

Marine Mammal Monitoring and Mitigation during a Marine Geophysical Survey (KR17-14) by the R/V *Kairei* in the Central Pacific Ocean

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1 Executive Summary

The Japan Agency for Marine-Earth Science and Technology and the University of Hawaii conducted a 2D marine geophysical seismic survey in the central Pacific Ocean north of the Hawaiian Islands from 16 through 25 September 2017. During this period, seismic data were acquired using an airgun array, ocean bottom seismometers, and a recording streamer.

Visual and acoustic marine mammal observations were conducted by a team of six protected species observers (four dedicated visual observers and two dedicated passive acoustic monitoring operators) during the survey as directed by the National Marine Fisheries Service to maintain compliance with the Marine Mammal Protection Act.

Monitoring for marine mammals was conducted for a total of 264 hours 4 minutes, of which 122 hours 49 minutes was via visual methods and 141 hours 15 minutes through acoustic monitoring. Visual observations were conducted during all daylight hours, including during transits to and from port, as well as at night prior to the initiation of source activity at night. Acoustic monitoring was conducted continuously while the hydrophone cable was deployed. The acoustic source was active (at all power outputs) for 100 hours 39 minutes over the duration of the survey.

An unidentified small delphinid was acoustically detected on 24 September 2017 during the final two hours of the last survey line. The source array was active at the time of the detection; however, a mitigation action was not required as the delphinid was determined to be outside the 500m exclusion zone. The detection resulted in a level B take.

2 Introduction

2.1 Survey Objectives

The Japan Agency for Marine-Earth Science and Technology (JAMSTEC), in collaboration with the University of Hawaii, conducted a 2D marine geophysical seismic survey (KR17-14) to image the oceanic crust, Moho (Mohorovicic Discontinuity layer), and mantle as part of the planning phase for a proposed Project Mohole drilling operation. The aim of Project Mohole is to collect a sample of the mantle by drilling through the Earth's crust and Moho layer that separates the crust from the mantle (National Academies of Sciences 2017). Data from the survey will provide the information needed refine future efforts.

2.2 Survey Location and Duration

The KR17-14 seismic survey was conducted from the 106m research vessel *Kairei* between 16 and 25 September 2017 in an area of the central Pacific Ocean, northeast of the Hawaiian Islands (LGL, 2017). Water depth in the survey area ranged from 4000 to 5000m.

The survey consisted of three transect lines, one west-east line and two north-south lines. The west-east line and the easternmost north-south line (numbered 1 and 2 in Figure 1) were each surveyed once while the westernmost north-south line (numbered 3 in Figure 1) was surveyed twice for a total transect length of approximately 900km.

The *Kairei* departed Honolulu, Hawaii at 19:00 UTC (local time plus 10 hours) on 16 September 2017 and began deploying the seismic equipment (source array followed by the recording streamer cable) at 16:00 UTC on 17 September. Two ocean bottom seismometers (OBS) were deployed by a separate vessel prior to the start of the survey, one each at the intersections of the west-east line and two north-south lines (Figure 1). Use of the seismic source began with a single airgun source test at 04:51 UTC on 18 September 2017. The first survey line (the west-east line) began at 05:54 UTC on 18 September. The survey was completed at 18:00 UTC on 24 September 2017 after the second run of the westernmost north-south line. Recovery of the seismic equipment began immediately after the completion of the survey line, with all towed gear onboard and secured for transit by 22:56 UTC on 24 September. The *Kairei* arrived in the port of Honolulu at 19:00 UTC on 25 September 2017. The OBS remained deployed and will be retrieved at a later date by the University of Hawaii.

2.3 Seismic Survey Equipment

2.3.1 Seismic Source

The seismic source used for the survey was a 32 airgun, 7800in³ array. The source array consisted of four sub-arrays, each with eight airguns ranging in volume from 100in³ to 600in³ (Figure 2). The first and last airguns within each sub-array were 10m apart. The port and starboard pairs of sub-arrays were spaced 20m apart, while each sub-array in the pair was 10m apart. The estimated source level of the array was 265dB re 1μPa at 1m (peak to peak) and the frequency ranged from 2 to 120Hz (LGL 2017). The source array was deployed 83m astern of the *Kairei* and towed at a depth of 10m. The source was activated every 50m (approximately every 20s) for the three survey lines, except for the second run of the westernmost north-south survey line which had a shot point interval of 200m (approximately every 80s).

Seismic data were recorded using a single, 6km long streamer towed from the *Kairei* and two OBS deployed on the seabed. The streamer was recovered for the second run of the westernmost north-south survey line, with data recorded only by the OBS.

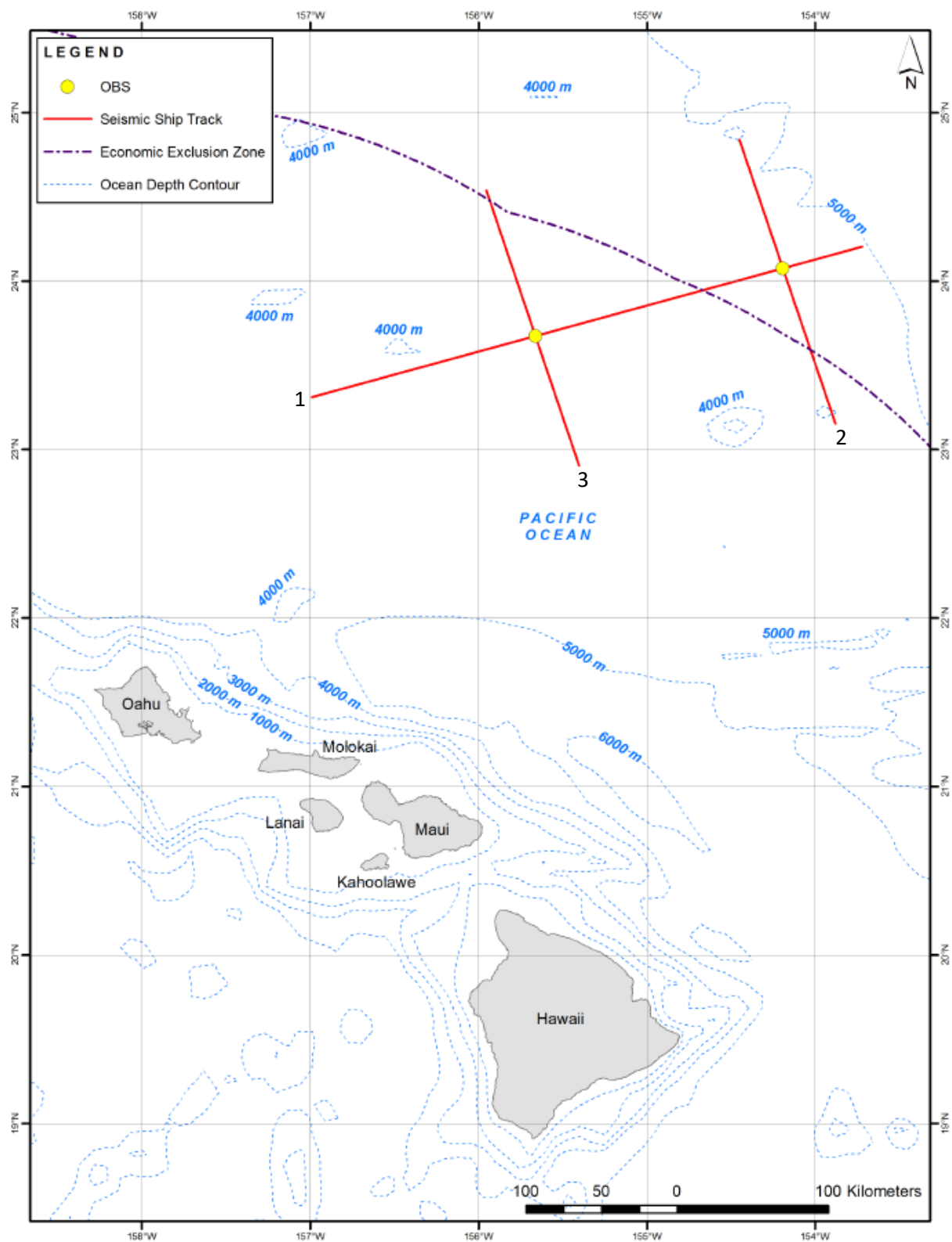


Figure 1: Location and survey lines acquired by the *R/V Kairei* during the KR17-14 seismic survey in the central Pacific Ocean. Image from LGL 2017.

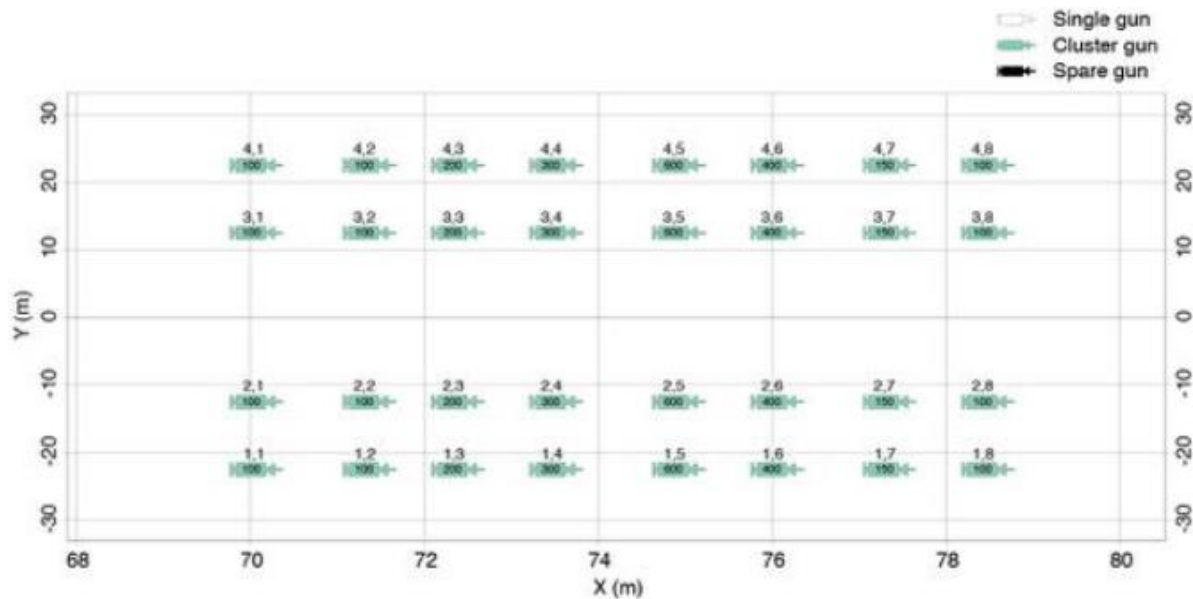


Figure 2: Seismic source array with 32 airguns totaling 7800 in³. Image from LGL 2017.

2.3.2 Other Acoustic Sources

Two additional acoustic sources were active during the KR17-14 survey on the *Kairei*, including a SeaBeam multibeam echosounder (MBES) and a sub-bottom profiler (chirper). Both devices were activated during all seismic source operations and between survey lines, except for the line change between the initial and second runs of the westernmost north-south line. The MBES operated at 12kHz and was hull mounted to the *Kairei*, while the sub-bottom profiler operated between 3 and 8kHz (Figure 3).

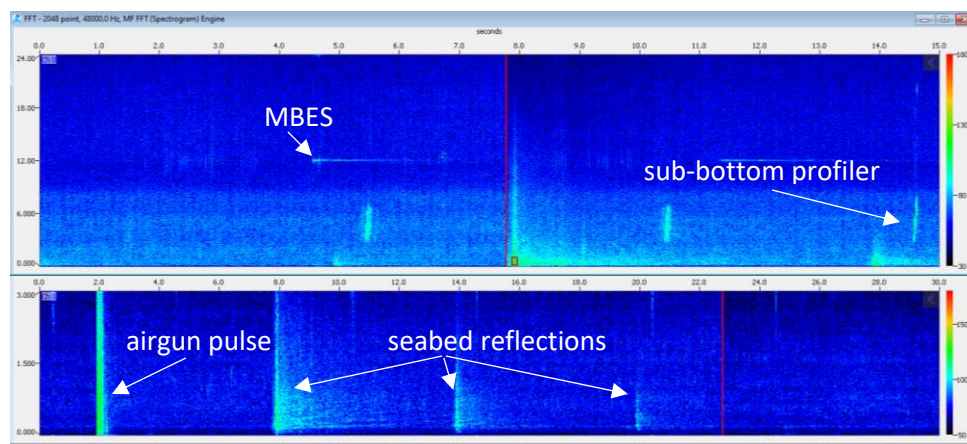


Figure 3: Spectrogram display from PAMGUARD showing MBES, sub-bottom profiler, airgun pulse, and seabed reflections from the airgun.

2.4 Marine Mammals in the Survey Area

Twenty four species of marine mammals may be observed in the survey area, including six species of mysticetes and 18 species of odontocetes (Table 1). Of the 24 species potentially observed in the survey area, four are listed as endangered on the Endangered Species Act (ESA), including blue, fin, sei, and sperm whales; all of which are also listed as depleted under the Marine Mammal Protection Act (MMPA).

Table 1: Marine mammals potentially observed in the survey area. Adapted from LGL 2017 and Federal Register 82 FR 34352 (July 24, 2017).

| Species | Stock | Occurrence in Survey Area | MMPA Status | ESA Status |
|-----------------------------|-----------------------|---------------------------|-------------|------------|
| Humpback Whale | central north Pacific | seasonal | not listed | not listed |
| Minke Whale | Hawaii | seasonal | not listed | not listed |
| Bryde's Whale | Hawaii | uncommon | not listed | not listed |
| Sei Whale | Hawaii | rare | depleted | endangered |
| Fin Whale | Hawaii | seasonal | depleted | endangered |
| Blue Whale | central north Pacific | seasonal | depleted | endangered |
| Sperm Whale | Hawaii | widely distributed | depleted | endangered |
| Cuvier's Beaked Whale | Hawaii | common | not listed | not listed |
| Longman's Beaked Whale | Hawaii | uncommon | not listed | not listed |
| Blainville's Beaked Whale | Hawaii | common | not listed | not listed |
| Rough-Toothed Dolphin | Hawaii | common | not listed | not listed |
| Bottlenose Dolphin | Hawaii pelagic | common | not listed | not listed |
| Pantropical Spotted Dolphin | Hawaii pelagic | common | not listed | not listed |
| Spinner Dolphin | Hawaii pelagic | common | not listed | not listed |
| Striped Dolphin | Hawaii | common | not listed | not listed |
| Fraser's Dolphin | Hawaii | common | not listed | not listed |
| Risso's Dolphin | Hawaii | common | not listed | not listed |
| Melon-Headed Whale | Hawaiian Islands | common | not listed | not listed |
| Pygmy Killer Whale | Hawaii | common | not listed | not listed |
| False Killer Whale | Hawaii pelagic | uncommon | not listed | not listed |
| Killer Whale | Hawaii | rare | not listed | not listed |
| Short-Finned Pilot Whale | Hawaii | common | not listed | not listed |
| Pygmy Sperm Whale | Hawaii | common | not listed | not listed |
| Dwarf Sperm Whale | Hawaii | common | not listed | not listed |

Timing of the survey by JAMSTEC and the University of Hawaii corresponded to the period when most mysticetes were expected to be on their northern/summer foraging grounds and were unlikely to be observed.

A detailed review of the local stocks for the species included in Table 1 is provided in the IHA application (LGL 2017 – available online at <http://www.nmfs.noaa.gov/pr/permits/incidental/research/>).

2.5 Regulatory Framework

All activities in the territorial waters of the United States that may negatively impact marine mammals are required to comply with the MMPA and ESA, both of which prohibit the taking of marine mammals through harassment. Two levels of harassment are recognized, level A harassment (potential to injure) and level B harassment (potential to disrupt behaviours or disturb). Acoustic threshold criteria for different types of acoustic sources (impulsive, non-impulsive, and continuous) have been established for both levels of harassment, with level A acoustic thresholds taking marine mammal hearing sensitivity into account. Airgun arrays are classified as impulsive sounds. The level A acoustic thresholds (peak SPL_{flat}) for a 100in³ and 7800in³ airgun array are provided in Table 2 (LGL 2017). The level B acoustic thresholds for impulsive sounds is 160dB re 1μPa (rms).

Table 2: Level A acoustic thresholds (peak SPL_{flat}) for a 100in³ and 7800in³ airgun array. All levels reported as dB re 1μPa. Source: LGL 2017.

| Hearing Group | Source Array Volume | |
|-------------------------|---------------------|---------------------|
| | 100in ³ | 7800in ³ |
| Low Frequency Cetacean | 219 | 219 |
| Mid-Frequency Cetacean | 230 | 230 |
| High Frequency Cetacean | 202 | 202 |

In order to conduct activities that may result in marine mammal takes, an application for an incidental harassment authorization must be submitted. The application includes an analysis of the acoustic source to be used and the results of propagation models to derive areas ensonified to the level A and level B acoustic threshold levels. Upon review of the application by the National Marine Fisheries Service (NMFS), an incidental harassment authorization (IHA) is issued permitting the takes of marine mammals (within limits not expected to have significant impacts on the population) for the proposed activity.

The University of Hawaii applied for an IHA for the KR17-14 marine geophysical seismic survey on 15 March 2016. In their application, the University of Hawaii provided the modelled radial distances to the level A and level B harassment acoustic thresholds (Tables 3 and 4).

Table 3: Modelled radial distances for level A harassment for a 100in³ and 7800in³ airgun array. Source: LGL 2017.

| Functional Hearing Group | 100in ³ array (peak SPL _{flat}) (m) | 100in ³ array (SEL _{cum}) (m) | 7800in ³ array (peak SPL _{flat}) (m) | 7800in ³ array (SEL _{cum}) (m) |
|--------------------------|--|--|---|---|
| Low Frequency Cetaceans | 3.2 | 4.48 | 61.5 | 752.8 |
| Mid Frequency Cetaceans | 0.0 | n/a | 0.0 | 0.0 |
| High Frequency Cetaceans | 3.7 | n/a | 14.5 | 1.7 |

Table 4: Modelled radial distances for level B harassment for a 100in³ and 7800in³ airgun array. Source: LGL 2017.

| Source and Volume (in ³) | Predicted Distance to Threshold (160 dB re 1μPa) (m) |
|--------------------------------------|--|
| 1 airgun, 100 | 722 |
| 4 strings, 32 airguns, 7800 | 9289 |

The IHA for the survey, which was issued on 14 September 2017, outlined the required mitigation and monitoring measures for the KR17-14 survey. All requirements stipulated by the IHA are described in detail in the next section. Level B harassment was authorized for all species expected in the survey area, however authorization for level A harassment was only provided for three species: Bryde's whale, pygmy sperm whale, and dwarf sperm whale (Table 5). A copy of the IHA is provided in Appendix A.

Table 5: Authorized level A and level B takes. Source: IHA 2017.

| Species | Proposed Level A Takes | Proposed Level B Takes | Total Proposed Takes |
|-----------------------------|------------------------|------------------------|----------------------|
| Humpback Whale | 0 | 2 | 2 |
| Minke Whale | 0 | 1 | 1 |
| Bryde's Whale | 2 | 25 | 27 |
| Sei Whale | 0 | 6 | 6 |
| Fin Whale | 0 | 2 | 2 |
| Blue Whale | 0 | 3 | 3 |
| Sperm Whale | 0 | 51 | 51 |
| Cuvier's Beaked Whale | 0 | 8 | 8 |
| Longman's Beaked Whale | 0 | 85 | 85 |
| Blainville's Beaked Whale | 0 | 76 | 76 |
| Rough-Toothed Dolphin | 0 | 812 | 812 |
| Bottlenose Dolphin | 0 | 246 | 246 |
| Pantropical Spotted Dolphin | 0 | 639 | 639 |
| Spinner Dolphin | 0 | 32 | 32 |
| Striped Dolphin | 0 | 685 | 685 |
| Fraser's Dolphin | 0 | 577 | 577 |
| Risso's Dolphin | 0 | 130 | 130 |
| Melon-Headed Whale | 0 | 97 | 97 |
| Pygmy Killer Whale | 0 | 119 | 119 |
| False Killer Whale | 0 | 16 | 16 |
| Killer Whale | 0 | 5 | 5 |
| Short-Finned Pilot Whale | 0 | 218 | 218 |
| Pygmy Sperm Whale | 7 | 87 | 94 |
| Dwarf Sperm Whale | 18 | 214 | 232 |

3 Marine Mammal Monitoring and Mitigation Program

The aim of the vessel-based monitoring program was to ensure that provisions outlined in the incidental harassment authorization (IHA) were satisfied with respect to mitigation, disturbances to marine mammals were minimized, and marine mammal observations during the survey were documented.

The primary purposes of the monitoring and mitigation program are:

Monitoring: Visual and acoustic observations to determine whether marine mammals are present inside the survey area, including relevant exclusion zones and the estimated level A and B harassment zones, and to document behaviours as best as practically possible.

Mitigation: An action or activity implemented to minimize the risk of a potential impact occurring to a marine mammal observed or detected inside the designated exclusion zones and level A and B harassment zones; for example: seismic source array soft start procedure, delay to the start of a sound source, or a source being powered down or shutdown as per the project IHA.

The following mitigation measures were adopted for visual and acoustic monitoring for marine mammals during the KR17-14 marine geophysical survey. The mitigation measures implemented included:

- exclusion and buffer zones,
- soft start procedures,
- soft start delay procedures,
- power down procedures, and
- shutdown procedures.

Additionally, measures were implemented for vessel strike avoidance and dead or injured protected species reporting. The mitigation measures and monitoring protocols are detailed here. An abbreviated summary and decision flow chart are provided in Appendix B and Appendix C respectively.

3.1 Mitigation Requirements

3.1.1 Seismic Operations

3.1.1.1 Exclusion and Buffer Zones

Two exclusion zones, a 500m zone for power down and a 100m zone for shutdowns, were established and monitored for the presence or absence of marine mammals by a team of protected species observers (PSOs). The exclusion zones were monitored both visually and/or acoustically depending on visibility (acoustic only at night). Additionally, a 1000m buffer zone, which served as a warning zone to the crew that marine mammals were present and a mitigation action (power down or shutdown may occur in the future), was also established and monitored.

All three zones were based on the radial distance from any source element within the full array, and not from the center of the array.

3.1.1.2 Soft Start

The intent of soft start is to warn marine mammals in close proximity to a source array of pending fully active seismic source operations and to allow sufficient time for those animals to leave the immediate vicinity. Under normal conditions, animals sensitive to these activities are expected to move away from an activated source array.

When required, soft start began with the smallest airgun in the array (100in³). Airguns were added in a sequence such that the sound source level of the array gradually increased over a minimum 30 minute period until the full output of the array was reached. Soft start for source testing was not required for single airgun or single gun string tests.

If the source array was reduced in volume or shut down due to the presence of marine mammals within the relevant exclusion zones, soft start procedures were required to return the array to the full operational output.

Unplanned cessations in source array activity due to a malfunction of the seismic equipment or a technical problem did not require a soft start if the following criteria were met:

- the array was inactive for less than 30 minutes,
- visual and acoustic observations for marine mammals were continuous during the period of inactivity,
- marine mammals were not visually detected within the 1000m buffer zone during the period the source was inactive, and
- marine mammals were not acoustically detected during the period of source inactivity.

If a marine mammal was observed within the buffer zone whilst the source was inactive, the source remained off and a soft start was conducted after the zone was clear of marine mammals.

3.1.1.3 Soft Start Delay

Prior to initiating the seismic source, either for soft start or source array testing, the 500m exclusion zone was visually and acoustically monitored for the presence of marine mammals for a minimum of 30 minutes. If marine mammals were detected approaching or within the exclusion zone either visually and/or acoustically, soft start was delayed until 30 minutes had elapsed from the last visual or acoustic detection of marine mammals in the 500m exclusion zone.

3.1.1.4 Power Down

The seismic source array was immediately powered down to a single 100in³ airgun, including during soft start and source array testing, when a marine mammal for which takes were authorized was visually and/or acoustically detected within the 500m exclusion zone or about to enter the zone whether due to the animal's movement, the vessel's movement, or because the animal surfaced inside the exclusion zone.

A power down was also implemented for:

- acoustic detections where the species and/or the distance from the source was uncertain or unknown,
- large whale (mysticete, sperm, or beaked) cow/calf pairs detected at any distance from the source, and
- aggregations (greater than six individuals) of large whales (mysticete, sperm, or beaked) detected at any distance from the source and were not travelling (stationary, foraging, socializing, resting, etc).

Small delphinids from the *Lagenodelphis* (Fraser's), *Steno* (rough-toothed), *Stenella* (panropical spotted, spinner, and striped), or *Tursiops* (bottlenose) genera observed travelling were exempt from the power down procedure. If the observer was uncertain of the species and/or behaviour of the dolphin, a power down was required.

Operations could resume via a soft start for power downs of 30 minutes or less after:

- the marine mammal was observed leaving the 500m exclusion zone,
- 15 minutes had elapsed from the last detection of a small delphinid (from the four genera noted above) within the 500m exclusion zone, or
- 30 minutes had elapsed from the last detection of all other marine mammals within the 500m exclusion zone.

If the power down was initiated due to the presence of a large whale cow/calf pair, an aggregation of large whales, or an acoustic detection where species and/or distance from the source was unknown, soft start could commence after 30 minutes had elapsed from the last detection of the marine mammals.

Power downs greater than 30 minutes resulted in a shutdown of the source array.

3.1.1.5 Shutdown

The seismic source array was immediately shutdown, regardless of source output, when a marine mammal for which takes were authorized was visually and/or acoustically detected within the 100m exclusion zone or about to enter the zone whether due to the animal's movement, the vessel's movement, or because the animal surfaced inside the exclusion zone. The shutdown procedure was also required when marine mammals for which takes were not authorized were detected at any distance from the source.

As with power downs, small delphinids from the four genera noted above were exempt from the shutdown procedure if observed travelling. If the observer was uncertain of the species and/or behaviour of the dolphin, a shutdown was required.

Operations could resume via a soft start for shutdowns of 30 minutes or less after:

- the marine mammal was observed leaving the 500m exclusion zone,
- 15 minutes had elapsed from the last detection of a small delphinid within the 500m exclusion zone, or
- 30 minutes had elapsed from the last detection of all other marine mammals within the 500m exclusion zone.

If the shutdown was initiated due to the presence of a marine mammal for which takes were not authorized, soft start could commence after 30 minutes had elapsed from the last detection of the marine mammals.

A 30 minute clearance period for the 500m exclusion zone was also required prior to initiating soft start for shutdowns greater than 30 minutes in duration (or when the combined power down and shutdown period exceeded 30 minutes).

3.1.1.6 PAM System Malfunction

In the event the passive acoustic monitoring (PAM) system malfunctioned, operations could continue for a period of 30 minutes without acoustic monitoring while the operator diagnosed the issue. If the diagnosis indicated that the PAM system needed repairs or a component required replacement, operations were permitted for an additional 2 hours if:

- the malfunction occurred during daylight hours,
- visual monitoring was continuous throughout the period without acoustic monitoring,
- the sea state was classified as less than or equal to Beaufort 4, and

- marine mammals (excluding small delphinids from the four genera noted above) were not detected within the 500m exclusion zone solely by PAM in the 2 hours leading up to the system malfunction.

Operations without PAM could not exceed a total of 4 hours in a 24 hour period. All operations conducted in the absence of PAM were reported to the NMFS as soon as was practically possible and included the time and location for operations in the absence of PAM.

3.1.1.7 Other Mitigation Measures

A few additional mitigation measures were required for operations on the *Kairei*. When not acquiring data, or preparing to acquire data the source array was to be deactivated, with an exemption for source testing which was permitted. The source array output was not to exceed the operational capacity of 7800in³, except where unavoidable for source testing and calibration. If the operational capacity was exceeded, the PSOs were to be notified. The 100in³ airgun was not to be used for any purpose other than in response to a marine mammal detected within or approaching the 500m exclusion zone.

3.1.2 Vessel Strike Avoidance

While monitoring for marine mammals within the relevant exclusion zones, the PSOs and crew aboard the *Kairei* also monitored for marine mammals in close proximity to the survey vessel that may be at risk for collision or strike with the survey vessel or nearby vessels. If a marine mammal, including cow/calf pairs and assemblages, was observed near the vessel, the vessel would slow (speed not to exceed 10 knots), stop and/or alter course to avoid striking the animal (when operationally possible). The vessel would also maintain a parallel track to any marine mammal observed during transit periods.

Separation distances were also maintained, including a 100m distance for large whales and a 50m distance for all other marine mammals (except for those from the four genera noted above that approach the vessel to bow ride). When operationally feasible (to prevent the collapse of towed seismic equipment), the vessel would slow and shift to neutral for marine mammals observed within the designated separation distances. The engines would not be engaged until the animals moved outside the vessel's path and the separation distance had been re-established.

3.1.3 Dead or Injured Marine Mammal Reporting

Dead and injured marine mammal detections were reported to the NMFS Office of Protected Resources (301-427-8401) and the NMFS Pacific Islands Regional Stranding Coordinator (808-725-5161) within 24 hours of the detection for mammals observed with moderate to advanced decomposition, immediately for mammals observed with less than a moderate state of decomposition, or immediately if the death or injury was the result of survey operations. Information reported included:

- time, date, and location of incident,
- vessel's speed during and leading up to incident,
- description of incident
- status of all sound source use in 24 hours preceding the incident,
- water depth,
- environmental conditions,
- description of all marine mammal observations in the 24 hours preceding the incident,
- species identification or description of the animal(s) involved,
- fate of animal, and
- photographs or video footage of animal

If the death or injury was the result of survey operations, operations were suspended until NMFS reviewed the circumstances of the incident.

3.2 Marine Mammal Survey Methodology

3.2.1 Visual Monitoring

3.2.1.1 Daytime Observations

Visual observations for marine mammals were conducted by a team of four NMFS approved PSOs during all daytime operations regardless of source activity, as well as during transit to and from port and between survey lines. An observer schedule was set that ensured two PSOs were on duty at any given time, except for a 30 minute period around breakfast during which time only one observer was on watch. Each PSO worked no more than four consecutive hours before taking a minimum one hour break period.

Monitoring began approximately 30 minutes prior to sunrise (roughly 15:40 UTC) and continued until 30 minutes after sunset (approximately 05:00 UTC) or until the 500m exclusion zone was no longer visible due to darkness. Watches were primarily conducted from the navigation (bridge and bridge wings) and hangar decks (full hangar deck area and aft wheelhouse), approximately 15m and 16m above the sea surface respectively (Figure 4). Occasional observations were also carried out from the monkey deck, however watches from this deck were limited due to its location immediately under the vessel's radar.

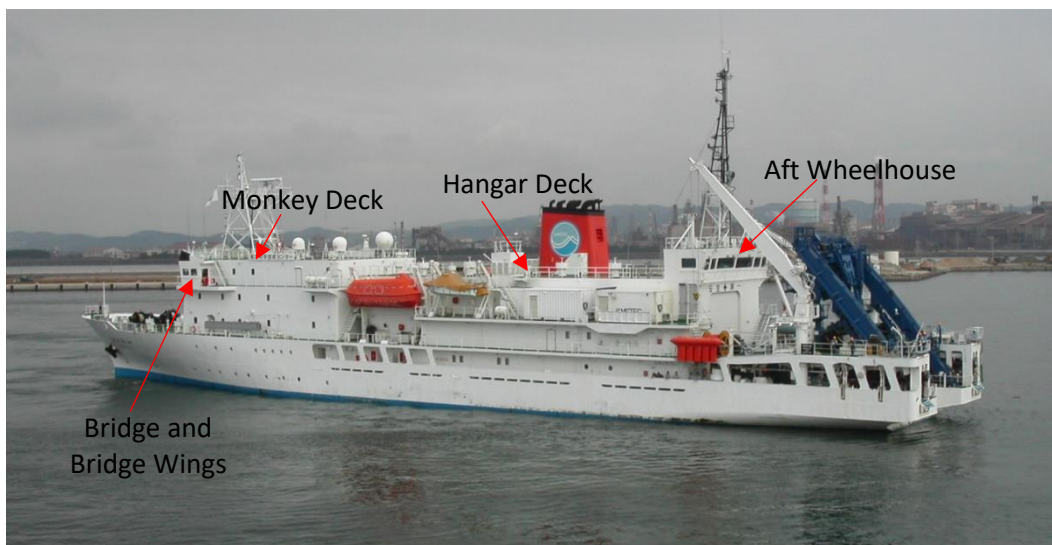


Figure 4: Locations of visual observations on the *Kairei*. Vessel photograph provided by JAMSTEC.

PSOs scanned the sea surface with the naked eye, 7x50 marine reticle binoculars, and 25-40x100 big eye reticle binoculars. Two big eyes were stationed using secure tripods on the hangar deck, one on the port side and one on the starboard side of the *Kairei* (Figure 5). Distant waters were scanned using the big eyes at least once per hour. Three DSLR cameras (a Nikon D5500, Nikon D3000, and Canon 60D) were available for photographing observed wildlife, each with lenses up to 300mm.

Distance to observed marine species was estimated using reticle binoculars and by using known reference distances (distance astern of the seismic equipment, distance to passing vessels, etc). Species were identified based upon physical characteristics and behaviours. Identification was facilitated by consulting relevant field guides or by observer experience.



Figure 5: Big eye binocular positioned on the starboard side of the *Kairei*.

Upon making a visual detection, the PSOs determined whether the presence of the marine species immediately warranted a mitigation action. The PSOs maintained visual contact with the animal until the marine mammal could no longer be observed, whether because the animal sounded or the distance at which the PSO could maintain visual contact had been exceeded. Mitigation actions were implemented when appropriate and were made through the PAM operator to the seismic crew via hand held radios or direct verbal communications. Notes on the detection, such as behaviour of the animal, distance to the animal from the seismic source, bearing to the animal, animal direction of travel, number of individuals, etc. were maintained by the PSOs throughout their monitoring shifts using field notebooks. Details on operations, vessel position, and weather conditions are also recorded at one hour intervals or when conditions and/or operations changed during the monitoring shift. All data were recorded electronically in an Excel spreadsheet.

3.2.1.2 Night-time Observations

PSOs conducted visual watch at night on an as needed basis when operations were due to begin during periods of darkness. Monitoring began no less than 30 minutes prior to the initiation of the source from silence (source testing or soft start) and continued through the duration of the source test or soft start and for one hour after the test was complete or the source array reached full power.

The 500m exclusion zone and surrounding area was scanned from the hangar deck using a FLIR Ocean Scout 320 infrared device (specifications can be found in Appendix D). Two PSOs were on duty during each night shift, alternating use of the infrared device every 15-20 minutes to minimize eye fatigue from looking through the monocular lens for the device.

All other methods for night-time visual observations were the same as those for daytime visual observations, however distances to observed animals was determined only by comparison to objects at known distances.

3.2.2 Passive Acoustic Monitoring (PAM)

Acoustic monitoring for marine mammals was conducted by two experienced passive acoustic monitoring (PAM) operators during all seismic operations (day and night) and during transits between survey lines

when the seismic equipment was deployed. One operator was on shift from midnight to mid-day (local) and the second on the reverse schedule from mid-day to midnight. Each operator worked no more than six consecutive hours before taking a break period. PAM trained PSOs relieved the PAM operators for break periods of approximately two hours, once per day during their shifts.

Monitoring began no less than 30 minutes prior to the start of soft start and was continuous for 24 hours whilst the hydrophone cable was deployed. Acoustic monitoring was conducted from the geophysical laboratory on the *Kairei* (Figure 6).



Figure 6: Acoustic monitoring station in the geophysical laboratory on the *Kairei*.

During an acoustic monitoring shift, the PAM operator aurally monitored the signal from the hydrophones while monitoring pertinent visualization modules in PAMGUARD. Upon making an acoustic detection of marine mammal vocalizations, the PAM operator would immediately collect audio recordings, make note of vessel position and water depth, collect screen images of the PAMGUARD visualization displays, and continue to monitor for vocalizations, while using existing tracking and localisation functions within PAMGUARD to assess range to vocalizing marine mammals. Detections were monitored until vocalizations were no longer detected aurally and/or visually in PAMGUARD. Mitigation actions were implemented when appropriate and were made direct to the seismic crew. Notes on the detection including vocalization type, frequency, duration, etc. were collected throughout the detection event. Details on operations and vessel position were also recorded during the monitoring shift.

A detection was defined as any acoustic event during which cetacean vocalizations were aurally and/or visually observed in PAMGUARD, regardless of the total duration of the event. Cetacean vocalizations detected greater than 10 minutes apart were considered separate detections

Species identification can be challenging, particularly with delphinid species. As such species were identified to the lowest level of confidence (unidentified cetacean, unidentified odontocete, unidentified delphinid, etc.), unless the operator was confident in their species identification or there was visual confirmation.

Range estimates in PAMGUARD were obtained by analyzing the bearings to vocalizations obtained through the click detector, clip generator, and whistle and moan detector modules and looking for concentrated areas of cross-bearings on the map display.

3.2.2.1 Passive Acoustic Monitoring Equipment

3.2.2.1.1 PAM Hardware

The 250m hydrophone array contained four hydrophone elements, two broadband elements with a frequency response of 200Hz to 200kHz and two standard elements with a frequency response of 2kHz to 200kHz (Figure 7). The frequency responses for the hydrophones represents the flat response between the two 3dB points. The hydrophones remain sensitive beyond the minimum and maximum frequencies quoted, however the gain begins to roll off as the frequencies move above or below these values. Hydrophone sensitivity was -166dB re 1V/ μ Pa for the standard elements and -157dB re 1V/ μ Pa for the broadband elements. In addition to the hydrophone elements, the array cable also contained a depth sensor.

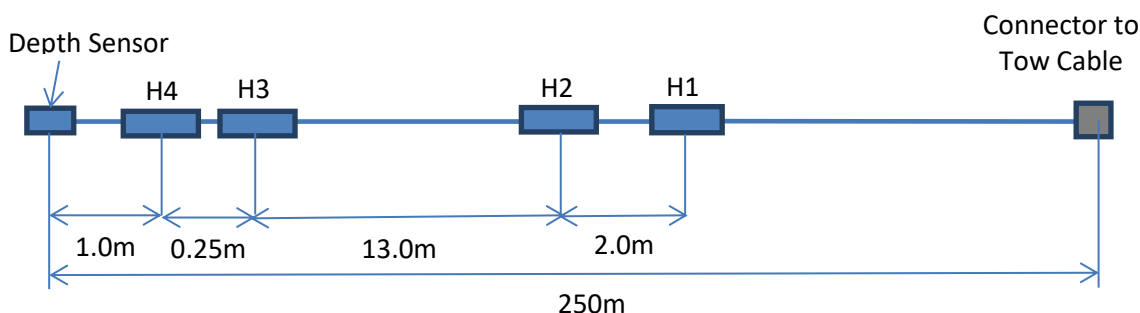


Figure 7: Array configuration with hydrophone separation distances and position of the depth sensor.

A 100m deck cable was used as an interface between the hydrophone array cable and the acoustic monitoring station.

The electronics processing unit contained two analogue to digital converters (ADCs) used for sampling the raw signal from the hydrophones and an additional ADC for the depth sensor. Power to the hydrophone array is also provided by the electronics processing unit. One sound ADC, the National Instruments (NI) DAQ card, was used to sample acoustic signals at 500kHz, while the second sound ADC, the Fireface 800, was used to sample acoustic signals at 48kHz. Use of the two sound cards allowed for acoustic signals to be sampled at rates consistent with low, mid, and high frequency cetacean vocalizations.

The PAM system was designed and manufactured by Seiche Limited.

3.2.2.1.2 Hydrophone Deployment

Approximately 165m of the hydrophone array was deployed from the stern of the *Kairei* using one of two deployment methods. The hydrophone array was suspended from the streamer lead-in for the initial deployment method. With this method, the first 100m of the array cable was taped to the lead-in at approximately 1m increments and the remaining 65m was towed freely from the lead-in via a Chinese-finger knot (Figure 8). The tow depth with this deployment configuration ranged from 14m to 18m. This method of deployment was utilized from 04:20 UTC on 18 September to 03:39 UTC on 23 September.

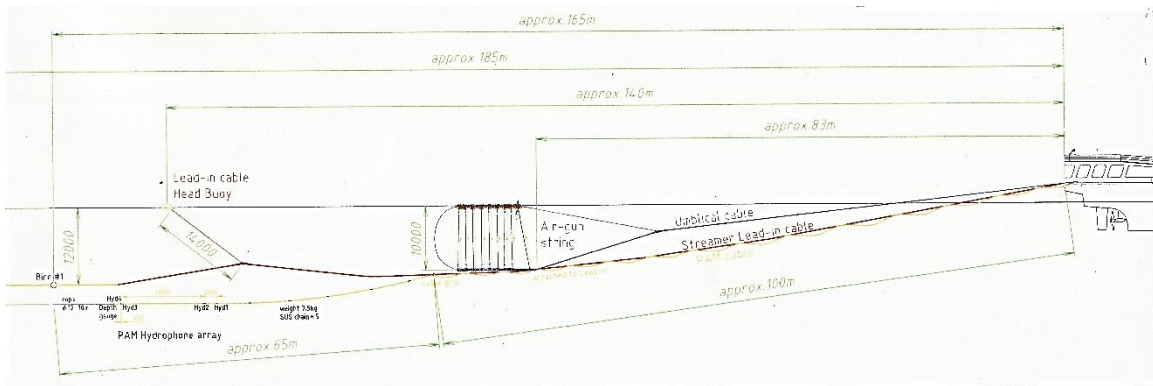


Figure 8: Hydrophone deployment from the streamer lead-in. Schematic provided by JAMSTEC.

The streamer was not deployed for the second run of the westernmost north-south survey line, therefore an alternative method for deployment was devised. The full 165m of hydrophone cable was deployed freely from the stern for the second deployment method (Figure 9). Multiple lengths of chain were added to the cable to deploy the cable underneath the source array. The tow depth with this deployment method also ranged from 14m to 18m. This deployment configuration was utilized from 21:01 UTC on 23 September to 18:03 UTC on 24 September.

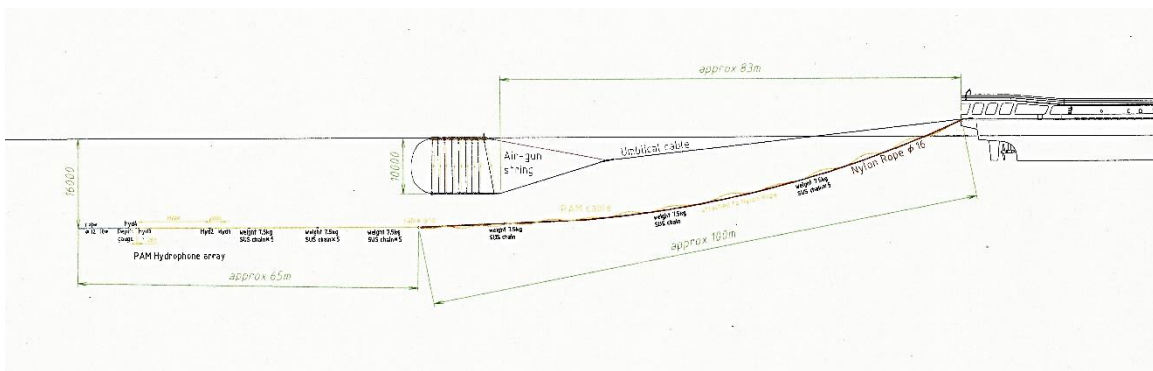


Figure 9: Hydrophone deployment directly from the stern of the *Kairei*. Schematic provided by JAMSTEC.

The cable was hand deployed from a spool that was supported by a frame and secured to the main deck for both deployment methods. While deployed, the hydrophone cable was positioned approximately 82m behind the seismic source array.

3.2.2.1.3 PAM Software

PAMGUARD is an open source software program for passive acoustic monitoring developed with the support from the OGP E&P Sound and Marine Life Program. The software can be configured by the user to meet any specific project requirements. The user can add in various modules that will allow for visualization of the raw and/or filtered signal from the hydrophones, implementation of detectors for tonal and pulsed vocalizations, permit recording of one to multiple hydrophone channels, and provide tracking and localisation capabilities.

The PAM system was configured to monitor for low, mid, and high frequency cetacean vocalizations using PAMGUARD version 1.15.11 (64 bit). Two click detectors were incorporated, one for low/mid frequency clicks produced by delphinids and sperm whales and one for high frequency clicks produced by echolocating delphinids, *Kogia*, and beaked whales. The low/mid frequency click detector utilized the raw

signal from the Fireface 800 ADC, with a 4kHz (4th order) high pass Butterworth pre-filter and trigger filter of the same configuration. The high frequency click detector utilized the raw signal from the NI DAQ ADC, with a 15kHz to 180kHz (8th order) band pass Butterworth pre-filter and a 5kHz to 160kHz (6th order) band pass Butterworth trigger filter. The trigger threshold was set to 10dB for both click detectors.

General classifiers for beaked whales, delphinids, and *Kogia* were included in the high frequency click detector. Click waveforms, spectrums, and Wigner plots were also available through the click detector for further analysis and potential identification/confirmation of cetacean group or in some cases species.

Two whistle and moan detectors were included in the PAMGUARD configuration. One detector, the moan detector, was configured to detect low frequency tonal calls from mysticetes and the second, the whistle detector, was configured to detect mid frequency delphinid whistles. To improve the efficiency for the detection of low frequency vocalizations, a decimator was integrated which resampled the 48kHz raw signal from the Fireface 800 ADC at 6kHz and a 2.8kHz (4th order) low pass Butterworth filter. The decimated data was used as the data source for the moan detector, while the raw signal from the Fireface 800 ADC was used as the data source for the whistle detector.

Four spectrogram displays were incorporated to cover the wide range of frequencies used by cetacean vocalizations. The configuration for each spectrogram is provided in Table 6.

Table 6: Spectrogram parameters.

| Spectrogram | FFT Spectrogram Engine Settings | | | | Frequency Range |
|--------------------|---------------------------------|------------|---------|--------|-----------------|
| | Data Source | FFT Length | FFT Hop | Window | |
| Very Low Frequency | decimator | 512 | 50% | Hann | 0-500Hz |
| Low Frequency | decimator | 512 | 50% | Hann | 0-3kHz |
| Mid-Frequency | Fireface raw | 2048 | 50% | Hann | 3-24kHz |
| High Frequency | NI DAQ raw | 1048 | 50% | Hann | 10-125kHz |

The click detector, whistle and moan detector, and clip generator modules in PAMGUARD may all be used for localisation based on target motion analysis (TMA). The two detectors and clip generator use cross-correlation to match the occurrence of a signal on different hydrophone channels and calculate a bearing angle to the signal from the time of arrival differences (TOADs) between the hydrophones in the pairing. When a detection event is long enough, a series of bearings to the vocalising marine mammal will be plotted on the map display as the vessel advances along the survey line and the animal remains at approximately the same location. These bearing lines will begin to converge, providing an estimated position to the marine mammal (Figure 10).

The use of TMA for localising marine mammals requires the animal to be stationary or moving slowly relative to the vessel. A long series of vocalisations must also be confidently assigned to an individual animal or very close group of animals. The process works well for sperm whales and singing humpback whales. However, because delphinids are fast moving and change position rapidly, the use of TMA to localise delphinids is not appropriate and should be avoided due to potentially large errors in range estimates.

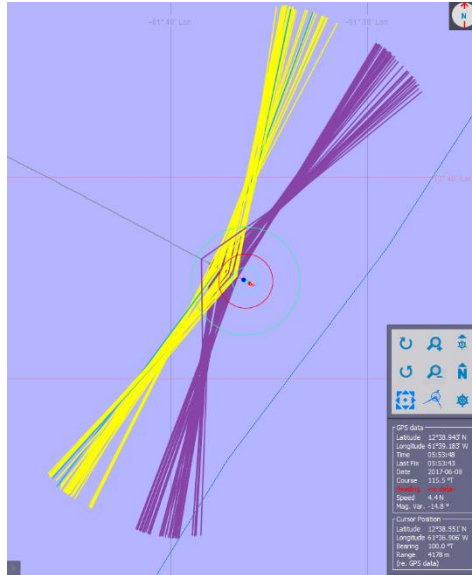


Figure 10: Two localizations (not from KR17-14 survey) shown on the map display.

3.3 Communication and Reporting

The PSO team liaised with the PAM operator on duty using handheld radios on a dedicated English language channel. The PAM operator verbally relayed messages to and from the seismic crew who were also stationed in the geophysical laboratory. Notification of the pre-source monitoring periods was given at least 60 minutes prior to the start of soft start, along with a clearance check prior to activating the source. Requests for mitigations were relayed immediately and communication was maintained until operations resumed.

Throughout the survey, a daily report was submitted to the lead scientists onboard the *Kairei*. The report included information on source operations, observer effort (visual and acoustic), marine mammal detections, and mitigation actions.

4 Survey Results

4.1 Seismic Source Operations

The seismic source array was in operation for a total of 100 hours 39 minutes, of which 94.7% was a full power while acquiring data on survey lines (Figure 11). The remaining 5% of source operations was composed of soft start (2 hours 53 minutes; 2.9%), single airgun source tests (33 minutes; 0.5%), and reduced power on a survey line (1 hour 54 minutes; 1.9%). A portion of the easternmost north-south line was survey using only the port side sub-arrays after a malfunction for the source was noted in the starboard sub-arrays. This period coincides with the reduced power data acquisition portion of the source activity. Details on the timing for each of the survey lines are provided in Table 7.

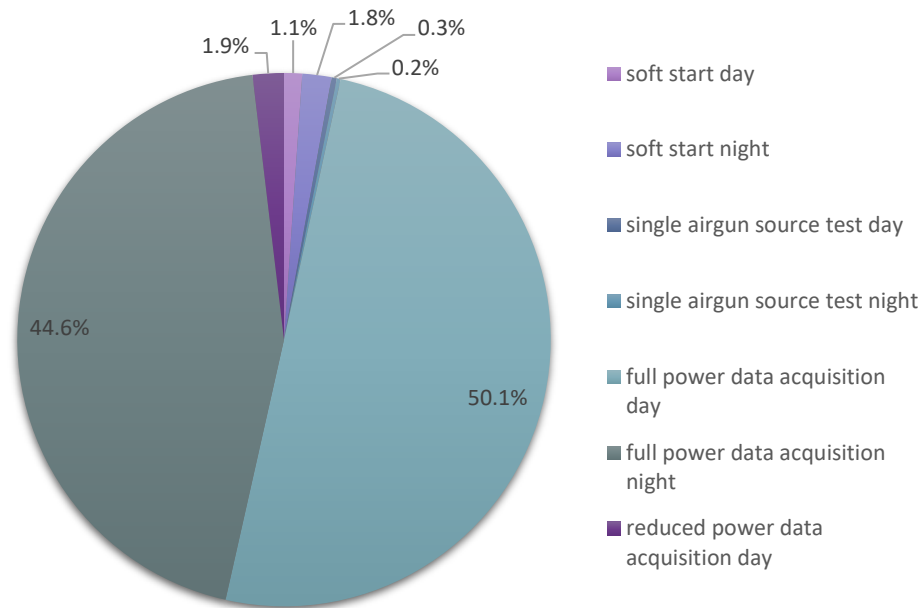


Figure 11: Summary of source array operations during the KR17-14 survey on the *Kaiei*.

Table 7: Survey line details.

| Survey Line | Start of Line | | End of Line | | Line Duration (HH:MM) |
|--|---------------|------------|--------------|------------|-----------------------|
| | Date | Time (UTC) | Date | Time (UTC) | |
| west-east | 18 September | 05:54 | 19 September | 22:42 | 40:48 |
| easternmost north-south | 20 September | 11:48 | 21 September | 03:02 | 15:14 |
| westernmost north-south (line aborted due to source issue, then restarted) | 21 September | 21:48 | 22 September | 00:51 | 03:03 |
| | 22 September | 06:40 | 23 September | 01:09 | 18:29 |
| westernmost north-south (OBS only – no streamer) | 23 September | 22:21 | 24 September | 18:00 | 19:39 |

Soft start was used to initiate source activity on five occasions during the KR17-14 survey, two during daylight hours and three at night. Each soft start was preceded by 30 minutes of visual and acoustic monitoring of the 500m exclusion zone. The average duration of soft start was 34 minutes. Four single airgun source tests were completed prior to soft start or immediately after the completion of the survey

line. The tests were used to confirm the functionality and calibration for each of the airguns in the array. All but one source test was conducted during daylight hours and each was preceded by 30 minutes of visual and acoustic monitoring.

4.2 Observer Effort and Sighting Conditions

4.2.1 Visual Monitoring

Visual monitoring for marine mammals was conducted for 122 hours 49 minutes over the course of the survey, including 15 hours 4 minutes (12.3%) during transit to and from port (Figure 12). The majority of observations took place during the day, whilst the source was active on a survey line (52 hours 20 minutes; 42.6% of monitoring effort) followed by observations during the day while the source was inactive and outside the pre-source monitoring period ('other' category; 43 hours 9 minutes; 35.1% of the total visual effort). Observations at night prior to, during, and for one hour after soft start accounted for 9 hours 13 minutes (7.5%) of the visual observer effort.

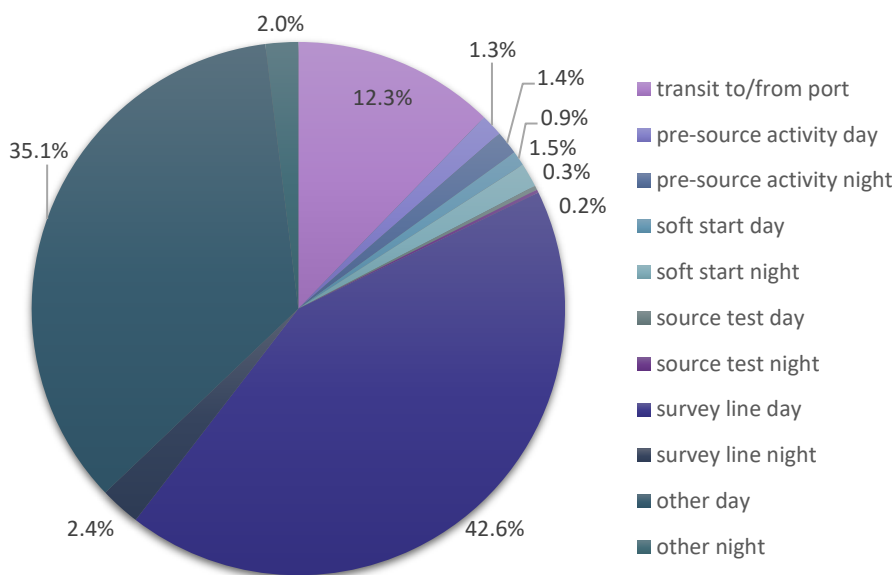


Figure 12: Summary of visual observer effort during various categories source activity during the day and at night.

4.2.1.1 Environmental Conditions

Environmental conditions can influence an observer's ability to detect marine mammals visually, therefore details on various environmental conditions were recorded by the PSOs every hour or when conditions changed. Conditions during the transit from port and the initial days of the survey were poor, with elevated seas, strong winds in excess of 20 knots, and rough sea surface conditions. Wind speeds began to come down on 20 September, averaging around 15 knots, and conditions improved from that point through to the completion of the survey.

Winds during the KR17-14 survey were predominantly from the east (Figure 13) and of a force of 3 on the Beaufort scale (50.7% of all records; Figure 14). Conditions were at Beaufort 4 or above for 33.6% of visual observations.

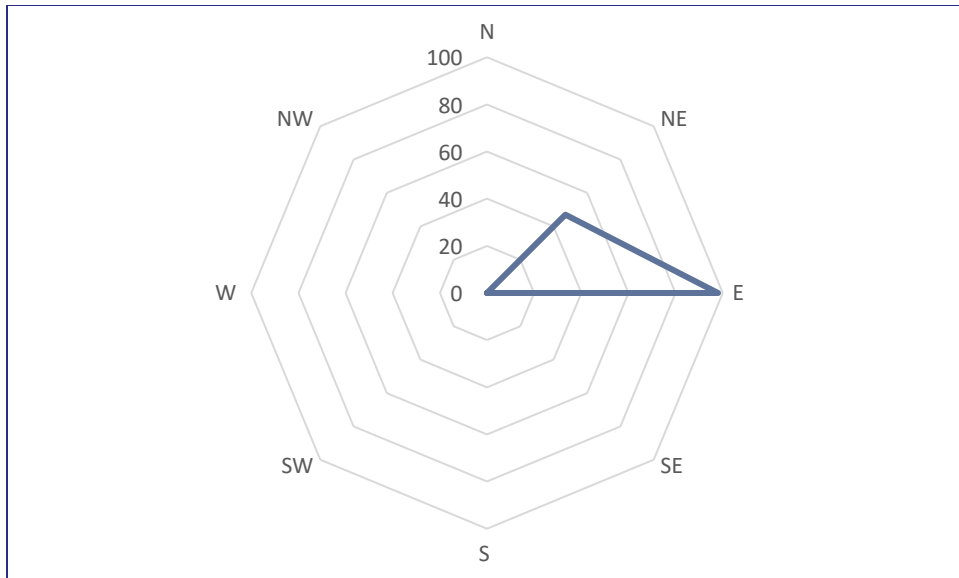


Figure 13: Wind direction recorded during the KR17-14 survey.

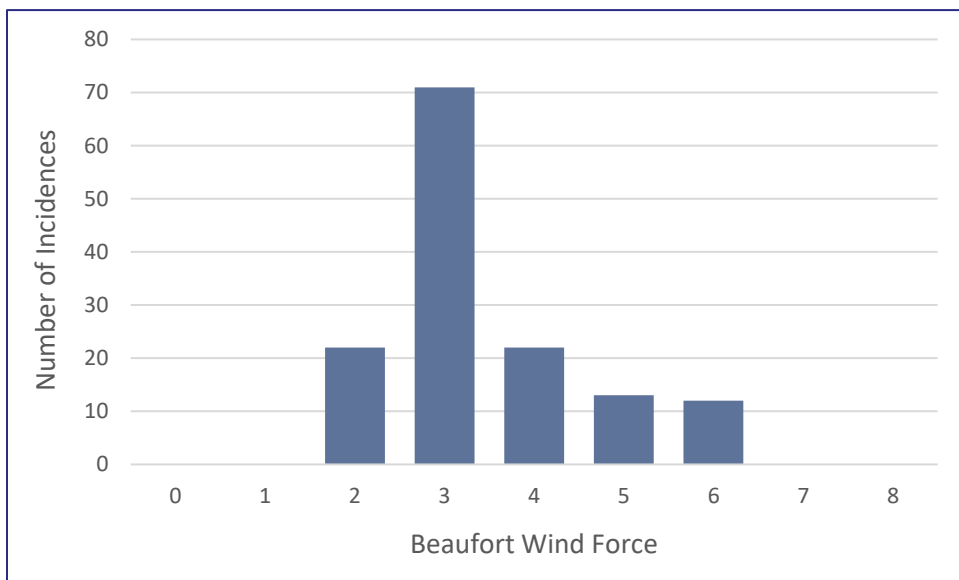


Figure 14: Beaufort wind force recorded during the survey.

Sea surface conditions varied from slight to rough (Figure 15), with slight conditions (small wavelets with few whitecaps) occurring most often (51%) during the course of the survey. Swell height was less than 2m for 80% of the visual survey effort (Figure 16). The swell was elevated during the first few days of the project, but came down after the wind speeds dropped.

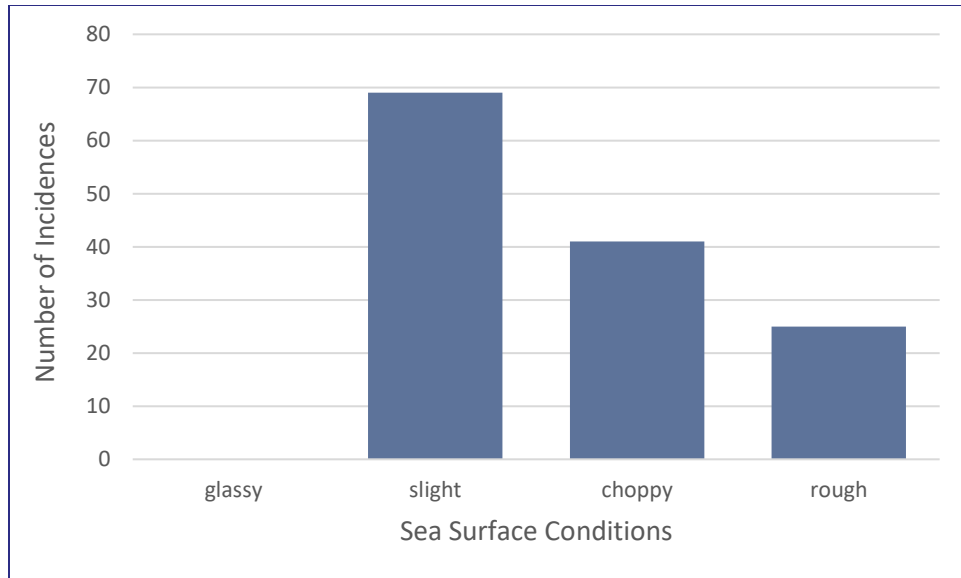


Figure 15: Sea surface conditions recorded during the survey.

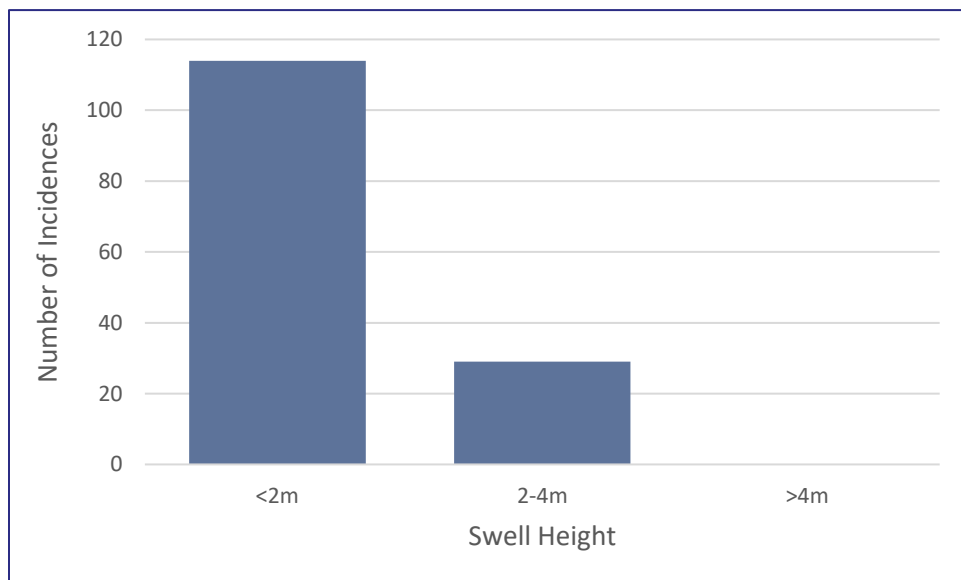


Figure 16: Swell height recorded during visual observation periods over the course of the survey.

Visibility was good, with clear conditions allowing for observations at ranges greater than 5km (Figure 17), however there were numerous periods of strong glare throughout the survey which made observations difficult in the direction of the glare (Figure 18).

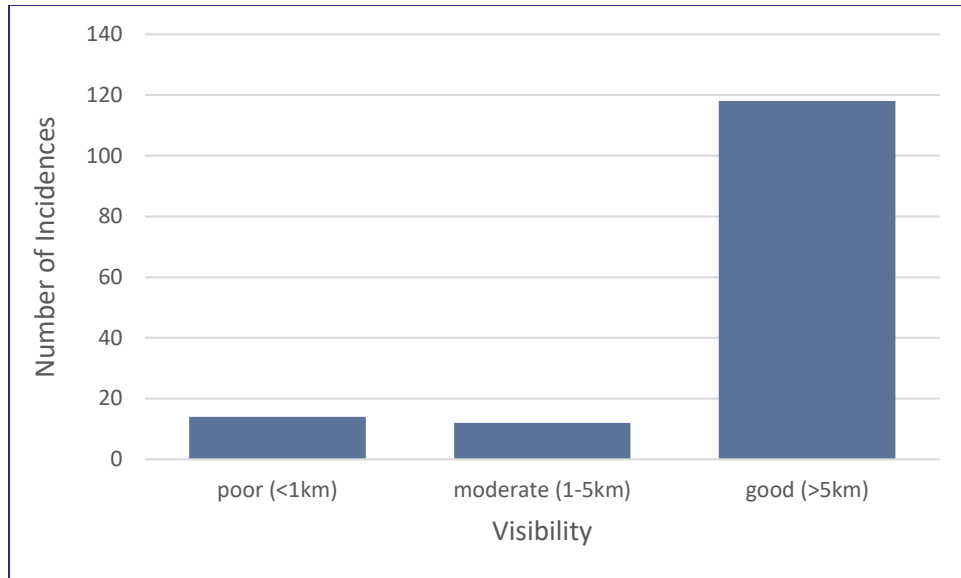


Figure 17: Range of visibility during the survey.

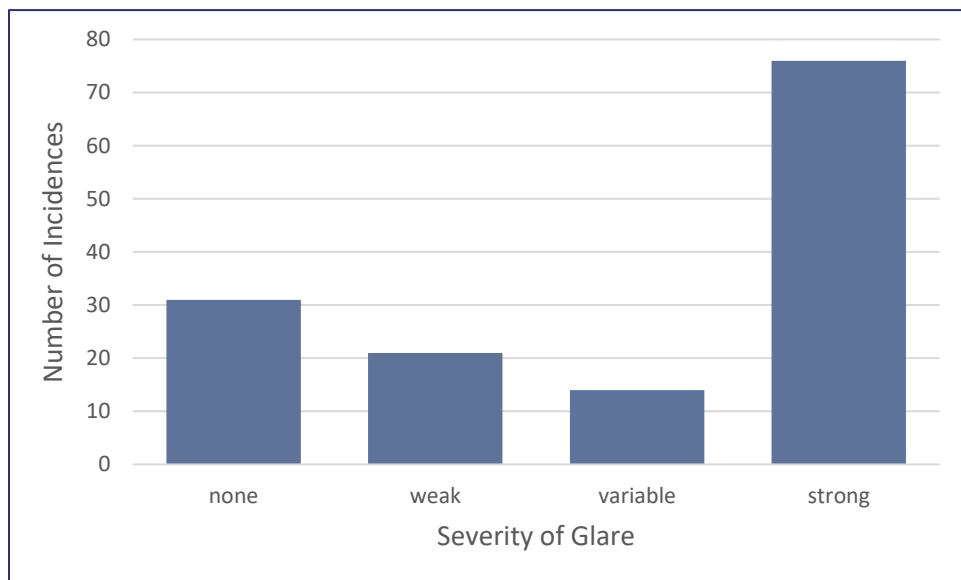


Figure 18: Glare severity observed during the survey.

Cloud cover was variable throughout the course of the survey, however cover was between 25 and 75% in most records (72%; Figure 19). Brief periods of light to heavy rain showers were encountered as small squalls moved through the survey area, with most showers consisting of only light levels of precipitation (Figure 20).

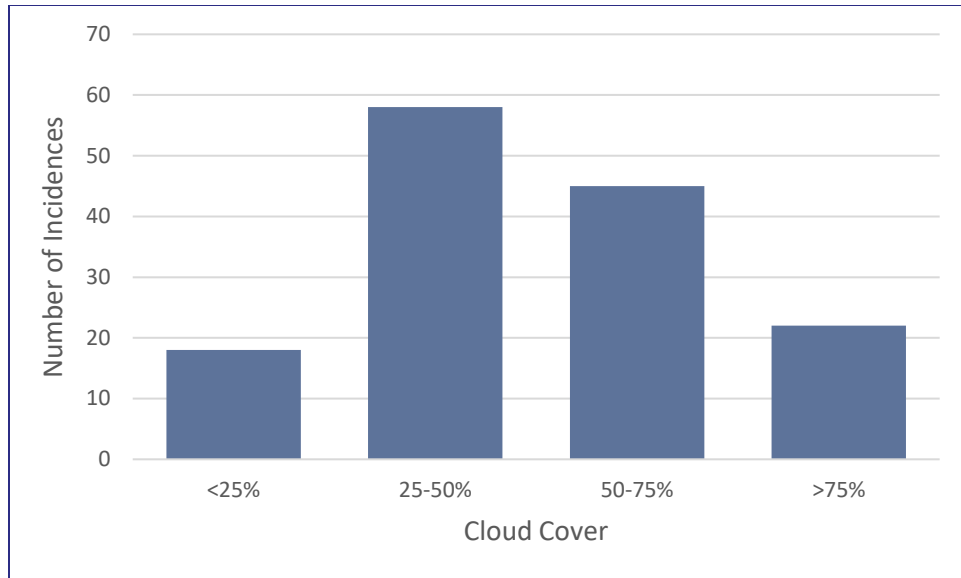


Figure 19: Percentage of cloud cover during the survey.

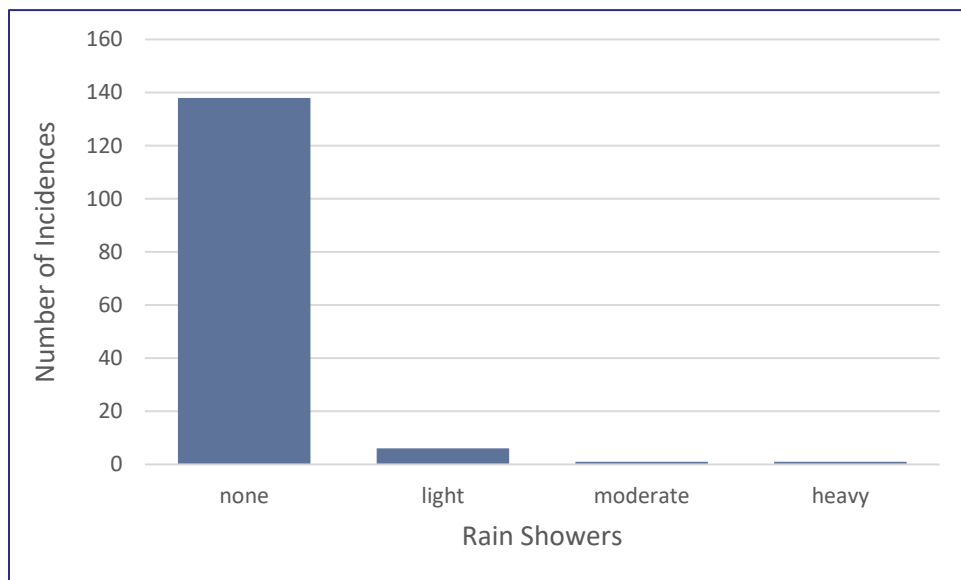


Figure 20: Occurrence and intensity of rain showers during the KR17-14 survey.

4.2.2 Passive Acoustic Monitoring

Acoustic monitoring was conducted for 141 hours 15 minutes over the course of the survey, including 75 hours 36 minutes (54%) during the day and 65 hours 39 minutes (46%) at night. The majority of observations took place whilst the source was active on a survey line (68.9%), followed by observations during the while the source was inactive and outside the pre-source monitoring period ('other' category; 26.3% of the total visual effort; Figure 21).

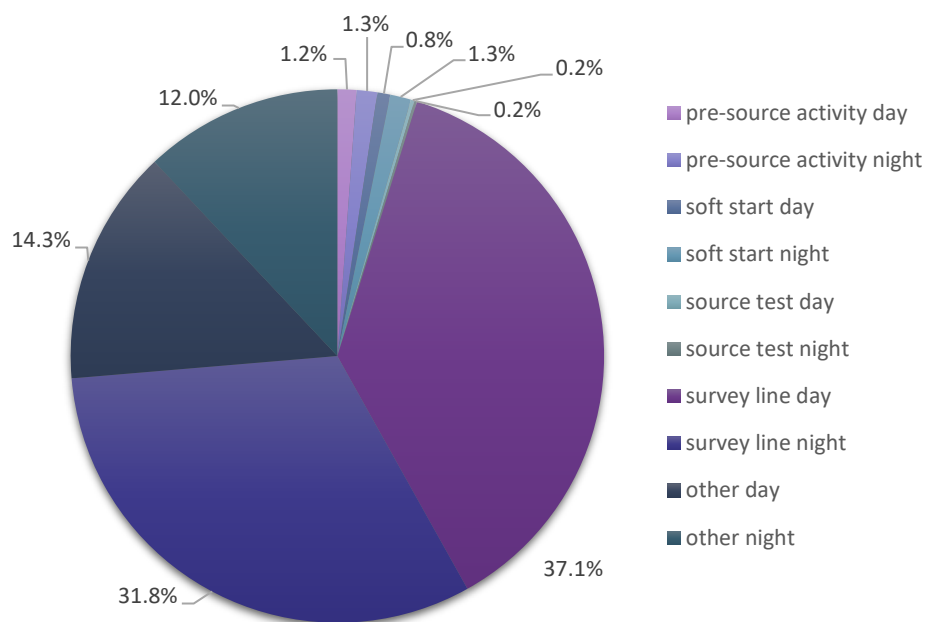


Figure 21: Summary of acoustic monitoring effort during various categories source activity during the day and at night.

4.3 Wildlife Summary

4.3.1 Marine Mammal Detections

4.3.1.1 Visual Detections

Marine mammals were not detected by the PSOS while on the survey area or during the transits to and from port.

4.3.1.2 Acoustic Detections

An unidentified small delphinid was acoustically detected from 16:00 to 16:05 UTC on 24 September 2017. Three upswept whistles (6.5 to 13kHz in frequency), each less than 2 seconds were detected (Figure 22). The three whistles were roughly 90s apart from each other. The source was active at full power and on the second run of the westernmost north-south line at the time of the detection (Figure 23). The weak signal to noise ratio (SNR) and sporadic nature of the whistles, led the operator to the determination that the dolphin was likely more than 500m from the source.

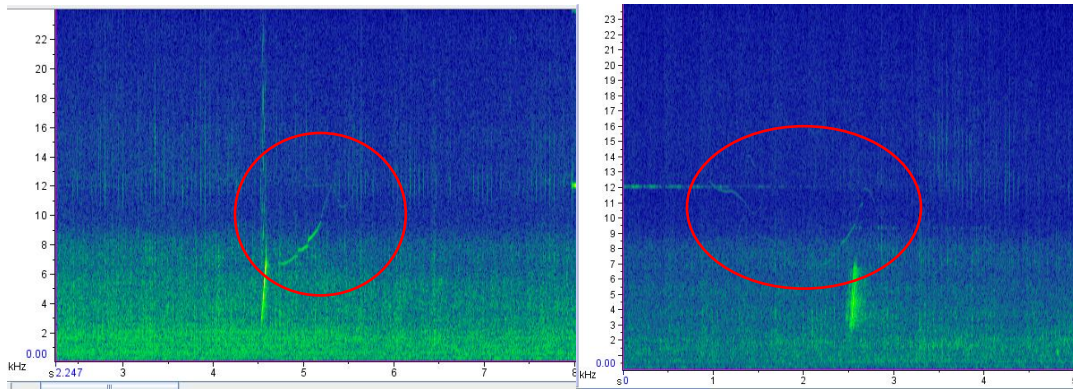


Figure 22: Spectrogram displays of two of the three small dolphin whistles detected on 24 September. Images produced using Raven.

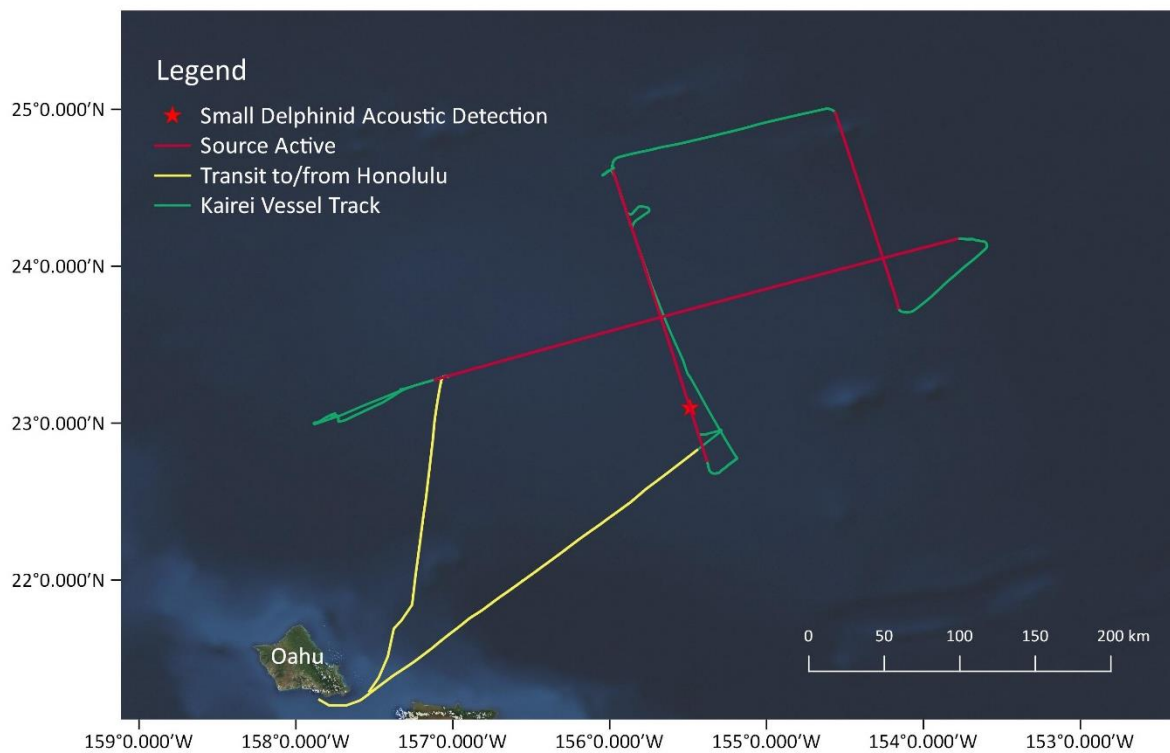


Figure 23: Location of the small dolphin acoustic detection during the KR17-14 survey on the *Kairei*.

4.3.2 Other Notable Wildlife

The PSOs also recorded birds and fish observed while monitoring for marine mammals. Six bird species were identified, including masked and red-footed boobies, great frigatebird, wedge-tailed shearwater, white-tailed tropicbird, and Pacific golden plover (Figure 24).

Numerous flying fish and a few larger fish, including mahi mahi, were also observed (Figure 25).



Figure 24: Avifauna observed by the PSOs during watch; red-footed booby (A), great frigatebird (B), wedge-tailed shearwater (C), and white-tailed tropicbird (D).



Figure 25: Flying fish (left) and mahi mahi (right) observed by the PSO team.

4.4 Mitigation Actions and Estimated Takes

Although the source array was active at full power, the acoustic detection of an unidentified small delphinid on 24 September 2017 did not result in a mitigation action, as the delphinid was determined to be outside the 500m exclusion zone by the PAM operator on duty. Therefore, no mitigation actions were required over the course of the KR17-14 survey.

The detection did, however, result in a level B take as the delphinid was most likely within the 9.2km modelled radial distance for the level B 160dB re 1 μ Pa acoustic threshold for the 7800in³ source array. Based on this observation, the minimum number of level B takes is estimated to be one (based on an assumption that the three whistles were produced by the same individual), with a maximum number of level B takes of 3 (based on an assumption that each of the three whistles was produced by different individuals).

Survey operations did not result in any level A takes.

5 Compliance with Mitigation

The scientific crew of the *Kairei* successfully completed the 2D marine geophysical seismic survey KR17-14 while showing a proactive and conservative approach to marine mammal mitigation and monitoring by fully complying with all operational requirements of seismic activities outlined in the IHA.

6 Acknowledgements

The PSO and PAM team would like to thank the maritime and scientific crew of the *Kairei* for their hospitality, cooperation, and their assistance with deploying and recovering the PAM hydrophone array cable. The team would also like to thank the scientists from JAMSTEC and the University of Hawaii for providing a profession and friendly working environment.

7 References

LGL. 2017. Request by the University of Hawaii for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals during a Marine Geophysical Survey by the R/V *Kairei* in the Central Pacific Ocean, September 2017.

The National Academies of Sciences. 2017. Commemorating the Accomplishments of Project Mohole – 1961-2011. Accessed on 04 October 2017 at www.nationalacademies.org/mohole.html.

8 Appendices

8.1 Appendix A: IHA



INCIDENTAL HARASSMENT AUTHORIZATION

The University of Hawaii (UH) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1371(a)(5)(D)) to harass marine mammals incidental to a marine geophysical survey in the central Pacific Ocean, when adhering to the following terms and conditions.

1. This incidental harassment authorization (IHA) is valid for a period of one year from the date of issuance.
2. This IHA is valid only for marine geophysical survey activity, as specified in UH's IHA application and using an array aboard the R/V *Kairei* with characteristics specified in the IHA application, in the central Pacific Ocean.
3. General Conditions
 - (a) A copy of this IHA must be in the possession of UH, the vessel operator and other relevant personnel, the lead protected species observer (PSO), and any other relevant designees of UH operating under the authority of this IHA.
 - (b) The species authorized for taking are listed in Table 1. The taking, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 1. Any taking exceeding the authorized amounts listed in Table 1 is prohibited and may result in the modification, suspension, or revocation of this IHA.
 - (c) The taking by serious injury or death of any species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA.
 - (d) During use of the airgun(s), if marine mammal species other than those listed in Table 1 are detected by PSOs, the acoustic source must be shut down to avoid unauthorized take.
 - (e) UH shall ensure that the vessel operator and other relevant vessel personnel are briefed on all responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements prior to the start of survey activity, and when relevant new personnel join the survey operations.

4. Mitigation Requirements

The holder of this Authorization is required to implement the following mitigation measures:

- (a) UH must use at least five dedicated, trained, NMFS-approved Protected Species Observers (PSOs), including at least four visual PSOs and one acoustic PSO. The PSOs must have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with



regard to the presence of marine mammals and mitigation requirements. PSO resumes shall be provided to NMFS for approval.

- (b) At least two PSOs must have a minimum of 90 days at-sea experience working as PSOs during a high energy seismic survey, with no more than eighteen months elapsed since the conclusion of the at-sea experience. At least one of these must have relevant experience as a visual PSO and at least one must have relevant experience as an acoustic PSO. One “experienced” visual PSO shall be designated as the lead for the entire protected species observation team. The lead shall coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. The lead PSO shall devise the duty schedule such that “experienced” PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience, to the maximum extent practicable.
- (c) Visual Observation
 - (i) During survey operations (*e.g.*, any day on which use of the acoustic source is planned to occur; whenever the acoustic source is in the water, whether activated or not), two PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.*, from 30 minutes prior to sunrise through 30 minutes following sunset) with the limited exception of meal times during which one PSO may be on duty. PSOs shall monitor the entire extent of the estimated Level B harassment zone (or, as far as they can see, if they cannot see to the extent of the estimated Level B harassment zone).
 - (ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up, including for nighttime ramp-ups of the airgun array, and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.
 - (iii) Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.
 - (iv) Visual PSOs shall communicate all observations to the acoustic PSO, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.
 - (v) Visual PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours observation per 24 hour period.
 - (vi) During good conditions (*e.g.*, daylight hours; Beaufort sea state 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

- (d) Acoustic Observation – The *R/V Kairei* must use a towed passive acoustic monitoring (PAM) system, which must be monitored beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.
- (i) One acoustic PSO (in addition to the four visual PSOs) must be on board to operate and oversee PAM operations. Either the acoustic PSO or a visual PSO with training in the PAM system must monitor the PAM system at all times while airguns are operating, and when possible during periods when the airguns are not operating, in shifts lasting no longer than six hours.
 - (ii) Acoustic PSOs shall communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.
 - (iii) Survey activity may continue for brief periods of time if the PAM system malfunctions or is damaged. Activity may continue for 30 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring under the following conditions:
 - (A) Daylight hours and sea state is less than or equal to Beaufort sea state 4;
 - (B) No marine mammals (excluding small delphinids) detected solely by PAM in the exclusion zone in the previous two hours;
 - (C) NMFS is notified via email as soon as practicable with the time and location in which operations began without an active PAM system; and
 - (D) Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24 hour period.
- (e) Exclusion Zone and buffer zone – PSOs shall establish and monitor a 500 m exclusion zone (EZ) and 1,000 m buffer zone. The zones shall be based upon radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source, occurrence of marine mammals outside the EZ but within 1,000 m from any element of the airgun array shall be communicated to the operator to prepare for potential further mitigation measures as described below. During use of the acoustic source, occurrence of marine mammals within the EZ, or on a course to enter the EZ, shall trigger further mitigation measures as described below.
- (i) Ramp-up – A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source, including following a power down or shutdown of the array, except as described under 4.(e)(v). Ramp-up shall begin by activating

a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration.

- (ii) If the airgun array has been powered down or shut down due to a marine mammal detection, ramp-up shall not occur until all marine mammals have cleared the EZ. A marine mammal is considered to have cleared the EZ if:
 - (A) It has been visually observed to have left the EZ
 - (B) It has not been observed within the EZ, for 15 minutes (in the case of small odontocetes) or for 30 minutes (in the case of mysticetes and large odontocetes including sperm, pygmy sperm, dwarf sperm, and beaked whales).
- (iii) Thirty minutes of pre-clearance observation of the 500 m EZ and 1,000 m buffer zone are required prior to ramp-up for any power down, shutdown, or combination of power down and shutdown of longer than 30 minutes. This pre-clearance period may occur during any vessel activity. If any marine mammal (including delphinids) is observed within or approaching the 500 m EZ during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the buffer zone or until an additional time period has elapsed with no further sightings (*i.e.*, 15 minutes for small odontocetes and 30 minutes for mysticetes and large odontocetes including sperm, pygmy sperm, dwarf sperm, and beaked whales).
- (iv) During ramp-up, PSOs shall monitor the 500 m EZ and 1,000 m buffer zone. Ramp-up may not be initiated if any marine mammal (including delphinids) is observed within or approaching the 500 m EZ. If a marine mammal is observed within or approaching the 500 m EZ during ramp-up, a power down or shutdown shall be implemented as though the full array were operational. Ramp-up may not begin again until the animal(s) has been observed exiting the 500 m EZ or until an additional time period has elapsed with no further sightings (*i.e.*, 15 minutes for small odontocetes and 30 minutes for mysticetes and large odontocetes including sperm, pygmy sperm, dwarf sperm, and beaked whales).
- (v) If the airgun array has been shut down for reasons other than mitigation (*e.g.*, mechanical difficulty) for a period of less than 30 minutes, it may be activated again without ramp-up if PSOs have maintained constant visual and acoustic observation and no visual detections of any marine mammal have occurred within the buffer zone and no acoustic detections have occurred.
- (vi) Ramp-up shall only occur at night and at times of poor visibility where operational planning cannot reasonably avoid such circumstances. Ramp-up may occur at night and during poor visibility if the 500 m EZ and 1,000 m buffer zone have been continually monitored by visual PSOs for 30 minutes prior to ramp-up with no marine mammal detections and if

acoustic monitoring has occurred for 30 minutes prior to ramp-up with no acoustic detections during that period.

- (vii) The vessel operator must notify a designated PSO of the planned start of ramp-up as agreed-upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed.
- (f) Power Down Requirements – UH shall power down the airgun array if a PSO detects a marine mammal within, approaching, or entering the 500 m EZ. A power down involves a decrease in the number of operational airguns. During a power down, one 100-in³ airgun shall be continuously operated.
- (i) Any PSO on duty has the authority to call for power down of the airgun array (visual PSOs on duty should be in agreement on the need for power down before requiring such action). When there is certainty regarding the need for mitigation action on the basis of either visual or acoustic detection alone, the relevant PSO(s) must call for such action immediately.
 - (ii) When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs and initiation of dialogue as necessary.
 - (iii) The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the airgun array to ensure that power down commands are conveyed swiftly while allowing PSOs to maintain watch.
 - (iv) When power down is called for by a PSO, the power down must occur and any dispute resolved only following power down.
 - (v) The power down requirement is waived for dolphins of the following genera: *Steno*, *Tursiops*, *Stenella* and *Lagenodelphis*. This power down waiver only applies if animals are traveling, including approaching the vessel. If animals are stationary and the vessel approaches the animals, the power down requirement applies. If there is uncertainty regarding identification (*i.e.*, whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, power down must be implemented.
 - (vi) Upon implementation of a power down, the source may be reactivated under the conditions described at 4(e)(vi). Where there is no relevant zone (*e.g.*, power down due to observation of a calf), a 30-minute clearance period must be observed following the last observation of the animal(s).
 - (vii) Power down of the acoustic source is required upon observation of a whale (*i.e.*, sperm whale or any baleen whale) with calf at any distance, with “calf” defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult.

- (viii) Power down of the acoustic source is required upon observation of an aggregation (*i.e.*, six or more animals) of large whales of any species (*i.e.*, sperm whale or any baleen whale) that does not appear to be traveling (*e.g.*, feeding, socializing, etc.), at any distance.
- (ix) When only the acoustic PSO is on duty and a detection is made, if there is uncertainty regarding species identification or distance to the vocalizing animal(s), the airgun array must be powered down as a precaution.
- (x) Power down shall occur for no more than a maximum of 30 minutes at any given time. If, after 30 minutes of the array being powered down, marine mammals have not cleared the 500 m Exclusion Zone as described under 4(e)(iv), the array shall be shut down. Operation of the single 100-in³ airgun (*i.e.*, a power-down state) shall not occur for any purpose other than in response to a marine mammal in the exclusion zone (pursuant to relevant requirements herein).
- (g) Shutdown requirements – An exclusion zone of 100 m for the single 100-in³ airgun shall be established and monitored by PSOs. If a marine mammal is observed within, entering, or approaching the 100 m exclusion zone for the single 100-in³ airgun, whether during implementation of a power down or during operation of the full airgun array, all airguns including the 100-in³ airgun shall be shut down. If, after 30 minutes of the array being powered down, marine mammals have not cleared the 500 m Exclusion Zone as described under 4(e)(iv), the full array shall be shut down.
 - (i) Upon implementation of a shutdown, the source may be reactivated under the conditions described at 4(e).
 - (ii) Measures described for power downs under 4(f)(i-v) shall also apply in the case of a shutdown.
- (h) Vessel Strike Avoidance – Vessel operator and crew must maintain a vigilant watch for all marine mammals and slow down or stop the vessel or alter course, as appropriate, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena. Vessel strike avoidance measures shall be followed during surveys and while in transit.
 - (i) The vessel must maintain a minimum separation distance of 100 m from large whales. The following avoidance measures must be taken if a large whale is within 100 m of the vessel:
 - (A) The vessel must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.
 - (B) If the vessel is stationary, the vessel must not engage engines until

the whale(s) has moved out of the vessel's path and beyond 100 m.

- (ii) The vessel must maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for animals described in 4(g)(v) that approach the vessel. If an animal is encountered during transit, the vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.
- (iii) Vessel speeds must be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near the vessel.
- (i) Miscellaneous Protocols
 - (i) The airgun array must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Notified operational capacity (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be noticed to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.
 - (ii) Testing of the acoustic source involving all elements requires normal mitigation protocols (*e.g.*, ramp-up). Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance.

5. Monitoring Requirements

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring shall be conducted in accordance with the following requirements:

- (a) The operator must provide bigeye binoculars (*e.g.*, 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (*i.e.*, Fujinon or equivalent) solely for PSO use. These shall be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel. The operator must also provide a night-vision device suited for the marine environment for use during nighttime ramp-up pre-clearance, at the discretion of the PSOs. At minimum, the device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations.
- (b) PSOs must also be equipped with reticle binoculars (*e.g.*, 7 x 50) of appropriate quality (*i.e.*, Fujinon or equivalent), GPS, digital single-lens reflex camera of appropriate quality (*i.e.*, Canon or equivalent), compass, and any other tools necessary to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals.
- (c) PSO Qualifications

- (i) PSOs must have successfully completed relevant training, including completion of all required coursework and passing a written and/or oral examination developed for the training program.
 - (ii) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must include written justification. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.
- (d) Data Collection – PSOs must use standardized data forms, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source to resume survey. If required mitigation was not implemented, PSOs should submit a description of the circumstances. NMFS requires that, at a minimum, the following information be reported:
- (i) PSO names and affiliations
 - (ii) Dates of departures and returns to port with port name
 - (iii) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort
 - (iv) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts
 - (v) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change
 - (vi) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon
 - (vii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (*e.g.*, vessel traffic, equipment malfunctions)
 - (viii) Survey activity information, such as acoustic source power output while in

operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (*i.e.*, pre-ramp-up survey, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.)

- (ix) If a marine mammal is sighted, the following information should be recorded:
- (A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform)
 - (B) PSO who sighted the animal
 - (C) Time of sighting
 - (D) Vessel location at time of sighting
 - (E) Water depth
 - (F) Direction of vessel's travel (compass direction)
 - (G) Direction of animal's travel relative to the vessel
 - (H) Pace of the animal
 - (I) Estimated distance to the animal and its heading relative to vessel at initial sighting
 - (J) Identification of the animal (*e.g.*, genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species
 - (K) Estimated number of animals (high/low/best)
 - (L) Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.)
 - (M) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics)
 - (N) Detailed behavior observations (*e.g.*, number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior)
 - (O) Animal's closest point of approach (CPA) and/or closest distance from the center point of the acoustic source;
 - (P) Platform activity at time of sighting (*e.g.*, deploying, recovering, testing, shooting, data acquisition, other)
 - (Q) Description of any actions implemented in response to the sighting (*e.g.*, delays, shutdown, ramp-up, speed or course alteration, etc.); time and location of the action should also be recorded

- (x) If a marine mammal is detected while using the PAM system, the following information should be recorded:
 - (A) An acoustic encounter identification number, and whether the detection was linked with a visual sighting
 - (B) Time when first and last heard
 - (C) Types and nature of sounds heard (*e.g.*, clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal, etc.)
 - (D) Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), and any other notable information.

6. Reporting

- (a) UH shall submit a draft comprehensive report on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of marine mammals near the activities, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). Geospatial data regarding locations where the acoustic source was used must be provided. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize the data collected as required under condition 5(d) of this IHA. The report must also provide an estimate of the number (by species) of marine mammals with known exposures to seismic survey activity at received levels greater than or equal to thresholds for Level A and Level B harassment, (based on visual observation) including an estimate of those on the trackline but not detected. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments from NMFS on the draft report.
- (b) Reporting injured or dead marine mammals:
 - (i) In the event that the specified activity clearly causes the take of a marine mammal in a manner not permitted by this IHA, such as serious injury or mortality, UH shall immediately cease the specified activities and immediately report the incident to the NMFS Office of Protected Resources ((301) 427-8401) and the NMFS Pacific Islands Regional Stranding Coordinator ((808) 725-5161). The report must include the following information:
 - (A) Time, date, and location (latitude/longitude) of the incident;
 - (B) Vessel's speed during and leading up to the incident;

- (C) Description of the incident;
- (D) Status of all sound source use in the 24 hours preceding the incident;
- (E) Water depth;
- (F) Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- (G) Description of all marine mammal observations in the 24 hours preceding the incident;
- (H) Species identification or description of the animal(s) involved;
- (I) Fate of the animal(s); and
- (J) Photographs or video footage of the animal(s).

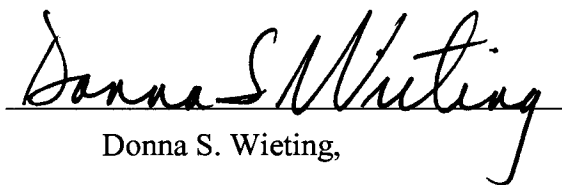
Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with UH to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. UH may not resume their activities until notified by NMFS.

- (ii) In the event that UH discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.*, in less than a moderate state of decomposition), UH shall immediately report the incident to the NMFS Office of Protected Resources and the NMFS Pacific Islands Regional Stranding Coordinator. The report must include the same information identified in condition 6(b)(i) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with UH to determine whether additional mitigation measures or modifications to the activities are appropriate.
- (iii) In the event that UH discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), UH shall report the incident to the NMFS Office of Protected Resources and the NMFS Pacific Islands Regional Stranding Coordinator. within 24 hours of the discovery. UH shall provide photographs or video footage or other documentation of the sighting to NMFS.

- 7. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

Dated:

SEP 14 2017

A handwritten signature in black ink, reading "Donna S. Wieting", is written over a horizontal line.

Donna S. Wieting,

Director, Office of Protected Resources,

National Marine Fisheries Service.

Table 1. Numbers of Incidental Take of Marine Mammals Authorized.

| Species | Authorized Level A Takes | Authorized Level B Takes | Total Authorized Level A and Level B takes |
|-----------------------------|---------------------------------|---------------------------------|---|
| Humpback whale | 0 | 2 | 2 |
| Minke whale | 0 | 1 | 1 |
| Bryde's whale | 2 | 25 | 27 |
| Sei whale | 0 | 6 | 6 |
| Fin whale | 0 | 2 | 2 |
| Blue whale | 0 | 3 | 3 |
| Sperm whale | 0 | 51 | 51 |
| Cuvier's beaked whale | 0 | 8 | 8 |
| Longman's beaked whale | 0 | 85 | 85 |
| Blainville's beaked whale | 0 | 76 | 76 |
| Rough-toothed dolphin | 0 | 812 | 812 |
| Bottlenose dolphin | 0 | 246 | 246 |
| Pantropical spotted dolphin | 0 | 639 | 639 |
| Spinner dolphin | 0 | 32 | 32 |
| Striped dolphin | 0 | 685 | 685 |
| Fraser's dolphin | 0 | 577 | 577 |
| Risso's dolphin | 0 | 130 | 130 |
| Melon-headed whale | 0 | 97 | 97 |
| Pygmy killer whale | 0 | 119 | 119 |
| False killer whale | 0 | 16 | 16 |
| Killer whale | 0 | 5 | 5 |
| Short-finned pilot whale | 0 | 218 | 218 |
| Pygmy sperm whale | 7 | 87 | 94 |
| Dwarf sperm whale | 18 | 214 | 232 |

8.2 Appendix B: Mitigation Guide

Mitigation Guide

Visual Observations

- 2 PSOs on duty at all times during daylight hours (30 minutes prior to sunrise to 30 minutes after sunset) including during transit and other non-operational periods
- maximum 4 consecutive hours per watch period (minimum 1 hour break between watch periods)
- no more than 12 hours on watch within 24 hour period
- as needed at night for soft starts using Ocean Scout infrared device
 - ❖ 1 PSO
 - ❖ 30 minutes prior to soft start
 - ❖ 60 minutes after soft start
- communicate all visual detections to PAM operator
- communicate mitigations to seismic crew as needed

Acoustic Observations

- 1 PAM operator on duty at all times when deployment of hydrophone array is operationally feasible
- maximum 6 consecutive hours per watch period
- no more 12 hours on watch within 24 hour period
- communicate all acoustic detections to visual observers
- communicate mitigations to seismic crew as needed

Mitigation Zones

- mitigation zones are based on the radial distance from any source element within the full array, not from centre of the full source array
- 1000m buffer zone to alert crew of possible mitigation
- 500m exclusion zone for power down
- 100m exclusion zone for shutdown

Soft Start

- Pre-Soft Start Monitoring
 - ❖ seismic crew notify PSOs at least 60 minutes prior to the planned start of source operations
 - ❖ PSOs conduct minimum 30 minute pre-soft start visual and acoustic monitoring
 - ❖ seismic crew request clearance for soft start **BEFORE** activating the source
- Delays
 - ❖ delay soft start for marine mammals observed approaching or within the 500m exclusion zone
 - ❖ soft start delayed until 30 minutes have elapsed from the last sighting of the marine mammal in the 500m exclusion zone
 - ❖ PSOs notify seismic crew of the delay
- Soft start conducted over a 30 minute period
 - ❖ seismic crew notify PSOs when soft start has begun and when soft start is complete (when the desired output is reached)
- Night-time Soft Start
 - ❖ may occur if:
 - 30 minutes of visual monitoring of 500m exclusion and 1000m buffer zone with no marine mammal detections **AND**
 - 30 minutes of acoustic monitoring with no acoustic detections

Source Testing

- soft start required when testing full array
- soft start is not required when testing a single airgun or a gun string
- 30 minutes of visual and acoustic pre-soft start monitoring is required prior to testing, even if testing only a single airgun or single gun string

Power Down

- immediately power down the source array to a **single 100in³ airgun** for:
 - ❖ marine mammals observed approaching or within the 500m mitigation zone
 - ❖ acoustic detections where species and/or distance is uncertain/unknown
 - ❖ large whale (mysticete, sperm, or beaked) cow/calf pairs at any distance from the source
 - ❖ aggregations (> 6 individuals) of large whales (mysticete, sperm, or beaked) that are not travelling (stationary, foraging, socialising, resting, etc) at any distance from the source
- power down > 30 minutes
 - ❖ **proceed with shutdown** of the 100in³ airgun if marine mammals have not cleared the 500m exclusion zone after 30 minutes of array being powered down
- *exception* for small delphinids from *Stenella* (pantropical spotted, spinner, striped), *Steno* (rough-toothed), *Tursiops* (bottlenose), or *Lagenodelphis* (Fraser's) genera that are travelling
 - ❖ if animals not travelling (stationary, foraging, socialising, resting, etc), power down should be implemented
 - ❖ if observer is uncertain of behaviour or genera, power down should be implemented
- power down ≤ 30 minutes
 - ❖ soft start may commence if:
 - animal visually observed to leave the 500m exclusion zone
 - 15 minutes have elapsed from the last detection of small delphinids from listed genera within the 500m exclusion zone
 - 30 minutes have elapsed from the last detection of all other marine mammals and within the 500m exclusion zone
- power down for acoustic detections with unknown species and/or distance
 - ❖ soft start may begin if the cow/calf pair or aggregation has not been observed for 30 minutes
- power down for cow/calf pairs or aggregations
 - ❖ soft start may begin if the cow/calf pair or aggregation has not been observed for 30 minutes
- PSOs request power down
- seismic crew advise PSOs of time when source reduced to single 100in³ airgun

Shutdown

- immediately shutdown the source array, regardless of source output, if:
 - ❖ a marine mammal for which takes are authorized is observed approaching or within the 100m exclusion zone
 - ❖ a marine mammal for which takes are not authorized is detected at any distance from the source
- *exception* for small delphinids from *Stenella* (pantropical spotted, spinner, striped), *Steno* (rough-toothed), *Tursiops* (bottlenose), or *Lagenodelphis* (Fraser's) genera that are travelling (includes approaching to bow ride)
 - ❖ if animals not travelling (stationary, foraging, socialising, resting, etc), shutdown should be implemented
 - ❖ if observer is uncertain of behaviour or genera, shutdown should be implemented

- shutdown \leq 30 minutes
 - ❖ soft start may commence if:
 - animal visually observed to leave the 500m exclusion zone
 - 15 minutes have elapsed from the last detection of small delphinids from listed genera within the 500m exclusion zone
 - 30 minutes have elapsed from the last detection of all other marine mammals within the 500m exclusion zone
- shutdown $>$ 30 minutes (or if combined power down + shutdown $>$ 30 minutes)
 - ❖ soft start may commence if 30 minutes have elapsed from the last detection of marine mammals within the 500m exclusion zone
- shutdown for marine mammal species for which takes are not authorized
 - ❖ soft start may begin if the marine mammal has not been observed for 30 minutes
- PSOs request shutdown
- seismic crew advise PSOs of time when source was shutdown

Operational Shutdown (mechanical issues)

- soft start is not required for operational shutdowns $<$ 30 minutes, if:
 - ❖ PSOs (visual and acoustic) have maintained constant observations, **AND**
 - ❖ no visual detections of marine mammals have occurred within the **1000m buffer zone** during the period of source inactivity, **AND**
 - ❖ no acoustic detections occurred during the period of source inactivity
- soft start is required for operational shutdowns \geq 30 minutes and for any shutdowns $<$ 30 minutes that do not meet the criteria noted above

PAM System Malfunction

- source activity may continue for 30 minutes without acoustic monitoring while operator diagnosis issue
- if diagnosis indicates the PAM system needs to be repaired, operations may continue for an additional 2 hours if:
 - ❖ daylight and sea state is \leq B4 **AND**
 - ❖ no marine mammals (excluding small delphinids from *Stenella*, *Steno*, *Tursiops*, or *Lagenodelphis* genera) were detected in the 500m exclusion zone solely by PAM in the previous 2 hours
- NMFS should be notified via email as soon as is practical, provide time and location for operations in absence of PAM
- operations without PAM may not exceed a total of 4 hours in a 24 hour period

Strike Avoidance

- when operationally possible, the vessel should slow, stop, and/or alter course to avoid striking a marine mammal
- vessel operator should maintain a minimum separation distance of 100m from large whales
 - ❖ if a large whale is observed within 100m
 - vessel should reduce speed and shift to neutral
 - do not engage engines until whale has moved outside vessel's path and minimum separation distance has been established
- vessel operator should maintain a separation distance of 50m for all other marine mammals, except for those from *Stenella*, *Steno*, *Tursiops*, or *Lagenodelphis* genera that approach the vessel
- if animals observed during transit, vessel should attempt to remain parallel to the animal's course, avoid excess speed and/or abrupt changes in direction

- vessel operator should reduce speed to < 10 knots when cow/calf pairs or assemblages of cetaceans are observed near the vessel

Other Mitigations

- single 100in³ airgun shall not occur for any purpose other than in response to marine mammal in the 500m exclusion zone
- source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing
- notified operational capacity must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes
 - ❖ PSOs must be notified when/if this occurs

Dead/Injured Marine Mammal Reporting

- if survey operations clearly cause the take of marine mammal not permitted by IHA (serious injury or mortality), UH shall immediately cease the specified activities and report the incident to the NMFS Office of Protected Resources (301-427-8401) and the NMFS Pacific Islands Regional Stranding Coordinator (808-725-5161)
 - ❖ report should include:
 - time, date, and location of incident,
 - vessel's speed during and leading up to incident,
 - description of incident
 - status of all sound source use in 24 hours preceding the incident,
 - water depth,
 - environmental conditions,
 - description of all marine mammal observations in the 24 hours preceding the incident,
 - species identification or description of the animal(s) involved,
 - fate of animal, and
 - photographs or video footage of animal
 - ❖ activities shall not resume until NMFS is able to review the circumstances of the prohibited take
- if discover injured or dead marine mammal and cause of injury/death is unknown and death is relatively recent (less than a moderate state of decomposition), UH shall immediately report (same information as noted above) incident to the two NMFS noted
 - ❖ activities may continue while NMFS reviews circumstances of the incident
- if discover dead/injured marine mammal and cause is not associated with or related to the specified activities (previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), UH shall report incident to two NMFS offices noted within 24 hours of the discovery

Data Recording

- seismic crew should keep a source operations log including:
 - ❖ start and end of soft start times
 - ❖ start and end of line/acquisition times
 - ❖ time source powered down or shutdown for marine mammal detections
 - ❖ time source shutdown for mechanical, weather, or other operational issues
- PSOs will collect data from the source operations log (gun log) from the seismic crew daily
- PSOs will collect effort data for visual and acoustic observations
- PSOs will collect detailed data on marine mammal detections
- a final report will be submitted upon completion of the project

8.3 Appendix C: Mitigation Decision Flow Chart



Mitigation and Monitoring Decision Flow Chart



seismic crew contact PSOs (visual and acoustic) at least 60 minutes before planned soft start

PSOs visually and acoustically monitor 500m exclusion zone and 1000m buffer zone for a minimum of 30 minutes before soft start

seismic crew contact PSOs to confirm clear to begin soft start

marine mammal visually and/or acoustically detected within 500m exclusion zone

yes

delay soft start until 30 minutes have elapsed from last detection in the 500m exclusion zone

PSOs give 'all clear'

no

PSOs give 'all clear'

begin soft start *

30 minutes in duration

source active at any power level
(soft start/full power/partial array/single 100in³)

marine mammals
visually and/or
acoustically detected
within 1000m buffer
zone

PSOs notify seismic crew of detection
and potential for future mitigation

seismic operations continue until
notified otherwise by PSOs

marine mammals visually and/or
acoustically detected approaching or
within 500m exclusion zone
OR
acoustic detection where species and/or
distance is unknown/uncertain
OR
large whale (mysticete, sperm, beaked)
cow/calf pair at any distance
OR
aggregation (6+ individuals) large whales
not travelling at any distance

marine mammals visually
and/or acoustically detected
approaching or within 100m
exclusion zone
OR
marine mammal for which
takes are not authorized at any
distance

all other marine mammals
and sea turtles

small delphinid from
listed genera

travelling

no action

stationary **OR** uncertain
of behaviour or genera

all other marine mammals
and sea turtles

PSOs request 'shutdown' *
source array completely off

stationary **OR** uncertain
of behaviour or genera

travelling

no action

PSOs request 'power down' *

reduce source to single 100in³ airgun

soft start after may commence after +:

- animal visually observed to leave exclusion zone
- small dolphin from listed genera not observed within zone for 15 minutes
- all other marine mammals and sea turtles not observed within zone for 30 minutes
- marine mammal not detected acoustically for 30 minutes
- large cetacean cow/calf pair, aggregation, or species where takes are not authorized not observed for 30 minutes

+ if power down > 30 minutes, source must be shutdown; if shutdown > 30 minutes (or combined power down + shutdown > 30 minutes), soft start may commence 30 minutes after the last sighting in the exclusion zone

NOTE: operational shutdowns of <30 minutes do not require a soft start if:

- PSOs maintained constant watch (visual and acoustic),
- no visual detections within 1000m buffer zone, and
- no acoustic detections

*seismic crew advise PSOs of exact time source output changes (reduced output or shutdown)

8.4 Appendix D: FLIR Ocean Scout 320 Specifications

OPEN SEAS AHEAD

OCEAN SCOUT MARINE THERMAL HANDHELD CAMERA

Ocean Scout is a rugged, compact thermal night vision camera that lets you see other vessels, landmarks, buoys, and floating debris in total darkness. Now with a high resolution LCD display and FLIR's industry-leading thermal sensor technology, Ocean Scout makes your time on the water safer and more relaxing.



The World's **Sixth Sense**™



ENHANCE AWARENESS

See marine traffic and navigational aids at night

- Quickly scan your surroundings for other vessels
- Easily recognize buoys in river channels or open water
- Detect key landmarks like islands or docks



STEER CLEAR

Boat with confidence day or night

- Avoid obstacles, such as rocks, floating logs, and other debris
- Be aware of kayakers, personal watercraft, and small boats without lights
- Detect marine mammals above the water surface



STAY SAFE

A lifesaving tool for a "man over board" emergency

- Locate the body heat of anyone in the water
- Quickly identify overboard people and pets
- InstAlert™ mode highlights the hottest objects in red

| | Ocean Scout 240 | Ocean Scout 320 |
|--|--|------------------------------|
| Detector Type | 240 × 180 VOx Microbolometer | 336 × 256 VOx Microbolometer |
| Video Refresh Rate | <9Hz NTSC | |
| Field of View (H × V) | 24° × 18° NTSC | 17° × 13° NTSC |
| Start up | < 1.5 seconds | |
| Waveband | 7.5 - 13.5 μm | |
| Thermal Sensitivity | <50 mK @ f/1.0 | |
| Image Processing | FLIR Proprietary Digital Detail Enhancement™ | |
| USER INTERFACE | | |
| Zoom Button | Freeze Frame | 2X Zoom |
| Black Hot/White Hot | BH/WH/InstAlert™ | |
| Brightness | Adjusts display Brightness Setting | |
| Task Light | LED Enabled during Power off state | |
| SYSTEM SPECIFICATIONS | | |
| Display | 640 X 480 LCD Display | |
| Video Output | no | Composite NTSC or Pal |
| Image Polarity | White Hot/Black Hot/InstAlert™; Selectable | |
| POWER | | |
| Battery Type | Internal Li-Ion Cell | |
| Battery Life (Operating) | >5 Hours | |
| ENVIRONMENTAL | | |
| Rating | IP-67, Submersible | |
| Operating Temp. | -4°F to 122°F (-20°C to 50°C) | |
| Storage Temp. | -40°F to 140°F (-40°C to 60°C) | |
| Drop | 1 m drop | |
| PHYSICAL | | |
| Weight (incl. lens) | 12 oz (340 g) | |
| Size (L × W × H) | 6.70" × 2.31"× 2.44" | |
| Range Performance | | |
| Detect Man (1.8 m × 0.5 m) | 1150ft(350m) | 1800ft(550m) |
| Detect a Small Boat | 2,940 ft (0.48 nm) | 5085 ft (1550 meters) |
| PACKAGES INCLUDE | | |
| Handheld Thermal Camera,USB Power Adapter/Charger,Wrist strap, Custom Video out cable (320 version), USB Cable, Quick Start Guide, Molle bag | | |

AMERICAS

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The World's **Sixth Sense™**