oceanic and does not follow along the coastline (Bannister et al. 1996). Fin whales were seen off southern Australia (South Australia and Victoria) in November–May during aerial surveys conducted from 2002 to 2013 (Gill et al. 2015). Fin whale calls were recorded from 2004 to 2007 at instruments located southwest of Fremantle, Western Australia, at 34.4°S, 115.1°E; the peak in calls was during May–August (Gedamke et al. 2007).

According to Kasuya and Wada (1991), sighting rates during Japanese surveys in the expedition area were 20/10,000 n.mi. surveyed during October and 5/10,000 n.mi. during November. Sighting rates immediately to the west ranged up to 28/10,000 n.mi. during October; no sightings were made along the south coast of Western Australia, between 115° and 130°E (Kasuya and Wada 1991).

Two stranding events were reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). There are 5 records in the Australian National Whale and Dolphin Sightings and Strandings Database for the southwestern coast: 3 during March 1979 to the north of the proposed drill sites between 30.5–32.0°S, 113.0–114.7°E; 1 in September 1990 southeast of the proposed drill sites at 35.4°S, 117.3°E; and 1 in June 1991 to the southeast of the drill sites at 35.0°S, 119.3°E (OBIS 2016). An additional sighting was made in August 1996 at 15.5°S, 124.4°E (OBIS 2016).

Fin whales could be encountered near the proposed drill sites during the expedition.

Blue Whale (*Balaenoptera musculus*)

The blue whale is listed as ***Endangered*** under the ESA (NMFS 2016b), under the EPBC Act of Australia (Commonwealth of Australia 2016a), and on the IUCN Red List of Threatened Species (IUCN 2016), and it is listed in CITES Appendix I (UNEP-WCMC 2016). The blue whale is cosmopolitan, with separate populations in the North Atlantic, North Pacific, and Southern Hemisphere (Sears and Perrin 2009). In the Southern Hemisphere, two subspecies are generally recognized: the Antarctic or true blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*B. m. brevicauda*), which inhabits the Indian Ocean and the southwestern Pacific Ocean (Bannister et al. 1996; Perry et al. 1999; Branch et al. 2007a; Sears and Perrin 2009). In the following paragraphs, blue whales not identified to the subspecies level are referred to as blue whales or *B. musculus*.

Blue whales in the southern Indian Ocean migrate between high-latitude feeding areas in austral summer to lower-latitude breeding areas in austral winter (Rudolph and Smeenk 2009). During the feeding season, the Antarctic blue whale occurs in polar waters whereas the pygmy blue whale is found in temperate waters (Attard et al. 2012a). The Antarctic blue whale generally remains south of 55°S in austral summer, whereas the pygmy blue whale primarily occurs north of 54°S (Kato et al. 1995). Similarly, Branch et al. (2007b) reported that most historic catches of Antarctic blue whales occurred south of 52°S, whereas pygmy blue whale catches primarily occurred north of 52°S. Nonetheless, some pygmy blue whales are known to occur in Antarctic waters during austral summer (Gedamke and Robinson 2010; Attard et al. 2012a).

There are four different populations of pygmy blue whale: (1) Madagascar population (Ljungblad et al. 1998; Samaran et al. 2010, 2013); (2) Northern Indian Ocean population (McDonald et al. 2006; Samaran et al. 2013); (3) Eastern Indian Ocean population, occurring in the waters west and south of Australia (Gill 2002; Rennie et al. 2009; Samaran et al. 2013); and (4) Southwestern Pacific population (McDonald 2006). Sighting rates of blue whales (in particular, pygmy blue whales) are especially high around Sri Lanka (Branch et al. 2007a; Ilangakoon and Sathasivam 2012), Indonesia, south of Madagascar, and southern Australia (Branch et al. 2007a). There are ~2300 true blue whales in the Southern Hemisphere (IWC 2016b). Based on pygmy blue whale calls, McCauley and Jenner (2010)

estimated their abundance off Western Australia at 662–1559, indicating that this is only a portion of the population. Both types of blue whales have been reported off the west coast of Australia (McCauley et al. 2001; McDonald et al. 2006; Gedamke et al. 2007; Stafford et al. 2011). Attard et al. (2016) found that the pygmy blue whale in Australian waters has the lowest genetic diversity of any blue whale population.

Based on data for the Indian Ocean from 1965–1985, the southerly migration for the blue whale begins in November–December, with a peak in January–February (Kato et al. 1995). Early in the southbound migration, sightings are relatively rare between 0 and 25ºS; during December–February, whales were absent from 0 to 25ºS, and relatively large numbers were recorded in mid-latitudinal waters (40–50ºS). Based on this timing, Kato et al. (1995) assumed that concentrations at mid latitudes consisted of pygmy blue whales, as Antarctic blue whales are found at higher latitudes at that time of year. Similarly, Stafford et al. (2011) reported that in the central Indian Ocean, some pygmy blue whales move south during the austral summer and north for the winter. Kasuya and Wada (1991) reported on Japanese sighting records in the southern Indian Ocean during October–April 1965–1985. Blue whales were only seen in the expedition area during November, at a sighting rate of 9/10,000 n.mi.; sighting rates immediately to the east ranged from 37/10,000 n.mi. during November to 142/10,000 n.mi. during December.

The blue whale occurs throughout the Indo-West Pacific in areas with higher productivity (Branch et al. 2007a; Rudolph and Smeenk 2009). Pygmy blue whales from the eastern Indian Ocean population occur from at least Tasmania, along the south and west coasts of Australia, to Indonesia (Branch et al. 2007a). Blue whales have been reported for all Australian states (Bannister et al. 1996). Sightings include concentrations off Rottnest Island, Geographe Bay, and near the Dampier Archipelago, Western Australia; the Great Australian Bight; off southeast New South Wales; and near Tasmania (Bannister et al. 1996; Commonwealth of Australia 2016e). Although Antarctic and pygmy blue whales are known to occur off Australia, most strandings and sightings have been of pygmy blue whales (Bannister et al. 1996; Groom and Coughran 2012b).

Pygmy blue whales migrate between Australian feeding areas occupied during austral summer to lower-latitude breeding areas in austral winter (Attard et al. 2010). The South-west Marine Region is known to have biologically important areas for foraging, migrating, and resting (Commonwealth of Australia 2012d). Pygmy blue whales feed at two distinct feeding areas off western and southern Australia during austral summer: off Perth Canyon, Western Australia (Rennie et al. 2009); and Bonney Upwelling and adjacent areas, South Australia and Victoria (Gill 2002); these areas tend to have increased prey concentrations (Gill 2002; Rennie et al. 2009; Gill et al. 2011). The proposed drill sites on the west coast of Australia occur within the known Perth Canyon foraging area (Commonwealth of Australia 2015). One individual that was tagged off the southwest coast of Australia, just north of the proposed drill sites, was reported lunge feeding between 28.5°–31.5°S and 113.4°–114.8°E during April–May 2014 (Owen et al. 2016).

Pygmy blue whales start appearing in the Perth Canyon area in November and reach a peak during March–May (McCauley et al. 2004). Seventy-five pygmy blue whales were seen in Perth Canyon between January and March 2001 (Jenner et al. 2002). Twenty-two blue whale sightings were made west of Rottnest Island during December 1995: 9 pygmy and 3 Antarctic blue whales, and 10 *B. musculus* sp.; all sightings were made in water depths 500–2000 m (Kato et al. 2007). One blue whale sighting was made near drill site MBAS-9A (Kato et al. 2007). Blue whale sightings were also made off the south coast of Western Australia during February–March 1993 and December 1995 (Kato et al. 1995). In the southern feeding area, blue whales are only sighted between November and May (Gill et al. 2011). It is

estimated that 671 individuals occur off the southern coast of Australia (Kato et al. 2007), and 569–1147 individuals occur in the feeding area off western Australia (Jenner et al. 2008). Animals in the two feeding areas are thought to be part of the same breeding stock (Attard et al. 2010).

Pygmy blue whales, including calves, occur in Geographe Bay during October–December (McCauley et al. 2004; Attard et al. 2012b; Commonwealth of Australia 2012d; Salgado Kent et al. 2012a; Recalde-Salas et al. 2014). From Geographe Bay, they migrate southward, likely to the Bonney Upwelling feeding area or to an as-of-yet undescribed feeding ground in the Antarctic or Subtropical Convergence (Commonwealth of Australia 2015; Attard et al. 2012b). Preliminary analysis showed that individuals in Geographe Bay are likely from the same population as those that use the Perth Canyon and Bonney Upwelling feeding areas (Attard et al. 2012b).

Eleven pygmy blue whales were satellite-tagged off the southwestern coast of Australia during March and April and were documented in the area during March–May (Double et al. 2014). The tagged whales travelled near the coastline (~100 km offshore) until they reached North West Cape (~22°S), then continued their northbound migration offshore (~238 km from shore) to their potential breeding grounds in Indonesia. The water depths at some nearshore tracking locations were <1000 m, but most signals were obtained from locations where water depths were >1000 m. The whales arrived in Indonesia by June and were documented there during July–September. One tagged whale departed Indonesia in September, arrived south of Western Australia in December, and remained in the vicinity until February. Pygmy blue whales might also follow other migration paths farther offshore. Double et al. (2014) also reported on numerous catches and sightings off the western and southern coasts of Australia before 1973, and sightings near the expedition area after 1973.

Blue whales were seen during surveys off North West Cape during March–April 2000 and June–November 2001, with the greatest number (15) observed during October–November (Sleeman et al. 2007). During May 2009–May 2010 aerial surveys between North West Cape and Barrow Island, 11 pygmy blue whales were sighted in November–December 2009, and 4 were seen during April 2010 in water depths of 250–900 m; calls were also detected in the area during May–July 2009 (Jenner et al. 2010). Blue whales were also sighted near Browse Island, Western Australia, during vessel-based surveys in 2008; 1 pygmy blue whale was seen during June, 2 *B. musculus* were seen in October, and 1 *B. musculus* was seen in November (CWR 2009 *in* URS 2009).

Pygmy blue whale calls have also been detected off the coast of Western Australia by a number of authors (McCauley et al. 2001, 2004; Gedamke et al. 2007; McCauley and Jenner 2010; Stafford et al. 2004, 2011; Gavrilov and McCauley 2013). Acoustic data have shown that pygmy blue whales arrive in the Perth Canyon area as early as November on their northward migration, with peak numbers during March–May (McCauley et al. 2001, 2004). They then pass Exmouth during April–August on their northbound migration and again on their way south from October to December (McCauley and Jenner 2010). During the peak season, an average of 30 whales typically occurs in the area to feed for 2–4 weeks; the numbers drop during May; by late June most whales have left the area, although some acoustic detections were made during July (McCauley et al. 2004; McCauley and Jenner 2010). They migrated along the shelf edge out to water depths of 1000 m, but the general route is likely centered near the 500-m isobath (McCauley and Jenner 2010). Most sightings were in water depths 400–500 m, with some in water 100–400 m deep and >500 m (McCauley et al. 2004). One singer was detected near drill site MBAS-9A during February–April 2003 (McCauley et al. 2004).

Both Antarctic and pygmy blue whale calls were detected off Cape Leeuwin, southwestern Australia, during austral fall (Stafford et al. 2004, 2011). Hydrophones deployed there from January 2002

to December 2003 recorded pygmy blue whale vocalizations during December–June, with peak calling activity in May (Stafford et al. 2011). Antarctic-type blue whales were recorded from May to November 2002, with most calls detected in July (Stafford et al. 2004). Based on analysis of a 9-y dataset (2002–2010) of acoustic recordings off Cape Leeuwin, Gavrilov and McCauley (2013) reported that pygmy blue whale calls were detected from November to July, with a peak during April–May. They suggested that whales detected off southwestern Australia during November–January were traveling to southern feeding grounds in the Southern Ocean, whereas whales detected during February–July were traveling to breeding areas to the north of Australia.

Australian-type pygmy blue whales were also recorded from 2004 to 2007 at instruments located southwest of Fremantle at 34.4°S, 115.1°E with a peak during March–May (Gedamke et al. 2007). In contrast, Antarctic-type blue whale calls recorded at the same location had a peak during May–August (Gedamke et al. 2007), suggesting that true blue whales overwinter around Perth Canyon and migrate south during mid-October (McCauley et al. 2004). Pygmy blue whale calls were also recorded at 44°S from March through January and at 54°S from January to October, and Australian-type pygmy blue whale calls were recorded at locations south of 60°S throughout the year (Gedamke et al. 2007).

Australian-type pygmy blue whale calls were detected northeast of Amsterdam Island (31.6°S, 83.2°E) during March–June 2007 and southwest of Amsterdam Island (43°S, 74.6°E) during January–June 2007 (Samaran et al. 2013). Northeast of Amsterdam Island, the majority of calls were detected during late fall/early winter, which agrees with data that showed that pygmy blue whales move north toward Indonesia during winter (Samaran et al. 2013). Samaran et al. (2010) also reported Australian-type calls near the Crozet Islands (~46.4°S) during autumn, suggesting movements from Australia along the Subantarctic and Subtropical fronts. Antarctic-type blue whale calls were detected northeast of Amsterdam Island from March to December, and southwest of Amsterdam Island from March to January (Samaran et al. 2013).

Five blue whale stranding events were reported for Western Australia between 1981 and 2010, including 4 pygmy blue whales (Groom and Coughran 2012b). There are no records of blue whales for Western Australia in the OBIS database (OBIS 2016). However, both Antarctic and pygmy blue whales could be encountered near the proposed drill sites at the time of the expedition.

Odontocetes

Sperm Whale (*Physeter macrocephalus*)

The sperm whale is listed as ***Endangered*** under the ESA (NMFS 2016b), ***Vulnerable*** on the IUCN Red List of Threatened Species (IUCN 2016), and it is listed in CITES Appendix I (UNEP-WCMC 2016). The sperm whale is widely distributed, from the edge of the polar pack ice in both hemispheres to the Equator (Whitehead 2009). It generally occurs in deep water, especially along continental slopes (Davis et al. 1998; Rice 1998). The sperm whale can dive as deep as ~2 km and possibly deeper on rare occasions, for periods of over 1 h; most foraging occurs at depths of ~300–800 m for 30–45 min (Whitehead 2003).

The sperm whale's extensive worldwide distribution is linked to social structure: mixed groups of adult females and juveniles of both sexes generally occur in tropical and subtropical waters, whereas adult males are commonly found alone or in same-sex aggregations, often occurring in higher latitudes outside the breeding season (Best 1979; Rice 1989). Females typically inhabit water >1000 m deep and latitudes <40° (Rice 1989). In some middle latitudes, there appears to be a seasonal north-south migration, with

sperm whales migrating towards the pole in summer; in equatorial waters and some temperate regions, there is no seasonal migration (Whitehead 2003). Rudolph and Smeenk (2009) reported that the deep waters between the islands of the Indo-Malayan Archipelago could be a migration route for sperm whales between the Indian and Pacific oceans. Eyre (1995) reported one sperm whale sighting between northwestern Australia and Indonesia during a May–July 1993 survey in the IOS.

In Australia, sperm whales likely number in the tens of thousands (Bannister et al. 1996). Off Western Australia, they primarily occur where the shelf slopes steeply and are less concentrated near the shelf edge; they are widely dispersed offshore (Bannister et al. 1996). The South-west Marine Region has biologically important foraging areas for the sperm whale (Commonwealth of Australia 2012d). Feeding concentrations off Western Australia occur off the shelf edge near Albany Canyon and Perth Canyon; sperm whales also aggregate near Bremer Canyon off the south coast of Western Australia (Bannister et al. 1996; Commonwealth of Australia 2012d, 2016e).

Based on historical commercial whaling, and modern visual and acoustic survey data, the waters off southwestern Australia, in particular the Perth and Albany canyons, were also deemed as important habitat by Johnson et al. (2016). There is no indication that the population of sperm whale bulls off Albany has recovered since the whaling era (1955–1978); the mean index of abundance of sperm whales seen on transect during 21 aerial surveys from September to November (the time of peak numbers in the area) in 2009 was 2.4 (3.4 with off-transect sightings included); these estimates are much lower than those between 1968 and 1978, which ranged between 6.3 in 1976 and 12.5 in 1968 (Carroll et al. 2014). Based on Japanese surveys, Kasuya and Wada (1991) reported sighting rates up to 1019/10,000 n.mi. surveyed in the expedition area during October; the rate in November was 805/10,000 n.mi. and dropped to 449/10,000 n.mi. during December. In adjacent areas (immediately to the west), the sighting rate was as high as 2150/10,000 n.mi. during October; sighting rates to the east of the expedition area ranged up to 24/10,000 n.mi. during November.

Sperm whales were sighted off southwestern and northwestern Australia during surveys of the Southern Ocean Sanctuary from 1978 to 2004 (Van Waerebeek et al. 2010), including near the proposed drill sites. Four sperm whale sightings were made during January 1995 just south of 35°S near 114°E (Tynan 1996). Sperm whale clicks have been recorded in Carnarvon Basin, ~220 km northwest of Exmouth Gulf, during acoustic monitoring in 2010; most clicks were recorded from May to August, and they were least common from December to February (McCauley 2011 *in* ExxonMobil 2013). During May 2009–May 2010 aerial surveys between North West Cape and Barrow Island, 10 sperm whales were seen on 11 July 2009, 2 were sighted on 6 February 2010, and 2 were sighted on 29 April 2010 (Jenner et al. 2010). Sperm whales have also been seen north of Broome (Commonwealth of Australia 2012f).

Groom and Coughran (2012b) reported 36 stranding events for Western Australia between 1981 and 2010. There are 21 records of sperm whales in the Australian National Whale and Dolphin Sightings and Strandings Database for the waters off Western Australia, including 11 sightings near the proposed drill sites during March 1979 between 29–35°S and 113–115°E (OBIS 2016). Of the 11 records, 2 sightings were reported near drill site MBAS-9A at ~33°S, 114°E; 1 was just to the south of the drill sites at 34.5°S, 114.1°E; and 8 were to the north (OBIS 2016). Of the remaining 10 records, 3 were reported for the south coast near ~35°S and between 122.3–122.7°E; 5 were to the north between 19–25°S and 110–116°E; and 2 were for the north coast near 13°S, 122°E (OBIS 2016). Two of the 21 records (the most northerly ones) were made in October, but no records were reported for September or November (OBIS 2016). There are an additional 4 records in the OBIS database for Western Australia that are not based on historical whaling records: 1 to the southeast of the proposed drill sites at ~35.1°S, 117.9°E; 1 to

the west at ~33°S, 107°E; 1 to the southwest at 38°S, 111°E; and 1 to the north at 18°S, 122°E (OBIS 2016).

Sperm whales could be encountered near the proposed drill sites off Western Australia.

Pinnipeds

There are no conservation listed pinniped species in the waters near the proposed drill sites.

Species that are Common off Western Australia

Mysticetes

Humpback Whale (*Megaptera novaeangliae*)

The Western Australia DPS of the humpback whale has been delisted (NMFS 2016b), but this population is considered ***Vulnerable*** under the EPBC Act of Australia (Commonwealth of Australia 2016a). The humpback whale is found in all ocean basins (Clapham 2009). It is highly migratory, traveling between mid- to high-latitude waters where it feeds during spring–fall, and lower latitude wintering grounds over shallow banks, where it calves (Winn and Reichley 1985). Although considered to be mainly a coastal species, the humpback whale often traverses deep pelagic areas while migrating (Baker et al. 1998; Garrigue et al. 2002).

Humpback whales in the Southern Hemisphere make annual migrations between summer feeding grounds in the Antarctic and winter breeding grounds at 15–20°S. There are seven breeding stocks of Southern Hemisphere humpback whales, including two in the Indian Ocean: Stock C off Africa and Stock D off Western Australia (IWC 2007; Rosenbaum et al. 2009). An eighth stock (Stock X) has been proposed for humpbacks that feed and breed in the northern Indian Ocean (Reeves et al. 1991; Mikhalev 1997; IWC 2007). Stock D off Western Australia shows weak genetic differentiation from Stock E1 off eastern Australia (Schmitt et al. 2014).

Stock D migrates along the coast of Western Australia during June–November (Commonwealth of Australia 2005). The South-west Marine Region is known to have biologically important areas for resting and migrating (Commonwealth of Australia 2012d). Key concentration areas for humpbacks include Cape Naturaliste/Geographe Bay, north of Rottnest Island off Perth, Shark Bay, North West Cape, Dampier Archipelago, and coastal islands off Kimberley (Bannister et al. 1996; Commonwealth of Australia 2016e). The abundance of humpback whales migrating northward was estimated at 33,850 based on surveys off Shark Bay during 2008 (Hedley et al. 2011). In comparison, surveys conducted off North West Cape during 2008 provided an abundance estimate of 26,100 humpback whales, with a maximum estimate of 33,300 (Salgado Kent et al. 2012b). The population showed an annual rate of increase of ~13% since 2000 (Hedley et al. 2011; Salgado Kent et al. 2012b), although the maximum possible growth rate is believed to be 11.8% (Salgado Kent et al. 2012b).

Migratory paths primarily lie within the 200-m isobath on the continental shelf, and major resting areas include Exmouth Gulf and Shark Bay (Jenner et al. 2001). The Abrolhos Islands are also resting areas (Commonwealth of Australia 2016e). The northern endpoint of the migration appears to be Camden Sound, Kimberley; this area is a major calving ground (Jenner et al. 2001). The northern migratory route occurs farther from shore than the southern route, and the northern and southern routes diverge at Perth Basin, Dampier Archipelago, and Kimberley (Jenner et al. 2001). The northern migratory period to calving grounds occurs during June–August, whereas the southern migratory period to feeding areas takes

place during September–November (Commonwealth of Australia 2005). Humpbacks that were satellite-tagged in Kimberley during late August–early September 2009 showed southbound movements close to shore, except for two individuals that moved into offshore waters off Shark Bay (Double et al. 2010; Gales et al. 2010). Twenty-eight humpbacks tagged off North West Cape in July 2011 migrated northward along the coast, and some of them stopped south of the recognized calving area (Double et al. 2012).

In Geographe Bay, acoustic detections of humpbacks have been made during the northward (June–July) and the southbound (November–January) migrations (Salgado Kent et al. 2012a). Humpbacks were sighted in Shark Bay and surrounding waters within ~30 km during June–August between 1963 and 1991 (Bannister 1994; Jenner et al. 2001). During June–August 2005 surveys west of Shark Bay, sightings were made within ~55 km from shore in water depths up to 160 m with a peak distribution at ~90 m (Paxton et al. 2011). Surveys for humpback whales were also conducted off Shark Bay during June–August 2008; peak densities were seen during mid July 20–35 km from shore and were much lower beyond 60 km from shore (Hedley et al. 2011). During 1995–1998 boat surveys, humpbacks were observed in nearshore waters south of Shark Bay (Jenner et al. 2001). In addition, humpback calls were recorded in Carnarvon Basin, ~220 km northwest of Exmouth Gulf, during 2010; calls were first detected in May and increased until August, peaking in early September, before decreasing by early October (McCauley 2011 *in* ExxonMobil 2013).

Humpback whales have been observed off North West Cape during June–November surveys (Sleeman et al. 2007; Salgado Kent et al. 2012b). These surveys indicated that humpbacks might make up most of the cetacean biomass on the shelf off Western Australia (Sleeman et al. 2007; Pitman et al. 2015). The highest densities were recorded within the 200-m isopleth, but humpbacks were also sighted farther offshore; peak numbers were observed from July to September (Sleeman et al. 2007; Salgado Kent et al. 2012b). Adults and calves were also observed off North West Cape during the months of June–August from 2006 to 2013 during a total of 34 interactions with killer whales, most in water depths <100 m; at least 14 humpback whale calves were attacked and killed (Pitman et al. 2015).

During May 2009–May 2010 aerial surveys between North West Cape and Barrow Island, 1221 humpback whales (including calves) were observed from June to December, with peak numbers sighted during August and September; densities were lower nearshore (5–50 m deep) and higher in offshore waters, 50–950 m deep (Jenner et al. 2010). Humpback whale calls were also detected in the area during May–December 2009 (Jenner et al. 2010). Surveys for humpbacks took place in Exmouth Gulf and adjacent waters during August–October 1995–1998 (Jenner et al. 2001). Females with calves were seen heading north during August and south during September–November (Jenner et al. 2001).

Sightings are made regularly between the Dampier Archipelago and Broome during August–November and June–August (Jenner et al. 2001; Jenner and Jenner 2010). At least 6 sightings were also made in that region in September 2015 during IODP Expedition 356 (M. Malone, Texas A&M, pers. comm.). Humpback whales in Pender Bay, Kimberley region, use the area for staging, calving, breeding, feeding, and resting (Double et al. 2010), with sightings from July through November, including mothers and calves (Blake et al. 2011). Breeding and calving also occur along the rest of the coast of Kimberley (Commonwealth of Australia 2016e), and individuals have been sighted or detected acoustically in the region during numerous studies (Jenner et al. 2001; URS 2009; RPS 2012; Woodside 2014).

Sighting rates during Japanese surveys in the expedition area off Western Australia were 31/10,000 n.mi. surveyed during October and 9/10,000 n.mi. during November; sighting rates in adjacent areas to the east (115–120°E) ranged from 49/10,000 n.mi. during November up to 142/10,000 n.mi. during December (Kasuya and Wada 1991). There are 639 records of humpback whales for Western

Australia in the OBIS database, ranging along the entire coast, with most records occurring off the northwestern coast, particularly between 15 and 22°S (OBIS 2016). Most records (359) were from the Australian National Whale and Dolphin Sightings and Strandings Database, with the highest numbers reported from July to September; 279 records were from whaling logbooks, and 1 record was from Diveboard–Scuba diving citizen science observations (OBIS 2016). There are 7 records in the Australian National Whale and Dolphin Sightings and Strandings Database near the proposed drill sites: 2 at 33.9°S, 115°E near site MBAS-6A during February and May 1991; 1 immediately to the south at 34.4°S and 115°E in June 1991; 1 farther south at 36.3°S and 115.3°E in September 1993; and 3 to the north between 31.8–32.2°S and 115.4–115.7°E during February, May, and September (OBIS 2016).

Groom and Coughran (2012a) reported 56 humpbacks entangled in fishing gear in coastal waters and 1 in offshore waters off Western Australia during 1990–2010 from Albany in the south to north of Broome. Entanglements were documented from May to December, with most occurring during June. Coughran et al. (2013) reported 146 stranding incidents in Western Australian between 1989 and 2012; most strandings occurred during July–November. It is uncertain what caused peak numbers (46) to strand during 2009.

Humpback whales are common off Western Australia during June–November, thus are likely to be encountered near the proposed drill sites at the time of the expedition (September–November).

Bryde's Whale (*Balaenoptera edeni/brydei*)

Bryde's whale occurs in all tropical and warm temperate waters in the Pacific, Atlantic, and Indian oceans, between 40°N and 40°S (Kato and Perrin 2009). It is one of the least known large baleen whales, and it remains uncertain how many species are represented in this complex (Kato and Perrin 2009). *B. brydei* is commonly used to refer to the larger form or "true" Bryde's whale and *B. edeni* to the smaller form, which is also known as Sittang whale; however, some authors apply the name *B. edeni* to both forms (Rudolph and Smeenk 2009). Although both forms could occur off Western Australia, the smaller form is restricted to coastal waters (Rudolph and Smeenk 2009). Bryde's whale remains in warm (>16°C) water year-round, and seasonal movements towards the Equator in winter and offshore in summer have been recorded (Kato and Perrin 2009). It is frequently observed in biologically productive areas such as continental shelf breaks (Davis et al. 2002) and in regions subjected to coastal upwelling (Gallardo et al. 1983; Siciliano et al. 2004).

Bryde's whale is one of the most abundant mysticetes in the Indian Ocean (Reeves et al. 1999; Sathasivam 2004; Kato and Perrin 2009). There is almost certainly more than one stock in the Indian Ocean because of the large area and the heterogeneity of the environment (IWC 1981; Kato and Perrin 2009). Separate stocks of oceanic Bryde's whale have been proposed for the Indian Ocean, including a Madagascar stock (~35–60ºE and 0–40ºS), a Western Australian stock (from the west coast of Australia to ~90ºE and 0–40ºS), and a Northern Indian Ocean stock, or more probably two, separated along the meridian of the Maldives (Ivashin 1982; Kasuya and Wada 1991). Ivashin (1980, 1982) and Kasuya and Wada (1991) proposed another 'Central' stock between 60 and 90ºE and 0 and 45ºS. Kato and Perrin (2009) also reported concentrations off South Africa (east of 35°E).

Bryde's whales have been reported from all Australian states except the Northern Territory (Bannister et al. 1996). Single sightings have been reported off Victoria and New South Wales, and 11 strandings have been reported for South Australia, New South Wales, Victoria, and Queensland (DEW 2007 *in* Commonwealth of Australia 2016e). Bryde's whale calls were detected between North West Cape and Barrow Island during April 2009 (Jenner et al. 2010), and near Carnarvon Basin, ~220 km

northwest of Exmouth Gulf, primarily from February to June (McCauley 2011 *in* Exxon Mobil 2013). One sighting was made near Browse Island during November 2008 (CWR 2009 *in* URS 2009). Bryde's whales were also seen and detected acoustically from 2006 to 2009 near Scott Reef and between Scott Reef and the coast (Jenner et al. 2009, RPS 2010, McCauley 2011 *in* Woodside 2014). Two were seen in January 2010 off Anketell Point, east of Dampier Archipelago, and 6 were seen during March 2010 (Jenner and Jenner 2010). One was found entangled in fishing gear off the west coast of Australia, near Jurien Bay (Groom and Coughran 2012a). Eyre (1995) also made ~11 sightings of Bryde's whales between northwestern Australia and Indonesia during a May–July 1993 survey in the IOS.

Kasuya and Wada (1991) only reported Bryde's whales in the expedition area off Western Australia during December, at a sighting rate of 7/10,000 n.mi. surveyed; rates ranged as high as 34/10,000 n.mi. in areas adjacent (northwest) of the expedition area during December. Sighting rates directly to the east were zero during November and December, whereas the sighting rate was at least 50/10,000 n.mi. during February (Kasuya and Wada 1991). One stranding event was reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). Although there are no Bryde's whale records in the OBIS database for Western Australia, there are 11 records for the southeast coast (OBIS 2016).

Bryde's whales could be encountered near the proposed drill sites.

Common Minke (*Balaenoptera acutorostrata*) and Antarctic Minke Whales (*B. bonaerensi*)

There are two species of minke whale: the common minke and the Antarctic minke whale. The common minke whale has a cosmopolitan distribution that spans ice-free latitudes in both hemispheres (Stewart and Leatherwood 1985; Jefferson et al. 2015). It generally inhabits both coastal and offshore waters (Perrin and Brownell 2009). A smaller form (unnamed subspecies) of the common minke whale, known as the dwarf minke whale, occurs in the Southern Hemisphere, where its distribution overlaps with that of the Antarctic minke whale during summer (Perrin and Brownell 2009). The range of the dwarf minke whale is thought to extend as far south as 65°S (Jefferson et al. 2015) and as far north as 11°S off Australia, where it can be found year-round (Perrin and Brownell 2009). The Antarctic minke whale has a circumpolar distribution in coastal and offshore areas of the Southern Hemisphere from ~7°S to the ice edge (Jefferson et al. 2015); off Western Australia, it probably does not occur as far north as the dwarf minke whale (Bannister et al. 1996). The Antarctic minke whale is found between 60°S and the ice edge during austral summer; in austral winter, it is mainly found at breeding grounds at mid latitudes, including 10°S–30°S and 170°E–100°W in the Pacific and off eastern Australia, western South Africa, and northeastern Brazil (Perrin and Brownell 2009). In the following paragraphs, minke whales not identified to the species level are referred to as minke whales.

Australian records are common, especially for the dwarf minke whale (Bannister et al. 1996). Minke whales have been reported for all Australian states except the Northern Territory (Bannister et al. 1996). One minke whale was sighted during December 1994 to the northwest of the proposed drill sites at 31.3°S, 106.7°E (Tynan 1996). One minke whale was also sighted during surveys in Shark Bay during spring 2007 (Hodgson 2007). Minke whales were seen during surveys off North West Cape during July–September 2000, April–October 2001, and May 2002, with the highest number (9) seen during June 2001 (Sleeman et al. 2007). During May 2009–May 2010 aerial surveys between North West Cape and Barrow Island, single minke whales were observed on 26 June and 5 August 2009; dwarf minke whale calls were also detected in the area during April–July, with slightly more calls detected during June and July (Jenner et al. 2010).

Five minke whale sightings were made during 2006–2007 vessel surveys near Browse Island and just north of Broome; three of those were positively identified as dwarf minke whales (RPS 2007b *in* URS 2009). In addition, five sightings totaling 218 dwarf minke whales were seen near Browse Island during July 2008, and one undetermined minke whale was also sighted (CWR 2009 *in* URS 2009). A possible Antarctic minke whale call was detected on acoustic loggers in the same area in September 2006 (McCauley 2009 *in* URS 2009). Dwarf and Antarctic minke whales have also been sighted and detected acoustically near Scott Reef during 2006–2008 (Jenner et al. 2009, McCauley 2009, 2011 *in* Woodside 2014); Antarctic minke whales were detected acoustically primarily between July and October (McCauley 2009, 2011 *in* Woodside 2014). Minke whales were also seen between Scott Reef and the mainland during 2008 and 2009 (Jenner et al. 2009, RPS 2010a *in* Woodside 2014), and two minke whales were sighted in water depths 50–100 m off Dampier Peninsula (RPS 2011a *in* Woodside 2014). Additionally, possible Antarctic minke whale calls were detected in Carnarvon Basin, ~220 km northwest of Exmouth Gulf, during acoustic monitoring in 2010 (McCauley 2011 *in* Exxon Mobil 2013). During Japanese surveys in the expedition area, Kasuya and Wada (1991) reported sighting rates of 10/10,000 n.mi. surveyed during October and 72/10,000 n.mi. during November. Sighting rates in adjacent areas (to the southeast) ranged up to 195/10,000 n.mi during December, and rates along the south coast of Western Australia ranged up to 24/10,000 n.mi. surveyed during November.

In the Australian National Whale and Dolphin Sightings and Strandings Database, there are at least 3 distinct sighting records for the southwest coast of Western Australia: 1 in March 1979 near the proposed drill site MBAS-9A at 33.2°S, 114.2°E; 1 in March 1979 to the north of the drill sites at 32.6°S, 114.2°E; and 1 in August 1984 to the north of the drill sites at 32.0°S, 115.5°E (OBIS 2016). There are an additional 2 sightings off Western Australia: 1 in March 1992 at 20.9°S, 115.3°E; and 1 in August 1991 at 20.5°S, 114.8°E (OBIS 2016). Twenty-two stranding events were reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). No records of Antarctic minke whales were reported for the waters around mainland Australia (OBIS 2016). A minke whale was found entangled in fishing gear off the southwest coast of Australia near Bunbury (Groom and Coughran 2012a).

Both species of minke whale could be encountered at the proposed drill sites off Western Australia.

Odontocetes

Risso's Dolphin (*Grampus griseus*)

Risso's dolphin is distributed worldwide in temperate and tropical oceans (Baird 2009a), although it shows a preference for mid-temperate waters of the shelf and slope between 30° and 45° (Jefferson et al. 2014). Although it is known to occur in coastal and oceanic habitats (Jefferson et al. 2014), it appears to prefer steep sections of the continental shelf, 400–1000 m deep (Baird 2009a) and is known to frequent seamounts and escarpments (Kruse et al. 1999).

Risso's dolphin occurs throughout the Indian Ocean, including Australia, although sightings are more scarce in the eastern regions (Kruse et al. 1991; de Boer et al. 2003; Jefferson et al. 2014). In a review of Risso's dolphin, Jefferson et al. (2014) reported records in the Timor Sea, other waters north of Australia, and eastern Australia, but no records for Western Australia. However, Bannister et al. (1996) reported that Risso's dolphin occurs from Western Australia along the south coast to northern Queensland, and south to 39°S. The Commonwealth of Australia (2012f) also reported that Risso's dolphin occurs off the Kimberley coast.

Eyre (1995) made 3 sightings between northwestern Australia and Indonesia during a May–July 1993 survey in the IOS. Near Browse Island, 1 group of 24 was seen during June 2008, 2 groups totaling 16 were sighted in July 2008, and 1 group of 30 was seen during November 2008 (CWR 2009 *in* URS 2009). One sighting of 40 was made during 2002–2013 aerial surveys off southeastern Australia during the month of February (Gill et al. 2015). Leatherwood et al. (1991) reported 1 stranding for the southwest coast of Australia. According to Ross (2006), strandings have been reported from ~23 to 39°S. Two stranding events have been reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). Although there are no records for Risso's dolphin in the OBIS database for Western Australia, there are 13 records for southeastern Australia (OBIS 2016).

Risso's dolphin could be encountered near the proposed drill sites.

False Killer Whale (*Pseudorca crassidens*)

The false killer whale is found in all tropical and warm temperate oceans of the world, with only occasional sightings in cold temperate waters (Baird 2009b). In the Indian Ocean, it ranges from South Africa to the Arabian Sea and east to Australia (de Boer et al. 2003; Rudolph and Smeenk 2009). Typically pelagic, it has been observed approaching close to shore around oceanic islands (Baird 2009b). Records are known for waters of all Australian states and the Northern Territory, as well as New Zealand (Baker 1983; Bannister et al. 1996).

Off Western Australia, a sighting of 6 false killer whales was reported on 27 August 1979 at 29.7°S, 101.6°E; a sighting of 35 was made on 31 January 1967 at 18.1°S, 116°E; and a sighting of 10 was made on 1 February 1967 at 21.1°S, 113.1°E (Leatherwood et al. 1991); 2 strandings were reported for the west coast for June 1976 and July 1981 (Mörzer Bruyns 1969 *in* Leatherwood et al. 1991). On the south coast of Western Australia, strandings of 250, 34, and 114 were reported for October 1944, May 1964, and July 1986, respectively (Leatherwood et al. 1991). False killer whales have also been reported near Browse Island and along the Kimberley coast between Broome and the Maret Islands (RPS 2007b, CWR 2009 *in* URS 2009). Four false killer whales were seen in July 2010 during surveys off Anketell Point, east of Dampier Archipelago (Jenner and Jenner 2010).

Bannister et al. (1996) and Ross (2006) reported 17 false killer whale strandings in Western Australia, 3 in South Australia, 2 in Victoria, 15 in Tasmania, 11 in New South Wales, 5 in Queensland, and 2 in the Northern Territory. Groom and Coughran (2012b) reported 18 stranding events involving 397 individuals for Western Australia between 1981 and 2010. Strandings have been reported in all months, with most for the south and southeastern coasts from May to September (Bannister et al. 1996). One stranding of 120 was reported for Geographe Bay on the southwest coast of Australia on 2 June 2005 (Chambers and James 2005).

There are 3 records of false killer whales in the National Whale and Dolphin Sightings and Strandings Database for Western Australia (OBIS 2016): 2 on the south coast (at 35.0°S, 119.1°E in June 1991; and 35.4°S, 117.3°E in September 1990), and 1 off the west coast at 20.5°S, 114.6°E in August 1991. There are 23 other records for Australia (OBIS 2016).

False killer whales could be encountered near the proposed drill sites.

Killer Whale (*Orcinus orca*)

The killer whale is cosmopolitan and widely distributed; it has been observed in all oceans of the World (Ford 2009). The killer whale is well studied in the eastern North Pacific Ocean and is known to segregate socially, genetically, and ecologically into three distinct groups: resident, transient, and offshore

animals. Offshore whales do not appear to mix with the other types of killer whales (Dahlheim and Heyning 1999; Ford 2009). The killer whale appears to prefer coastal areas, but also occurs in deep water. It is known to occur in Australian waters and other areas of the Indian Ocean (Leatherwood et al. 1991; de Boer et al. 2003). Between 1978 and 1986, 106 killer whales were reported to the Dolphin Survey Project from throughout the Indian Ocean (Leatherwood et al. 1991). In Australia, concentrations are known around Tasmania, and frequent sightings have been made in South Australia and Victoria (Bannister et al. 1996; Gill et al. 2015). One sighting was recorded from the Northern Territory in April 1999 (Chatto and Warneke 2000 *in* Ross 2006).

Leatherwood et al. (1991) reported 4 sightings of 18 killer whales off the south coast of Western Australia (between 35°S and 37°S) during April 1980, June 1984, and October 1986. Sightings and acoustic detections have also been reported for Bremer Canyon during February and March (Wellard et al. 2015); killer whales aggregate in this area during summer (Commonwealth of Australia 2016d). Additionally, 1 killer whale sighting was made during January 1995 south of the proposed drill sites at 36°S, 115°E (Tynan 1996). Killer whales have also been sighted south of ~37°S (Van Waerebeek et al. 2010).

One sighting was reported for Dirk Hartog Island in Shark Bay in May 1983; a group of 2–10 was seen attacking dugongs (Anderson and Prince 1985 *in* Leatherwood et al. 1991). Killer whales have also been seen attacking and killing humpback whales off North West Cape during June–August from 2006 to 2013 during 34 interactions, most in water <100 m deep (Pitman et al. 2015). During May 2009–May 2010 aerial surveys between North West Cape and Barrow Island, five killer whales were seen during November 2009 (Jenner et al. 2010). One satellite-tagged individual was tracked for 22 days in July–August off Western Australia, during which time it moved between North West Cape and Shark Bay (Pitman et al. 2015). Sightings have also been made off Dampier Peninsula during 2009 and 2010 (RPS 2010a, 2011a *in* Woodside 2014).

During Japanese surveys in the expedition area off Western Australia, sighting rates were zero during October and December, but 8/10,000 n.mi. surveyed during November (Kasuya and Wada 1991). Sighting rates in adjacent areas to the south ranged up to 43/10,000 n.mi. during November and 53/10,000 n.mi. during December. Sighting rates immediately to the east, along the south coast of Western Australia, were zero from October through March.

Two stranding events involving 8 individuals were reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). There are 25 records for Australia in the Australian National Whale and Dolphin Sightings and Strandings Database, including 2 for the Timor Sea and 8 for Western Australia (OBIS 2016). The 8 sightings in Western Australia include 1 for June 1992 at 29.1°S, 113.7°E; 1 for October 1991 at 20.6°S, 114.8°E; and 6 for the south coast in March 1979 between 34.5–35.2°S and 119.1–120.1°E (OBIS 2016).

The killer whale could be encountered near the proposed drill sites.

Long-finned Pilot (*Globicephala melas*) and Short-finned Pilot Whales (*G. macrorhynchus*)

The short-finned pilot whale is found in tropical and warm temperate waters, and the long-finned pilot whale is distributed antitropically in cold temperate waters (Olson 2009). Seasonal movements onshore and offshore are related to the distribution of their favored prey item, squid (Olson 2009). Both species primarily occur in oceanic waters, but they have also been reported in coastal waters (Jefferson et al. 2015). Short-finned pilot whale distribution does not generally range south of 40°S (Jefferson et al. 2015). Both species are known to occur in the Indian Ocean (de Boer et al. 2003; Rudolph and Smeenk

2009), and although the ranges of the two species show little overlap, both are known to occur off southern Australia (Olson 2009).

The long-finned pilot whale is widely reported for waters off Australia, including Western Australia (Bannister et al. 1996) and southern Australia (Gill et al. 2015). Sightings have been reported for Western Australia (1), New South Wales (2), Queensland (3), Tasmania (3), and the Northern Territory (1; DEW 2007 *in* Commonwealth of Australia 2016e). Ross (2006) reported 9 stranding records for Western Australia, 16 for South Australia, 26 for Victoria, 54 for Tasmania, 4 for New South Wales, and 1 for Queensland. Groom and Coughran (2012b) reported 22 stranding events for Western Australia between 1981 and 2010. Two strandings of long-finned pilot whales have been reported for Geographe Bay: 320 on 20 August 1996 and 19 on 3 April 2005 (Chambers and James 2005). There is 1 record of a long-finned pilot whale in the Australian National Whale and Dolphin Sightings and Strandings Database for Western Australia, for August 1986 at 32.0°S, 115.5°E (OBIS 2016). There are ~52 other records for Australia, including 9 in the Australian National Whale and Dolphin Sightings and Strandings Database (OBIS 2016).

Short-finned pilot whales occur throughout the waters of Australia, but are typically not as common off the southern coast (Bannister et al. 1996). Leatherwood et al. (1991) reported 2 sightings of short-finned pilot whales off the south coast of Australia; 1 group of 12 was seen during December 1983 off the south coast of Western Australia at 36.2°, 123.1°E; no sightings were made off the west or north coasts. Twenty-five pilot whales (*Globicephala* sp.) were seen on 12 June 2009 during aerial surveys between North West Cape and Barrow Island (Jenner et al. 2010). Near Browse Island, 1 group of 12 was sighted during 2006–2007 vessel surveys (RPS 2007b *in* URS 2009), and 1 group of 25 was seen during June 2009 (CWR 2009 *in* URS 2009); 4 groups totaling 150 *Globicephala* sp. were seen during November 2008 (CWR 2009 *in* URS 2009).

Ross (2006) reported several strandings of short-finned pilot whales for Australia, including 2 for Western Australia, 8 for South Australia, 1 for Victoria, 1 for Tasmania, 3 for New South Wales, 3 for Queensland, and 2 for the Northern Territory. Groom and Coughran (2012b) reported 7 stranding events for Western Australia between 1981 and 2010. According to Leatherwood et al. (1991), 58 short-finned pilot whales stranded in Australia in July 1980. There is one record of a short-finned pilot whale in the Australian National Whale and Dolphin Sightings and Strandings Database for Western Australia, for October 1995 at 20.1°S, 115.6°E (OBIS 2016). There are 14 other records for Australia, including 6 in the Australian National Whale and Dolphin Sightings and Strandings Database (OBIS 2016). Pilot whales (*Globicephala* sp.) have also been sighted south of the proposed drill sites, south of ~37°S (Van Waerebeek et al. 2010).

Both short- and long-finned pilot whales could be encountered near the proposed drill sites.

Pinnipeds

Australian Sea Lion (*Neophoca cinerea*)

The Australian sea lion is listed as ***Vulnerable*** under the EPBC Act of Australia (Commonwealth of Australia 2016a) and ***Threatened*** in each Australian state where it occurs (Commonwealth of Australia 2013). It is listed as ***Endangered*** on the IUCN Red List of Threatened Species (IUCN 2016). The Australian sea lion is the only endemic pinniped in Australia (Campbell 2005). The population size in 2011 was estimated at 14,780 sea lions (Shaughnessy et al. 2011), most of which (86%) were born in South Australia (Goldsworthy et al. 2009 *in* Shaughnessy et al. 2011).

The breeding range of the Australian sea lion is along the west coast of Australia southward from the Abrolhos Islands and eastward along the southern coast to the Pages Islands, South Australia (Commonwealth of Australia 2013). Breeding sites are concentrated in three main areas: the southwest coast of Western Australia, the south coast of Western Australia, and along the coast of South Australia (Campbell 2005). Historically, the population occurred along the entire south coast of Australia (Campbell 2005; Hamer et al. 2011).

Australian sea lions breed in colonies at offshore islands and on the mainland; they have a non-seasonal, asynchronous breeding cycle, so pups can be born at any month of the year across colonies (Gales et al. 1992a; Commonwealth of Australia 2013). Gales et al. (1992a) reported that the pupping season for Western Australia lasts 4–5 months and occurs every ~17–18 months. Pups have been reported at 76 sites over the last two decades, 28 in Western Australia and 48 in South Australia (Commonwealth of Australia 2013). Of the 76 sites, 58 are considered to be breeding colonies, where more than 5 pups have been born; the largest breeding colonies occur in South Australia (Commonwealth of Australia 2013). The other 18 sites where pups have been reported are considered haul-out sites where breeding occurs occasionally (Commonwealth of Australia 2013). There are at least an additional 151 haul-out sites in Australia (Goldsworthy et al. 2009 *in* Shaughnessy et al. 2011).

The number of breeding sites along the west coast of Australia has decreased over the years (Campbell 2005). Although breeding sites used to be located in the greater Perth area, there are currently only four breeding sites along the west coast located between 28 and 31°S: Abrolhos Islands, Beagle Island, North Fisherman Island, and Buffer Island (Campbell 2005; Campbell et al. 2008; Commonwealth of Australia 2013). The breeding season on Abrolhos and Buller islands are not synchronized with those on North Fisherman and Beagle islands (Gales et al. 1992a). Annually, 30–100 pups are born at these sites; 1–5 pups have also been born at three haul-out sites in the area (Commonwealth of Australia 2013). The west coast population is small but stable (Campbell 2005; Campbell et al. 2008).

Australian sea lion foraging occurs near breeding and haul-out sites in Western Australia and South Australia, and in adjacent states (Commonwealth of Australia 2013). Haul-out sites are know to occur in the Perth area (Campbell et al. 2008), and some animals have been sighted as far north as Shark Bay (Campbell 2005). Adult males and females forage over the continental shelf, and males also forage farther offshore near the slope (Goldsworthy and Page 2009; Goldsworthy et al. 2014). Females display two foraging ecotypes: inshore and offshore (Lowther and Goldsworthy 2011; Lowther et al. 2011). Females are known to feed at depths up to 90 m (Costa and Gales 2003) and travel up to 180 km to forage (Hamer et al. 2011). Young sea lions forage at depths up to 60 m and up to 10 km from their birth colony (Fowler and Costa 2004; Fowler et al. 2006). Campbell et al. (2008) outfitted pups (2) and juvenile sea lions (10) with satellite-linked transmitters; although most animals stayed close to shore, some juveniles travelled offshore, up to ~45 km from land. Off South Australia, adult males have been shown to forage more than 200 km from shore (Lowther et al. 2013).

Between 1980 and 1996, 150 sick, injured, or dead Australian sea lions were reported for Western Australia; 14% of those were returned to the wild (Mawson and Coughran 1999). There are ~13 records for Western Australia in the OBIS database, including 1 for December 2013 near the proposed drill sites at 32.0°S, 115.5°E; 2 to the north between 28.5–29.5°S, 111.5–117.5°E; 3 to the south between 36.5–37.5°S, 114.5–119.5°E; and 7 for the south coast between 32.2–34.5°S, 120.5–126.5°E (OBIS 2016). Records were reported for October–May (OBIS 2016).

Australian sea lions could be encountered near the proposed drill sites at the time of the expedition.

Species that are Uncommon or Rare off Western Australia

Mysticetes

Pygmy Right Whale (*Caperea marginata*)

The pygmy right whale's distribution is circumpolar in the Southern Hemisphere between ~30°S and 55°S in oceanic and coastal environments (Bannister et al. 1996; Kemper 2009; Jefferson et al. 2015). It appears to be non-migratory, although there might be some movement inshore in spring and summer (Kemper 2002; Jefferson et al. 2015). The number of strandings indicate that the pygmy right whale could be relatively common in Australia and New Zealand (Kemper 2009). There are 136 records for Australia between 1884 and 2007, 122 strandings and 14 sightings (Kemper et al. 2013). Strandings appear to be associated with favorable feeding areas, including upwelling regions, along the Subtropical Convergence and the Southland Current (Kemper 2002; Kemper et al. 2013).

According to Kemper et al. (2013), most pygmy right whale records (sightings and strandings) in Australia are for Tasmania (74) and South Australia/West Victoria (41); there are also records for Western Australia (10), pelagic offshore waters of Australia (6), and East Victoria/New South Wales (5). Four strandings have occurred near Perth Canyon, and 5 were reported for the south coast of Western Australia (Kemper et al. 2013). Kemper et al. (2013) reported on sightings in Australia, including 6 for South Australia/West Victoria, 5 for pelagic Australia, and 1 for Western Australia. The sighting off Western Australia occurred in October 1990 just to the north of the proposed drill sites, ~10 km southwest of Fremantle, at 32.2°S, 115.7°E (Bannister et al. 1996; Kemper 2002; Kemper et al. 2013). One pelagic sighting was made at ~42°S, 116°E (Kemper et al. 2013).

Records have been reported throughout the year for Australia, but appear to be more frequent during austral spring and summer, from September to January (Bannister et al. 1996; Kemper et al. 2013). Feeding likely occurs in coastal waters (Kemper 2002). There are 29 records of pygmy right whales for southeastern Australia in the OBIS database, but none for Western Australia (OBIS 2016).

Pygmy right whales likely would be rare near the proposed drill sites.

Omura's whale (*Balaenoptera omurai*)

Omura's whale was first described in 2003 from records from the eastern Indian Ocean, the Sea of Japan, and the Solomon Islands (Wada et al. 2003). Wada and Numachi (1991) and Yoshida and Kato (1999) had reported that whales in the Solomon Islands were distinct from Bryde's whales from offshore waters of the western North Pacific and the East China Sea. In fact, this species is not as closely related to Bryde's or sei whales (*B. borealis*) as previously thought (Sasaki et al. 2006).

Little is know about the distribution of Omura's whale, but it likely ranges throughout tropical and subtropical waters of the western Pacific and Indian oceans between ~34°N and 35°S (Yamada 2009). It likely occurs over the continental shelf in nearshore waters (Jefferson et al. 2015). Until recently, it was thought to be restricted to the eastern Indian Ocean (Yamada 2009; Jefferson et al. 2015), but there are now also records for the western Indian Ocean (Cerchio et al. 2015). Off Madagascar, it appears to prefer shelf waters with temperatures ranging from 27.4° to 30.2°C (Cerchio et al. 2015). Although Jefferson et al. (2015) did not include the southwest or south-central coasts of Australia as part of its distributional range, Yamada (2009) speculated that Omura's whale could occur along the entire coastline of Australia. One Omura's whale stranded near Exmouth on the northwest coast in March 2015 (Ottewell et al. 2016), and one dead Omura's whale was reported for South Australia at 34.6°S (Yamada 2009). Given the

recent sightings in the western Indian Ocean, and the strandings off Western and South Australia, it is possible that Omura's whale occurs throughout the Indian Ocean (Jefferson et al. 2015).

Omura's whale likely would be rare near the proposed drill sites.

Odontocetes

Dwarf Sperm (*Kogia sima*) and Pygmy Sperm Whales (*K. breviceps*)

Dwarf and pygmy sperm whales are distributed widely throughout tropical and temperate seas, but their precise distributions are unknown because much of what we know of the species comes from strandings (McAlpine 2009). They are difficult to sight at sea, because of their dive behavior and perhaps because of their avoidance reactions to ships and behavior changes in relation to survey aircraft (Würsig et al. 1998). The two species are often difficult to distinguish from one another when sighted (McAlpine 2009). Dwarf sperm whales in the Indo-Pacific could be genetically distinct from those in the Atlantic and may be a separate species (Chivers et al. 2005).

Both *Kogia* species are sighted primarily along the continental shelf edge and slope and over deeper waters off the shelf (Hansen et al. 1994; Davis et al. 1998; Jefferson et al. 2015). Several studies have suggested that pygmy sperm whales live mostly beyond the continental shelf edge, whereas dwarf sperm whales tend to occur closer to shore, often over the continental shelf (Rice 1998; Wang et al. 2002; MacLeod et al. 2004). Barros et al. (1998), on the other hand, suggested that dwarf sperm whales could be more pelagic and dive deeper than pygmy sperm whales. It has also been suggested that the pygmy sperm whale is more temperate and the dwarf sperm whale more tropical, based at least partially on live sightings at sea from a large database from the eastern tropical Pacific (Wade and Gerrodette 1993). This idea is also supported by the distribution of strandings in South American waters (Muñoz-Hincapié et al. 1998). Also, in the western tropical Indian Ocean, the dwarf sperm whale was sighted more frequently than the pygmy sperm whale, which is consistent with this hypothesis (Ballance and Pitman 1998). Similarly, Caldwell and Caldwell (1989) found that dwarf sperm whales were more common in the Indian Ocean than pygmy sperm whales, and Hoyt (2005) reported that dwarf sperm whales were seen more frequently in the northeastern Indian Ocean than were pygmy sperm whales.

Kogia spp. are relatively rare throughout the Indian Ocean, but they have been reported for Australia (Chantrapornsyl et al. 1991). There are dwarf sperm whale sighting and stranding records for Western Australia, South Australia, Tasmania, New South Wales, and South Australia (Bannister et al. 1996; Chatto and Saalfed 2000; Ross 2006; Groom and Coughran 2012b). One individual was seen near Browse Island during October 2008 (CWR 2009 *in* URS 2009). Four stranding events were reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). In the OBIS database, there is one record of a dwarf sperm whale for South Australia (OBIS 2016).

A total of 82 pygmy sperm whale strandings have been reported for South Australia, Western Australia, Queensland, New South Wales, Victoria, and Tasmania (Baker 1983; Bannister et al. 1996; DEW 2007 *in* Commonwealth of Australia 2016e). Eighteen stranding events have been reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). They are also known to strand frequently along the coast of southeastern Australia (Caldwell and Caldwell 1989). Additionally, there have been 2 reported sightings of pygmy sperm whales in Australian waters (DEW 2007 *in* Commonwealth of Australia 2016e). There are no records of pygmy sperm whales for Western Australia in the OBIS database, but there are 47 records for the rest of Australia (OBIS 2016).

Kogia spp. likely would be uncommon near the proposed drill sites.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

Cuvier's beaked whale is probably the most widespread of the beaked whales, although it is not found in high-latitude polar waters (Heyning 1989). It is rarely observed at sea and is mostly known from strandings; it strands more commonly than any other beaked whale (Heyning 1989). Cuvier's beaked whale is found in deep water and appears to prefer steep continental slope waters (Jefferson et al. 2015).

Strandings have been reported for all Australian states and the Northern Territory, primarily from January to July (Bannister et al. 1996; Hamilton and Lindsay 2013). Ross (2006) reported 31 strandings up to 1994: 5 for Western Australia, 2 for South Australia, 3 for Victoria, 13 for Tasmania, 2 for New South Wales, 3 for Queensland, 1 for the Northern Territory, and 2 for Macquarie Island. Southwestern Australia is considered a key area for this species (MacLeod and Mitchell 2006). Groom et al. (2014) reported 8 stranding records for Western Australia along the southwest coast, ranging from Perth to Cape Riche. There are 5 records in the OBIS database for Australia, none of which is for Western Australia (OBIS 2016). Cuvier's beaked whale also frequently strands in New Zealand (Ross 2006).

Cuvier's beaked whale likely would be uncommon near the proposed drill sites.

Arnoux's Beaked Whale (*Berardius arnuxii*)

Arnoux's beaked whale is distributed in deep, temperate and subpolar waters of the Southern Hemisphere, with most records for southeast South America, the Antarctic Peninsula, South Africa, New Zealand, and southern Australia (Jefferson et al. 2015). It typically occurs south of 40°S, but it could reach latitudes of 34°S or even farther north (Jefferson et al. 2015). Arnoux's beaked whale strands frequently in New Zealand, but only 7 strandings are known for Australia, including Western Australia, South Australia, Tasmania, and New South Wales (Ross 2006; Hamilton and Lindsay 2013). One stranding was reported for Cape Riche on the south coast of Western Australia (34.7°S) in February (Hamilton and Lindsay 2013; Groom et al. 2014). Possible sightings have been reported off South Australia and the south coast of New South Wales (Bannister et al. 1996). There are no records in the OBIS database for Australia (OBIS 2016).

Arnoux's beaked whale likely would be rare near the proposed drill sites.

Shepherd's Beaked Whale (*Tasmacetus shepherdi*)

Based on known records, it is likely that Shepherd's beaked whale has a circumpolar distribution in the cold temperate waters of the Southern Hemisphere (Mead 1989). It is thought to occur in mid latitudes from ~33° to 50°S (Ross 2006). This species is primarily known from strandings, most of which have been recorded in New Zealand, followed by southern Australia and the South Pacific (Pitman et al. 2006; Mead 2009). Three stranding records exist for Western Australia (Groom et al. 2014). The northern-most record was reported for Shark Bay at 26.3°S on 10 November 2008 (Holyoake et al. 2013), and the other 2 strandings occurred between 33.5°S and 35.0°S (Groom et al. 2014). There is also an unconfirmed sighting of 3 whales for Western Australia (Baker 1990 *in* Commonwealth of Australia 2016e). One sighting of 6 individuals was made during 2002–2013 aerial surveys off southern Australia in February (Gill et al. 2015). There are also stranding records for South Australia and Tasmania (Bannister et al. 1996; Ross 2006; Hamilton and Lindsay 2013), and 2 records in the OBIS database for South Australia (OBIS 2016).

Shepherd's beaked whale likely would be rare near the proposed drill sites.

Southern Bottlenose Whale (*Hyperoodon planifrons*)

The southern bottlenose whale can be found throughout the Southern Hemisphere from 30°S to the ice edge, with most sightings occurring from ~57°S to 70°S (Jefferson et al. 2015). It is apparently migratory and can be found in Antarctic waters during austral summer (Jefferson et al. 2015). The holotype of this species was from Dampier Archipelago, Western Australia (Van Waerebeek et al. 2010). There are several stranding records for New Zealand and the southern coast of Australia (Bannister et al. 1996; Hamilton and Lindsay 2013), including at least 2 strandings in Western Australia, 2 in New South Wales, 1 in Tasmania, 7 in South Australia, and 2 in Victoria (Ross 2006; Groom et al. 2014). The most northerly record of the southern bottlenose whale has been reported for 20.6°S (MacLeod et al. 2006).

A group of 2 was sighted during 2002–2013 aerial surveys off southern Australia in February (Gill et al. 2015). There are 33 records of the southern bottlenose whale for Australia in the OBIS database, including 25 in the Australian National Whale and Dolphin Sightings and Strandings Database (OBIS 2016). Of the 25, 3 distinct records were reported in March 1979 off the southwest coast of Western Australia, including north of the proposed drill sites at 32.3°S, 114.3°E; south at 35.9°S, 114.3°E; and southeast at 35.6°S, 117.9°E (OBIS 2016).

The southern bottlenose whale likely would be uncommon near the proposed drill sites.

Hector's Beaked Whale (*Mesoplodon hectori*)

Hector's beaked whale is rarely reported in the Southern Hemisphere, with only a few strandings in South America, South Africa, and Australia (MacLeod et al. 2006). It is thought to occur in oceanic and slope regions of Australia between 35°S and 55°S (Ross 2006). Southwestern Australia is considered a key area for this species (MacLeod and Mitchell 2006). It was sighted off Perth on 24 February 1999, just north of the proposed drill sites at 32.3°S, 115.2°E, swimming in shallow water within 50 m of shore (Gales et al. 2002). Three stranding events have been reported for Western Australia between 34.4°S and 35.0°S (Groom et al. 2014). There are also records for South Australia and Tasmania (Bannister et al. 1996; Ross 2006; Hamilton and Lindsay 2013). There is one record in the OBIS database for Southern Australia, but none for Western Australia (OBIS 2016).

Hector's beaked whale likely would be rare near the proposed drill sites.

True's Beaked Whale (*Mesoplodon mirus*)

True's beaked whale has a disjunct, antitropical distribution in the Northern and Southern hemispheres (Jefferson et al. 2015). In the Southern Hemisphere, it is known to occur in the Atlantic and Indian oceans, including Brazil, South Africa, Madagascar, and southern Australia (Jefferson et al. 2015). Seven stranding records exist for Western Australia (Groom et al. 2014), and strandings have also been reported for Victoria, South Australia, and Tasmania (Bannister et al. 1996; Ross 2006; Hamilton and Lindsay 2013). The 7 stranding records in Western Australia ranged from 23.1°S to 34.5°S, and consisted of 4 strandings of single individuals (including two calves), 2 cow/calf pairs, and 1 adult/subadult mass stranding (Groom et al. 2014). The presence of calves suggests that Western Australia is a breeding area for True's beaked whale (Groom et al. 2014). There is one record in the OBIS database for Victoria (OBIS 2016).

True's beaked whale likely would be rare near the proposed drill sites.

Gray's Beaked Whale (*Mesoplodon grayi*)

Gray's beaked whale is thought to have a circumpolar distribution in temperate waters of the

Southern Hemisphere (Pitman 2009). Strandings have been recorded for Argentina, Chile, South Africa, New Zealand, and Australia, and sightings exist for the Indian Ocean (Gambell et al. 1975). It primarily occurs in deep waters beyond the edge of the continental shelf (Jefferson et al. 2015). Some sightings have been made in very shallow water, usually of sick animals coming in to strand (Gales et al. 2002; Dalebout et al. 2004). There are many sighting records from Antarctic and sub-Antarctic waters, and in summer they appear near the Antarctic Peninsula and along the shores of the continent, sometimes in the sea ice.

Gray's beaked whale is the most commonly reported beaked whale in Western Australian waters and one of the most commonly stranded beaked whales in Australia (Groom et al. 2014; Commonwealth of Australia 2016e). Strandings have been reported from the south coast of Western Australia to southern New South Wales and Tasmania, mostly from December to April (Bannister et al. 1996; Hamilton and Lindsay 2013). Groom et al. (2014) reported 33 strandings for Western Australia, including up to 15 immature individuals; the strandings ranged from 31.0°S to 35.1°S. There could be up to 48 stranding records for Australia: 16 for Western Australia, 8 for South Australia, 3 for Victoria, 14 for Tasmania, and 7 for New South Whales (Commonwealth of Australia 2016e). One stranding of 6 whales was reported for 14 January 2003 in Geographe Bay (Chambers and James 2005). Gray's beaked whale was sighted off Western Australia on 17 February 1999 to the east of the proposed drill sites at 33.6°S, 115.3°E, swimming in shallow water within 200 m of shore; it had been seen in the area for several weeks (Gales et al. 2002). There are 17 records in the OBIS database for Australia, none of which is for Western Australia (OBIS 2016). Gray's beaked whale could be common off Tasmania and New Zealand (Bannister et al. 1996).

Gray's beaked whale likely would be uncommon near the proposed drill sites.

Andrew's Beaked Whale (*Mesoplodon bowdoini*)

Andrew's beaked whale has a circumpolar distribution in temperate waters of the Southern Hemisphere (Baker 2001). This species is known only from stranding records between 32°S and 55°S, with more than half of the strandings occurring in New Zealand (Jefferson et al. 2015). Five stranding records exist for Western Australia (Groom et al. 2014); there are also stranding records for South Australia, Victoria, New South Wales, and Macquarie Island (Baker 2001; Ross 2006; Hamilton and Lindsay 2013). Southwestern Australia is considered a key area for this species (MacLeod and Mitchell 2006). One stranding in Western Australia occurred at Bird Island at 32.2°S, 115.7°E (Bannister et al. 1996; Van Waerebeek et al. 2010); the others occurred along the southwestern tip (Groom et al. 2014). There are 2 records in the OBIS database for Southern Australia (OBIS 2016).

Andrew's beaked whale likely would be rare near the proposed drill sites.

Ginkgo-toothed Beaked Whale (*Mesoplodon ginkgodens*)

The ginkgo-toothed beaked whale is only known from stranding records (Mead 1989). It is hypothesized to occupy tropical and warm temperate waters of the Indian and Pacific oceans (Pitman 2009). The majority of the records come from Japanese waters: 8 of the 15 stranding records summarized by Mead (1989) and 15 of the 23 records compiled by MacLeod et al. (2006) were from Japan.

In the Indian Ocean, there are records from Sri Lanka, the Maldives, Strait of Malacca, north of Madagascar, and southeast Australia (Rudolph and Smeenk 2009; Dalebout et al. 2012). Five stranding records exist for Australia, including the southern coast of New South Wales and western Victoria (Bannister et al. 1996; Ross 2006; Hamilton and Lindsay 2013). There is one record in the OBIS database for Victoria (OBIS 2016).

The ginkgo-toothed beaked whale likely would be rare near the proposed drill sites.

Strap-toothed Beaked Whale (*Mesoplodon layardii*)

The strap-toothed beaked whale is thought to have a circumpolar distribution in temperate and sub-Antarctic waters of the Southern Hemisphere, mostly between 35° and 60°S (Jefferson et al. 2015). It could be seasonally common off southern Australia based on the number of strandings (Ross 2006; Groom et al. 2014). It is the most commonly stranded beaked whale in Australia (Groom et al. 2014; Commonwealth of Australia 2016e). Strandings have been reported for Western Australia, South Australia, Victoria, Tasmania, New South Wales, Queensland, Macquarie Island, and Heard Island (Ross 2006; Hamilton and Lindsay 2013). Groom et al. (2014) reported 9 stranding records for Western Australia, ranging from Cable Beach near Broome to 35°S. Most strandings have been reported from January to April (Bannister et al. 1996). There are 51 records in the OBIS database for Australia, including 1 for the south coast of Western Australia at 31.7°S, 128.9°E (OBIS 2016).

The strap-toothed beaked whale likely would be uncommon near the proposed drill sites.

Blainville's Beaked Whale (*Mesoplodon densirostris*)

Blainville's beaked whale is the most widely distributed *Mesoplodon* species (Mead 1989), although it is generally limited to pelagic tropical and warmer temperate waters (Jefferson et al. 2015). Long-term habitat studies in the northern Bahamas found that Blainville's beaked whales preferred continental slope waters 200–1000 m deep characterized by intermediate depth gradients, where they spent most of their time along a canyon wall in waters <800 m deep (MacLeod and Zuur 2005). Studies elsewhere indicate that they occur most frequently in waters 300–1400 m deep (Society Islands; Gannier 2000) and 100–500 m deep (Canary Islands; Ritter and Brederlau 1999). They can also occur in enclosed seas that have deep water (Jefferson et al. 2015).

In Australia, there are records for Blainville's beaked whale from the northern Tasman Sea, and strandings have been reported on all coasts (Bannister et al. 1996; Ross 2006; Hamilton and Lindsay 2013). Groom et al. (2014) reported 3 strandings for Western Australia, near Perth (~32°S), Shark Bay (~26°S), and Coral Bay (~23°S). It is known to occur in the waters of the North-west Marine Region of Australia (Commonwealth of Australia 2012f). There are 3 records in the OBIS database for eastern Australia (OBIS 2016).

Blainville's beaked whale likely would be uncommon near the proposed drill sites.

Common Bottlenose Dolphin (*Tursiops truncatus*)

The common bottlenose dolphin occurs in tropical, subtropical, and temperate waters throughout the World. It ranges from the Okhotsk Sea and Kuril Islands south into the Indian Ocean (Wells and Scott 2009). It is found most commonly in coastal and shelf waters and occurs in enclosed or semi-enclosed seas (Jefferson et al. 2015). Coastal common bottlenose dolphins exhibit a range of movement patterns including seasonal migration, year-round residency, and a combination of long-range movements and repeated local residency (Wells and Scott 2009).

Another species of bottlenose dolphin, the Indo-Pacific bottlenose dolphin, is also known to occur along the coast of Western Australia, but only in shallow, coastal waters. A new species, the Burrunan dolphin (*T. australis*) has been proposed for southern Australian coastal waters (Charlton-Robb et al. 2011). Unidentified bottlenose dolphins (*Tursiops* sp.) have also been reported for Australia (e.g., Krützen et al. 2004; Hodgson 2007; CWR 2009 *in* URS 2009).

The distribution of the common bottlenose dolphin in Australia is not well known, with few records for Western Australia, South Australia, New South Wales, Queensland, and Tasmania (Bannister et al. 1996; Ross 2006). It is thought to occur in offshore waters of Australia >30 m deep, although it is also known to occur in coastal waters (Hale et al. 2000). According to the Commonwealth of Australia (2012f), both inshore and offshore forms occur off northwestern Australia. Common bottlenose dolphin sightings and vocalizations were detected off the southwestern coast of Australia during 2000 (McCauley et al. 2001). Preen et al. (1997) provided an abundance estimate of 2000–3000 bottlenose dolphins (*Tursiops* sp.) in Shark Bay; Exmouth Gulf and Ningaloo Reef did not appear to have key habitat for bottlenose dolphins during winter. A group of 100 was sighted near Browse island, north of Broome, and a group of 7 was seen in Camden Sound during 2006–2007 vessel surveys off the Kimberley coast (RPS 2007 *in* URS 2009). Common bottlenose dolphins have also been taken as bycatch in the fishery off the Pilbara coast (Stephenson et al. 2006), and in the Timor and Arafura seas (Harwood et al. 1984).

There are 20 records of common bottlenose dolphin in the Australian National Whale and Dolphin Sightings and Strandings Database for Western Australia: 11 near the proposed drill sites between 33.5–33.9°S and ~115°E (including 1 for October); 7 to the south between 35.2–35.7°S and 117.2–118.6°E; 1 on the south coast at 31.9°S, 127.0°E in December 1977; and 1 to the north at 20.7°S, 115.6°E in November 1999 (OBIS 2016).

Common bottlenose dolphins likely would be uncommon near the proposed drill sites.

Pantropical Spotted Dolphin (*Stenella attenuata*)

The pantropical spotted dolphin is distributed worldwide in tropical and some subtropical waters (Perrin 2009a), between ~40°N and 40°S (Jefferson et al. 2015). It is one of the most abundant cetaceans and is found in coastal, shelf, slope, and deep waters (Perrin 2009a). In the Indian Ocean, pantropical spotted dolphins occur from South Africa to the Red Sea and Persian Gulf and east to Australia (de Boer et al. 2003; Rudolph and Smeenk 2009). It is known to occur in Western Australia, Northern Territory, Queensland, and New South Wales (Bannister et al. 1996). In Western Australia, several sightings were made near Browse Island and along the coast from Broome to the Maret Islands during vessel surveys in 2006–2008 (RPS 2007b, CWR 2009 *in* URS 2009). Two stranding events have been reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). In the OBIS database, there is a single record for the east coast of Australia (OBIS 2016).

Pantropical spotted dolphins likely would be uncommon near the proposed drill sites.

Spinner Dolphin (*Stenella longirostris*)

The spinner dolphin occurs throughout the tropical and warm temperate waters of the Indo-West Pacific (Rudolph and Smeenk 2009). Two subspecies are known to occur there: the widespread, offshore spinner dolphin *S.l. longirostris* and the dwarf spinner dolphin *S.l. roseiventris* (Perrin 2009b). *S.l. longirostris* is pantropical, occurring from Japan to the Philippines and south to Australia; *S.l. roseiventris* only inhabits shallow waters of inner Southeast Asia and is known to occur along the coast of northern Australia (Perrin et al. 1999). There is little or no genetic interchange between the two subspecies (Dizon et al. 1991). Spinner dolphins sighted in the Cable Beach area of Western Australia were believed to be of the dwarf form, which would be the southernmost record of this subspecies (Allen et al. 2012).

The distribution of the spinner dolphin in the Indian Ocean is not well known, although it was the most abundant dolphin species seen during a 9748-km vessel survey in the pelagic western tropical Indian Ocean during March–July 1995 (Ballance and Pitman 1998). Numerous records also exist for other regions of the Indian Ocean, including Australia (Perrin and Gilpatrick 1994; de Boer et al. 2003). The

spinner dolphin is known to occur from ~33.3°S, Western Australia, along the Northern Territory, to Queensland and New South Wales on the east coast of Australia (Bannister et al. 1996). Spinner dolphins were among the most common species sighted during surveys off Dampier Peninsula and near Scott Reef (Woodside 2014). Several sightings were made near Browse Island and along the coast from Broome to the Maret Islands during vessel surveys in 2006–2008 (RPS 2007b, CWR 2009 *in* URS 2009). Eyre (1995) sighted this species near the Timor Sea during a May–July 1993 survey. Six stranding events have been reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). There are no records for in the OBIS database for Western Australia, but there are 2 records for the east coast of Australia (OBIS 2016).

Spinner dolphins likely would be uncommon near the proposed drill sites.

Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin has a cosmopolitan distribution in tropical to warm temperate waters from ~50°N to 40°S (Perrin et al. 1994; Jefferson et al. 2015). It occurs primarily in pelagic waters, but has been observed approaching shore where there is deep water close to the coast (Rudolph and Smeenk 2009). The striped dolphin's preferred habitat appears to be cool, deep, oceanic waters (Davis et al. 1998) along the edge and seaward of the continental shelf, particularly convergence zones and upwelling areas (Au and Perryman 1985).

In the Indian Ocean, striped dolphins occur from South Africa to the Arabian Sea and east to Australia (de Boer et al. 2003; Rudolph and Smeenk 2009). Off Western Australia, they are abundant around Barrow Island (Commonwealth of Australia 2012f), and several sightings were made near Browse Island and along the coast from Broome to the Maret Islands during vessel surveys in 2006–2007 (RPS 2007b *in* URS 2009). Ross (2006) noted that strandings occur infrequently in Australia; he reported 4 or 5 records for Western Australia, 2 from Queensland, and 2 for New South Wales. Twenty-seven stranding events have been reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b).

There are 5 records in the Australian National Whale and Dolphin Sightings and Strandings Database, including 1 sighting during March 1979 off Western Australia just to the north of the proposed drill sites at 30.9°S, 114.3°E (OBIS 2016). Eyre (1995) reported 1 sighting between northwestern Australia and Indonesia during a May–July 1993 survey in the IOS.

Striped dolphins likely would be uncommon near the proposed drill sites.

Short-beaked (*Delphinus delphis*) and Long-beaked (*D. capensis*) Common Dolphins

The common dolphin is found in tropical and temperate oceans around the world (Evans 1994). There are two species of common dolphin: the more coastal long-beaked common dolphin and the more offshore short-beaked common dolphin. The latter is more widely distributed than is the former (Heyning and Perrin 1994). Even though *D. delphis* shows a preference for offshore waters and *D. capensis* shows a preference for coastal waters, the two species are narrowly sympatric in some nearshore waters (Perrin 2009c). Long-beaked common dolphins are usually found within 90 km of shore (Barlow et al. 1997) and are generally not sighted farther than ~180 km from shore (Jefferson et al. 2015). In coastal areas of the northern and eastern Indian Ocean and the western Pacific, a subspecies, *D.c. tropicalis* is suggested to occur (Jefferson and Van Waerebeek 2002); this subspecies may occur off Western Australia (Commonwealth of Australia 2012f). However, Perrin et al. (2009) commented that the existence of this subspecies is not strongly supported by morphological or genetic evidence.

Short-beaked common dolphins occur in Western Australia, South Australia, New South Whales, and Queensland; long-beaked common dolphins have not been confirmed in Australia (Bannister et al. 1996; Jefferson and Van Waerebeek 2002; Perrin et al. 2005; Jefferson et al. 2015). However, 3 sightings of long-beaked common dolphins and numerous sightings of short-beaked common dolphins were made near Browse Island, north of Broome, during vessel surveys in 2006–2008; short-beaked common dolphins were also sighted along the coast between Broome and the Maret Islands (RPS 2007b *in* URS 2009). A possible sighting of short-beaked dolphin was also made in Shark Bay during 1989 (Preen et al. 1997). Common dolphins appear to concentrate in two areas of Australia: the southern southeastern Indian Ocean and the Tasman Sea (Commonwealth of Australia 2016e). There were 28 stranding events of short-beaked common dolphins in Western Australia between 1981 and 2010 (Groom and Coughran 2012b). Although there are no records of *D. delphis* for Western Australia in the OBIS database, there are 281 records for southeastern Australia (OBIS 2016). There were no records of *D. capensis* for Australia in the OBIS database (OBIS 2016).

Short-beaked common dolphins likely would be uncommon near the proposed drill sites.

Dusky Dolphin (*Lagenorhynchus obscurus*)

The dusky dolphin occurs in temperate and subantarctic zones of the Southern Hemisphere, at ~26–55°S, with occurrences to the north of that in association with colder currents (Bannister et al. 1996). It occurs in disjunct subpopulations in the waters off southern Australia, New Zealand (including some sub-Antarctic islands), central and southern South America (including the Falkland Islands), and southwestern Africa (Jefferson et al. 2015). Dusky dolphins migrate northward to warmer waters in winter and south during summer (Gaskin 1968). They are resident inshore for much of the year, but could also occur in offshore pelagic waters as temperatures increase during austral summer (Bannister et al. 1996). Würsig et al (2007) reported that they occur in coastal and continental slope waters and are uncommon in waters >2000 m deep.

Dusky dolphins are considered rare in Australian waters (Ross 2006). There are only a few records for waters off southern Australia, from Western Australia to Tasmania (Bannister et al. 1996; Gill et al. 2000). In the OBIS database, there is 1 record far offshore from Western Australia at 20.1°S, 90.8°E; 4 far offshore to the south of Australia; 1 for Victoria; and 4 east of Tasmania (OBIS 2016).

The dusky dolphin likely would be rare near the proposed drill sites.

Southern Right Whale Dolphin (*Lissodelphis peronii*)

The southern right whale dolphin is distributed between the Subtropical and Antarctic Convergences in the Southern Hemisphere, generally between ~30ºS and 65ºS (Jefferson et al. 2015). It is sighted most often in cool, offshore waters and along the outer edge of the continental shelf, although it is sometimes seen near shore where coastal waters are deep (Bannister et al. 1996; Jefferson et al. 2015). It is known to occur off southern continental Australia, Tasmania, and southwestern Australia (Bannister et al. 1996; Ross 2006). Southern right whale dolphins were sighted off southwestern Australia during surveys of the Southern Ocean Sanctuary between 1978 and 2004 (Van Waerebeek et al. 2010). One sighting of 120 individuals was made during 2002–2013 aerial surveys off southeastern Australia during the month of November (Gill et al. 2015). There are 9 records in the OBIS database for pelagic waters off southern and eastern Australia (OBIS 2016).

The southern right whale dolphin likely would be rare near the proposed drill sites.

Melon-headed Whale (*Peponocephala electra*)

The melon-headed whale is an oceanic species found worldwide in tropical and subtropical waters from ~35°N to 35°S (Ross 2006). It occurs most often in deep offshore waters and occasionally in near-shore areas where deep oceanic waters occur near the coast (Perryman 2009). In the Indian Ocean, the melon-headed whale occurs from the Seychelles to the Arabian Sea and Bay of Bengal and south to Australia (de Boer et al. 2003; Rudolph and Smeenk 2009). Records have been reported for various regions of the Indian Ocean (de Boer et al. 2003) including Australia (Leatherwood et al. 1991).

In Australia, the melon-headed whale has been recorded for Western Australia, Northern Territory (2 strandings involving 41 animals), Queensland (1 stranding of 53), and New South Wales (2 strandings of up to 257) (Ross 2006; Bannister et al. 1996). One stranding occurred at Mundrabilla, Western Australia, in the Great Australian Bight on the south coast, which might have been related to the warm Leeuwin Current (Bannister et al. 1996). One group of 10 melon-headed whales was sighted near Browse Island during 2006–2007 vessel surveys (RPS 2007b *in* URS 2009). No records were reported for Australia by Leatherwood et al. (1991). One stranding event was reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). There are 5 records in the OBIS database: 1 for the Northern Territory and 4 for the east coast (OBIS 2016).

The melon-headed whale likely would be uncommon near the proposed drill sites.

Pygmy Killer Whale (*Feresa attenuata*)

The pygmy killer whale has a worldwide distribution in tropical and subtropical waters (Donahue and Perryman 2009), generally not ranging south of 35°S (Jefferson et al. 2015). It is usually seen close to the coast in warm water, but it is also found in deep water (Wade and Gerrodette 1993). This species is known to inhabit the warm waters of the Indian, Pacific, and Atlantic oceans. In the Indian Ocean, pygmy killer whales occur from South Africa to the Arabian Sea and east to Australia (de Boer et al. 2003; Rudolph and Smeenk 2009).

In Australia, pygmy killer whale strandings have been reported for New South Wales and Western Australia, and sighting records exist for northeast Australia between August 2001 and February 2002 (Bannister et al. 1996; Ross 2006). The most southerly sighting was made off New South Wales at 37.3°S on 27 February 2004; 3 other sightings in the vicinity were made on 21 May 2005, 17 March 2007, and 18 March 2007 (Owen and Donnelly 2014). Off Western Australia, 1 group of 5 was sighted in Camden Sound during 2006–2007 vessel surveys along the Kimberley coast (RPS 2007b *in* URS 2009). No records of pygmy killer whales for Australia were reported by Leatherwood et al. (1991) for Australia. One stranding event was reported for Western Australia between 1981 and 2010 (Groom and Coughran 2012b). There are 2 records of pygmy killer whales in the OBIS database for the east coast of Australia (OBIS 2016).

The pygmy killer whale likely would be uncommon near the proposed drill sites.

Pinnipeds

Subantarctic Fur Seal (Arctocep*halus tropicalis*)

The subantarctic fur seal is listed as ***Vulnerable*** under the EPBC Act of Australia (Commonwealth of Australia 2016a); the world population was estimated at 277,000–356,000 by Hofmeyr et al. (1997). Subantarctic fur seals breed on subantarctic islands north of the Antarctic Polar Front and north of the subtropical front (Jefferson et al. 2015). The northern limit of their range is uncertain, but their secondary

range could include the waters of southwestern Australia (Jefferson et al. 2015). Small numbers are known to haul out along the southern coast of Australia, from Kalbarri, Western Australia, through South Australia, Tasmania, Victoria, and New South Wales (Gales et al. 1992b). Between 1980 and 1996, 45 sick, injured, or dead subantarctic fur seals were reported for Western Australia, mostly during summer and fall (Mawson and Coughran 1999). Of the 45, 17 returned to the wild; the most northerly record was for a resting seal at North West Cape (21.8°S) that returned to the sea (Mawson and Coughran 1999). There are 17 records for southeastern Australia in the OBIS database, none of which is for Western Australia (OBIS 2016).

The subantarctic fur seal likely would be rare near the proposed drill sites.

New Zealand Fur Seal (*Arctocephalus forsteri*)

The New Zealand fur seal is distributed in New Zealand and its subantarctic islands, and in southern Australia (Shaughnessy et al. 1994). It is distributed from The Pages Islands to the Great Australian Bight in South Australia; in Western Australia, it ranges along the south coast from the Recherche Archipelago to Flinders Island off Cape Leeuwin (Shaughnessy et al. 1994). According to the Commonwealth of Australia (2016f), the distribution includes the southern coast of Australia, from south of Shark Bay to northern New South Wales. Shaughnessy et al. (1994) reported 29 breeding sites in Australia, 13 in South Australia and 16 in Western Australia. The Commonwealth of Australia (2012g) subsequently noted ~51 breeding sites, including 30 in South Australia and 17 in Western Australia. Campbell et al. (2014) reported several new breeding colonies in Western Australia, for a total of 20; one new site is located on the west coast at Bunker Bay (~33.5°S), north of the previously most northerly breeding site in Western Australia. New breeding colonies have also been established on offshore islands off Victoria (Goldsworthy 2008).

New Zealand fur seals breed during the austral summer, and pups are born during December and early January (Goldsworthy and Shaughnessy 1994). During the pupping season, females stay close to breeding locations, and foraging trips do not extend past the continental shelf (Harcourt et al. 1995). During autumn and winter, foraging occurs farther from the breeding sites, with trips extending more than 150 km from breeding beaches and into water depths >1000 m (Harcourt and Davis 1997; Harcourt et al. 2002). During breeding season surveys in 1989–1990, 5636 and 1429 pups were counted in South Australia and Western Australia, respectively, resulting in an abundance estimate of 34,600 fur seals for those two areas; the abundance estimate for all of Australia, including Tasmania, was 34,700 (Shaughnessy et al. 1994). Based on more recent surveys during 2010–2011, the population size in Western Australia was estimated at ~17,200 and could be approaching its carrying capacity (Campbell et al. 2014). The total population size in Australia is estimated at ~80,000, with most of the population (~80%) occurring in South Australia (Goldsworthy 2008).

Between 1980 and 1996, 11 sick, injured, or dead New Zealand fur seals were reported for Western Australia, 3 of which returned to the wild (Mawson and Coughran 1999). There are no records of New Zealand fur seals for Australia in the OBIS database (OBIS 2016). It is possible that New Zealand fur seals could be encountered at the proposed drill sites during the time of the expedition.

Southern Elephant Seal (*Mirounga leonina*)

The southern elephant seal is listed as ***Vulnerable*** under the EPBC Act of Australia (Commonwealth of Australia 2016a). The population size was estimated at 739,498 in the 2000s (McMahon et al. 2005). Its distribution is nearly circumpolar in the Southern Hemisphere, and it breeds on subantarctic islands (Commonwealth of Australia 2016f). There are two main populations of elephant

seals in Australia, with principal breeding colonies on Heard and Macquarie islands (Shaughnessy 1999; McMahon et al. 2005); breeding occurs during September–October (Shaughnessy 1999). After breeding, adult females and males spend ~10 weeks and 14 weeks, respectively, at sea before moulting (Slip et al. 1994). Moulting occurs for ~4 weeks; adult females moult in January–February, whereas adult males moult in March (Slipe et al. 1994). After the moult, the seals return to sea until the following breeding season (Slip et al. 1994). Thus, few elephant seals are found on shore during the austral winter (Shaughnessy 1999). The primary feeding areas are found in subantartic and antarctic waters, as well as near the Antarctic Polar Front (Slip et al. 1994). According to Jefferson et al. (2015), the secondary distribution range of southern elephant seals includes southern Australia.

The southern elephant seal is considered to be a visitor to mainland Australia, especially to Tasmania where births have been reported (Pemberton and Skira 1989, Kirkwood et al. 1992 *in* Shaughnessy 1999). Records of a small number of births and animals coming ashore exist for Victoria, South Australia, Tasmania, New South Wales (including 2 near Sydney), and Western Australia (Mawson and Coughran 1999; Shaughnessy 1999; van den Hoff 2001; van den Hoff et al. 2002). Between 1980 and 1996, 8 sick, injured or dead elephant seals were reported for Western Australia, including 1 in July 1990, 7 of which returned to the wild (Mawson and Coughran 1999). The most northerly record was for Ningaloo Marine Park at 22°S (Mawson and Coughran 1999). There are no records for Western Australia in the OBIS database, but there are 3 records for southeastern Australia (OBIS 2016).

The southern elephant seal likely would be rare near the proposed drill sites.

Crabeater Seal (*Lobodon carcinophagus*)

The crabeater seal is circumpolar in the Antarctic (Jefferson et al. 2015). It occurs as a vagrant as far north as New Zealand, Australia, southern Africa, and South America (Jefferson et al. 2015). Between 1980 and 1996, 3 sick, injured, or dead crabeater seals were reported for Western Australia, including 1 in July 1982, 1 of which returned to the sea (Mawson and Coughran 1999). The most northerly record was for Safety Bay at 32.3°S (Mawson and Coughran 1999). There are 5 records in the OBIS database for southeastern Australia, but no records for Western Australia (OBIS 2016).

The crabeater seal likely would be rare near the proposed drill sites.

Leopard Seal (*Hydrurga leptonyx*)

The leopard seal occurs widely in antarctic and subantarctic waters (Jefferson et al. 2015). Extralimital sightings have been reported for the southern Indian Ocean, and its secondary range could include the waters of southern Australia (Jefferson et al. 2015). Between 1980 and 1996, 27 sick, injured, or dead leopard seals were reported for Western Australia, mostly for summer and fall (Mawson and Coughran 1999). Of the 27, 12 returned to the wild; records were reported as far north as Geraldton at 28.8°S (Mawson and Coughran 1999). There are 37 records for southeastern Australia in the OBIS database, but no records for Western Australia (OBIS 2016).

The leopard seal likely would be rare near the proposed drill sites.

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