Protected Species Mitigation and Monitoring Report

Marine Geophysical (Seismic) and Oceanographic Survey in the Dumont d'Urville Sea off the coast of East Antarctica

29 January 2014 – 16 March 2014

RVIB *Nathaniel B. Palmer*

Prepared for

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for submission to

National Marine Fisheries Service, Office of Protected Resources 1315 East-West Hwy, Silver Spring, MD 20910-3282

Project No.		**10 Enterprise Rd.**
Cruise ID No.	**NBP14-02**	**Sandy Bay, Tasmania**
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1. EXECUTIVE SUMMARY

In support of the United States Antarctic Science Program (USAP), the National Science Foundation (NSF) Division of Polar Programs research vessel/icebreaker (RVIB) *Nathaniel B. Palmer*, operated by the Antarctic Support Contract (ASC), conducted a marine geophysical (seismic) and oceanographic survey in the Dumont d'Urville Sea off the coast of East Antarctica. The primary area for study was the Totten Glacier (TG) system including the Moscow University Ice Shelf (MUIS) along the Sabrina Coast and the Mertz Glacier (MG) and Cook Ice Shelf (CIS) along the Oates Coast. The purpose of the survey was to evaluate the recent behavior of the glacial systems, based on seafloor morphology, sub-bottom profiling, high-resolution seismic-imaging and marine sediment core evaluation; elucidate the longer term role of the TG as it responded to late Quaternary changes in climate and sea level, and assess the present day physical oceanographic and particulate dynamic processes associated with the deep basins that surround the TG tongue. The *Palmer* departed Hobart, Tasmania on 29 January 2014. The survey commenced on the 3 February 2014 and was completed on the 7 March 2014. The *Palmer* arrived back in Hobart on the 16 March 2014.

The NSF and ASC submitted an application to the National Oceanographic and Atmospheric Administration National Marine Fisheries Service (NMFS) for a permit to harass marine mammals, incidental to the low-energy geophysical (seismic) survey. An Incidental Harassment Authorization (IHA) was issued to the NSF and ASC on the 31 January 2014 (Appendix A) with several mitigation measures that stipulated harassment to marine mammals. Mitigation measures were implemented to minimize potential impacts to marine mammals during the cruise and the seismic survey. Measures included, but were not limited to, the use of NMFS-qualified, vessel-based Protected Species Observers (PSO) for visual monitoring; establishment of buffer and exclusion zone radii; implementation of start, ramp-up and shut-down procedures, and speed or course alteration.

The NSF and ASC engaged the services of two PSOs to provide PSO coverage and to fulfil the environmental regulatory requirements and reporting mandated by NMFS in the IHA. Both PSOs, including one marine mammal expert familiar with species in the Southern Ocean who served as the lead PSO, were present on board the *Palmer* throughout the survey in this capacity.

Protected Species Observers undertook visual watches for seismic operations as well as icebreaking activities. To facilitiate 24 hour visual observations for icebreaking activities (as required), members of the science party were trained and utilized to conduct observations. A total of 111 hours 58 minutes of visual observations were conducted for seismic operations and 152 hours 4 minutes were conducted for icebreaking activities over the course of the survey.

Visual monitoring effort for seismic operations produced a total of 17 protected species detection records for cetaceans and pinnipeds. Pinnipeds constituted the majority of sightings with 10 detection records. There were 3 detections of mysticetes including a detection of an unidentified baleen whale. There were no detections of odontocetes. Visual monitoring during icebreaking activities resulted in a total of 230 detections. Pinnipeds constituted the majority of sightings with 199 detection records. There was one detection record of mysticetes and one of odontocetes as well as one of an unidentified cetacean.

Detections of protected species resulted in 7 mitigation actions being implemented, including 5 course alterations and 2 shut-downs. This resulted in a total of 5 minutes of mitigation downtime. A total of 2 cetaceans and 27 pinnipeds were known to have been exposed to the seismic activity at received sound pressure levels (SPLs) greater than or equal to 160 dB re 1 ~Pa (rms), and 2 pinnipeds were known to have been exposed to the seismic activity at received SPLs greater than or equal to 190 dB re 1 ~Pa (rms), constituting a level B harassment take as defined by the NMFS. Cetacean level B harassment takes included 2 minke whales (*Balaenoptera acutorostrata*). Pinniped level B

harassment takes included 25 crabeater seals (*Lobodon carcinophaga*), 2 Weddell seals (*Leptonychotes weddellii*), and 2 unidentified seals.

A total of 3 cetaceans and 316 pinnipeds were known to have been exposed to received SPLs greater than or equal to 120 dB re 1 ~Pa (rms) of sound during icebreaking activities, constituting a level B harassment take as defined by the NMFS. Cetacean level B harassment takes included one minke whale, one Killer whale (*Orcinus orca*), and one unidentified whale. Pinniped level B harassment takes included 281 crabeater seals, 3 leopard seals (*Hydrurga leptonyx*), 10 Weddell seals, and 22 unidentified seals.

A project summary sheet of observation, detection and operational totals for the *Palmer* can be found in Appendix B.

2. INTRODUCTION

The following report details protected species mitigation and monitoring as well as seismic survey and icebreaking operations undertaken as part of the marine geophysical and oceanographic survey on board the RVIB *Palmer* from the 29 January to 16 March 2014 in the Dumont d'Urville Sea off the coast of East Antarctica.

This document serves to meet the reporting requirements pursuant to the IHA issued to the NSF and ASC by NMFS on the 31 January 2014. The IHA authorised the harassment of specific marine mammals, by level B harassment only, incidental to the low-energy marine seismic survey operations as well as icebreaking activities conducted aboard the *Palmer*. The NMFS has stated that seismic source SPLs greater than or equal to 160 dB re 1 ~Pa (rms) for seismic survey operations, or greater than or equal to 120 dB re 1 ~Pa (rms) for icebreaking activities could potentially disturb marine mammals, involving temporary changes in behaviour, such that they could be considered as 'takes' of these exposed animals. Potential effects of level B harassment taking could include one or more of the following: tolerance, masking of natural sounds, behavioural disturbance, temporary or permanent hearing impairment, or other physical effects (Richardson et al. 1995; Southall et al. 2007). It is not known to what degree these effects would be expressed in marine mammals exposed to the seismic or icebreaking activities at these received SPLs, and in order to take a precautionary approach, and to mitigate for these potential adverse effects on marine mammals, NMSF requires that provisions such as buffer and exclusion zone radii, and start, ramp-up, and shut-down procedures, be implemented.

2.1. PROJECT OVERVIEW AND LOCATION

The survey was conducted in two areas along the coast of East Antarctica (Figure 1). The survey took place in the approximate area of the Totten Glacier and Moscow University Ice Shelf systems, located on the Sabrina Coast, from greater than approximately 64° South and between 95 to 135° East, and the Mertz Glacier and Cook Ice Shelf systems located on the George V and Oates Coast, from greater than approximately 65° South and between approximately 140 to 165° East (Figure 2 and 3, respectively). Water depths ranged from approximately 100 to 1,000 metres, and possibly exceeded 1,000 metres in some areas. The low-energy seismic survey was conducted in International Waters (i.e. high seas) and consisted of 35 track lines, including 4 and 31 lines in the MG and TG-MUIS area, respectively. The *Palmer* deployed a two generator-injector (GI) airgun array as a low-energy seismic source. The receiving system consisted of a 100 metre long, 24-channel streamer, which was towed during multichannel seismic (MCS) operations (Figure 4). Channel spacing was 3.125 metres, with 3 hydrophones per channel. Total active length was 75 metres, with the center of the near channel located 23 metres behind the stern (maximum allowed by streamer

lead-in). This towing configuration led to a geometry with the near channel forward of the airguns by 12.5 or 6.25 metres, depending on source towing location. Depending on ice conditions, a small drogue or a Polyform buoy was attached to the tail of the streamer. As the airgun array was towed along the survey lines, the hydrophone streamer received the returning acoustic signals and transferred the data to the on-board acquisition system.

The aim of the proposed research was to collect data to study both the dynamics and the controls of the TG system, and to resolve ambiguity in large ice mass dynamic behaviour. The TG system, which drains one-eighth of the East Antarctic Ice Sheet and contains more ice volume than the entire West Antarctic Ice Sheet, remains the single largest and least understood glacial system which possesses a potentially unsteady dynamic. A total of 866.1 km of transect lines were surveyed, including 112.6 and 753.5 km in the MG and TG-MUIS study areas, respectively. The *Palmer's* cruising speed was approximately 10-12 knots during transits and varied between 4 and 5 knots during the seismic survey. Seismic acquisition commenced on the 4 February and continued until the end of the project on the 7 March.

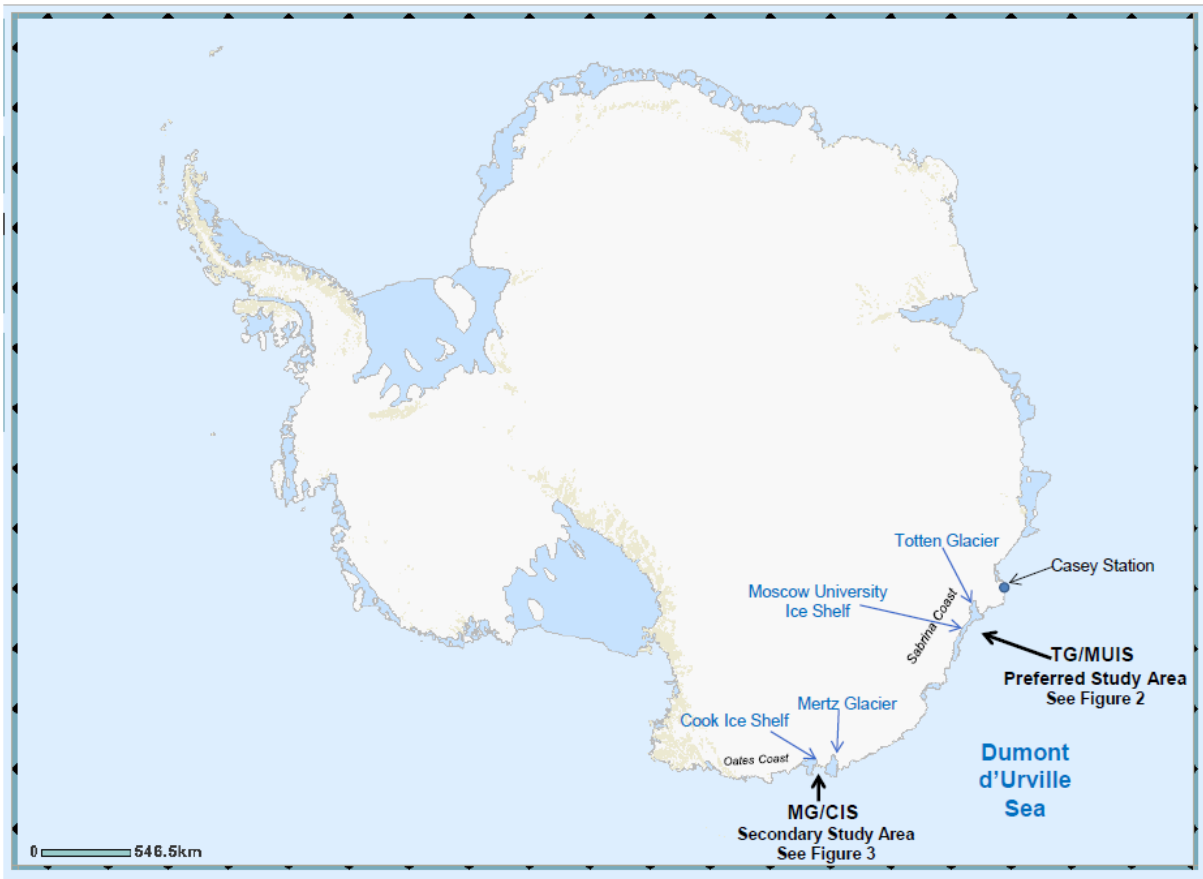


Figure 1. Location of the Totten Glacier/Moscow University Ice Shelf and Mertz Glacier-Cook Ice Shelf study areas off the coast of East Antarctica.

2.1.1. ENERGY SOURCE

The seismic source consisted of a pair of 45 in^3 Sercel GI airguns towed on a string at 3 metre spacing from each other, and at a tow depth of 2.3 or 2.8 metres (as inferred from frequency analysis of acquired data). A third 45 in^3 GI airgun was towed midway after the two primary guns, to serve as a hot spare when one of the primary airguns broke down. The two primary airguns were situated 35.5 metres from the stern for survey lines 1-4 and 29 metres for subsequent lines.

The two airguns fired the compressed air volume in unison in a harmonic mode, with a total generator volume of 90 in^3 and a maximum firing pressure of 2,000 psi. Seismic pulses were omitted at intervals of approximately 5 seconds equating to a shot point interval of 12.5 metres. The greatest energy output occurred in the 20-300 hertz (Hz) frequency range, with maximum power at 100-160 Hz. The receiving system during the acquisition of the MCS survey lines consisted of a gel-filled Teledyne 24-channel streamer. As the source was towed along the survey line, the towed hydrophone array (streamer) received the reflected acoustic signals and transferred the data to the on-board acquisition system.

Airgun synchronization and timing were controlled by a Real-Time Systems HotShot shotbox and HotShot software running on a shipboard Compaq laptop. Guns were fired every 5 seconds, with injector delay set to 39 ms (3.0 metre gun depth) or 40 ms (2.5 metre gun depth).

In addition to the operations of the airgun array, other geophysical measurements were made using swath bathymetry, backscatter sonar imagery, high-resolution sub-bottom profiling ("CHIRP"), imaging, and magnetometer instruments. In addition, other transducer-based instruments onboard the vessel were used continuously during the cruise for operational and navigational purposes. Instruments used onboard the RVIB *Palmer* included a two single beam echo sounders (Knudsen 3260 and Bathy 2000), a multi-beam sonar (Simrad EM120), two acoustic doppler current profilers (ADCP) (Teledyne RDI VM-150 and Ocean Surveyor OS-38), and an acoustic locator (Pinger). During the survey a precession magnetometer and Air-Sea gravity meter were also deployed. In addition, 24 expendable bathythermographs (XBTs) were released (and not recovered) over the course of the cruise to obtain temperature data necessary to calculate sound velocity profiles used by the multi-beam sonar.

3. MITIGATION AND MONITORING METHODS

The PSO monitoring program on the *Palmer* was established to meet the IHA requirements that were issued to the NSF and ASC by NMFS, which included both monitoring and mitigation objectives. The purpose of the survey mitigation program is to minimize potential impacts of the *Palmer's* seismic operations as well as icebreaking activities on marine mammals. The following monitoring protocols were followed to meet these objectives:

- Visual observations to watch for and monitor marine mammals in order to implement the mitigation measures that require real-time sighting data.
- The use of two Protected Species Observers (PSOs) consistent with NMFS requirements, including a marine mammal expert familiar with species in the Southern Ocean to serve as the lead PSO.
- Established buffer and exclusion radii for triggering mitigation.
- Minimum of one observer maintaining a visual watch for marine mammals during all airgun operations.
- Two observers maintaining a visual watch for marine mammals from at least 30 minutes before the start of ramp-ups, through the duration of the ramp ups (and when possible at other times) during the day and at night.
- Ascertain the effects of marine mammals exposed to sound levels constituting a 'take'.

In addition to the mitigation objectives outlined in the IHA, PSO's collected and analysed necessary data mandated by the IHA (see Appendix A).

3.1. VISUAL MONITORING SURVEY METHODOLOGY

There were two NMFS approved PSOs on board to conduct the monitoring for marine mammals, record and report on observations, and request mitigation actions in accordance to the IHA as necessary. The lead PSO was a marine mammal expert familiar with species in the Southern Ocean. The second PSO received additional training from the lead PSO to ensure that they could identify Southern Ocean species. To meet the IHA monitoring requirements for icebreaking activities (as required), members of the science party aboard the *Palmer* were trained and utilized, in addition to the two PSOs. A pre-operations training session was carried out by the PSOs for all science members on the 3 February. The training session included review of:

- IHA requirements for icebreaking.
- Marine mammal species protected under the Endangered Species Act (ESA) and the IHA authorised level of take for each of the ESA listed species.
- Taxonomy, physical and behavioural characteristics, and identification cues for species most likely to be encountered within the survey area.
- Monitoring and recording methods, including how to calculate distance to animals using reticule binoculars, and record weather and visibility conditions.

The PSOs also conducted one-on-one training with members of the science party prior to operations and were available before, during and after operations as necessary.

Visual monitoring was carried out from the ship's bridge deck located 19.8 metres above the water surface, which afforded the PSOs and members of the science party a 270 degree viewpoint around the acoustic source. The bridge was equipped with Fujinon 7x50 binoculars or equivalent and a laptop for data collection. Also available was a telephone for communication between the bridge and the main lab, monitors that displayed current information about the vessel's position, speed,

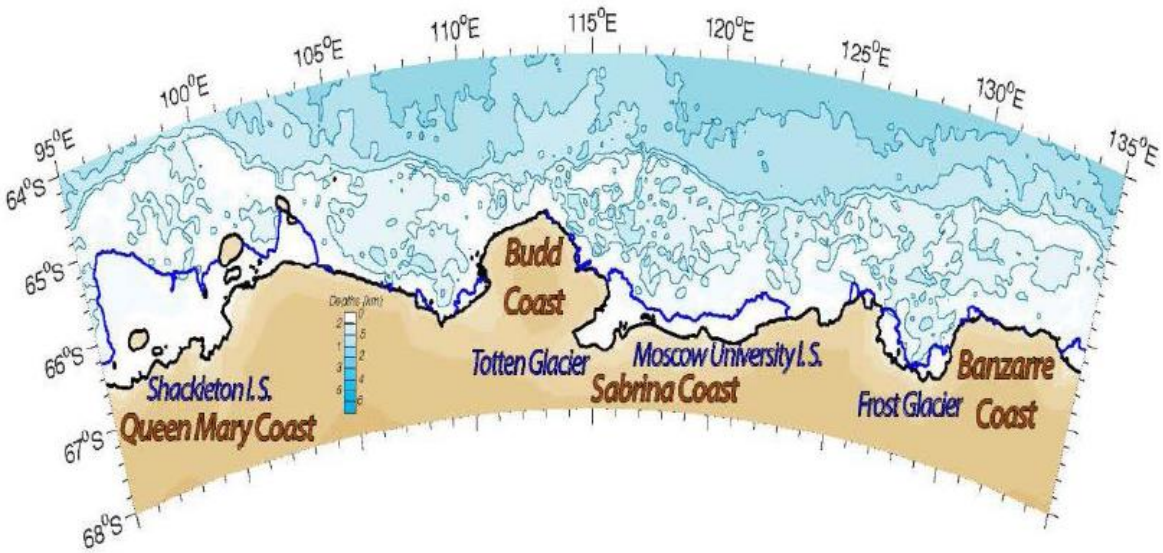


Figure 2. Location of the Totten Glacier/Moscow University Ice Shelf marine geophysical survey off the coast of East Antarctica.

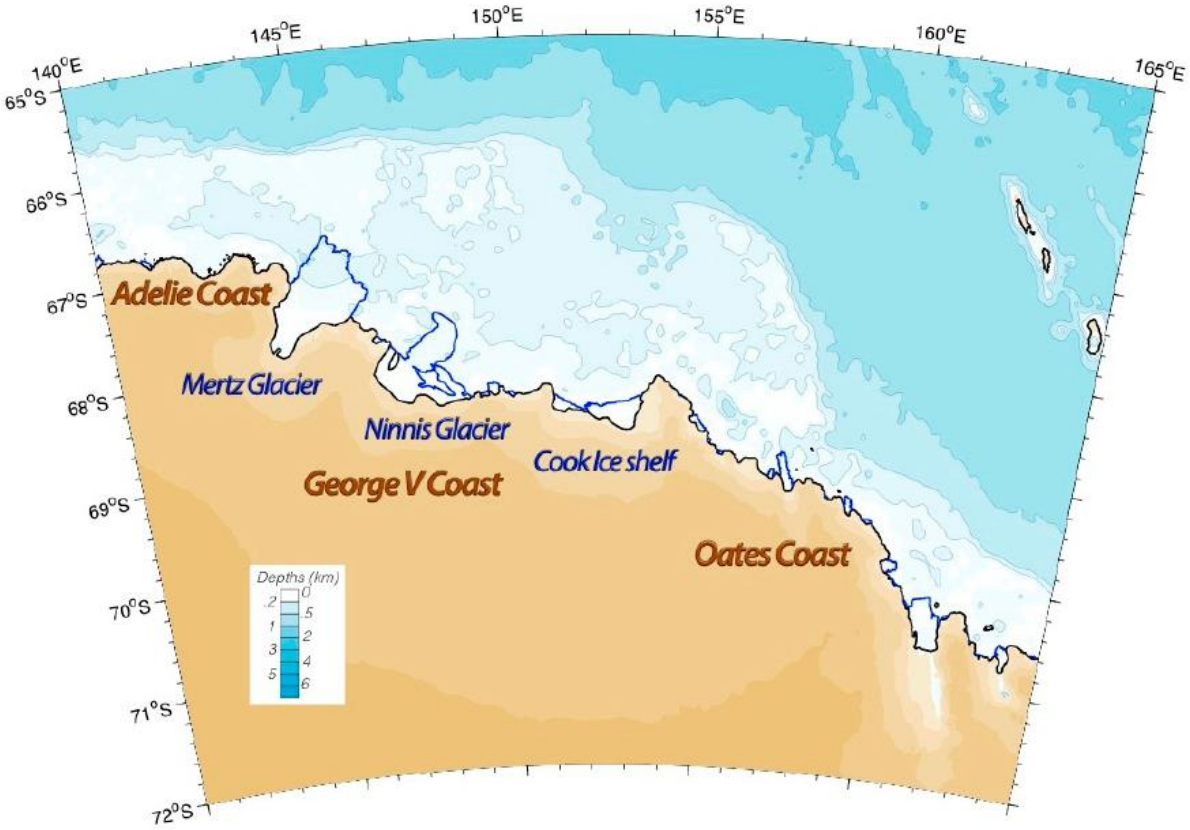


Figure 3. Location of the Mertz Glacier marine geophysical survey off the coast of East Antarctica.

and heading, along with water depth, wind speed and direction, and source activity. The ship's flood lights were also available to visualise and effectively monitor the entire relevant safety radii during low-light airgun operations, including when the airgun array and streamer were being recovered from the water, and were used once during seismic operations. Flood lights were also used to optimise visibility and monitoring of the relevant safety radii during night time icebreaking activities.

Observations were focused forward, to the sides and behind the vessel, with regular sweeps through the area around the active acoustic source. PSO(s) or science personnel searched for blows indicating the presence of a marine mammal, splashes or disturbances to the sea surface, the presence of large flocks of feeding seabirds, objects on the surface of the sea ice that may be pinnipeds hauled out, and other sighting cues indicating the possible presence of a protected species.

When a protected species was observed during seismic or icebreaking activities range estimations were made using reticule binoculars, the naked eye, and by relating the animal to an object at a known distance, such as the acoustic array located 35.5 or 29 meters astern. Specific species identifications were made whenever distance, length of sighting and visual observation conditions allowed. PSOs or science personnel observed anatomical features of animals sighted with the naked eye and through reticule binoculars and noted behavior of the animal or group. Photographs were taken during some sightings. Photographs were not taken due to the brevity of some sightings. The camera used was a Canon EOS M with either 18-55 or 55-250 millimeter telephoto lens. Marine mammal identification manuals were consulted and photos were examined during visual watch breaks to confirm identifications.

During or immediately after each sighting event PSOs and science personnel recorded the event per the requirements of the IHA. Each sighting event was linked to an entry on a datasheet such that environmental conditions were available for each sighting event. PSO(s) and science personnel recorded the species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading, bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel and behavioural pace for each sighting event. Time, location, heading, speed, activity of the vessel, Beaufort sea state and wind force, visibility, and sun glare were also recorded at the start and end of each observation watch and during a watch whenever there was a change in one or more of the variables.

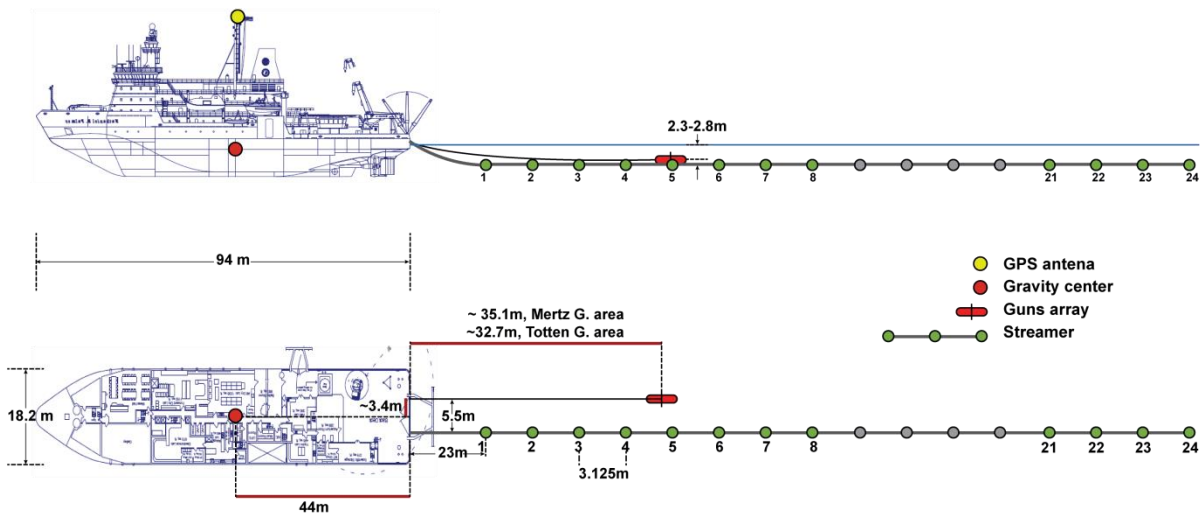


Figure 4. Geometry of the multichannel seismic array.

3.1.1. SEISMIC OPERATIONS

Visual monitoring methods were implemented in accordance with the survey requirements outlined in the IHA. During the majority of seismic operations, one PSO would visually watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from nautical twilight-dawn to nautical twilight-dusk), apart from before and during ramp-ups of airguns when PSOs conducted two-person visual watches.

PSOs maintained at least a 30 minute watch prior to the activation of the seismic source. If no animals were in or approaching the shut-down exclusion zone the airguns were ramped up (i.e. the output sound level was gradually increased by first using one GI airgun and then adding the second) to provide time for undetected animals to vacate the area. During ramp-up, the time between airgun shots was five minutes.

Commencement of visual watches varied from nautical twilight-dawn, beginning as soon as the safety radii were visible, to later in the daytime depending on the seismic survey schedule, and weather and sea ice conditions. Visual watches continued to nautical twilight-dusk until the safety radii became obscured, or when sea ice conditions prevented further operations. Start of observation times ranged from 04:52 to 17:01 24-hour local time, while end of observation times ranged from 16:37 to 22:59 24-hour local time.

In accordance with the IHA, PSO(s) shifts lasted no longer than 4 hours at a time during seismic operations. A visual monitoring schedule was established by the PSOs where each person completed

visual observations watches for 4 hours, twice a day, for a total of up to 16 hours of visual monitoring per day. During off hours, the resting PSO would be called for consultation should a second opinion be needed, but this did not occur during the seismic survey.

Upon the visual detection of a protected species, PSO(s) would first identify the animals range to the acoustic source while identifying the observed animal (cetacean or pinniped) to determine which safety radius applied to the animal. If the animal was observed inside the shut-down exclusion zone and a mitigation action was necessary, the PSO(s) notified the ship's mate on bridge duty to relay the message to the main lab via direct telephone contact. Table 1 describes the various safety radii applied to cetaceans and pinnipeds, as well as what constituted the Level B harassment zone.

Observations within the Level B harassment zone also included searching for pinnipeds that may be present on the surface of the sea ice (i.e. hauled out) and that could potentially dive into the water as the vessel approaches. The ship may alter vessel course and/or speed to avoid intercepting the path of an approaching marine mammal if the manoeuvre can be implemented safely and without damaging the deployed equipment.

Table 1. The buffer and exclusion zone radii used for triggering mitigation.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted RMS Radii Distances (m)		
			Shut-down Exclusion Zone for Pinnipeds 190 dB	Shut-down exclusion zone for cetaceans 180 dB	Level B Harassment Zone 160 dB
Two 45 in3 GI airguns (90 in3 total)	3	Intermediate (100 to 1,000)	100	100	600

3.1.2. ICEBREAKING ACTIVITIES

Visual monitoring methods were implemented during icebreaking activities in 50% or greater ice coverage, in accordance with the activity requirements contained in the IHA. During the majority of icebreaking activities, one trained member of the science party would visually watch for and monitor marine mammals near the vessel during day and night time icebreaking activities.

To achieve 24 hours of monitoring, science personnel and PSOs rotated through visual monitoring shifts with science personnel monitoring many of the night time hours (i.e. after sunset and before sunrise) when visual detection of the safety radius and presence of protected species was almost impossible. One trained scientific personnel or PSO conducted visual watches for 2 hours, once every 24 hours (as required). This schedule was arranged to ensure that the two dedicated PSOs were available to commence visual observations for seismic operations as required and that monitoring shifts did not impact on the marine science activities of scientific personnel.

Upon the visual detection of a protected species, science personnel or PSO(s) would first identify the animals range to the vessel while identifying the observed animal (cetacean or pinniped) to determine if the animal was exposed to icebreaking activities at received levels greater than or equal to 120 dB re 1 ~Pa (rms), constituting a take by level B harassment.

4. MONITORING EFFORT SUMMARY

4.1. SURVEY OPERATIONS SUMMARY

The *Palmer* departed Hobart, Tasmania for the marine geophysical (seismic) and oceanographic survey site in the Dumont d'Urville Sea, East Antarctica at approximately 03:00 UTC on 29 January 2014. The seismic gear was deployed and use of the acoustic source commenced at 23:35 UTC on 3 February in the MG study area. Acquisition began on the first survey line at 01:16 UTC on 4 February. Acquisition of the survey lines was completed at 12:07 UTC on 7 March in the TG/MUIS study area. The *Palmer* began the transit to Hobart, Tasmania arriving at approximately 20:00 UTC on 15 March 2014. The dates and times of acquisition for each survey line can be found in Appendix C.

The acoustic source was continuously active for up to 16 hours at a time throughout the survey, with several periods of source silence, for a total of 105 hours 22 minutes of source activity. This includes testing of airguns, ramp-up of the airguns, and full power firing both online and during line changes. Full power source operations, while online, accounted for 99% (104 hours 13 minutes) of airgun activity during the project. Testing of the airguns was carried out during full power online operations. Line changes were mostly shot at full power, totalling 33 minutes of array activity.

The acoustic source was ramped up nine times over the course of the survey in order to commence full power survey operations (Table 2). Single airgun operations occurred once during full power online firing (Line 7), lasting 2 hours 57 minutes, due to operational failure of one of the primary and 'hot spare' airguns.

Table 2. Total acoustic source operations during the seismic survey in the Dumont d'Urville Sea.

Acoustic source operations	Number	Duration (hh:mm)
Testing of airguns	2	00:02
Ramp-ups	9	01:09
Day time ramp-ups from silence	9	
Daytime ramp-ups from mitigation	0	
Night time ramp-ups from mitigation	0	
Full power survey acquisition		104:13
Full power line changes		00:33
Single 45 in^3 GI airgun	1	02:57
Total time acoustic source was active		**105:22**

4.2. VISUAL MONITORING SURVEY SUMMARY

4.2.1. SEISMIC OPERATIONS

The two PSOs began visual observations for seismic operations at 22:45 UTC on 3 February in the MG study area (66.61°, 145.82°; Figure 3). Observations ended at 12:09 UTC on 7 March in the TG/MUIS study area (65.76°, 120.8°; Figure 2), the day before the *Palmer* began transit back to Hobart, Tasmania. Visual monitoring was conducted for a total of 8 days of seismic survey operations, averaging approximately 13 hours 57 minutes of visual observations per day. The acoustic source was active for the majority of visual monitoring, accounting for 95% of the monitoring effort for seismic operations (Table 3).

Visual watches were held by one PSO, except before and during ramp-ups of airguns when PSOs conducted two-person visual watches. PSOs conducted alternating visual monitoring shifts for up to four hours, twice a day for a maximum operational period of 16 hours per day. The PSOs conducted visual observations from the ship's bridge deck, which provided the PSOs with a 270 degree view of the water around the vessel and acoustic source.

Table 3. Total visual monitoring effort for seismic operations and icebreaking activities.

Visual Monitoring Effort	Duration (hh:mm)
Seismic	
Total visual monitoring effort while acoustic source active	117:53
Total visual monitoring effort while acoustic source silent	05:55
Total monitoring effort for seismic	111:58
Icebreaking	
Total visual monitoring effort during night time	20:39
Total visual monitoring effort during day time	131:25
Total visual monitoring effort for icebreaking	152:04
Overall total monitoring effort	**264:02**

4.2.2. ICEBREAKING ACTIVITIES

Visual observations for icebreaking activities began at 11:04 UTC on 3 February. One trained science personnel commenced visual watch just prior to the *Palmer* entering 50% or greater ice cover to reach the open water region of the MG study area (65.75°, 144.95°; Figure 3). Observations continued to 09:23 UTC on 1 March 2014 just after the *Palmer* exited ice cover and entered the open water region of the TG/MUIS study area (66.75°, 119.01°; Figure 2). Visual watches were conducted by one person for two hours, once every 24 hours or as required. Thirteen trained science personnel, as well as the two PSOs, rotated through monitoring shifts. Visual monitoring was conducted for a total of 15 days of icebreaking activities (in conditions of 50% or greater ice cover). The majority of icebreaking activities occurred during daytime, with only 14% of total observation effort during night time (Table 3). Visual observations were conducted from the ship's bridge deck, which provided science personnel and PSOs with a 270 degree view of the water around the vessel.

Of the total observation effort performed by PSOs and science personnel for this survey, visual monitoring for icebreaking activities accounted for 58% (152 hours 4 minutes) while visual monitoring for seismic operations accounted for 42% (111 hours 58 minutes; Table 3).

4.3. ENVIRONMENTAL CONDITIONS

The environmental conditions varied over the 4 weeks and 5 days during the survey. Periods of fog and light to heavy snow fall were intermittently present throughout the survey and did at times affect visual observations. A total of 25 hours 32 minutes of snow fall were recorded during the survey, as well as 4 hours 39 minutes of fog (Table 4). Severe glare was often a factor that could affect sighting abilities. Excellent visibility for sighting conditions was considered to be 16 kilometres of visibility, a total of 164 hours 51 minutes was noted having less than 16 kilometres of visibility. Within these hours of reduced sighting conditions there was 45 hours 8 minutes with visibility of less than 1 kilometre (Table 4).

The Beaufort Sea State ranged from levels 0 through 11 during the survey. A sea state range of 0 to 3 was noted for a total of 100 hours 55 minutes, and was the most predominant during visual observations for icebreaking activities (Table 4). The next most observed sea state was a range of 4 to 5, recorded for a total of 64 hours 28 minutes, and was the most frequently recorded during

visual observations for seismic operations. A Beaufort Sea State reaching greater than 6 was noted for a total of 53 hours 44 minutes, with the majority occurring during visual observations for seismic operations (Table 4). The weekly totals recorded for the Beaufort Sea State during visual monitoring for seismic operations and icebreaking activities are presented in Figure 5 for comparison.

The predominant wind forces recorded during visual observations for seismic operations were 11 to 21 knots, with a total of 34 hours 13 minutes recorded (Table 4). Winds less than 10 knots were the most frequently recorded during icebreaking activities, with a total of 85 hours 1 minute recorded. Winds greater than 22 knots were the second most recorded for seismic operations (21 hours 54 minutes) and icebreaking activities (22 hours 33 minutes). The weekly wind speed totals for seismic operations and icebreaking activities are highlighted in Figure 6.

Swell heights remained relatively low throughout the survey with a total of 263 hours 6 minutes of swells noted less than two metres (Table 4). Week 3 of visual observations for icebreaking activities was the only period that swells greater than 2 metres were recorded; totalling 15 minutes of swells ranging from 2 to 4 metres.

Table 4. Summary of precipitation and visibility conditions during seismic operations and icebreaking activities.

Environmental conditions	Duration (hh:mm)		
	Seismic	Icebreaking	Total
Precipitation			
Fog	01:21	03:18	**04:39**
Snow	05:36	19:56	**25:32**
Visibility			
16 or greater kilometres	97:02	67:49	**164:51**
Less than 16 kilometres	11:42	86:48	**98:30**
(Less than 1 kilometre)	(01:07)	(44:01)	**(45:08)**
Wind force (Beaufort Scale)			
0 to 3	19:16	81:39	**100:55**
4 to 5	45:49	18:39	**64:28**
6 +	37:52	15:52	**53:44**
Wind speed (knots)			
Less than 10	19:29	85:01	**104:30**
11 to 21	34:13	13:47	**48:00**
22+	21:54	22:38	**44:32**
Swell			
Less than 2 metres	108:44	154:22	**263:06**
2 to 4 metres	00:00	00:15	**00:15**

5. MONITORING AND DETECTION RESULTS

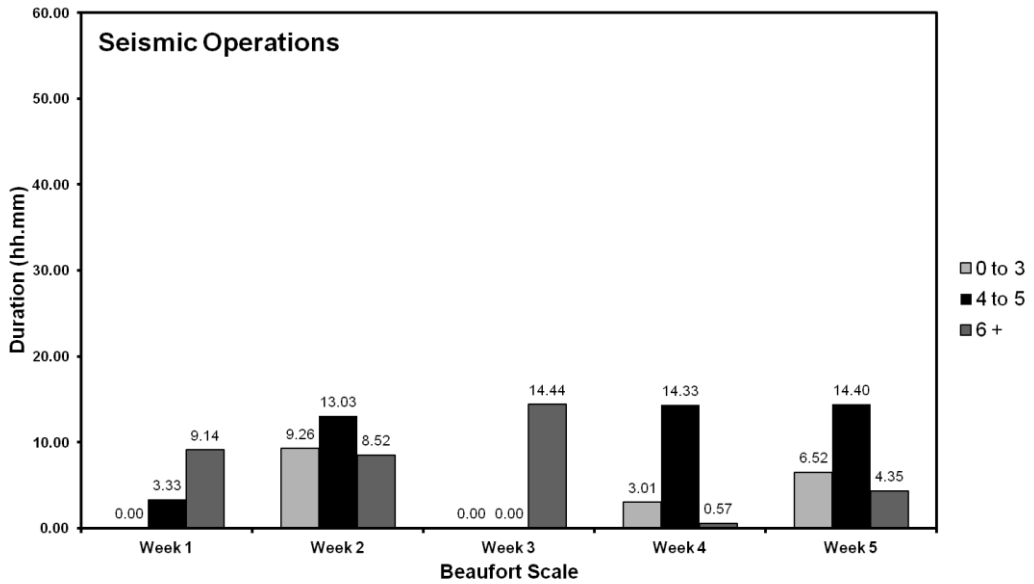
5.1. VISUAL DETECTIONS

Visual monitoring conducted during the marine geophysical (seismic) and oceanography survey in the Dumont d'Urville Sea resulted in the collection of 247 visual detection records for protected species by observers on the RVIB *Palmer*. A total of 230 detections were collected during icebreaking activities in 50% or greater ice cover and 17 detections were collected during seismic operation

(Table 5). Five species of marine mammals were positively identified, along with observations of an unidentified whale, unidentified baleen whale and unidentified pinnipeds.

Both cetaceans and pinnipeds were sighted during the survey, with pinnipeds the most frequently detected during seismic and icebreaking activities, accounting for 82% and 99% of total detection records, respectively (Table 5). Overall, the most detection records collected for a species was 209 records for crabeater seals, totaling 306 individuals. Additionally, there were 18 detections of unidentified pinnipeds, totaling 24 individuals, many of which were most likely to be crabeater seals.

(a)



(b)

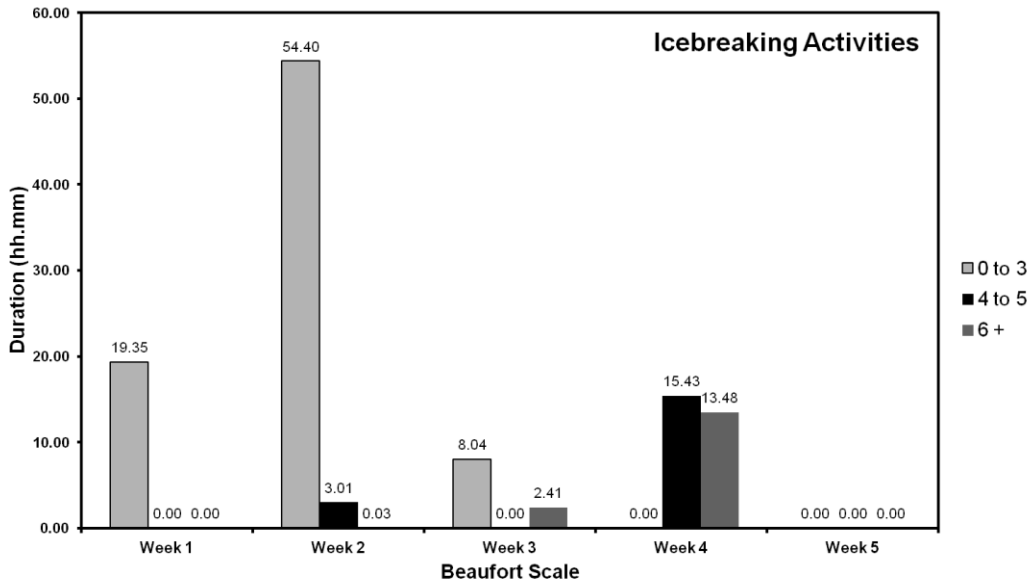
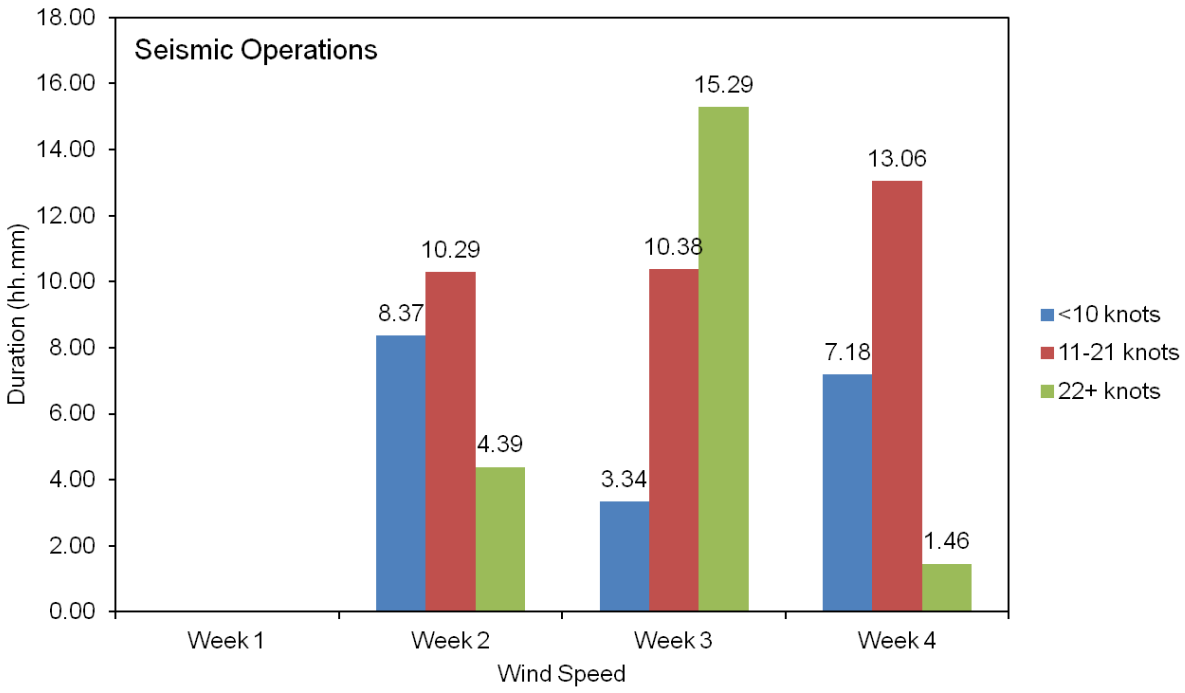


Figure 5. Beaufort Scale during visual monitoring for (a) seismic operations and (b) icebreaking activities throughout the marine geophysical and oceanography survey in the Dumont d'Urville Sea.

(a)



(b)

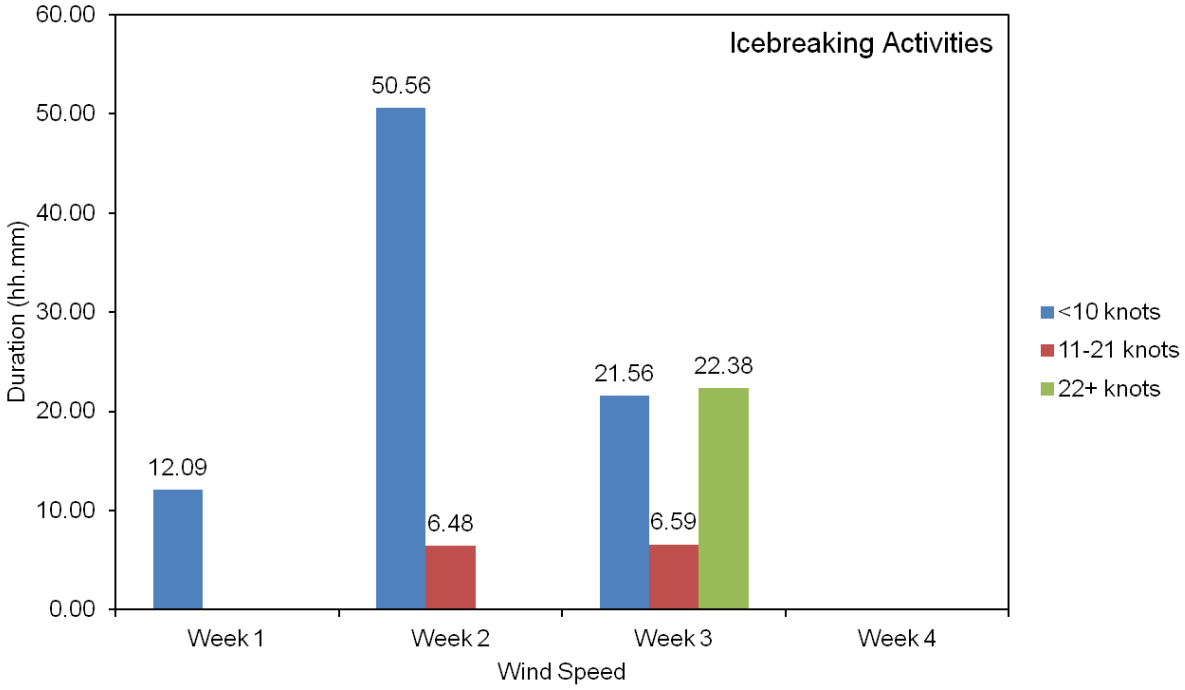


Figure 6. Average wind speed during visual monitoring for (a) seismic operations and (b) icebreaking activities throughout the marine geophysical and oceanography survey in the Dumont d'Urville Sea.

Table 5. Number of visual detection records, including number of individuals, collected for each protected species during icebreaking activities and seismic operations.

Species	Icebreaking		Seismic		Icebreaking and Seismic	
	No. detection records	No. individuals	No. detection records	No. individuals	No. detection records	No. individuals
Cetaceans						
Whale (unidentified)	1	1	0	0	1	1
Mysticetes						
Southern right whale	0	0	0	0	0	0
Minke whale	1	1	2	7	3	8
Sei whale	0	0	0	0	0	0
Blue whale	0	0	0	0	0	0
Fin whale	0	0	0	0	0	0
Humpback whale	0	0	0	0	0	0
Baleen whale (unidentified)	0	0	1	1	1	1
Odontocetes						
Dolphin (unidentified)	0	0	0	0	0	0
Long-finned pilot whale	0	0	0	0	0	0
Hourglass dolphin	0	0	0	0	0	0
Spectacled Porpoise	0	0	0	0	0	0
Killer whale	1	1	0	0	1	1
Sperm whale	0	0	0	0	0	0
Pinnipeds						
Crabeater seal	199	281	10	25	209	306
Leopard seal	3	3	0	0	3	3
Ross seal	0	0	0	0	0	0
Weddell seal	10	10	2	2	11	11
Southern elephant seal	0	0	0	0	0	0
Antarctic fur seal	0	0	0	0	0	0
Seal (unidentified)	15	22	2	2	18	24
TOTAL	**230**	**319**	**17**	**37**	**247**	**356**

5.1.1. SEISMIC OPERATIONS

There were relatively low numbers of sightings of protected species during the seismic survey in the Dumont d'Urville Sea with multiple detections of protected species occurring during only five days of the survey in the open water region of the MUIS study area (Figure 7). The highest number of detections occurred on 26 February UTC during seismic operations. Five detections of two positively

identified protected species were made on this day. The second highest number of detections was made on 23 February UTC, 5 March UTC and 7 March UTC with three detections of two positively identified protected species made on all of these days.

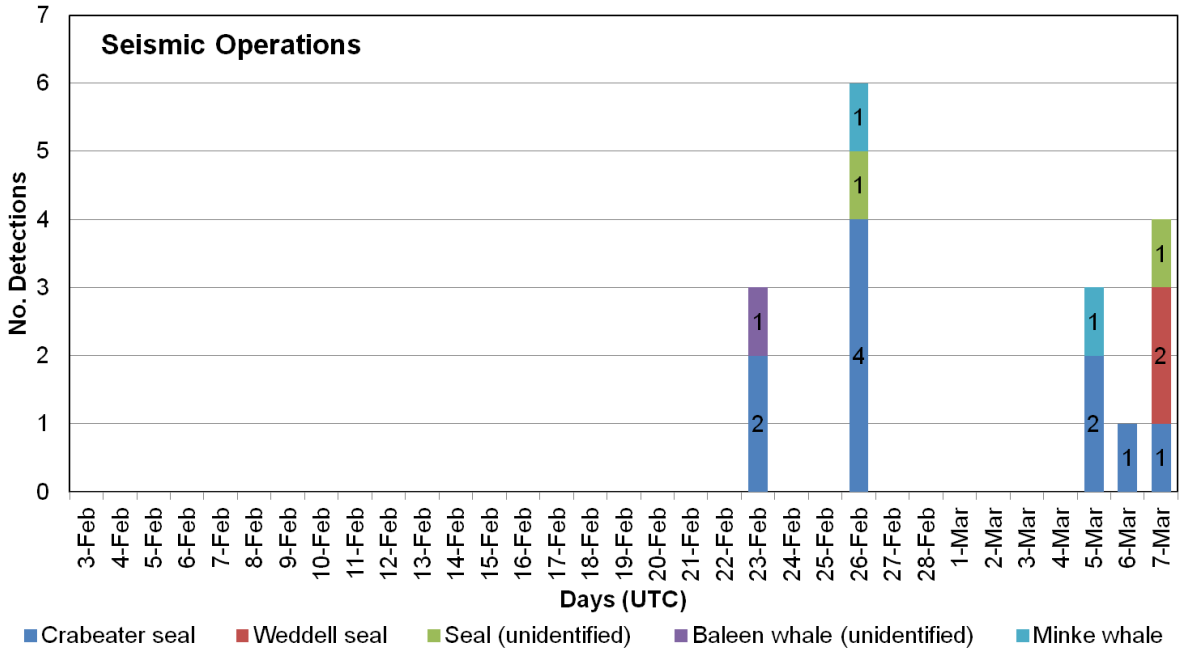


Figure 7. Number of protected species visual detections each day for seismic operations during the marine geophysical (seismic) survey in the Dumont d'Urville Sea, February and March 2014.

Of the 17 protected species detection events during seismic operations, 16 detections (94%) occurred while the acoustic source was active and 1 detection (12%) occurred while the acoustic source was silent. Figure 8 shows the species detected compared to acoustic source activity, and Table 6 shows the average closest approach of protected species to the source at various volumes.

5.1.1.1. CETACEAN AND PINNIPED DETECTIONS

5.1.1.1.1. Minke whale

There were 2 sightings of minke whales during seismic operations, totalling 7 individuals observed. The whales were noted to be in water depths ranging from 433-538 metres. The largest group size was five individuals observed on 26 February UTC. The second sighting consisted of two individuals observed on 5 March UTC. The closest approach to the sound source was 400 metres on 5 March UTC.

5.1.1.1.2. Unidentified baleen whale

There was one sighting of an unidentified baleen whale during the survey, consisting of one individual. Water depth was 446 metres, and the closest approach of the animal to the sound source was 1600 metres on 5 March UTC.

5.1.1.1.3. Crabeater seal

Twenty five crabeater seals were observed during ten sightings, three of which led to avoidance manoeuvres, but no source mitigation action was required. Six of the sightings consisted of one animal, one sighting consisted of two animals, two other sightings consisted of four and six animals, respectively, and another sighting consisted of seven seals, which was the largest group observed. Seals were noted to be in water depths ranging from 284-543 metres. There were eight sightings where seals were observed hauled out and on the sea ice and of these only one sighting resulted in an animal entering the water upon passing of the vessel. Only one sighting occurred while the airguns were not firing, during the pre-shooting observation, with the other nine sightings occurring during full power operations. The closest approach to the airguns was 120 metres on 7 March UTC.

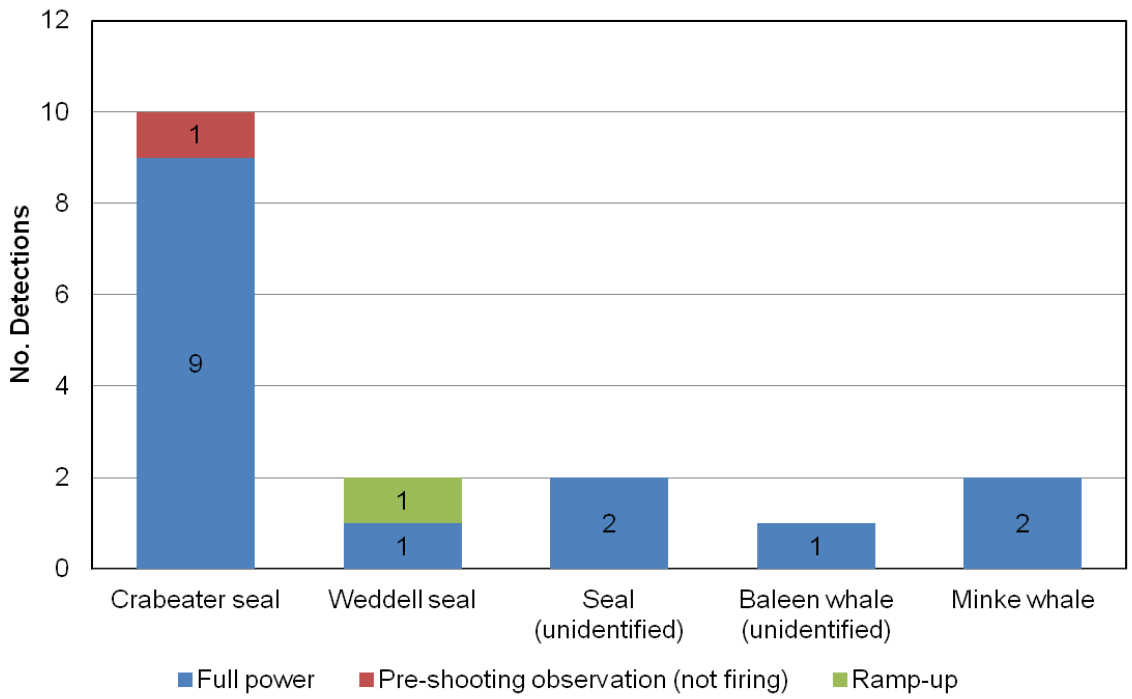


Figure 8. Acoustic (seismic) source activity compared to species detections.

5.1.1.1.4. Weddell seal

Two Weddell seals were observed during two sightings, resulting in one avoidance manoeuvre and two shut-downs. Both sightings occurred on 7 March UTC, 23 minutes apart, during the last day of seismic operations in the MUIS study area. The first sighting occurred during ramp-up (single airgun firing) and involved a seal hauled out on a passing ice flow. The vessel was averted slightly to the port side as the seal entered the exclusion zone and operations were shut-down. The seal remained hauled out on the ice flow upon passing of the vessel. The second sighting was of a seal in the water within the exclusion zone triggering a second shut-down. Both seals remained in the exclusion zone for less than one minute, with both seals observed exiting the exclusion zone. A water depth of 120 metres was noted for both sightings and the closest approach to the airguns was 50 metres.

5.1.1.1.5. Unidentified seal

Two unidentified seals were observed during two sightings, neither of which led to mitigation action. Seals were observed hauled out on the sea ice and remained on the ice upon passing of the vessel.

Water depth ranged from 120-121 metres. The closest approach to firing airguns was 200 metres on 7 March UTC.

5.1.2. ICEBREAKING ACTIVITIES

There were many sightings of protected species during icebreaking activities during the survey in the Dumont d'Urville Sea, with the majority of multiple detections of protected species occurring during the first two weeks of icebreaking operations (Figure 9). The highest number of detections occurred on the 10 February UTC, during week two of icebreaking activities to reach the open water region of the TG study area. On this day there were 74 detections of three positively identified protected species. The day with the second highest number detections was 4 February UTC, during week one of icebreaking activities to reach the open water region of the MG study area. A total of 57 visual detections of three positively identified protected species were made on this day. All visual detections for icebreaking activities occurred during transit of the vessel through 50% or greater ice cover to and from open water regions MG and TG/MUIS study areas.

Table 6. Average closest approach of protected species to the acoustic source at various volumes.

Species Detected	Full Power (90 in^3)		Pre-shooting observation (not firing)		Ramp-up (single airgun 45 in^3)	
	No. detections	Average closest approach to source (metres)	No. detections	Average closest approach to source (metres)	No. detections	Average closest approach to source (metres)
Crabeater seal	9	373	1	150	0	–
Weddell seal	1	50	0	–	1	80
Seal (unidentified)	2	400	0	–	0	–
Baleen whale (unidentified)	1	1600	0	–	0	–
Minke whale	2	700	0	–	0	–

5.1.2.1. CETACEAN AND PINNIPED DETECTIONS

5.1.2.1.1. Unidentified whale

There was one sighting of an unidentified whale observed during icebreaking activities on 3 February UTC. Closest approach to the vessel was 1000 metres (when the acoustic source was silent). Only the body was visible when the animal surfaced during this sighting.

5.1.2.1.2. Minke whale

There was one sighting of a minke whale observed during icebreaking activities on 4 February UTC. The whale was noted to be in a depth of 224 metres. The whale was first detected moving away from the vessel. The closest approach to the vessel was 200 metres.

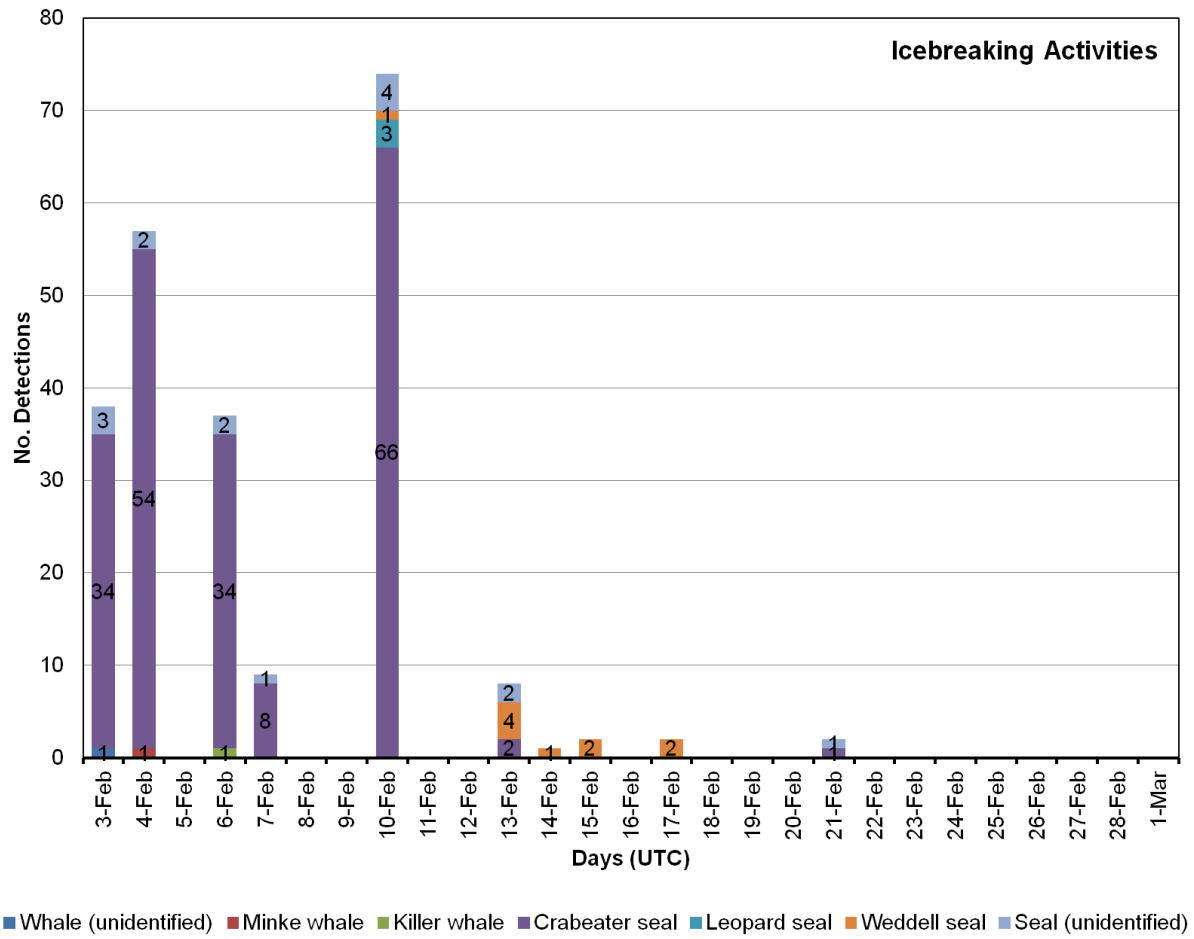


Figure 9. Number of protected species visual detections each day for icebreaking activities during the marine geophysical survey in the Dumont d'Urville Sea, February and March 2014.

5.1.2.1.3. Killer whale

A single killer whale was observed during icebreaking activities on 6 February UTC. The whale was observed breaching where a large crack in the sea ice had opened up, before diving under the surface upon the vessel approaching. The water depth for this animal was 412 metres. The closest approach to the vessel was 10 metres.

5.1.2.1.4. Crabeater seal

There were 199 sightings of crabeater seals during icebreaking activities, totalling 281 individuals observed. One of these sightings resulted in a single mitigation action, with the vessel slightly altering course to avoid two animals hauled out on an approaching ice floe. For each of the 199 sightings, seals were observed hauled out and on the sea ice and only four of these sightings involved animals entering the water upon passing of the vessel. The seals were noted at depths ranging from 15-3829 metres. The largest group size was seven individuals. Two groups of this size were observed on 4 and 10 February UTC. There were 149 sightings consisting of one individual, 32 sightings consisting of three individuals, 12 sightings of three individuals, four sightings of four individuals, and one sighting of five individuals. The closest approach to the vessel was 5 metres on 6 February UTC.

5.1.2.1.5. Leopard seal

Three individual leopard seals were observed during three sightings. All three sightings occurred during icebreaking operations to and from the open water region of the TG study area. The animals were noted to be in water depths ranging from 444-2690 metres. All animals were hauled out and on the ice when first detected and only one individual entered the water upon passing of the vessel. The closest approach to the vessel was 20 metres on 10 February UTC.

5.1.2.1.6. Weddell seal

Ten individual Weddell seals were observed during ten sightings. Eight sightings occurred during icebreaking activities to and from the open water region of the TG study area and two sightings occurred during icebreaking activities to search for open water regions in the MUIS study area. All animals were first observed hauled out and on the sea ice and only two of these sightings ended with animals entering the water upon passing of the vessel. Water depth for these sightings ranged from 376-887 metres. The closest approach to the vessel was 50 metres on 10 February UTC.

5.1.2.1.7. Unidentified seal

There were 15 sightings of unidentified seals during icebreaking activities, totalling 22 individuals observed. Water depth for these animals ranged from 215-2888 metres. There were nine sightings consisting of a single individual and six sightings consisting of two individuals. Thirteen sightings consisted of animals observed hauled out and on the sea ice. Only one of these sightings ended with an animal entering the water upon passing of the vessel. The closest approach to the vessel was 30 metres on 4 February UTC.

6. MITIGATION ACTION SUMMARY

There were 7 mitigations implemented during the marine geophysical and oceanography survey in the Dumont d'Urville Sea due to protected species being observed within the safety radii. Two mitigation actions consisted of shut-downs of the acoustic source and five consisted of avoidance manoeuvres in which the vessel altered course. The total duration of downtime caused by mitigation action was 5 minutes during the seismic survey. The number and duration of mitigation actions is summarized in Table 7. Seven mitigation actions were implemented for pinnipeds, while no mitigation action was required for mysticetes and odontocetes. There were no issues with implementing mitigation actions during this survey.

Table 7. Number and duration of mitigation actions implemented during the marine geophysical and oceanography survey in the Dumont d'Urville Sea.

Mitigation Action	Icebreaking Activities		Seismic Operations	
	Number	Duration (hh:mm:ss)	Number	Duration (hh:mm)
Shut-down of acoustic source	0	–	2	00:06
Avoidance manoeuvres	1	00:00	4	00:00
Course alteration	1	00:00	4	00:00
Speed alteration	0	–	0	–
Total	**1**	**00:00**	**6**	**00:05**

Mitigation actions were implemented more frequently for crabeater seals (4 avoidance manoeuvres) than for any other species (Table 8). Two shut-downs were implemented for two Weddell seal detections, accounting for 100% of the survey's mitigation downtime.

Table 8. Mitigation actions and downtime duration by species.

Species	Number of Avoidance Manoeuvres	Number of shut-downs	Duration of Downtime (hh:mm)	Percentage of Mitigation Downtime
Icebreaking Activities				
Crabeater seal	1	–	00:00	0%
Seismic Operations				
Crabeater seal	3	–	00:00	0%
Weddell seal	1	2	00:05	100%

Each mitigation action implemented during the survey is described in detail below:

The first mitigation action was implemented on 10 February for two crabeater seals (visual detection 166; Table 9 (a)) during icebreaking activities to reach the open water region of the TG study area. The seals were originally observed 200 metres off the starboard side of the vessel hauled out and stationary on an ice floe approaching the vessel at 03:53 UTC. To avoid intercepting the path of the approaching animals, the vessel was safely and successfully averted to port side. The seals were observed at regular intervals remaining approximately 50 metres from the vessel, hauled out and stationary on the ice floe as it passed the vessel on the starboard side. The duration of the sighting event was 4 minutes.

On 23 February a crabeater seal was observed hauled out on an ice floe within the 160 dB safety radius during full power operations at 05:14 UTC (visual detection number 1; Table 9 (b)). The vessel was averted to starboard side to avoid seal at approximately 05:15 UTC and at which time the seal entered the water, milling about at the surface for a few moments before diving under the surface as the vessel passed by. The seal did not enter the 190 dB safety radius, but remained within the 160 dB and no source mitigation action was required. The closest approach to the firing airguns by the seal was 200 metres. The surface of the water was observed at regular intervals for the next 22 minutes, but the seal was not detected again.

On 26 February another course alteration was implemented due to two crabeater seals that were observed milling in the water next to an ice floe within the 160 dB safety radius at 05:55 UTC during full power airgun operations (visual detection number 9; Table 9 (b)). The vessel was slightly averted to port side to avoid seals. The seals were observed to remain within the 160 dB radius (closest approach to firing airguns was 400 metres) for approximately the next 20 seconds before diving under the surface as the ship passed. The surface of the water was regularly scanned for the next 15 minutes, but the seals were not detected again. No source mitigation action was required.

On 5 March a crabeater seal was observed hauled out and lying stationary on an ice floe within the 160 dB safety radius at 07:38 UTC during the pre-shooting observation (visual detection number 10; Table 9 (b)). To avoid intercepting the path of the approaching animal and prevent it from entering the 190 dB safety radius, the vessel was averted to port side at approximately 07:40 UTC. The seal was observed at regular intervals remaining approximately 150 metres from the airguns (not firing) until the seal exited the 160 dB safety radius. The seal remained hauled out on the ice floe, lifting head momentarily upon passing of the vessel, but otherwise remained stationary throughout the event. No delay in ramp-up of airguns was required.

On 7 March a Weddell seal was observed hauled out and stationary on an ice floe within the 160 dB safety radius (visual detection number 14; Table 9 (a)). The ice floe was travelling towards the vessel approximately 10 degrees off the starboard bow. The seal was not detected before it entered the 160 dB safety radius as the line of sight from the vessel to the animal was blocked by ice which it was lying behind. It was not until closer approach by the vessel that the animal became visible, which

was within the 160 dB safety radius. The vessel was manoeuvred slightly to the port side and the animal was observed entering the 190 dB safety radius at 03:52 UTC and the acoustic source was shut-down. The animal was observed exiting the 190 dB safety radius approximately 30 seconds after entering it. The animal remained hauled out and stationary on the ice floe and was observed exiting the 160 dB safety radius and was not likely to return. The acoustic source was resumed at full power. These two mitigation actions resulted in 3 minutes of down time that occurred while the acoustic source was at 50% volume during the five minute ramp-up of airgun operations.

The last mitigation action was implemented on 7 March for a Weddell seal (visual detection number 15; Table 9 (b)). At 04:13 UTC the seal was detected in the water within the 190 dB safety radius on the port side of the vessel and the acoustic source was shut-down. The seal was observed exiting the 190 dB safety radius 15 seconds after initial detection. Once outside of the 190 dB safety radius, the seal was observed swimming away from the acoustic source, before diving under the surface and was not likely to return. The acoustic source was returned to full volume. This source mitigation action resulted in 2 minutes of down time during full power online seismic operations.

Table 9. Summary of each mitigation action implemented during (a) icebreaking activities and (b) seismic operations in the Dumont d'Urville Sea.

(a)

Date (UTC)	Visual Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Vessel	Mitigation Action	Total Duration of Mitigation Event (hh:mm:ss)
10-Feb	166	Crabeater seal	2	Icebreaking	50 m	Course Alteration	00:04:00

(b)

Date (UTC)	Visual Detection Number	Species	Group Size	Source Activity (initial detection)	Closest Approach to Source/ Volume	Mitigation Action	Total Duration of Mitigation Event (hh:mm:ss)
23-Feb	1	Crabeater seal	4	Full power	200 m / 90 in^3	Course Alteration	00:23:00
26-Feb	9	Crabeater seal	2	Full power	400 m / 90 in^3	Course Alteration	00:15:20
5-Mar	10	Crabeater seal	1	Pre-shooting Observation (Not firing)	150 m	Course Alteration	00:05.03
7-Mar	14	Weddell seal	1	Ramp-up	200 / 45 in^3	Course Alteration	00:01:00
7-Mar	14	Weddell seal	1	Ramp-up	80 / 45 in^3	Shut-down	00:02:00
7-Mar	15	Weddell seal	1	Full power	90 in^3	Shut-down	00:02:00

6.1. MARINE MAMMALS KNOWN TO HAVE BEEN EXPOSED TO 120 DB AND 160 DB

NMFS granted an IHA to the NSF and ASC for a marine seismic survey allowing Level B harassment takes (exposure to SPLs greater than or equal to120 dB re 1 ~Pa (rms) (for icebreaking activities), greater than or equal to 160 dB re 1 ~Pa (1ms) (for seismic airgun operations), and/or 180 dB re 1

~Pa (rms) for cetaceans and 190 dB re 1 ~Pa (rms) for pinnipeds) for 14 marine mammals, including: five mysticete, five odontocete and four pinniped species. Direct visual observations recorded by PSOs and trained members of the science party of five species of marine mammals for which Level B harassment takes were granted in the IHA, provide a minimum estimate of the actual number of cetaceans and pinnipeds exposed to received sound levels of 120 dB (for icebreaking activities), 160 dB (for seismic airgun operations), and/or 180 dB for cetaceans and 190 dB for pinnipeds.

During the low-energy seismic survey conducted aboard the RVIB *Palmer* in the Dumont d'Urville Sea off the coast of East Antarctica, minke whales, crabeater seals and Weddell seals were observed within the 160 dB safety radius where Level B harassment is expected to occur, while the acoustic source was active (Table 10). Only two Weddell seals were observed within the 190 dB safety radius. In addition, a minke whale, a killer whale, crabeater seals, leopard seals and Weddell seals were observed within the 120 dB safety radius where Level B harassment is expected to occur, while the vessel was icebreaking in conditions of 50% or greater ice (Table 10).

These numbers are very likely to be an underestimate and provide the absolute minimum number of animals actually exposed. It is possible that estimated numbers of animals recorded during each sighting event were underestimates, some animals not being seen or having moved away before they were observed. This was particularly true for visual watches during night time icebreaking activities, when the visual detection of the 120 dB safety radius and presence of marine mammals was almost impossible on many occasions due to darkness. Besides night time hours there were several occasions during daytime visual watches that the entire 160 dB and 120 dB safety radii for seismic and icebreaking activities, respectively, was not visible due to fog. Additionally, during daytime visual observations for icebreaking activities, the line of sight to pinnipeds hauled out and on the sea ice may have been obscured and/or blocked by the sometimes rough ice topography the vessel was transiting through. Figures 10 and 11 show the spatial distribution of cetaceans and pinnipeds, including unidentified species, which were exposed to 120 dB (for icebreaking activities) and 160 dB during the survey conducted in the MG and TG/MUIS study areas.

6.2. IMPLEMENTATION AND EFFECTIVENESS OF THE BIOLOGICAL OPINIONS'S INCIDENTAL TAKE STATEMENT (ITS) AND INCIDENTAL HARASSMENT AUTHORIZATION (IHA)

In order to minimize the incidental taking of marine mammals, by Level B harassment only, during the *Palmer's* low-energy marine seismic survey as well as icebreaking activities, mitigation measures were implemented whenever these protected species were seen approaching or within the safety radii stipulated in the IHA. Multiple mitigation actions were implemented during the survey for mysticetes, odontocetes and pinnipeds. Avoidance manoeuvres (course alterations) and shut-downs of the acoustic source were required during the survey.

Additional mitigation measures specific to the marine seismic survey in the Dumont d'Urville Sea off the coast of East Antarctica required that if any marine mammal species was sighted during seismic activities that was not listed as authorized take in the IHA and were likely to be exposed to SPLs greater than or equal to 160 dB re 1 ~Pa (rms) or greater than or equal to 120 dB re 1 ~Pa (rms) for icebreaking activities, then the vessel had to alter speed or course or shut-down the airguns to prevent take. No species that were not listed as authorized take in the IHA were positively identified during the survey in the Dumont d'Urville Sea.

Additionally, concentrations of minke whales, killer whales and crabeater seals (either in the water or hauled out and on the sea ice) were avoided when possible (i.e. exposing concentrations of animals to 160 dB) using evasive manoeuvres (altering vessel course or speed) to avoid intercepting

the path of an approaching marine mammal, but only if the manoeuvre could be implemented safely and without damaging the deployed equipment.

Other mitigation measures specific to the seismic survey required that operations only be initiated when the entire shut-down exclusion zone radius was visible and could be effectively monitored. Accordingly, all seismic survey activities occurred during daylight hours, and did not exceed more than 16 continuous hours. Operations did not occur during low-light hours (i.e. before nautical twilight-dawn or after nautical twilight-dusk) when the entire relevant exclusion zone could not be effectively monitored by the PSO(s) on duty.

Table 10. Level B harassment takes authorized by the National Marine Fisheries Service (NMFS) Incidental Harassment Authorization (IHA) for the low-energy marine geophysical (seismic) survey in the Dumont d'Urville Sea and number of known individuals exposed to 120 dB (for icebreaking activities), 160 dB (for seismic airgun operations), and/or 180 dB for cetaceans and 190 dB for pinnipeds.

Species	IHA Authorized Take (Airgun Operations / Ice breaking)	No. Animals Exposed to 180 dB (Cetaceans)	No. Animals Exposed to 190 dB (Pinnipeds)	No. Animals Exposed to 160 dB	No. Animals Exposed to 120 dB (Ice breaking)
Mysticetes					
Southern right whale	0	0	–	0	0
Humpback whale	2,798 (580/2,218)	0	–	0	0
Antarctic minke whale	1,598 (331/1,267)	0	–	2	1
Sei whale	47 (10/37)	0	–	0	0
Fin whale	2,727 (565/2,162)	0	–	0	0
Blue whale	24 (5/19)	0	–	0	0
Odontocetes					
Sperm whale	376 (78/298)	0	–	0	0
Arnoux' s beaked whale	0	0	–	0	0
Cuvier's beaked whale	0	0	–	0	0
Southern bottlenose whale	0	0	–	0	0
Killer whale	729 (151/578)	0	–	0	1
Long-finned pilot whale	282 (58/224)	0	–	0	0
Hourglass dolphin	305 (63/242)	0	–	0	0
Spectacled porpoise	388 (80/308)	0	–	0	0
Pinnipeds					
Crabeater seal	23,582 (4,885/18,697)	–	0	25	281
Leopard seal	1,399 (29011,109)	–	0	0	3
Ross seal	3,456 (716/2,740)	–	0	0	0
Weddell seal	2,053 (42511,628)	–	2	2	10
Southem elephant seal	0	–	0	0	0
Antarctic fur seal	0	–	0	0	0

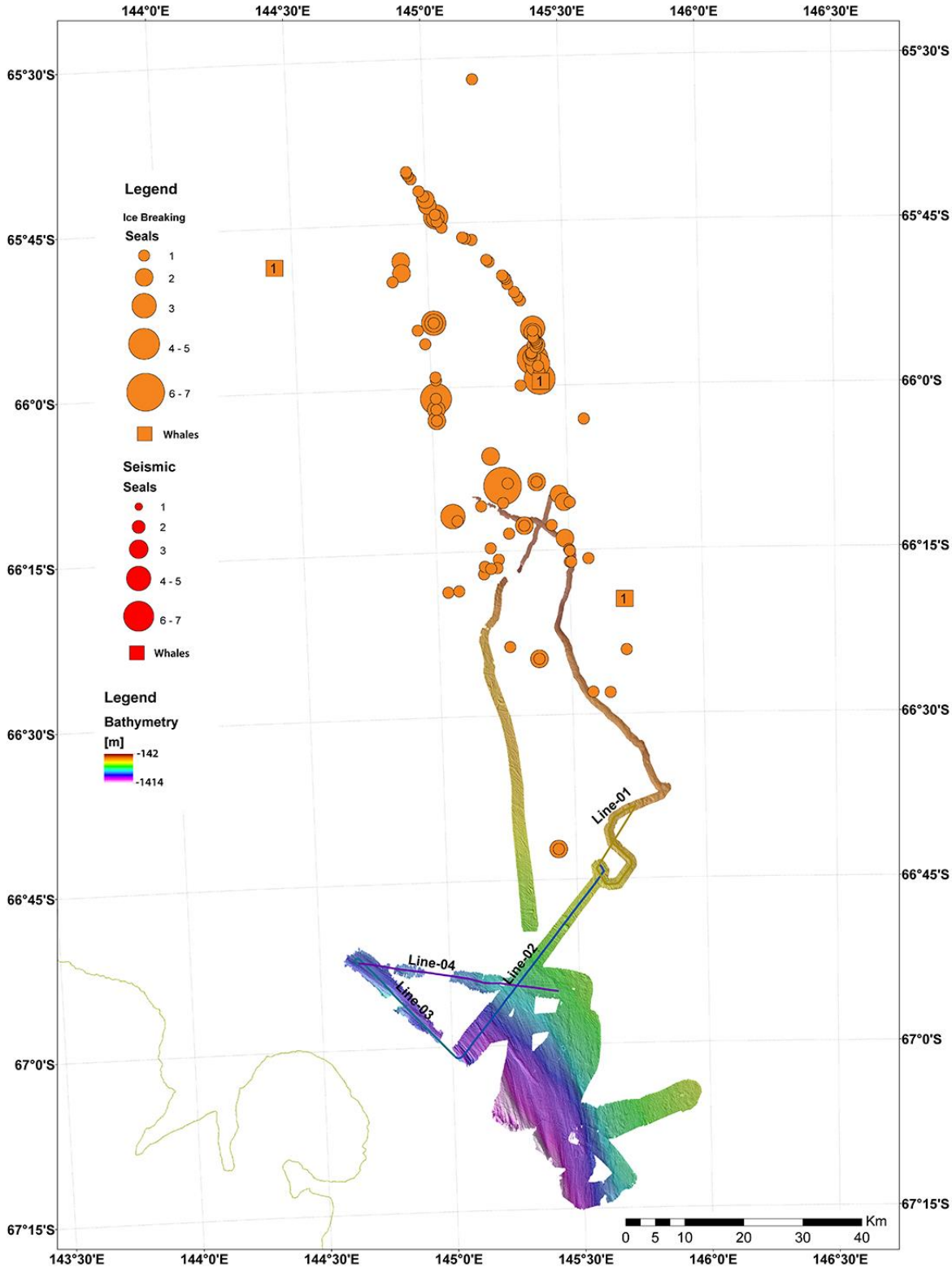


Figure 10. Locations of marine mammal authorized take from icebreaking and seismic operations in the Mertz Glacier survey area in the Dumont d'Urville Sea off the coast of East Antarctica. Locations are colour-coded according to icebreaking (orange) and seismic (red) operations. Circle and square symbols represent seal and whale take, respectively. The size of the circle symbols indicates the number of seals visually detected for each take event (1 to 6-7 individuals for small to large symbols, respectively). Also shown is the bathymetry (m) overlaid with the survey lines for the multi-channel seismic survey.

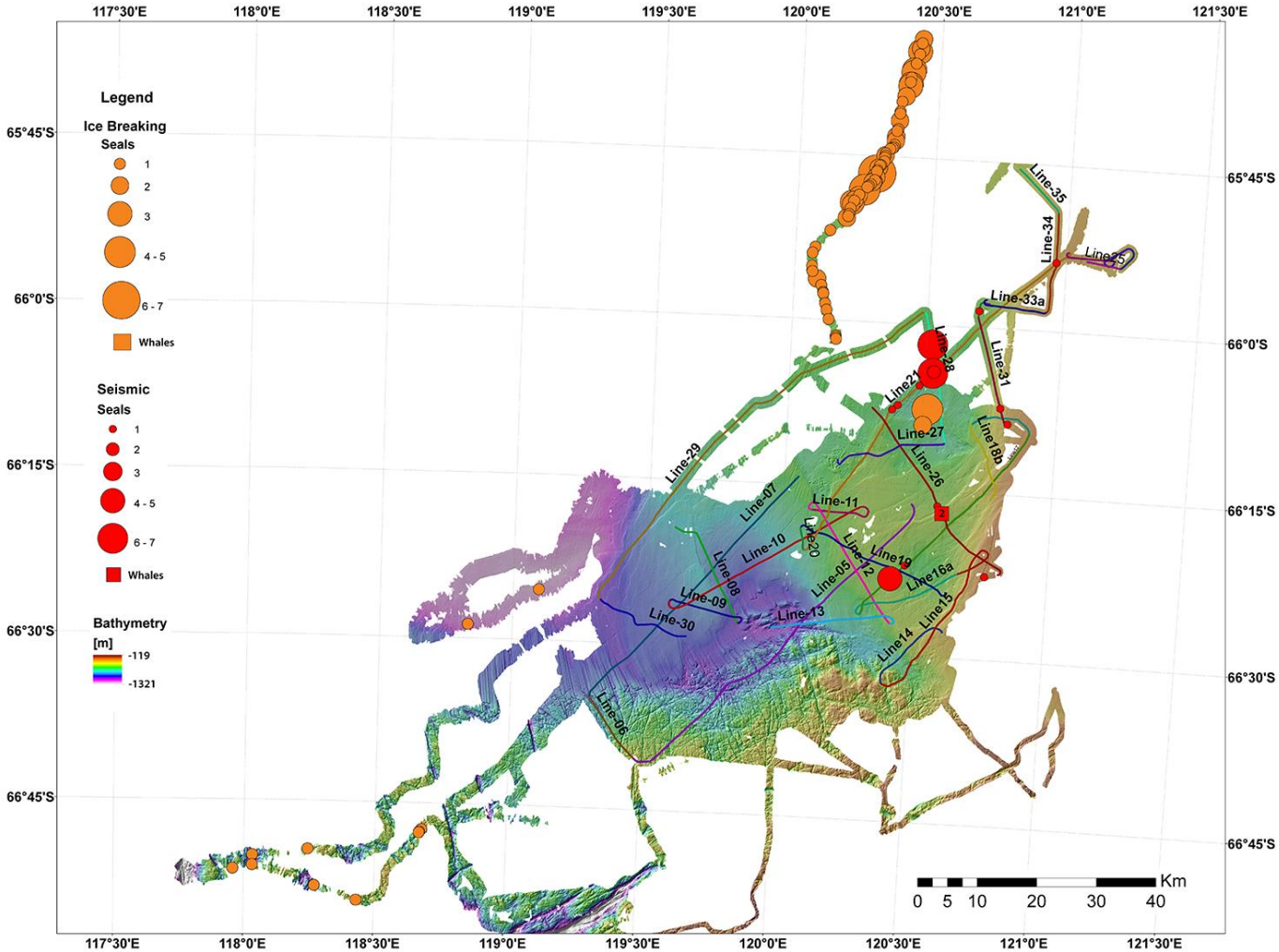


Figure 11. Locations of marine mammal authorized take from icebreaking and seismic operations in the Totten Glacier/Moscow University Ice Shelf survey area in the Dumont d'Urville Sea off the coast of East Antarctica. Locations are colour-coded according to icebreaking (orange) and seismic (red) operations. Circle and square symbols represent seal and whale take, respectively. The size of the circle symbols indicates the number of seals visually detected for each take event (1 to 6-7 individuals for small to large symbols, respectively). Also shown is the bathymetry (m) overlaid with the survey lines for the multi-channel seismic survey.

In accordance with the activity requirements contained in the IHA, visual monitoring methods were implemented during icebreaking activities in 50% or greater ice coverage. To meet the IHA requirements, members of the science party aboard the *Palmer* were trained and utilized, in addition to the two PSOs, to visually watch for and monitor marine mammals near the vessel during day and night time icebreaking activities. To achieve 24 hours of monitoring (as required), science personnel and PSOs rotated through visual monitoring shifts. Implementation of visual watches and monitoring of marine mammals during night time icebreaking activities were largely ineffective due to darkness. For future monitoring programs it is therefore recommended that acoustic monitoring (Passive Acoustic Monitoring (PAM) system and operator) be used during periods of darkness or low visibility when visual monitoring may not be applicable or effective. Moreover, visual monitoring for icebreaking activities accounted for the majority of the total observation effort performed by PSOs and science personnel for this survey (58%). It is therefore also recommended that for future monitoring programs at least one NMFS qualified, vessel based PSO be dedicated to visually watch for and monitor marine mammals near the vessel during icebreaking activities.

7. ACKNOWLEDGEMENTS

The Protected Species Observers on the *Palmer* during the marine geophysical (seismic) and oceanography survey in the Dumont d'Urville Sea would like to thank the National Science Foundation and the Antarctic Support Contract for the opportunity to work on this project. It was a pleasure to work with Prof. Amy Leventer, Prof. Eugene Domack, Prof. Sean Gulick, Steffen Saustrup, Prof. Amelia Shevnell and the rest of the science team. We would also like to thank the science team and marine crew on board the *Palmer* for their assistance and hospitality.

We would like to thank the following individuals for their considerable help in making the program a success:

- Ted Doerr, Polly Penhale, Lisa Clough, Adrian Dahood, Kaneen Christensen and others from NSF for their assistance in the planning and preparation for the cruise as well as their assistance during the cruise.
- Science team members Alix Post, Bruce Huber, Bruce Frederick, David Gwyther, David Morgan, Glenn Clark, Kara Vadman, Katy Smith, Michelle Guitard, Mikhaila Redovian and Rodrigo Fernandez for their assistance and hard work in conducting visual observations during icebreaking activities.
- Jamin Greenbaum for his support in setting up the electronic recording database for the PSO monitoring program.
- Rodrigo Fernandez for his help in the presentation of spatial data for this report.
- We would also like to thank Ted Doerr for reviewing this report.

We sincerely thank everyone who helped support and make this project a success.

8. LITERATURE CITED

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

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. & Tyack, P.L. (2007) Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals,* **33,** 411-522.

<u>APPENDIX A</u>: Incidental Harassment Authorization for the RVIB *Nathaniel B. Palmer's* low-energy marine geophysical (seismic) survey in the Dumont d'Urville Sea off the coast of East Antarctica.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

JAN 3 1 2014

B.K. Grant
Deputy Project Director
Antarctic Support Contract
7400 South Tucson Way
Centennial, Colorado 80112-3938

Dear Mr. Grant:

Enclosed is an Incidental Harassment Authorization (IHA) issued to the Antarctic Support Contract and National Science Foundation, under the authority of section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*), to harass small numbers of marine mammals, by Level B harassment, incidental to the RVIB *Nathaniel B. Palmer*'s low-energy marine geophysical (seismic) survey in the Dumont d'Urville Sea off the coast of East Antarctica during January to March 2014.

You are required to comply with the conditions contained in the IHA. In addition, you must submit a report to the National Marine Fisheries Service's (NMFS) Office of Protected Resources within 90 days of the completion of the cruise. The IHA also requires monitoring of marine mammals by qualified individuals before, during, and after seismic and icebreaking activities and reporting of marine mammal observations, including species, numbers, and behavioral modifications potentially resulting from these activities.

If you have any questions concerning the IHA or its requirements, please contact Howard Goldstein, Jeannine Cody, or Jolie Harrison, Office of Protected Resources, NMFS, at 301-427-8401.

Sincerely,

Donna S. Wieting

Donna S. Wieting
Director
Office of Protected Resources

Enclosures

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

JAN 3 1 2014

Incidental Harassment Authorization

The National Marine Fisheries Service (NMFS) hereby authorizes the National Science Foundation (NSF), Division of Polar Programs, 4201 Wilson Boulevard, Arlington, Virginia 22230 and Antarctic Support Contract (ASC), 7400 South Tucson Way, Centennial, Colorado 80112, under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1371(a)(5)(D)), to harass small numbers of marine mammals incidental to a low-energy marine geophysical (seismic) survey conducted aboard the RVIB *Nathaniel B. Palmer* (*Palmer*) in the Dumont d'Urville Sea off the coast of East Antarctica, January to March 2014:

1. This Authorization is valid from January 31, 2014 through April 27, 2014.

2. This Authorization is valid only for the NSF and ASC's activities associated with low-energy seismic, bathymetric profile, magnetrometry and imaging, and sediment coring and dredge sampling survey operations as well as icebreaking activities conducted aboard the *Palmer* that shall occur in the following specified geographic area:

(a) In selected regions of the Dumont d'Urville Sea in the Southern Ocean off the coast of East Antarctica and focus on the Totten Glacier and Moscow University Ice Shelf, located on the Sabrina Coast, from greater than approximately 64° South and between 95 to 135° East, and the Mertz Glacier and Cook Ice Shelf systems located on the George V and Oates Coast, from greater than approximately 65° South and between approximately 140 to 165° East. The study sites are characterized by heavy ice cover, with a seasonal break-up in the ice that structures biological patterns. The studies may occur in both areas, or entirely in one or the other, depending on ice conditions. Water depths in the survey area generally range from approximately 100 to 1,000 meters (m), and possibly exceeding 1,000 m in some areas. No airgun operations will occur in shallow (<100 m) water depths. The low-energy seismic survey will be conducted in International Waters (i.e., high seas), as specified in the NSF and ASC Incidental Harassment Authorization application and the associated NSF and ASC Initial Environmental Evaluation/Environmental Assessment (IEE/EA).

3. Species Authorized and Level of Takes

(a) The incidental taking of marine mammals, by Level B harassment only, is limited to the following species in the waters of the Southern Ocean off the coast of East Antarctica:

(i) Mysticetes – see Table 2 (attached) for authorized species and take numbers.

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(ii) Odontocetes – see Table 2 (attached) for authorized species and take numbers.

(iii) Pinnipeds – see Table 2 (attached) for authorized species and take numbers.

(iv) If any marine mammal species are encountered during seismic activities that are not listed in Table 2 (attached) and are likely to be exposed to sound pressure levels (SPLs) greater than or equal to 160 dB re 1 μPa (rms) or greater than or equal to 120 dB re 1 μPa (rms) for icebreaking activities, then the NSF and ASC must alter speed or course or shut-down the airguns to prevent take.

(b) The taking by injury (Level A harassment), serious injury, or death of any of the species listed in Condition 3(a) above or the taking of any kind of any other species of marine mammal is prohibited and may result in the modification, suspension or revocation of this Authorization.

4. The methods authorized for taking by Level B harassment are limited to the following acoustic sources without an amendment to this Authorization:

(a) A two Generator Injector (GI) airgun array (each with a discharge volume of 45 cubic inches [in^3]) or 105 in^3 with a total volume of 90 in^3 or 210 in^3 (or smaller);

(b) A multi-beam echosounder;

(c) A single-beam echosounder;

(d) An acoustic Doppler current profiler;

(e) An acoustic locator;

(f) A sub-bottom profiler; and

(g) Icebreaking.

5. The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to the Office of Protected Resources, National Marine Fisheries Service (NMFS), at 301-427-8401.

6. Mitigation and Monitoring Requirements

The NSF and ASC is required to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable impact on affected marine mammal species or stocks:

Protected Species Observers and Visual Monitoring

(a) Utilize one, NMFS-qualified, vessel-based Protected Species Observer (PSO) to visually watch for and monitor marine mammals near the seismic source vessel during daytime airgun operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during ramp-ups of airguns day or night.

(i) The *Palmer*'s vessel crew shall also assist in detecting marine mammals, when practicable.

(ii) PSO(s) shall have access to reticle binoculars (7 x 50 Fujinon).

(iii) PSO(s) shifts shall last no longer than 4 hours at a time.

(iv) When feasible, PSO(s) shall also make observations during daytime periods when the seismic airguns are not operating for comparison of animal abundance and behavior.

(v) PSO(s) shall conduct monitoring while the airgun array and streamer(s) are being deployed or recovered from the water.

(b) PSO(s) shall record the following information when a marine mammal is sighted:

(i) Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc., and including responses to ramp-up), and behavioral pace; and

(ii) Time, location, heading, speed, activity of the vessel (including number of airguns operating and whether in state of ramp-up or shut-down), Beaufort sea state and wind force, visibility, and sun glare; and

(iii) The data listed under Condition 6(b)(ii) shall also be recorded at the start and end of each observation watch and during a watch whenever there is a change in one or more of the variables.

Buffer and Exclusion Zones

(c) Establish a 160 dB re 1 μPa (rms) buffer zone as well as 180 dB re 1 μPa (rms) exclusion zone for cetaceans and 190 dB re 1 μPa (rms) exclusion zone for pinnipeds before the two GI airgun array (90 or 210 in^3 total volume) is in operation. Establish a 120 dB re 1 μPa (rms) buffer zone for cetaceans and pinnipeds before icebreaking activities begin. See Table 1 (attached) for distances and exclusion zones.

Visual Monitoring at the Start of the Airgun Operations

(d) Visually observe the entire extent of the exclusion zones (180 dB re 1 μPa [rms] for cetaceans and 190 dB re 1 μPa [rms] for pinnipeds; see Table 1 [attached] for distances) using two NMFS-qualified PSOs, for at least 30 minutes prior to starting the airgun array (day or night).

(i) If the PSO(s) sees a marine mammal within the exclusion zone, NSF and ASC must delay the seismic survey until the marine mammal(s) has left the area. If the PSO(s) sees a marine mammal that surfaces, then dives below the surface, the PSO(s) shall wait 30 minutes. If the PSO(s) sees no marine mammals during that time, they should assume that the animal has moved beyond the exclusion zone.

(ii) If for any reason the entire radius cannot be seen for the entire 30 minutes (i.e., rough seas, fog, darkness), or if marine mammals are near, approaching, or in the exclusion zone, the airguns may not be ramped-up. If one airgun is already running at a source level of at least 180 dB re 1 μPa (rms), NSF and ASC may start the second airgun without observing the entire exclusion zone for 30 minutes prior, provided no marine mammals are known to be near the exclusion zone (in accordance with Condition 6[f] below).

Ramp-up Procedures

(e) Implement a "ramp-up" procedure when starting up at the beginning of seismic operations or anytime after the entire array has been shut-down for more than 15 minutes, which means starting with a single GI airgun and adding a second GI airgun after five minutes. During ramp-up, the two PSOs shall monitor the exclusion zone, and if marine mammals are sighted, a shut-down shall be implemented as though the full array (both GI airguns) were operational. Therefore, initiation of ramp-up procedures from shut-down requires that the two PSOs be able to view the full exclusion zone as described in Condition 6(d) (above).

Shut-down Procedures

(f) Shut-down the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant exclusion zone (as defined in Table 1, attached). A shut-down means all operating airguns are shut-down (i.e., turned off).

(g) Following a shut-down, the airgun activity shall not resume until the PSO(s) has visually observed the marine mammal(s) exiting the exclusion zone and is not likely to return, or has not been seen within the exclusion zone for 15 minutes for species with shorter dive durations (small odontocetes) or 30 minutes for species with longer dive durations (mysticetes and large odontocetes, including sperm, killer, and beaked whales).

(h) Following a shut-down and subsequent animal departure, airgun operations may resume following ramp-up procedures described in Condition 6(e).

Speed or Course Alteration

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

Survey Operations at Night

(j) Marine seismic surveys may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire relevant exclusion zones are visible and can be effectively monitored.

(k) No initiation of airgun array operations is permitted from a shut-down position at night or during low-light hours (such as in dense fog or heavy rain) when the entire relevant exclusion zone cannot be effectively monitored by the PSO(s) on duty.

(l) To the maximum extent practicable, schedule seismic operations (i.e., shooting airguns) during daylight hours.

8. Reporting Requirements

The NSF and ASC are required to:

(a) Submit a draft report on all activities and monitoring results to the Office of Protected Resources, NMFS, within 90 days of the completion of the *Palmer*'s cruise in the Dumont d'Urville Sea off the coast of East Antarctica. This report must contain and summarize the following information:

(i) Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort sea state and wind force), and associated activities during all seismic operations and marine mammal sightings;

(ii) Species, number, location, distance from the vessel, and behavior of any marine mammals, as well as associated seismic activity (number of shut-downs), observed throughout all monitoring activities.

(iii) An estimate of the number (by species) of marine mammals that: (A) are known to have been exposed to the seismic activity (based on visual observation) at received levels greater than or equal to120 dB re 1 μPa (rms) (for icebreaking activities), greater than or equal to 160 dB re 1 μPa (rms) (for seismic airgun

operations), and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds with a discussion of any specific behaviors those individuals exhibited; and (B) may have been exposed (based on modeled values for the two GI airgun array) to the seismic activity at received levels greater than or equal to120 dB re 1 μPa (rms) (for icebreaking activities), greater than or equal to 160 dB re 1 μPa (rms) (for seismic airgun operations), and/or 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds with a discussion of the nature of the probable consequences of that exposure on the individuals that have been exposed.

(iv) A description of the implementation and effectiveness of the: (A) Terms and Conditions of the Biological Opinion's Incidental Take Statement (ITS) (attached); and (B) mitigation measures of the Incidental Harassment Authorization. For the Biological Opinion, the report shall confirm the implementation of each Term and Condition, as well as any conservation recommendations, and describe their effectiveness, for minimizing the adverse effects of the action on Endangered Species Act-listed marine mammals.

(b) Submit a final report to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, within 30 days after receiving comments from NMFS on the draft report. If NMFS decides that the draft report needs no comments, the draft report shall be considered to be the final report.

Reporting Prohibited Take

(c) In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), NSF and ASC shall immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and Howard.Goldstein@noaa.gov. The report must include the following information:

(i) Time, date, and location (latitude/longitude) of the incident; the name and type of vessel involved; the vessel's speed during and leading up to the incident; description of the incident; status of all sound source use in the 24 hours preceding the incident; water depth; environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility); description of marine mammal observations in the 24 hours preceding the incident; species identification or description of the animal(s) involved; the fate of the animal(s); and photographs or video footage of the animal (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with NSF and ASC to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. NSF and ASC may not resume their activities until notified by NMFS via letter, email, or telephone.

Reporting an Injured or Dead Marine Mammal with an Unknown Cause of Death

In the event that NSF and ASC discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), NSF and ASC will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Howard.Goldstein@noaa.gov. The report must include the same information identified in Condition 7(a) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with NSF and ASC to determine whether modifications in the activities are appropriate.

Reporting an Injured or Dead Marine Mammal Not Related to the Activities

In the event that NSF and ASC discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 2 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), NSF and ASC shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Howard.Goldstein@noaa.gov, within 24 hours of the discovery. NSF and ASC shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS. Activities may continue while NMFS reviews the circumstances of the incident.

9. Endangered Species Act Biological Opinion and Incidental Take Statement

(a) NSF and ASC are required to comply with the Terms and Conditions of the ITS corresponding to NMFS's Biological Opinion issued to both NSF/ASC, and NMFS's Office of Protected Resources (attached).

(b) A copy of this Authorization and the ITS must be in the possession of all contractors and PSO(s) operating under the authority of this Incidental Harassment Authorization.

Donna S. Wieting

Donna S. Wieting
Director
Office of Protected Resources
National Marine Fisheries Service

JAN 3 1 2014

Date

Attachments

Attachment

Table 1. Authorized take numbers, by Level B harassment, for each marine mammal species during NSF and ASC's low-energy marine seismic survey in the Dumont d'Urville Sea off the coast of East Antarctica, January to March 2014.

Species	Authorized Take in the Dumont d'Urville Sea Study Area (Airgun Operations/Icebreaking)
Mysticetes	
Southern right whale (*Eubalaena australis*)	0
Humpback whale (*Megaptera novaeangliae*)	2,798 (580/2,218)
Antarctic minke whale (*Balaenoptera acutorostrata*)	1,598 (331/1,267)
Sei whale (*Balaenoptera borealis*)	47 (10/37)
Fin whale (*Balaenoptera physalus*)	2,727 (565/2,162)
Blue whale (*Balaenoptera musculus*)	24 (5/19)
Odontocetes	
Sperm whale (*Physeter macrocephalus*)	376 (78/298)
Arnoux's beaked whale (*Berardius arnuxii*)	0
Cuvier's beaked whale (*Ziphius cavirostris*)	0
Southern bottlenose whale (*Hyperoodon ampullatus*)	0
Killer whale (*Orcinus orca*)	729 (151/578)
Long-finned pilot whale (*Globicephala melas*)	282 (58/224)
Hourglass dolphin (*Lagenorhynchus cruciger*)	305 (63/242)
Spectacled porpoise (*Phocoena dioptrica*)	388 (80/308)
Pinnipeds	
Crabeater seal (*Lobodon carcinophaga*)	23,582 (4,885/18,697)
Leopard seal (*Hydrurga leptonyx*)	1,399 (290/1,109)
Ross seal (*Ommatogphoca*	3,456 (716/2,740)

rossii)	
Weddell seal (*Leptonychotes weddellii*)	2,053 (425/1,628)
Southern elephant seal (*Mirounga leonina*)	0
Antarctic fur seal (*Arctocephalus gazella*)	0

Table 2. Modeled distances to which sound levels greater than or equal to 160, 180, and 190 dB could be received during the low-energy marine seismic survey in the Dumont d'Urville Sea off the coast of East Antarctica during January to March 2014. The buffer and exclusion zone radii are used for triggering mitigation. No airgun operations will occur in shallow water depths (<100 m).

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted RMS Radii Distances (m)		
			Shut-down Exclusion Zone for Pinnipeds 190 dB	Shut-down Exclusion Zone for Cetaceans 180 dB	Level B Harassment Zone 160 dB
Two 45 in^3 GI airguns (90 in^3 total)	3	Intermediate (100 to 1,000)	100	100	600
Two 45 in^3 GI airguns (90 in^3 total)	3	Deep (>1,000)	100	100	400
Two 105 in^3 GI airguns (210 in^3 total)	3	Intermediate (100 to 1,000)	100	100	1,005
Two 105 in^3 GI airguns (210 in^3 total)	3	Deep (>1,000)	100	100	670

APPENDIX B: Basic Data Summary Form

BASIC DATA FORM	
Project No.	
Seismic Contractor	Antarctic Support Contract
Area Surveyed During Reporting Period	>64°S, between 95°E and 135°E; >65°S, between 140°E and 165°E
Survey Type	Low-energy multichannel seismic system
Vessel Name	R/VIB *Nathaniel B. Palmer*
Permit Number	IHA granted by NMFS on 31 January 2014
Location/Distance of Airgun Deployment	35.5 and 29 metres aft of the stern
Water Depth	Min. 100 metres
	Max. 1000 metres
Dates of Project	29 January through to 16 March 2014
Total time airguns operating – all power levels:	105 hours 22 minutes
Time airguns operating at full power on survey lines:	104 hours 13 minutes
Time airguns operating at full power on line changes:	33 minutes
Amount of time single airgun (45 in^3) operations:	2 hours 57 minutes
Amount of time in ramp-up:	1 hour 9 minutes
Number of daytime ramp-ups:	9
Number of night time ramp-ups:	0
Number of ramp-ups from mitigation source:	0
Amount of time conducted in airgun testing:	2 minutes
Duration of visual observations for seismic operations:	111 hours 58 minutes
Duration of visual observations while airguns firing:	117 hours 53 minutes
Duration of visual observations during airgun silence:	5 hours 55 minutes
Duration of visual observations for icebreaking activities:	152 hours 25 minutes
Duration of visual observations for icebreaking activities during daytime:	131 hours 25 minutes
Duration of visual observations for icebreaking activities during night time:	20 hours 39 minutes
Lead Protected Species Observer:	Andrea Walters
Protected Species Observers:	Tasha Snow
Number of Marine Mammals Visually Detected during Seismic Operations:	37
Number of Marine Mammals Visually Detected during Icebreaking Activities:	318
List Mitigation Actions (e.g. course or speed alteration, acoustic source shut-down)	5 course alterations and 2 shut-downs
Duration of operational downtime due to mitigation:	5 minutes

APPENDIX C: Survey Lines Acquired

Survey Line	Location	Date Acquisition Commenced	Time Acquisition Commenced	Date Acquisition Completed	Time Acquisition Completed
1	MG	04-February-2014	01:16:04	04-February-2014	02:35:22
2	MG	04-February-2014	02:36:17	04-February-2014	08:01:10
3	MG	04-February-2014	08:02:53	04-February-2014	10:55:57
4	MG	04-February-2014	10:57:47	04-February-2014	14:53:47
5	TG/MUIS	10-February-2014	19:45:08	11-February-2014	03:31:35
6	TG/MUIS	11-February-2014	03:32:19	11-February-2014	05:02:23
7	TG/MUIS	11-February-2014	05:03:08	11-February-2014	11:01:49
8	TG/MUIS	15-February-2014	20:28:15	15-February-2014	22:30:29
9	TG/MUIS	15-February-2014	22:31:17	16-February-2014	00:14:35
10	TG/MUIS	16-February-2014	00:14:55	16-February-2014	04:43:42
11	TG/MUIS	16-February-2014	04:45:40	16-February-2014	06:07:09
12	TG/MUIS	16-February-2014	06:08:10	16-February-2014	09:03:29
13	TG/MUIS	16-February-2014	09:04:12	16-February-2014	11:43:10
14	TG/MUIS	22-February-2014	20:11:29	22-February-2014	22:03:15
15	TG/MUIS	22-February-2014	22:04:12	23-February-2014	01:27:45
16	TG/MUIS	23-February-2014	01:28:45	23-February-2014	02:10:57
16a	TG/MUIS	23-February-2014	02:12:07	23-February-2014	04:20:03
17	TG/MUIS	23-February-2014	04:20:34	23-February-2014	09:18:29
18a	TG/MUIS	23-February-2014	09:19:33	23-February-2014	10:30:00
18b	TG/MUIS	23-February-2014	10:30:05	23-February-2014	11:48:20
19	TG/MUIS	25-February-2014	21:54:13	26-February-2014	01:10:53
20	TG/MUIS	26-February-2014	01:12:29	26-February-2014	01:36:38
21	TG/MUIS	26-February-2014	01:37:43	26-February-2014	09:39:21
22	TG/MUIS	26-February-2014	09:40:13	26-February-2014	10:43:17
23	TG/MUIS	26-February-2014	10:45:19	26-February-2014	11:42:07
24	TG/MUIS	26-February-2014	11:42:12	26-February-2014	12:18:33
25	TG/MUIS	26-February-2014	12:19:06	26-February-2014	12:59:47
26	TG/MUIS	05-March-2014	02:05:50	05-March-2014	12:09:38
27	TG/MUIS	05-March-2014	20:37:16	05-March-2014	23:04:38
28	TG/MUIS	05-March-2014	23:05:26	06-March-2014	01:36:35
29	TG/MUIS	06-March-2014	01:38:24	06-March-2014	10:03:59
30	TG/MUIS	06-March-2014	10:04:42	06-March-2014	12:00:34
31	TG/MUIS	07-March-2014	03:49:59	07-March-2014	06:09:33
32	TG/MUIS	07-March-2014	06:09:57	07-March-2014	06:27:05
33	TG/MUIS	07-March-2014	06:27:34	07-March-2014	06:35:00
33A	TG/MUIS	07-March-2014	07:16:26	07-March-2014	09:04:51
34	TG/MUIS	07-March-2014	09:05:32	07-March-2014	11:01:37
35	TG/MUIS	07-March-2014	11:02:32	07-March-2014	12:07:56