Final Report

Cetacean Studies on the Hawaii Range Complex in December 2014 - January 2015: Passive Acoustic Monitoring of Marine Mammals Using Gliders

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14. ABSTRACT
A passive-acoustic glider survey was conducted in the Hawaii Range Complex (HRC) between 11 December 2014 and 26 January 2015. The goal of the project was to investigate the spatial and temporal distribution of odontocetes and mysticetes in offshore areas south of the Main Hawaiian Islands. The survey was essentially an exploration of offshore seamounts and adjacent abyssal areas.

The acoustic survey was very successful. The glider surveyed areas as far out as Bishop Seamount which is located approximately 180 nautical miles (nm) west of Kona, Hawaii. These areas are difficult to access and thus little is known about the abundance and distribution of cetaceans in these offshore areas. This survey demonstrated that autonomous underwater vehicles are useful tools to conduct acoustic monitoring efforts in these remote areas.

A total of 712 hours of data was collected over a 33-day period. The data analysis revealed the presence of a wide variety of cetacean vocalizations including the infrasonic calls produced by blue whales (Balaenoptera musculus) and the ultrasonic echolocation clicks of the Cross Seamount beaked whale (CSBW).

Odontocete acoustic encounters were abundant. Both Blainville's (Mesoplodon densirostris) whales and CSBWs were detected in the study area. The majority of CSBW echolocation clicks were recorded in the vicinity of Cross Seamount. However, one encounter occurred close to the start/end point of the acoustic survey approximately 60 nm south of the Island of Oahu. Other odontocete species detected included sperm whales (Physeter macrocephalus), Risso's dolphins (Grampus griseus) and a wide variety of delphinid species which were classified based on the frequency characteristics of their whistles.

Baleen whale calls were the most abundant bioacoustics signals in the data set. Calls produced by blue, fin (Balaenoptera phyalus), sei (Balaenoptera borealis), humpback (Megaptera novaeangliae) and minke (Balaenoptera acutorostrata) whales were identified. Fin, humpback, and minke whale calls were continuously present throughout most of survey. Sei whale calls were only identified in the first part of the survey; no sei whales were recorded after 25 December 2014. Blue whale calls were recorded intermittently. The three major detection periods occurred on 24 and 25 December 2014, 1 to 5 January 2015, and 14 to 19 January 2015.

U.S. Navy sonar produced by active sonobuoys was recorded on 15 and 16 January 2015 when the glider surveyed the area in the vicinity of Rainier Seamount. Additionally, seismic airgun pulses, presumably associated with a scientific seismic survey, were recorded south of N19.5° for over 2 weeks of the survey (23 December 2014 to 10 January 2015). Overall the surveyed area revealed a high degree of bioacoustics activity in this offshore area of HRC. A total of 639 cetacean encounters were recorded during 164 'passive-acoustic monitoring (PAM) active' dives, which is approximately four cetacean encounters per glider dive. Successful surveys like these demonstrate that mobile autonomous platforms can play an important role in future marine mammal monitoring efforts.

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Executive Summary

A passive-acoustic glider survey was conducted in the Hawaii Range Complex (HRC) between 11 December 2014 and 26 January 2015. The goal of the project was to investigate the spatial and temporal distribution of odontocetes and mysticetes in offshore areas south of the Main Hawaiian Islands. The survey was essentially an exploration of offshore seamounts and adjacent abyssal areas.

The acoustic survey was very successful. The glider surveyed areas as far out as Bishop Seamount which is located approximately 180 nautical miles (nm) west of Kona, Hawaii. These areas are difficult to access and thus little is known about the abundance and distribution of cetaceans in these offshore areas. This survey demonstrated that autonomous underwater vehicles are useful tools to conduct acoustic monitoring efforts in these remote areas.

A total of 712 hours of data was collected over a 33-day period. The data analysis revealed the presence of a wide variety of cetacean vocalizations including the infrasonic calls produced by blue whales (*Balaenoptera musculus*) and the ultrasonic echolocation clicks of the Cross Seamount beaked whale (CSBW).

Odontocete acoustic encounters were abundant. Both Blainville’s (*Mesoplodon densirostris*) whales and CSBWs were detected in the study area. The majority of CSBW echolocation clicks were recorded in the vicinity of Cross Seamount. However, one encounter occurred close to the start/end point of the acoustic survey approximately 60 nm south of the Island of Oahu. Other odontocete species detected included sperm whales (*Physeter macrocephalus*), Risso’s dolphins (*Grampus griseus*) and a wide variety of delphinid species which were classified based on the frequency characteristics of their whistles.

Baleen whale calls were the most abundant bioacoustics signals in the data set. Calls produced by blue, fin (*Balaenoptera phyalus*), sei (*Balaenoptera borealis*), humpback (*Megaptera novaeangliae*) and minke (*Balaenoptera acutorostrata*) whales were identified. Fin, humpback, and minke whale calls were continuously present throughout most of survey. Sei whale calls were only identified in the first part of the survey; no sei whales were recorded after 25 December 2014. Blue whale calls were recorded intermittently. The three major detection periods occurred on 24 and 25 December 2014, 1 to 5 January 2015, and 14 to 19 January 2015.

U.S. Navy sonar produced by active sonobuoys was recorded on 15 and 16 January 2015 when the glider surveyed the area in the vicinity of Rainier Seamount. Additionally, seismic airgun pulses, presumably associated with a scientific seismic survey, were recorded south of N19.5° for over 2 weeks of the survey (23 December 2014 to 10 January 2015).

Overall the surveyed area revealed a high degree of bioacoustics activity in this offshore area of HRC. A total of 639 cetacean encounters were recorded during 164 ‘passive-acoustic monitoring (PAM) active’ dives, which is approximately four cetacean encounters per glider dive. Successful surveys like these demonstrate that mobile autonomous platforms can play an important role in future marine mammal monitoring efforts.

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Acronyms and Abbreviations

°C	Degree(s) Celsius
APL-UW	Applied Physics Laboratory, University of Washington
bit	Basic unit of information
BW	Beaked whale
CSBW	Cross Seamount beaked whale
CTD	Conductivity, Temperature, and Depth
ESA	Endangered Species Act
GB	Gigabyte(s)
h	Hour(s)
HICEAS	Hawaiian Islands Cetacean and Ecosystem Assessment Survey
HRC	Hawaii Range Complex
Hz	Hertz
ICMP	Integrated Comprehensive Monitoring Program
ICI	Inter-click-interval
ITA	Incidental Take Authorization
kHz	Kilohertz
km	Kilometer(s)
LT	Local Time
LTSA	Long-term spectral average
m	Meter(s)
MB	Megabyte(s)
min	Minute(s)
ms	Millisecond(s)
m/s	Meter(s) per second
MIRC	Mariana Islands Range Complex
MMPA	Marine Mammal Protection Act
NAVFAC	Naval Facilities Engineering Command
nm	Nautical mile(s)
NMFS	National Marine Fisheries Service
NWPBW	Northwestern Pacific blue whale
PAM	Passive-acoustic monitoring
s	Second(s)
SG	Seaglider
SNR	Signal-to-noise ratio
U.S.	United States
UTC	Coordinated Universal Time
V	Volt(s)
WAV	WAVeform audio format
μs	Microsecond(s)

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1. Background and Objectives

As part of the regulatory compliance process associated with the Marine Mammal Protection Act and the Endangered Species Act, the U.S. Navy is responsible for meeting specific monitoring and reporting requirements for military training and testing activities. In support of these monitoring requirements, a passive-acoustic glider survey was conducted in the Hawaii Range Complex (HRC) between 11 December 2014 and 26 January 2015. The goal of the project was to investigate the spatial and temporal distribution of odontocetes and mysticetes in offshore areas south of the Main Hawaiian Islands.

Previous marine mammal survey effort in the Hawaiian Islands has largely focused on near shore waters (HDR 2012; Baird et al. 2013). Offshore areas are particularly limited for surveying during the winter months due to the increased swell height (Baird et al. 2013). In part, this reflects the low density of many species of odontocetes in the oligotrophic waters of the central tropical Pacific and the resultant large amount of effort necessary to effectively sample them. In regards to offshore survey effort in HRC, the National Marine Fisheries Service (NMFS) conducted two large-vessel surveys that covered waters of the Exclusive Economic Zone: Hawaiian Islands Cetacean and Ecosystem Assessment Survey (HICEAS) conducted in 2002 (Barlow et al. 2004) and HICEAS II in 2010 (NOAA Fisheries 2010). The Navy conducted marine species monitoring efforts during the Koa Kai training event, which included visual surveys in deep water areas (bottom depth to 4,800 meters [m]) south of Oahu and west of the Island of Hawaii (HDR EOC 2011); the vessel-based line-transect survey was designed to travel over seamounts within HRC and results of survey lines perpendicular to the seamount “ridgeline” seem to suggest that sighting frequency dramatically increased closer to the seamounts. Cascadia Research Collective (CRC) conducted survey effort off the Island of Hawaii during April to May 2008 to collect information on beaked whale movements using tagging and to examine the overlap of offshore and island-associated populations of false killer whales (CRC 2008). The survey route included waters over Indianapolis Seamount (approximately 70 kilometers [km] offshore) and to Jaggar/Peret seamount complex (approximately 105 to 145 km offshore).

Passive acoustic monitoring on several spatial scales provides valuable information on cetacean occurrence in deep waters, particularly during winter months when high sea states make survey effort difficult. For example, the high-frequency acoustic recording package deployed by NMFS at Cross Seamount to study the effects of seamounts on the presence and acoustic behavior of cetacean has resulted in many detections of beaked whales (McDonald et al. 2009; Oleson and Hildebrand 2012). A glider that is not a fixed passive acoustic monitoring (PAM) device provides greater spatial coverage and the benefit of collecting concurrent oceanographic data.

1.1 Monitoring Questions

This report presents findings from this monitoring effort, which was conducted in order to further our understanding of the following monitoring questions:

- Which species of toothed whales (and especially beaked whales) occur in offshore areas of the HRC and what is their spatial distribution?
- Which species of baleen whales occur in offshore areas of the HRC and what is their spatial distribution?

The marine mammal monitoring reported here is part of a long-term monitoring effort under the U.S. Navy's Marine Species Monitoring Program, Contract No. N62470-10-D-3011 supported by HDR.

2. Methods

2.1 General Glider Information

Underwater gliders use small changes in buoyancy to effect vertical motion, and wings to convert the vertical motion to horizontal movement, thereby propelling the glider forward with very low power consumption. This allows gliders to perform long-duration surveys autonomously (Rudnick et al. 2004). During a mission, a glider is piloted remotely, via Iridium™ satellite connection, from a control center onshore. The glider used in this project was the Seaglider™, originally developed by Applied Physics Laboratory, University of Washington (APL-UW) (commercially available from Kongsberg Inc., Lynwood, Washington, U.S.), which is capable of repeatedly diving to 1,000-m depth and back at a typical horizontal speed of 25 centimeters per second (**Figure 1**). Dive durations are usually on the order of 4 to 6 hours (h) for 1,000-m dives.

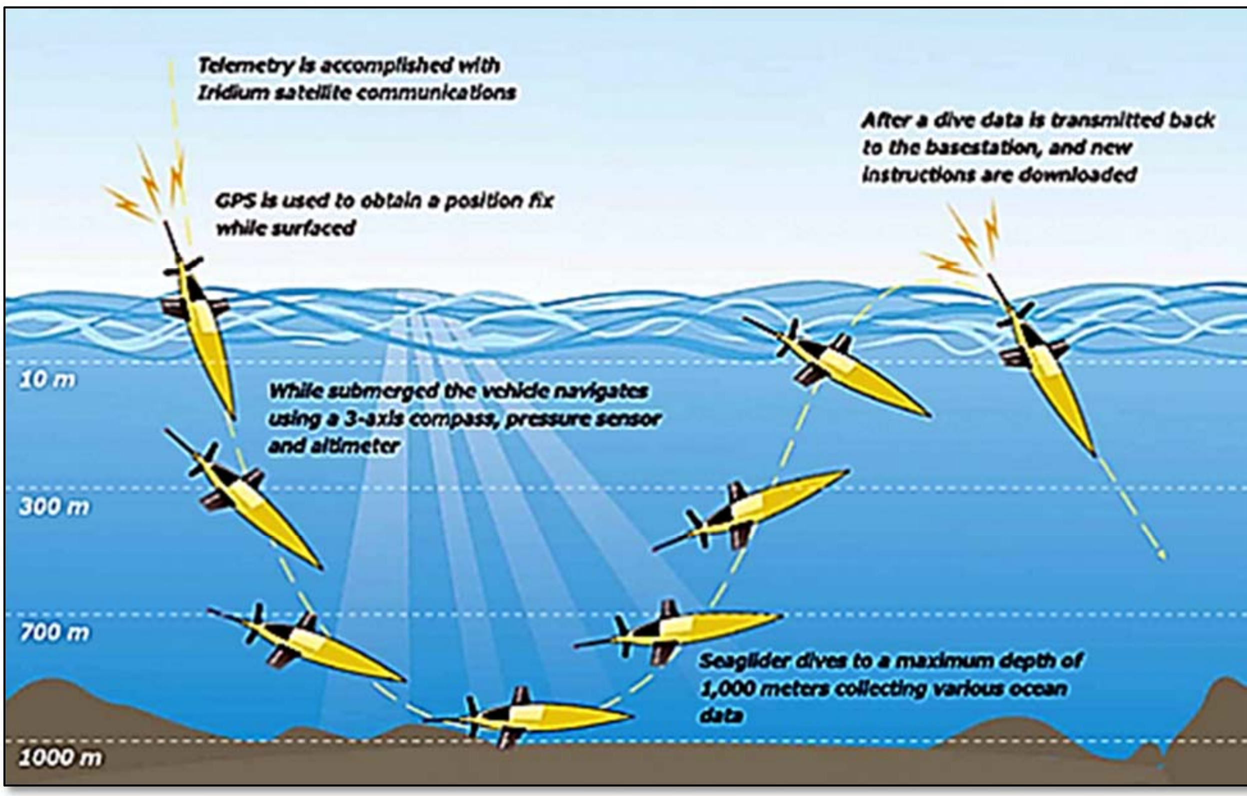

Figure 1: Mode of operation of the Seaglider™. Source: http://subseaworldnews.com.

The Seaglider was equipped with a custom-designed and -built passive acoustic recording system (APL-UW, Seattle, Washington, USA); acoustic signals were received by a single omni-directional hydrophone (type: HTI-99-HF, High Tech Inc, Gulfport, Mississippi, USA; sensitivity: -164 dB re 1 V/μPa), amplified by 36 decibels, and recorded at 194 kilohertz (kHz) sample rate and 16-bit resolution. Aliasing is prevented by the use of an analog 90-kHz low-pass filter (five-pole Chebyshev filter). Acoustic data were compressed using the Free Lossless Audio Codec and stored on flash memory drives. The calibrated PAM system was optimized for continuous data in the frequency range 15 Hertz (Hz) to 90 kHz, and thus was well suited for the recording of both baleen and toothed whales. However, the bandwidth of the system did not cover the frequency range of vocalizations produced by pygmy and dwarf sperm whales (*Kogia* spp.).

The system featured an automatic 'blanking mechanism' which mutes the PAM system during periods when the glider's noisy internal steering and buoyancy mechanisms were operated. During a typical 1,000-m dive, the associated data loss was between 5 and 10 percent. Because of high noise levels at the surface, recordings were made only at depths of 25 to 1,000 m. The passive-acoustic Seaglider is shown in **Figure 2**.

Figure 2: Passive-acoustic Seaglider™. The Seaglider is a commercial off-the-shelf instrument sold by Kongsberg, Inc. (Lynwood, Washington, USA). The PAM system was developed and incorporated into the Seaglider by APL-UW (Seattle, Washington, USA).

The glider was programmed to survey across diverse bathymetric features and cetacean habitats whenever possible (**Figure 3**). Waterspace management approval was received from the U.S. Navy prior to deployment of the glider. The glider position and schedule was updated as the survey progressed. The instrument carried on-board digital bathymetric maps used for deciding how deep to dive in areas where the water depths are shallower than 1,000 m. The glider's depth-choice algorithm was designed to operate best when the instrument's course is orthogonal to the isobaths. Use of this map-reading method avoided the need to use active acoustics for altimetry, which would have hindered passive-acoustic recordings.

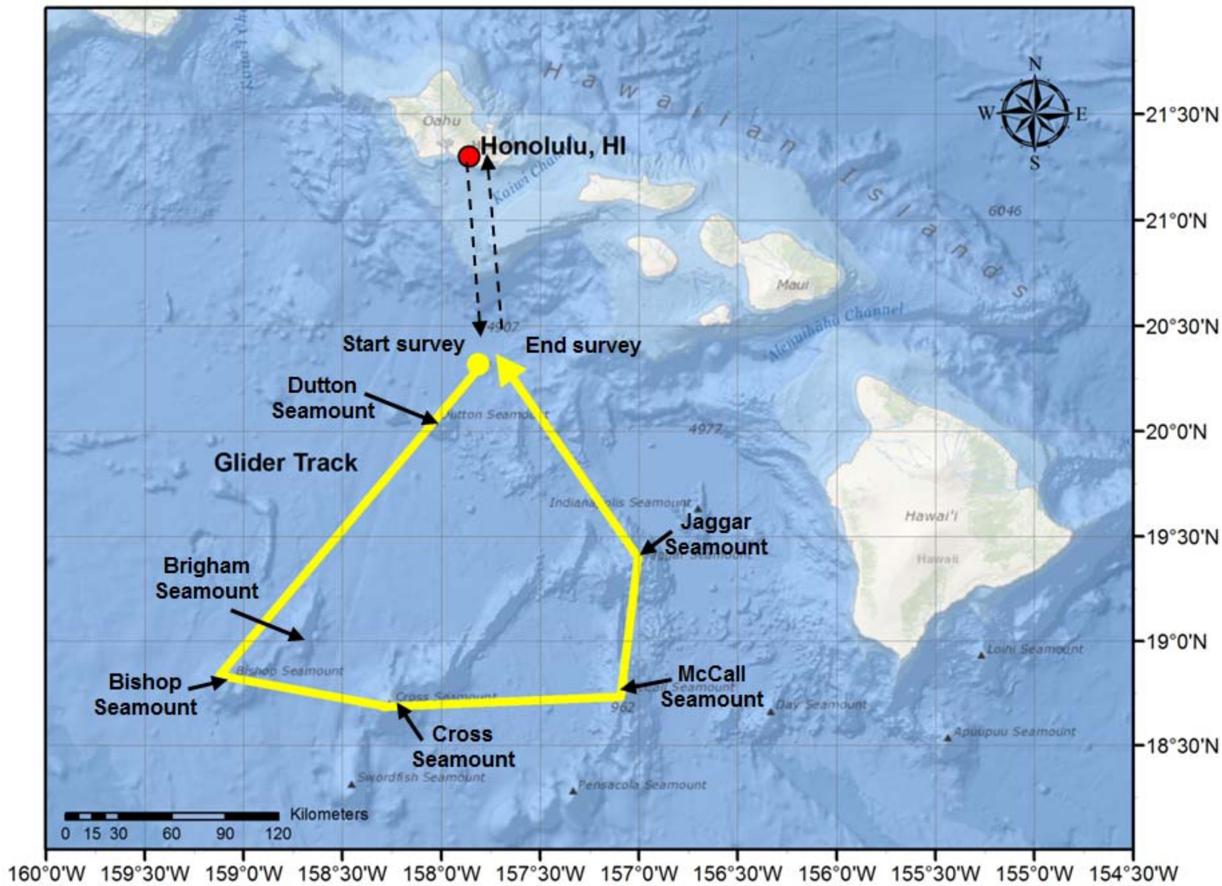

Figure 3: Proposed glider path through the Hawaiian Range Complex, including transit to and from Honolulu, HI.

The glider was programmed to transmit selected data and packages via Iridium satellite link, including position and standard conductivity, temperature, and depth profiles, to shore when surfacing between dives. The instruments typically stayed at the surface for less than 10 minutes.

In 2007, the U.S. Navy's Office of Naval Research, Marine Mammals and Biology program started the Passive Acoustic Autonomous Monitoring of Marine Mammals program to develop near-real-time monitoring systems on autonomous underwater vehicles (AUVs). The Marine Mammals and Biology program focused on passive acoustic systems for autonomous detection, classification, localization, and tracking of marine mammals on Navy exercise areas for periods in excess of a month. The passive-acoustic Seaglider used in this study is a result of this development effort. The system has been validated during several surveys, including short (week-long) deployments at both the Atlantic Undersea Test and Evaluation Center and Southern California Offshore Range (Klinck et al. 2013). The first long-duration (exceeding one month of quasi-continuous data collection) survey was conducted in the Mariana Islands Range Complex (MIRC) in fall 2014 under N62470-10-D-3011, Task Order KB25. The PAM board (Revision B) has been classified as a Demonstration and Validation 6.4 system. The 6.4 system encompasses integrated technologies ready to be evaluated in as realistic an operating environment as possible. During the first glider deployment in MIRC, it was discovered that the

PAM board firmware had an issue causing periodic acoustic data loss. This could be resolved by having the pilot reboot the PAM system. This lesson learned was noted; however, since there was insufficient time to thoroughly troubleshoot the problem before the HRC deployment, the glider pilot remained attentive to minimize the data loss and rebooted the system as soon as the issue was detected. The PAM board is a U.S. export controlled item, both under the Department of State's International Traffic in Arms Regulations and the Department of Commerce's Export Administration Regulations programs.

2.2 Data Analysis

Because [a] relatively little is known about the spatial and seasonal distribution of marine mammal species in this survey area and [b] the data set was only one month in duration, the entire analysis was conducted manually by experienced analysts. Detectors and classifiers were not used for the analysis. This approach, while more labor intensive, reduced the likelihood of missed marine mammal vocal encounters.

The Free Lossless Audio Codec files were decoded to standard .WAV audio file format, and three data sets with different sampling rates (194 kHz 10 kHz, and 1 kHz) were generated for specific analyses. Analysis was primarily done on a per dive basis, where vocalizations were summarized for each dive, and the percentage of time during a dive when we detected marine mammal sounds for each species was calculated. We also tallied marine mammal sounds on an encounter basis. An encounter was defined as a period when target signals were present in the acoustic data sets, separated from other periods of signal detections by 30 or more minutes of silence.

2.2.1 Environmental Data

The glider collected conductivity and temperature depth profiles as well as information on depth-averaged currents throughout the duration of the survey (including periods when the PAM system was deactivated). APL-UW processed the raw environmental data using custom software routines and provided temperature, sound speed, and depth-averaged currents plots for this report.

2.2.2 Odontocetes

The full bandwidth data (194-kHz sampling rate) were used to calculate long-term spectral average (LTSA) plots with a temporal resolution (Δt) of 5 seconds and a frequency resolution (Δf) of 100 Hz using the Triton Software Package (Scripps Whale Acoustics Lab, La Jolla, California, USA). Data slices of 15 minutes in duration were visually and aurally inspected by experienced analysts for acoustic encounters with odontocetes. We expected to record sounds from the following odontocete species, known to inhabit Hawaiian waters, with known acoustic signal types (Baird et al. 2013): Cuvier's beaked whales (*Ziphius cavirostris*), Blainville's beaked whales (*Mesoplodon densirostris*), Longman's beaked whales (*Indopacetus pacificus*), killer whales (*Orcinus orca*), Risso's dolphins (*Grampus griseus*), sperm whales (*Physeter macrocephalus*), short-finned pilot whales (*Globicephala macrorhynchus*), false killer whales (*Pseudorca crassidens*), bottlenose dolphins (*Tursiops truncatus*), rough-toothed dolphins (*Steno bredanensis*), melon-headed whales (*Peponocephala electra*), Fraser's dolphins (*Lagenodelphis hosei*), spinner dolphins (*Stenella longirostris*), striped dolphins (*Stenella* *coeruleoalba*), and pantropical spotted dolphins (*Stenella attenuata*). Pygmy killer whales (*Feresa attenuata)* are a potential species the glider could encounter in the Hawaiian Islands, however, there is very little known about this species' life history and acoustic behavior (Madsen et al. 2004; McSweeney et al. 2007) and we did not feel confident assigning them to any of the odontocete annotation classes listed below.

Vocalizations of odontocetes are typically placed into three categories: echolocation clicks, burst pulse sounds, and whistles. Echolocation clicks are broadband, impulsive sounds with peak frequencies from 5 to over 150 kHz, to aid in foraging and navigation. Burst pulse signals are click trains, or rapidly repeated clicks with a very short inter click interval, that sound like a buzz or creak. Burst pulse signals are thought to have social implications and echolocation functions. Whistles are frequency modulated signals and cover (depending on species) a wide frequency range from a few hundred Hz to many kHz, have a longer duration (hundredths to tenths of seconds) and are thought to be used in social contexts.

The analysts logged species information whenever possible. The first six species listed above have species-specific call features that allow acoustic encounters to be identified to the species level, and were classified using the following call characteristics:

- **Beaked whales (BW):** Cuvier's beaked whale clicks are uniquely identified by a frequency modulated click with a peak frequency of 40 kHz and an inter-click-interval (ICI) of over 300 milliseconds (ms) (Baumann-Pickering et al. 2013). Echolocation clicks recorded from Blainville's beaked whales have the characteristic beaked-whale frequency modulated pulse, a long click duration, and a long inter pulse interval (Baumann-Pickering et al. 2013). Such upsweeping clicks with peak frequencies near 35 kHz and ICIs of around 200 ms were identified as Blainville's beaked whales. Longman's beaked whale clicks are not as well documented as Cuvier's and Blainville's, but from the known recorded examples, the clicks exhibit the same frequency modulation and long click duration. The peak frequency for Longman's beaked whale echolocation clicks is lower than the other two species, at 22 kHz (Baumann-Pickering et al. 2013). Little is known about their ICIs, thus the click shape and peak frequency were used as the discriminating characteristics for this report. An additional distinct type of frequency modulated signal has been described from passive acoustic recordings made at Cross Seamount (McDonald et al. 2009). These clicks are marked by a long duration (over 700 μs), short ICI (around 130 ms) and a peak frequency near 47 kHz (Baumann-Pickering et al. 2013). These echolocation clicks have a very obvious frequency modulated upsweep, as seen in other beaked whale echolocation clicks, and so are thought to be made by a beaked whale. Three additional BW call types have been recorded in the Eastern Tropical Pacific, referred to as BW50, UBW, and BWP by Baumann-Pickering et al. (2012). These signals also exhibit the frequency modulated upsweep, long duration and ICI found in other beaked whale clicks, and analysts scanned for these signals, as well as any other beaked whale-like signals.
- **Sperm whale:** Echolocation clicks produced by sperm whales contain energy from 2-20 kHz with peak energy from 10-15 kHz (Møhl et al. 2003). These clicks are observed during foraging dives and are characterized by a metronomic ICI of about one second

(Møhl et al. 2003). Sperm whale click trains can be readily identified in the LTSA plots, and echolocation clicks were the focus of analysis as they are the easiest to differentiate from other species.

- **Killer whale:** Killer whale pulsed calls are the best described and well documented of their call types, and serve well to differentiate them from other species. Pulsed calls have energy between 1 and 6 kHz, with high-frequency components occasionally reaching over 30 kHz. Duration is typically 0.5 to 1.5 second (Ford 1987). Aural and visual detection of pulsed calls were used for killer whale encounter identification.
- **Risso's dolphin:** Risso's dolphin echolocation clicks have a unique band pattern observable in bouts of click on an LTSA. Peak energy bands are located at 22 26, 30, and 39 kHz, with distinct notches at 27 and 36 kHz (Soldevilla et al. 2008) This notch and peak pattern is not as apparent when looking at individual clicks, but the LTSA shows the characteristic appearance of many hundreds of clicks that was used to identify Risso's dolphins in this report.

The remaining thirteen delphinid species are very difficult to classify to the species level acoustically. Thus, these species were grouped by similarity of the acoustic features of their whistles, when possible, which overlap across species and thus cannot definitively be assigned to species without concurrent visual observations. As described by Frankel and Yin (2010) whistle acoustic characteristics in delphinids often vary geographically and as ground-truth data for the HRC are sparse, the following groups were used for classification (similar to Munger et al. 2014).

- **Low-frequency whistles:** This group included whistles produced by the false killer whale, short-finned pilot whale, melon-headed whale, and rough-toothed dolphin. The defining whistle characteristics for this group were whistles that were relatively low-frequency (predominately below 10 kHz). Number of inflection points/steps and frequency range of the whistles is variable and species dependent (Frankel and Yin 2010; Ketten 1998; Lima et al. 2012; Oswald et al. 2003; Richardson et al. 1995; Watkins et al. 1997).
- **High-frequency whistles:** This group included whistles produced by the bottlenose dolphin, pantropical spotted dolphin, spinner dolphin, striped dolphin, and Fraser's dolphin. The defining whistle characteristics for this group were whistles that were higher in frequency (predominantly above 10 kHz). Number of inflection points/steps and frequency range of the whistles is variable and species dependent (Frankel and Yin 2010; Ketten 1998; Lammers et al. 2003; Oswald et al. 2003; Richardson et al. 1995)
- **Low- and high-frequency whistles:** This group included encounters characterized by [a] whistles with significant energy below and above 10 kHz or [b] various whistle types which covered a wide frequency range in one encounter.
- **Echolocation clicks and/or burst pulses:** This group included encounters which only contained echolocation clicks and/or burst pulses. The recorded clicks and pulsed calls did not contain any characteristic acoustic features enabling species identification. Many of the identified whistle encounters did include echolocation clicks and burst pulses, but

because of the added information contained in the whistles, we were able to classify them more specifically. Click and burst pulse encounters could potentially be associated with any of the above-mentioned eleven delphinid species.

2.2.3 Mysticetes

The HRC study area provides habitat for numerous species of baleen whales that produce low-frequency vocalizations. During the winter months, we could potentially record the low-frequency sounds of blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), sei whales (*B. borealis*), Bryde's whales (*B. edeni/brydei*), minke whales (*B. acutorostrata*), and humpback whales (*Megaptera novaeangliae*), as these species typically migrate to low-latitudes in winter.

To analyze the collected data efficiently for these species, the broadband data were down-sampled and divided into two datasets: one with a sampling rate of 1,000 Hz (15 to 500 Hz effective band) and the other 10 kHz (5 kHz effective bandwidth). From these data we calculated long-term spectral average (LTSA) plots with a Δt of 1 s and Δf of 1 Hz (1 kHz data) and a Δt of 2 s and Δf of 10 Hz (10-kHz data) using the Triton Software Package. Both LTSAs were coarsely screened visually and aurally by analysts for bioacoustic activity and general quality assurance. The actual logging of acoustic encounters was done in Raven Pro (Bioacoustics Research Program, Cornell University, Ithaca, New York, USA). Based on experience with the MIRC dataset (Klinck et al. 2015), it was found that it is most efficient to import the two datasets into Raven Pro, time align them, and examine them simultaneously for the species of interest (**Figure 4**). This provided sufficient detail in all frequency bands, but also enabled us to clearly identify sounds that had both very low-frequency components (i.e., 50 Hz) and higher components (> 1,000 Hz) such as minke whale boings.

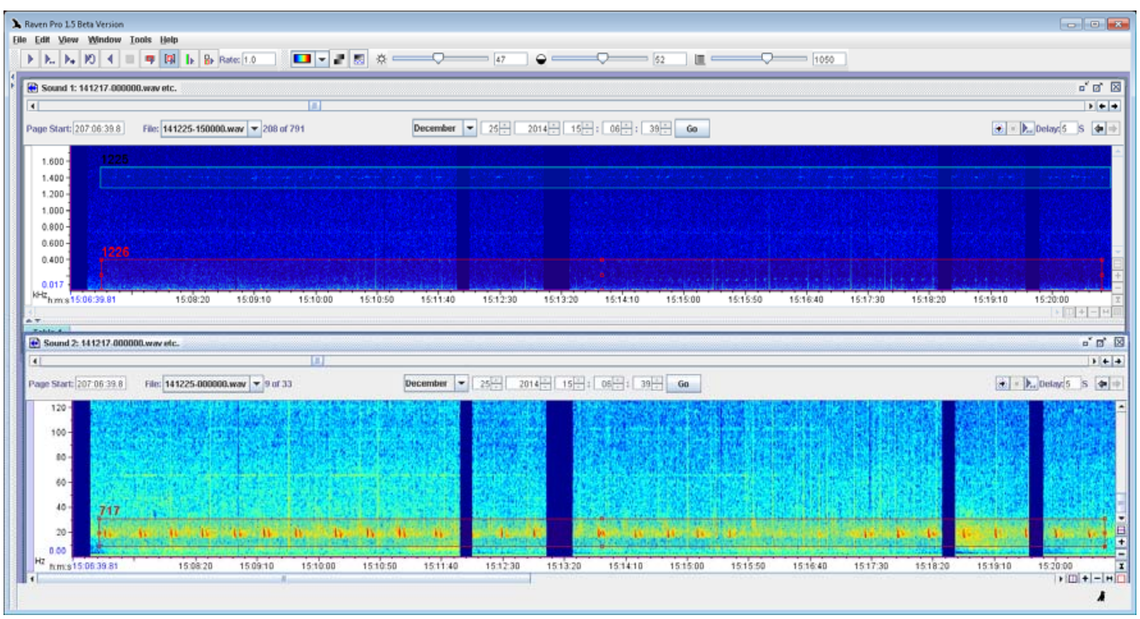

Figure 4: Example of time aligned spectra displayed in the software Raven Pro. The upper spectrogram is the 10-kHz down-sampled data and was used to identify mid-frequency vocalizations from minke whales (blue box) and humpback whales (red box). The lower spectrogram is the 1-kHz data and was used to identify calls from fin whales (red box) and blue whales, and also provided context when identifying the mid-frequency calls.

Experienced analysts examined the low-frequency data for down-sweeping calls from the sei whale (Baumgartner et al. 2008, Rankin and Barlow 2007a), the short and variable calls from Bryde's whale (Heimlich et al. 2005b, Oleson et al. 2003b), western and central pacific blue whale calls (Stafford et al. 2011 1999), blue whale D calls (McDonald et al. 2001) and 20-Hz and 40-Hz fin whale calls (Thompson et al. 1992, Watkins 1981). We also screened the data for North Pacific right whale "up calls" (90 to 150 Hz upsweeping 7-second calls; McDonald and Moore 2002), but detecting these calls in a dataset with singing humpback whales is extremely difficult (Mellinger et al. 2007; Waite et al. 2003). The mid-frequency data were primarily analyzed for humpback whale song and social sounds (Payne and McVay 1971, Stimpert and Au 2008), and the complex minke whale calls (Gedamke et al. 2001, Rankin and Barlow 2005). Because the recorded data set was comparatively short (one month), and because the 1 and 10 kHz data were time aligned and analyzed simultaneously we did not use automatic detection algorithms but instead we visually and aurally identified target vocalizations and manually marked identified sequences in Raven Pro.

2.2.4 Navy Sonar and Seismic Airgun Signals

The LTSA plots were also screened visually and aurally for occurrences of low- and mid-frequency active sonar and seismic airgun signals.

3. Results

Seaglider SG203 was deployed on 11 December 2014 at approximately 21:00 Coordinated Universal Time (UTC) 17 nautical miles (nm) west-southwest off of Honolulu, HI (N21° 11.09’, W158° 09.40’) using a small charter vessel. SG203 transited (PAM system inactive to save battery power) from the deployment location to the respective survey area. After the survey area was reached 60 nm south of the Island of Oahu (N20° 19.80’, W157° 50.49’), the PAM system was activated on 16 December 2014 21:00 UTC and captured sounds near-continuously in the 25 to 1,000 m depth range. The survey was essentially a ‘connect-the-dots’ between offshore seamounts with some abyssal areas in between.

The acoustic survey was completed on 18 January 2015 23:00 UTC at location N20° 15.73’, W157° 49.72’. After an 8-day transit, the recovery of the instrument was executed at N21° 09.57’, W158° 08.64’ on 26 January 2015 20:00 UTC.

A summary of the glider survey is provided in **Table 1** and **Figure 5**. A total of 849 gigabytes of acoustics data (16 December 2015 to 18 January 2015) and 95 megabytes of environmental/glider performance data were collected with SG203. SG203 conducted 164 dives with the PAM system active. The median recording time per dive was calculated as 4.8 hours (1.1 h standard deviation). All dates/times reported are in UTC.

Table 1: Summary of the glider survey.

Glider	# of dives	Distance over ground	Distance through water
SG203	238 (164)	857 km (627 km)	1072 km (794 km)

Note: Values in parentheses indicate ‘PAM active’ statistics.
Key: km = kilometer(s)

The glider recorded a total of 712 h (approximately30 days) of acoustic data over a 33-day period. It should be noted that SG203 did not record acoustic data during a few dives in the SW corner of the survey area. The cause for this data loss was associated with PAM system “hang ups” (PAM system stopped processing incoming acoustic data; likely associated with a firmware issue). While this was easily resolved by the glider pilot by rebooting the PAM system, it sometimes took a few hours before this issue was detected. This issue was also observed and documented in the previous MIRC deployment and a permanent fix will require additional engineering and bench testing.

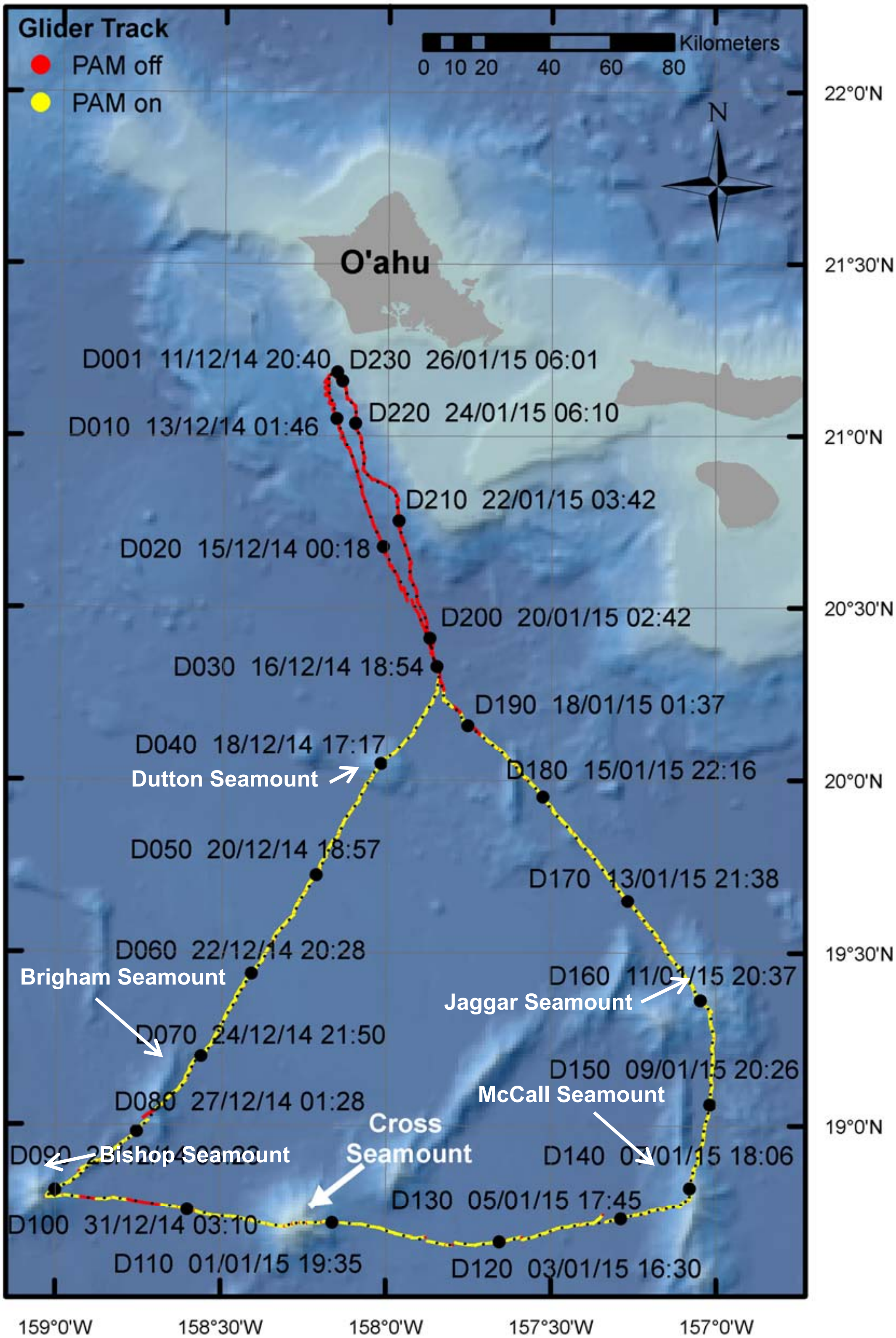

Figure 5: SG203 track line for the period 11 December 2015 to 26 January 2015. Each black dot on the track line indicates the midpoint location of a glider dive. Labels indicate dive number (e.g., D001 for dive no. 1) and date/time (format: dd/mm/yy hh:mm UTC). Red sections indicate that the PAM system was OFF. The yellow marks indicate that the PAM system was active.

3.1 Environmental Data

The results of the environmental data analysis are summarized in **Figure 6 through Figure 8**. White areas in the plots indicate no data and are a result of dives shallower than 1,000 m (e.g., bathymetry limited dives). The sea surface temperature (**Figure 6**) varied little geographically and temporally and was approximately 27 degrees Celsius (°C). The profiles indicated a temperature gradient of approximately 10°C in the 0 to 300-m depth range.

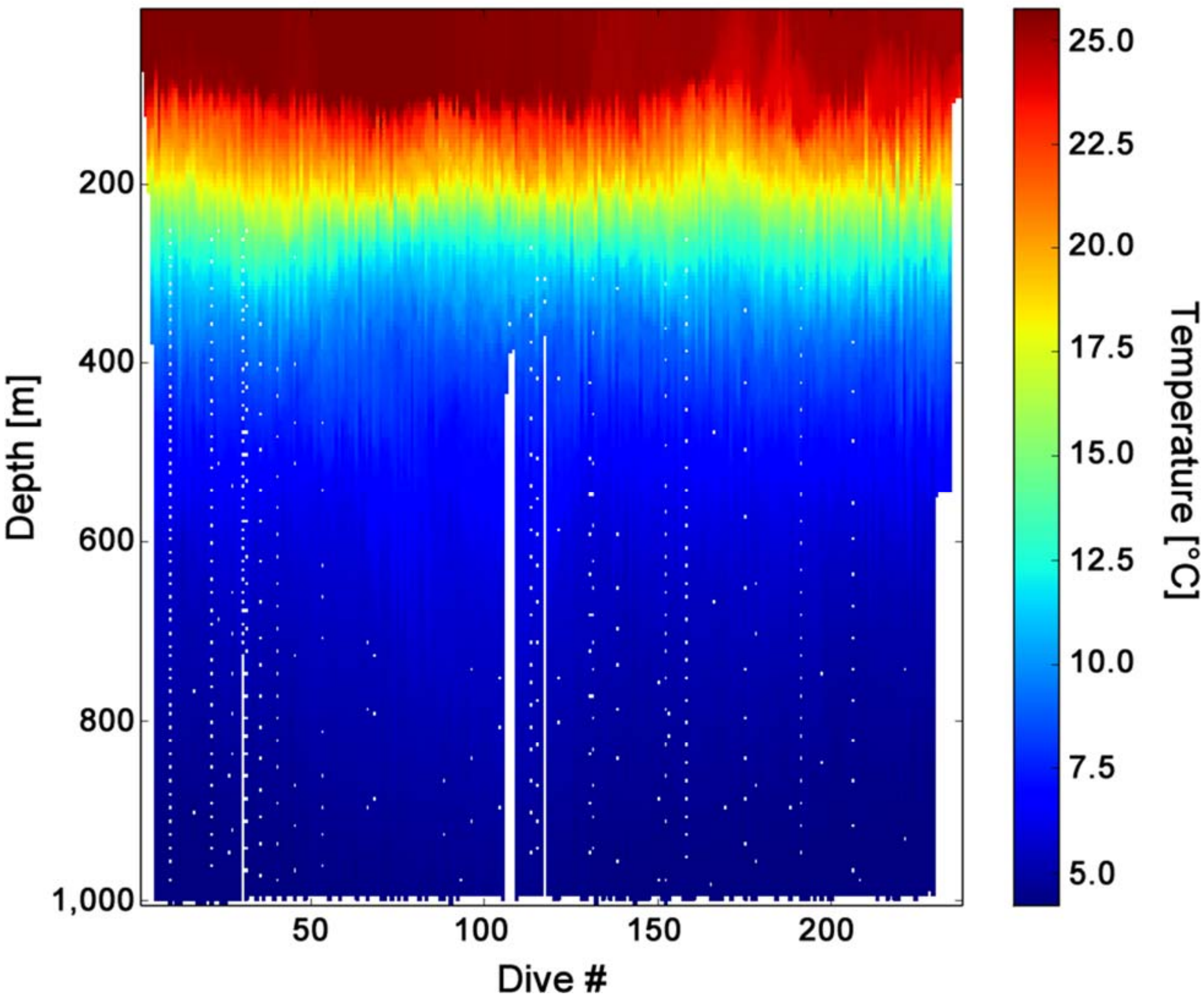

Figure 6: Temperature profiles recorded with SG203.

The sound-speed profile (**Figure 7**) showed downward refracting sound propagation conditions and no significant surface duct. There were no significant changes observed in time and space. Furthermore, the glider did not reach the sound fixing and ranging channel axis which in the deployment area is located below the instrument's maximum operation depth of 1,000 m. Signal propagation conditions were excellent for detecting biological sounds, however, estimating the absolute detection ranges for the various signals was not possible given the scope of this effort and the missing details on source levels etc.

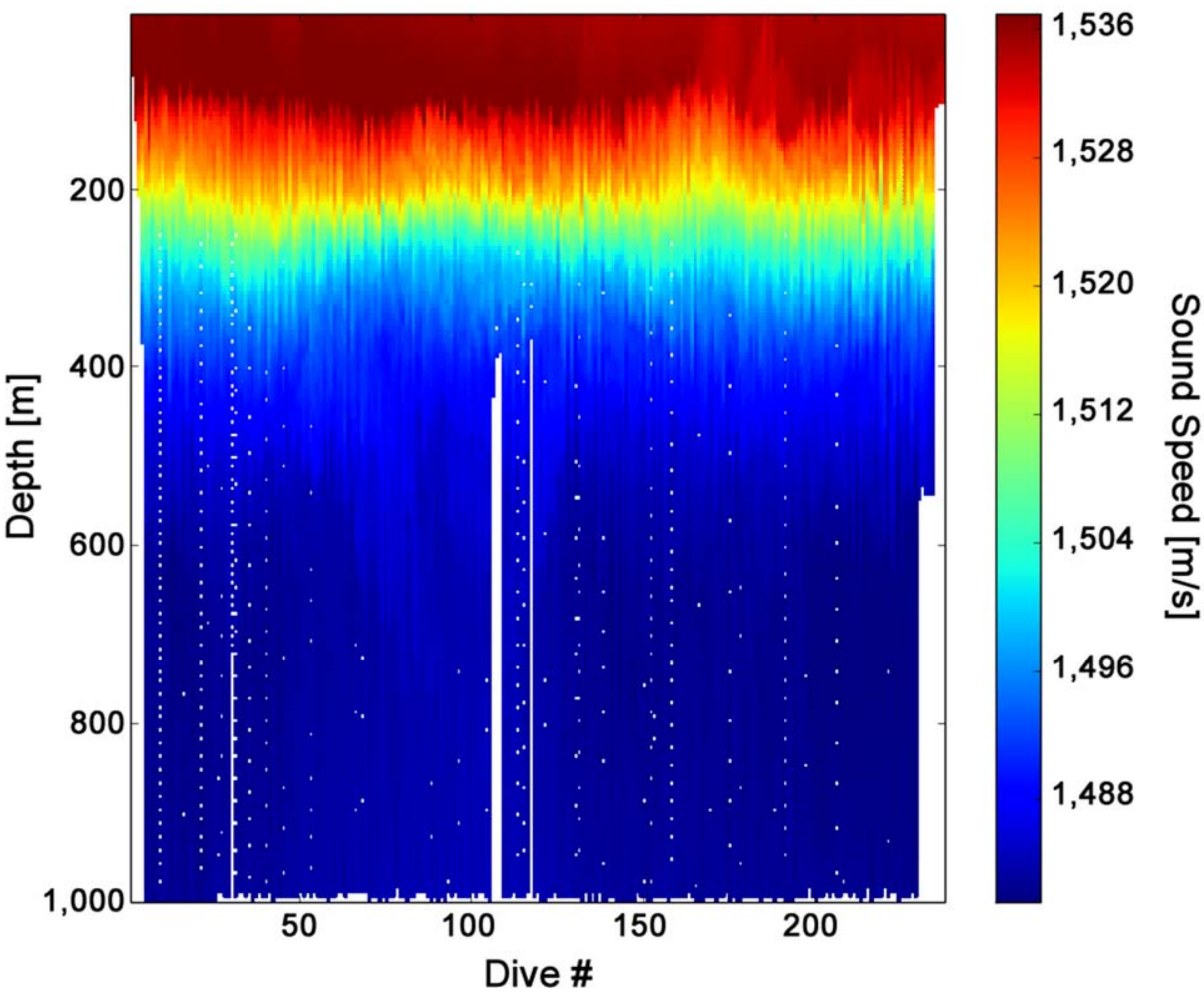

Figure 7: Sound-speed profiles recorded with SG203.

As shown in **Figure 8**, the depth-averaged ocean currents in the survey area were predominantly in southerly and south-easterly direction.

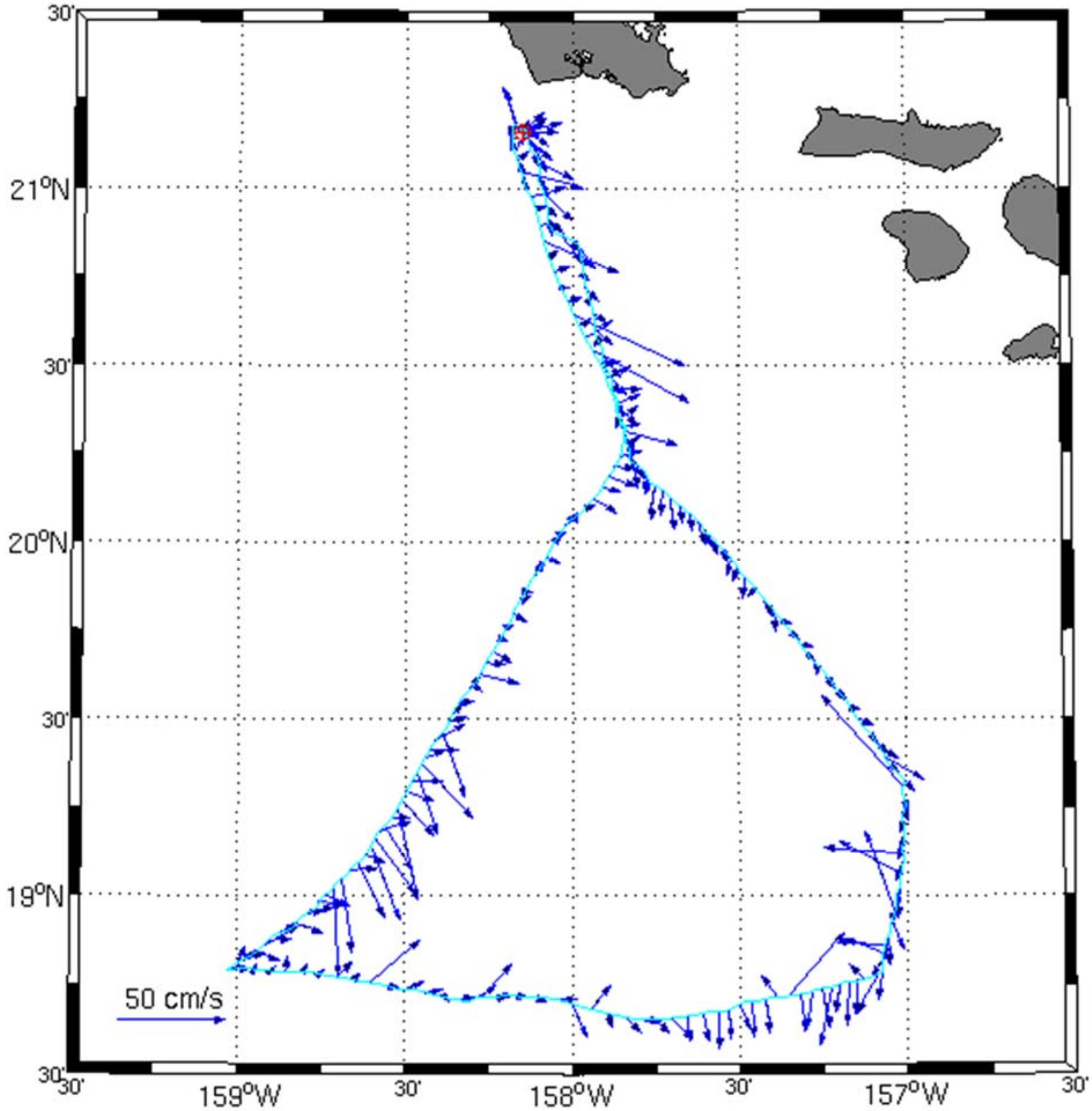

Figure 8: Depth-averaged currents measured with SG203.

SG203 reported a median depth-averaged current velocity of 9.9 centimeters per second and a median direction of 132°.

3.2 Odontocetes

SG203 recorded a wide variety of odontocete species throughout the HRC survey (See **Appendix A** for detail on all detections); however, killer whales and Cuvier's beaked whales were not detected.

Beaked whales

Beaked whale echolocation clicks were encountered 12 times on 11 different glider dives. Five of the encounters were identified as Blainville's beaked whales (**Figure 9**, left panel). The remaining seven encounters were identified as Cross Seamount beaked whales (CSBW) (**Figure 9**, right panel). Dive 127 contained both click types.

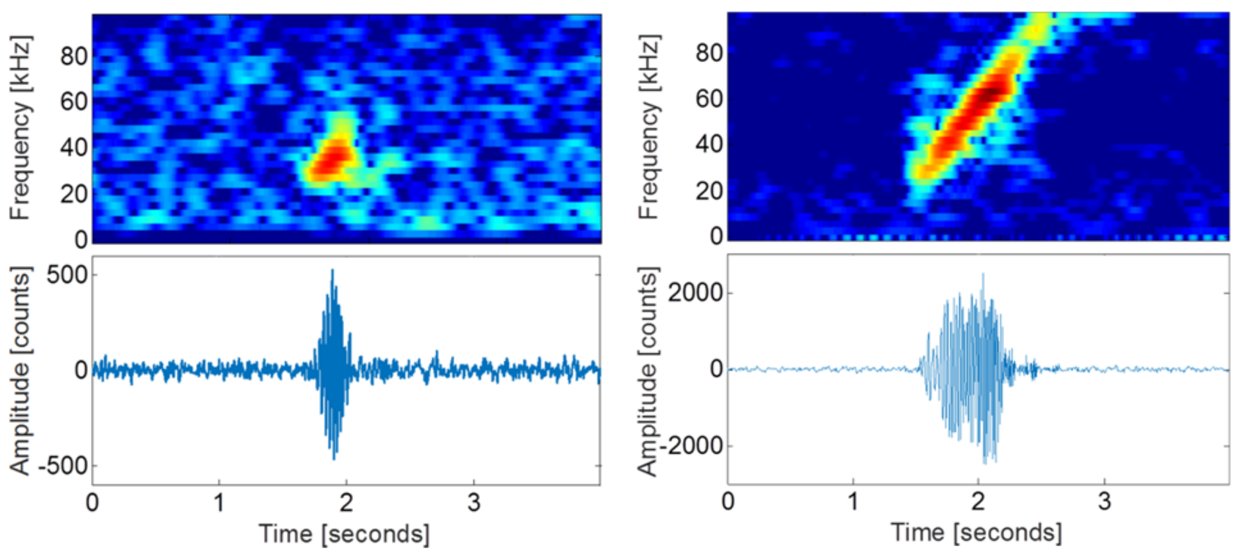

Figure 9: Blainville's beaked whale echolocation click (left) and CSBW echolocation click (right) recorded withSG203. Both examples are high-pass filtered at 10 kHz. Amplitude range of waveform is ±32,768 digital counts (16 bits).

The first Blainville's beaked whale detection occurred during the testing of the PAM systems immediately after the deployment of the instrument on 11 December 2014. The remaining Blainville's clicks were dispersed across the entire survey (**Figure 10**). The majority of CSBW clicks were recorded in the vicinity of Cross Seamount. Additional detections occurred in the vicinity of McCall Seamount further to the east. One encounter was registered close to the start/end point of the acoustic survey approximately 60 nm south of the island of Oahu (**Figure** 11).

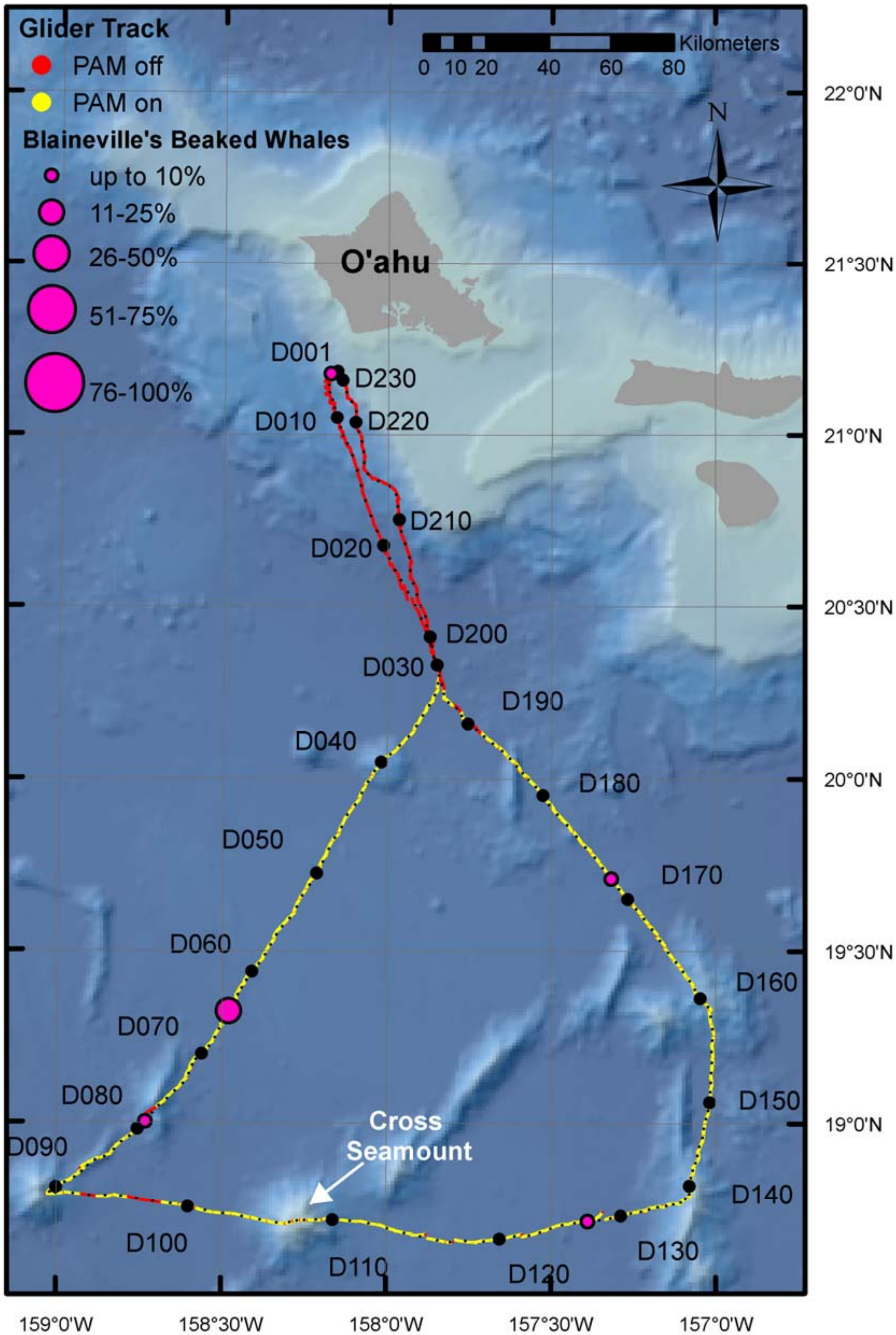

Figure 10: SG203 Blainville's beaked whale encounters. The circle size indicates percentage of recording time per dive with target signals.

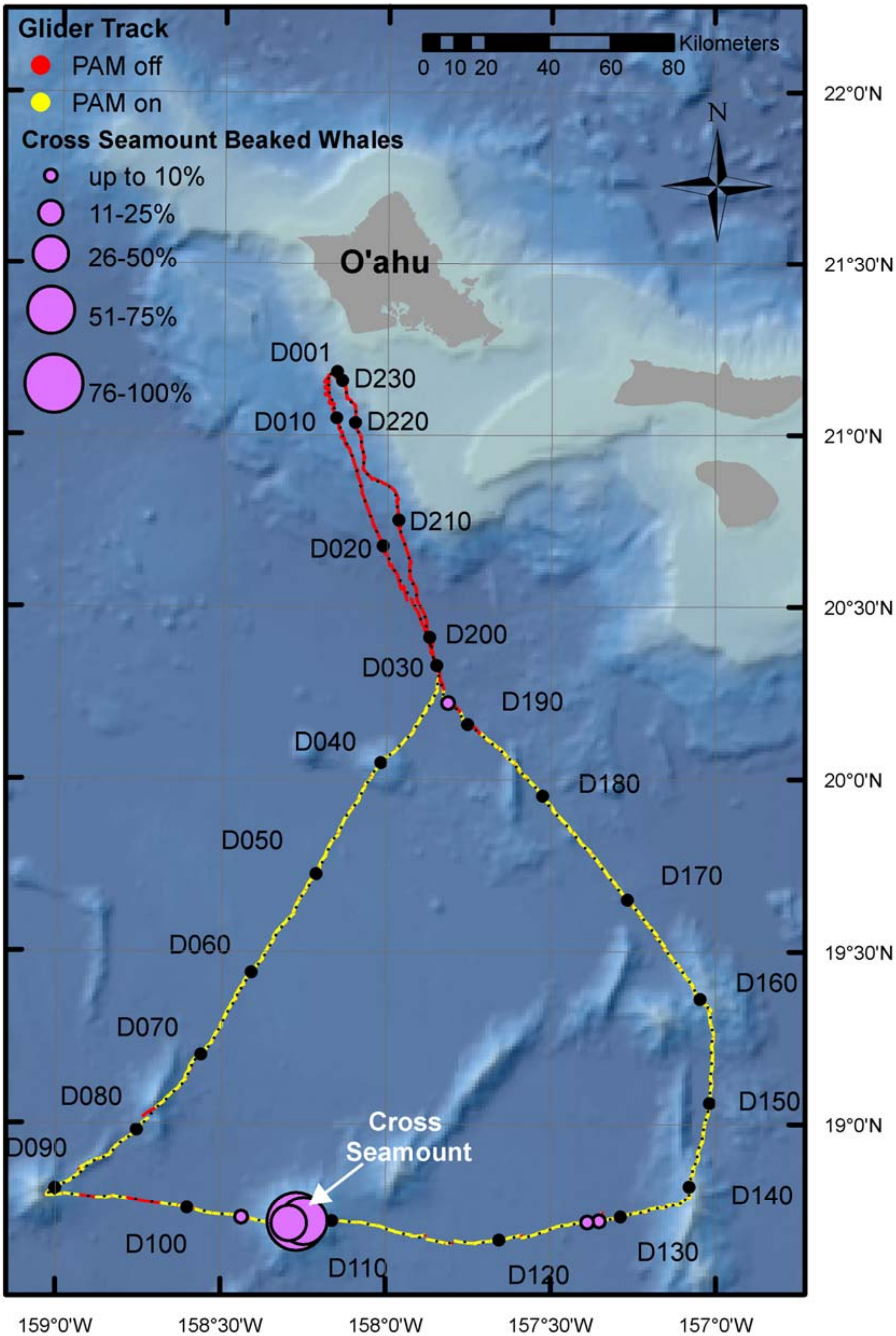

Figure 11: SG203 CSBW encounters. The circle size indicates percentage of recording time per dive with target signals.

Sperm whale

Sperm whale echolocation clicks (**Figure 12**) were detected on 30 different glider dives (total of 51.9 h of acoustic sperm whale data). No sperm whale clicks were detected from dive 107 to dive 170, when the glider was in the southeastern corner of the survey area.

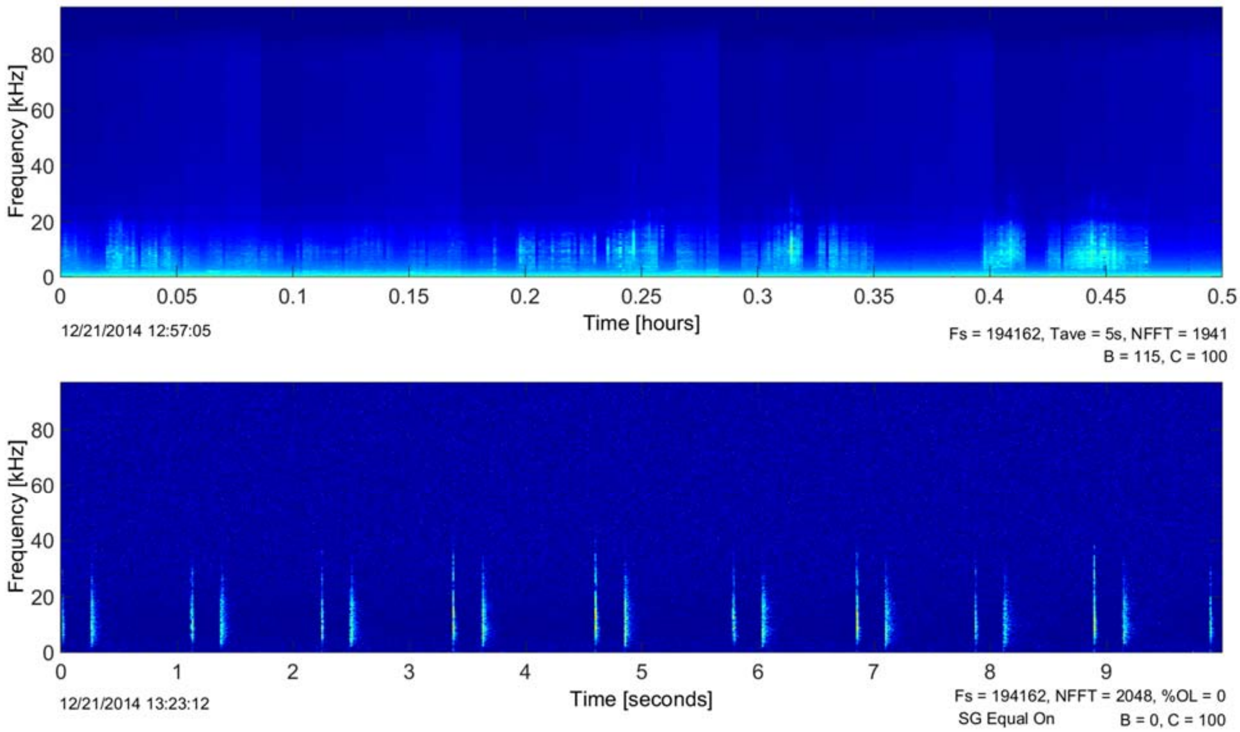

Figure 12: Sperm whale echolocation clicks recorded with SG203 on 21 December 2014. The first of two closely spaced clicks is the actual click; the following, longer duration signal is likely a bottom reflection.

The majority of sperm whale encounters occurred over the abyssal plain. Sperm whale occurrence did not seem related to bathymetric features such as seamounts (**Figure 13**).

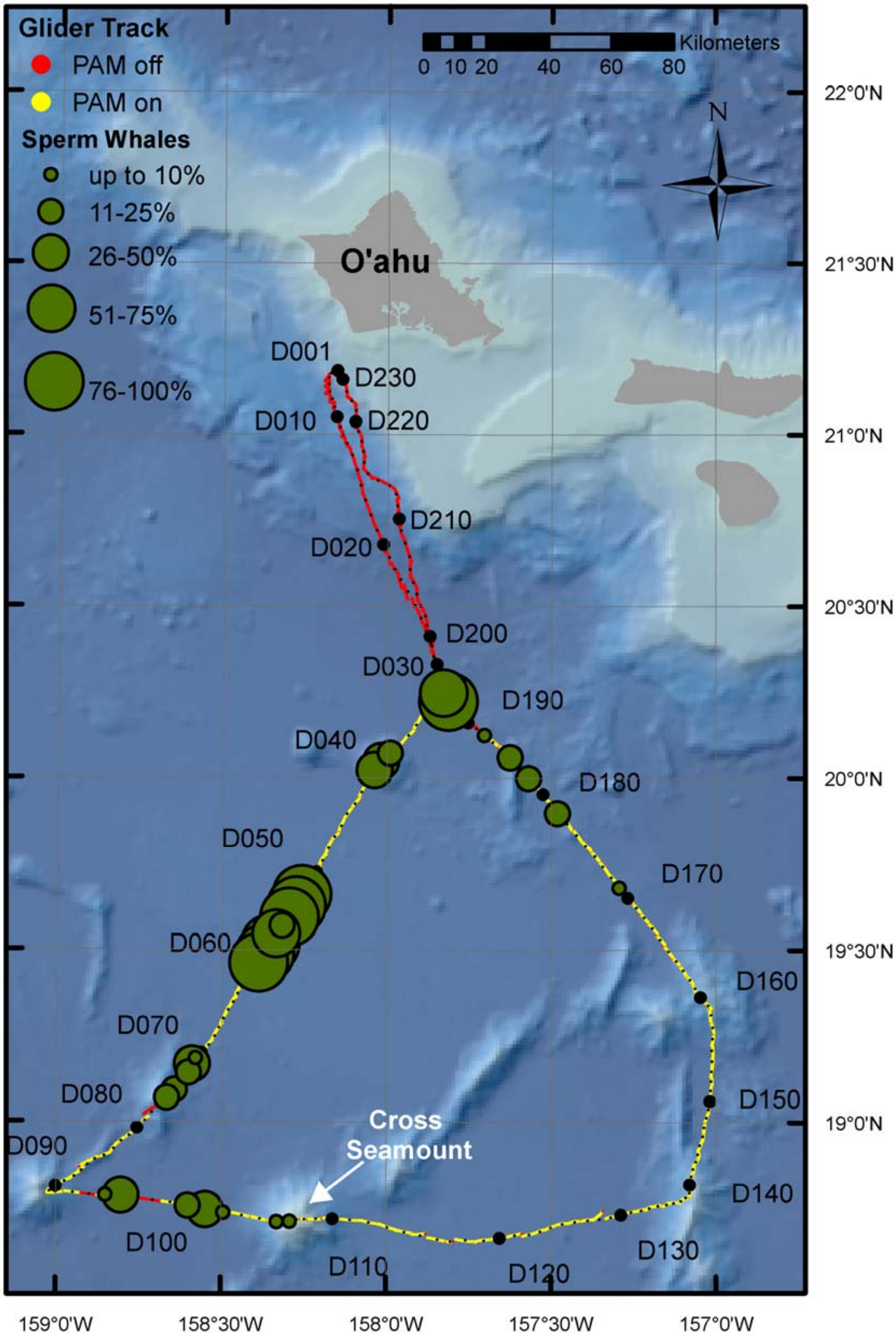

Figure 13: SG203 sperm whale encounters. The circle size indicates percentage of recording time per dive with target signals.

Risso's dolphin

Recordings of Risso's dolphin echolocation clicks (**Figure 14**) were made on 11 different dives. Encounters were, on average, of 1 h (± .49 h) duration.

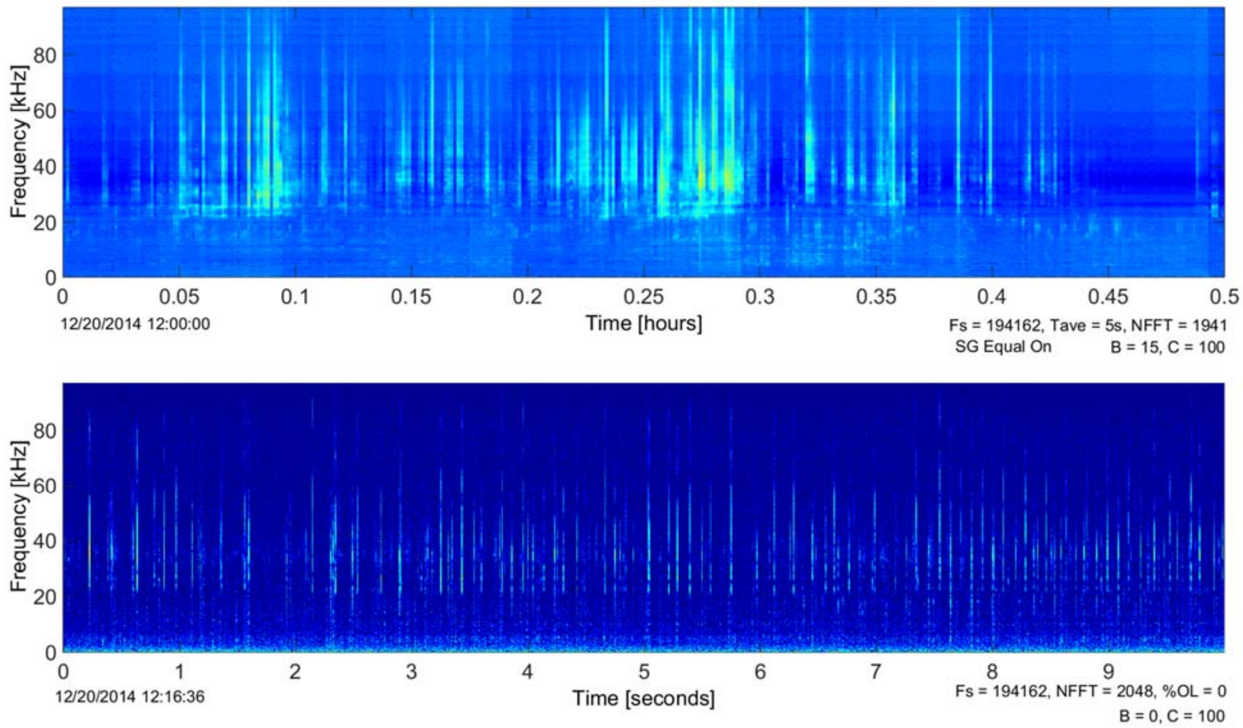

Figure 14: Risso's dolphin echolocation clicks recorded with SG203 on 20 December 2014.

Risso's dolphin encounters were registered throughout the entire survey area except for the southernmost part between Bishop Seamount and McCall Seamount (**Figure 15**).

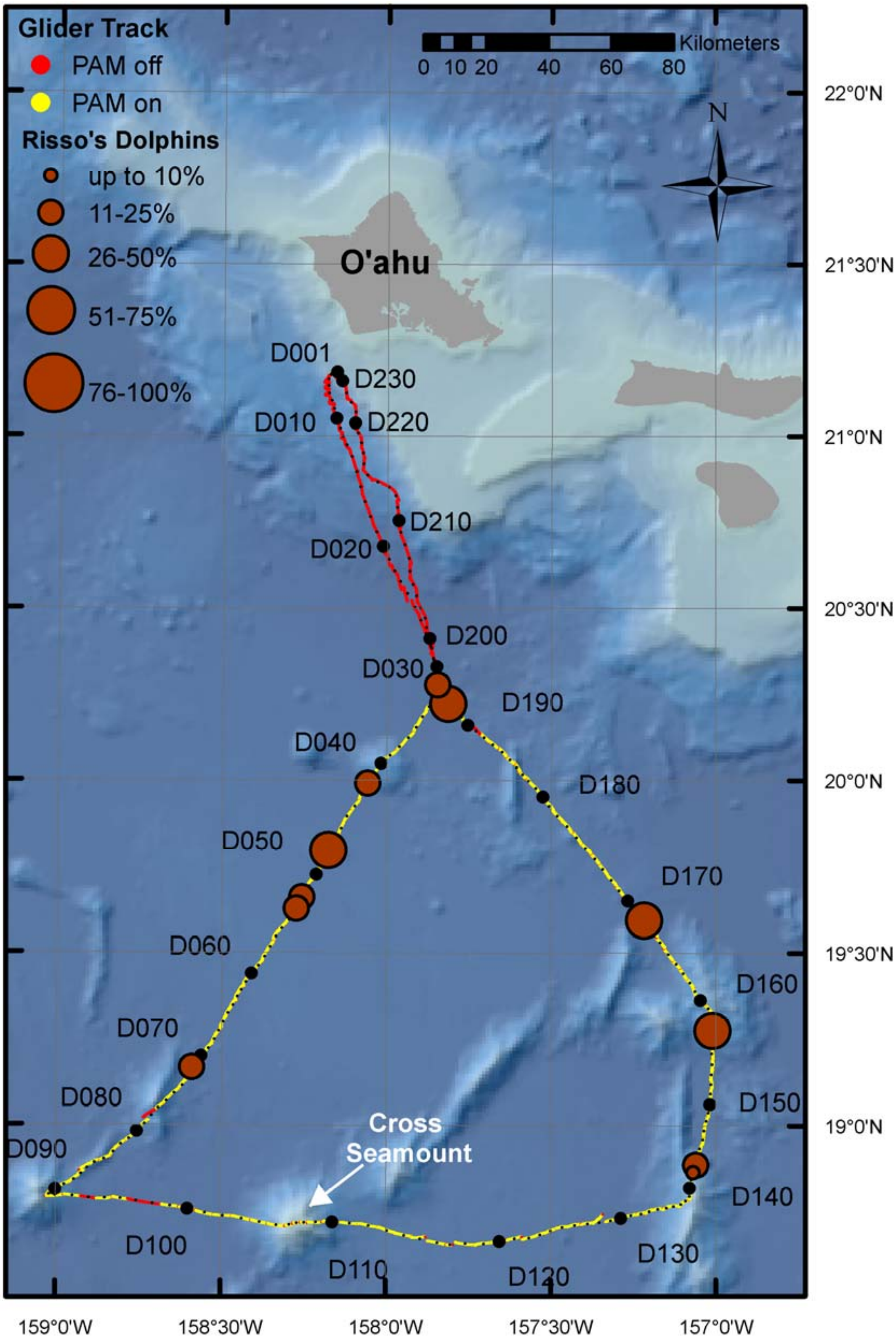

Figure 15: SG203 Risso's dolphin encounters. The circle size indicates percentage of recording time per dive with target signals.

Whistles

Recordings of odontocetes that contained whistles were classified according to the maximum frequency of the whistles, but often also included echolocation clicks and sometimes pulses.

Low-frequency whistles

Acoustic encounters that contained whistles with maximum frequencies below 10 kHz (**Figure** 16) were recorded on 18 glider dives.

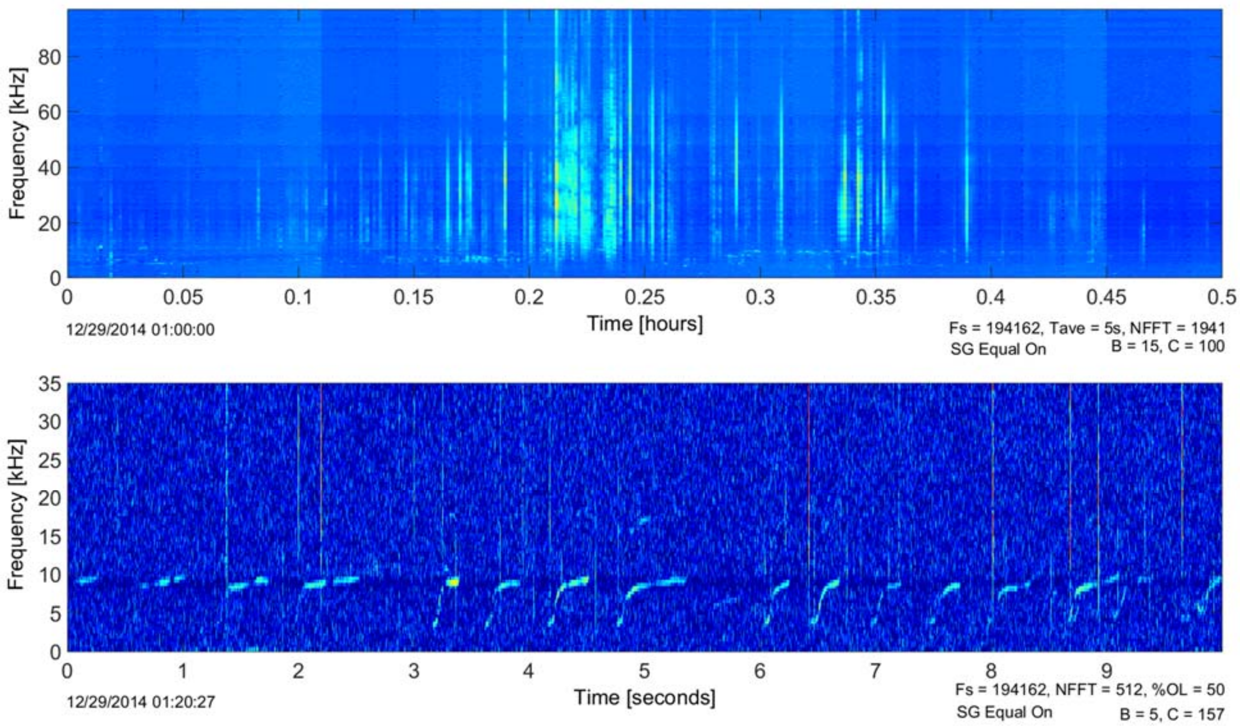

Figure 16: Low-frequency whistles recorded with SG203 on 29 December 2014.

These low-frequency whistles were detected throughout the survey, aside from two single week periods without any low-frequency whistle recordings: 17 to 24 December 2014 and 30 December 2014 to 05 January 2015. Detections were most often found in association with bathymetric features (**Figure 17**). These whistles are likely associated with one of the following species based on the maximum frequency and frequency range spanned by the whistle: false killer whale, short-finned pilot whale, melon-headed whale, or rough-toothed dolphin.

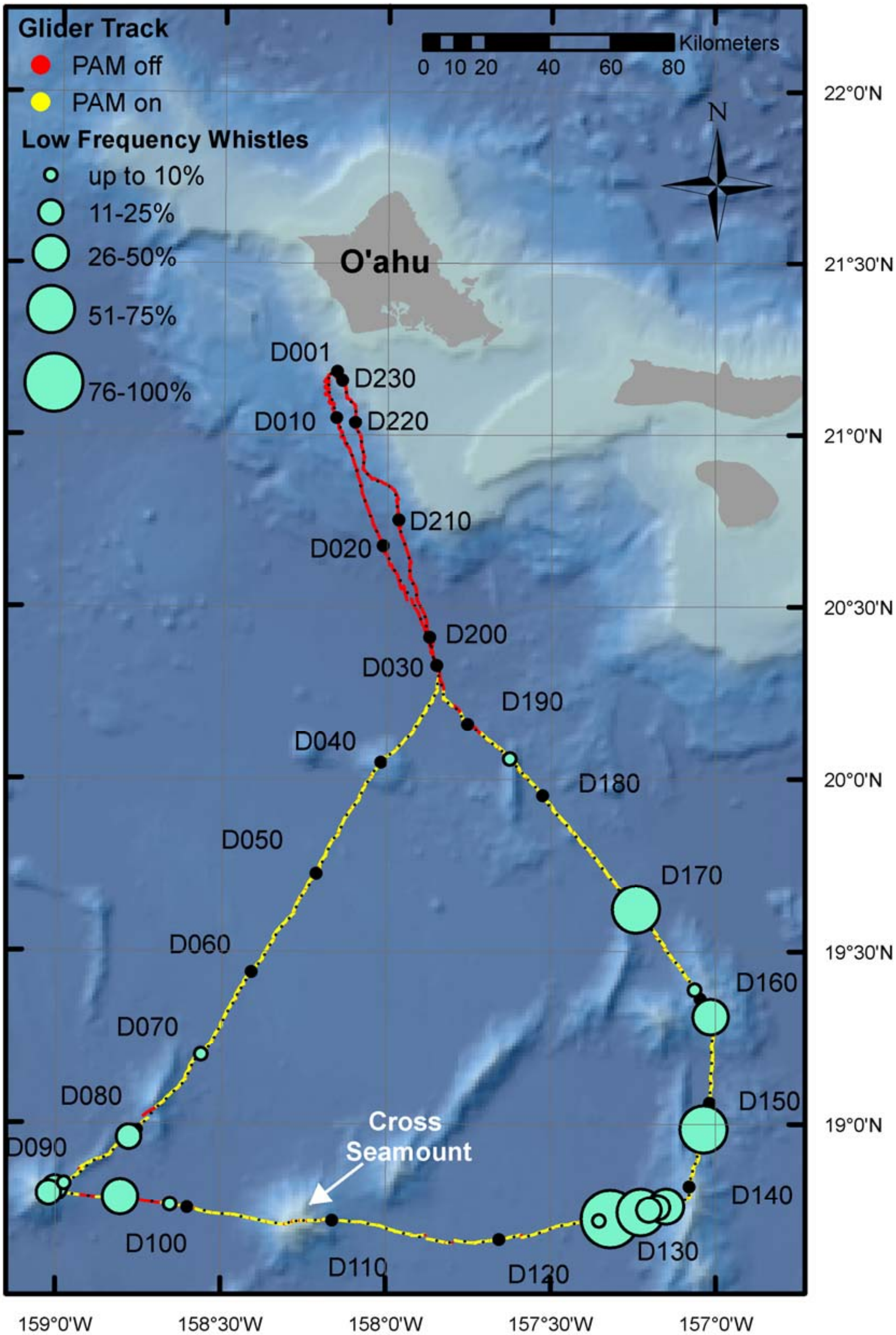

Figure 17: SG203 low-frequency whistle encounters. The circle size indicates percentage of recording time per dive with target signals.

High-frequency whistles

Acoustic recordings containing whistles with energy predominantly above 10 kHz (**Figure 18**) were recorded on only 5 glider dives.

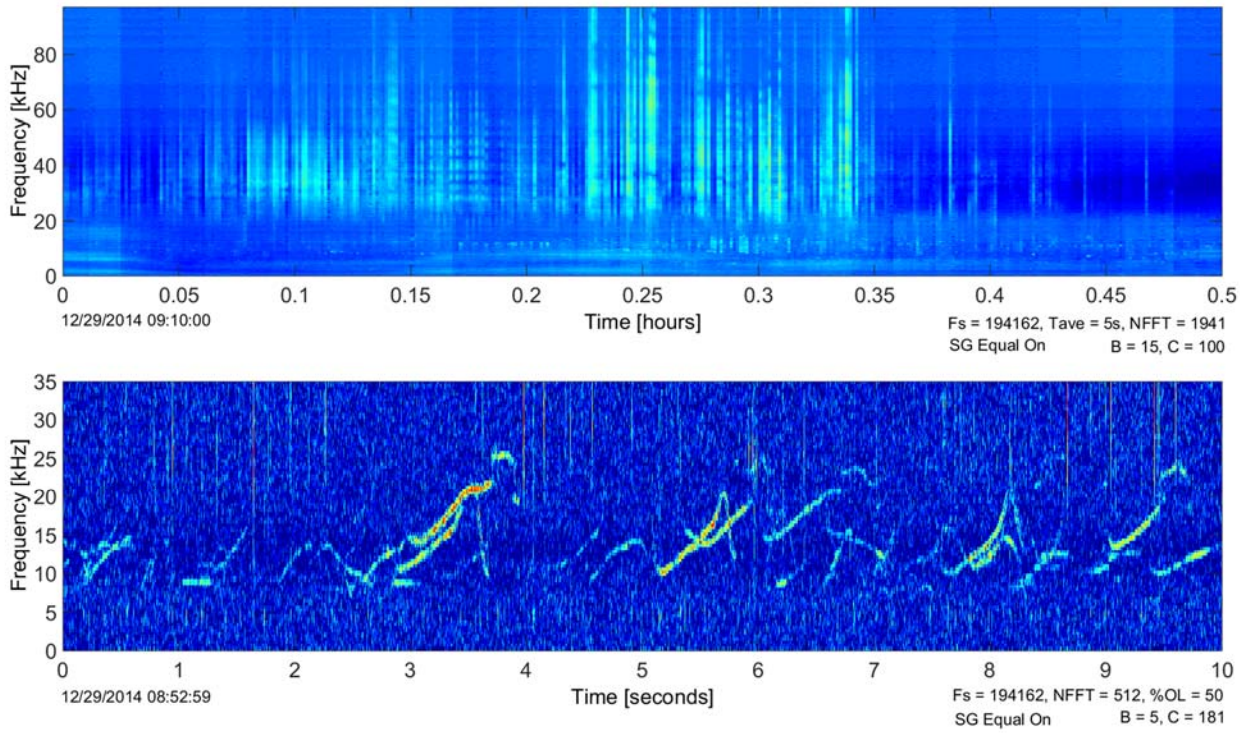

Figure 18: High-frequency whistles recorded with SG203 on 29 December 2014.

Such bouts containing high-frequency whistles ranged in duration from 4 seconds to 1.39 h and appear to be associated with bathymetric features (**Figure 19**). These whistles are likely associated with one of the following species, based on maximum frequency and range of frequencies within a whistle: bottlenose dolphin, pantropical spotted dolphin, spinner dolphin, striped dolphin, and Fraser's dolphin.

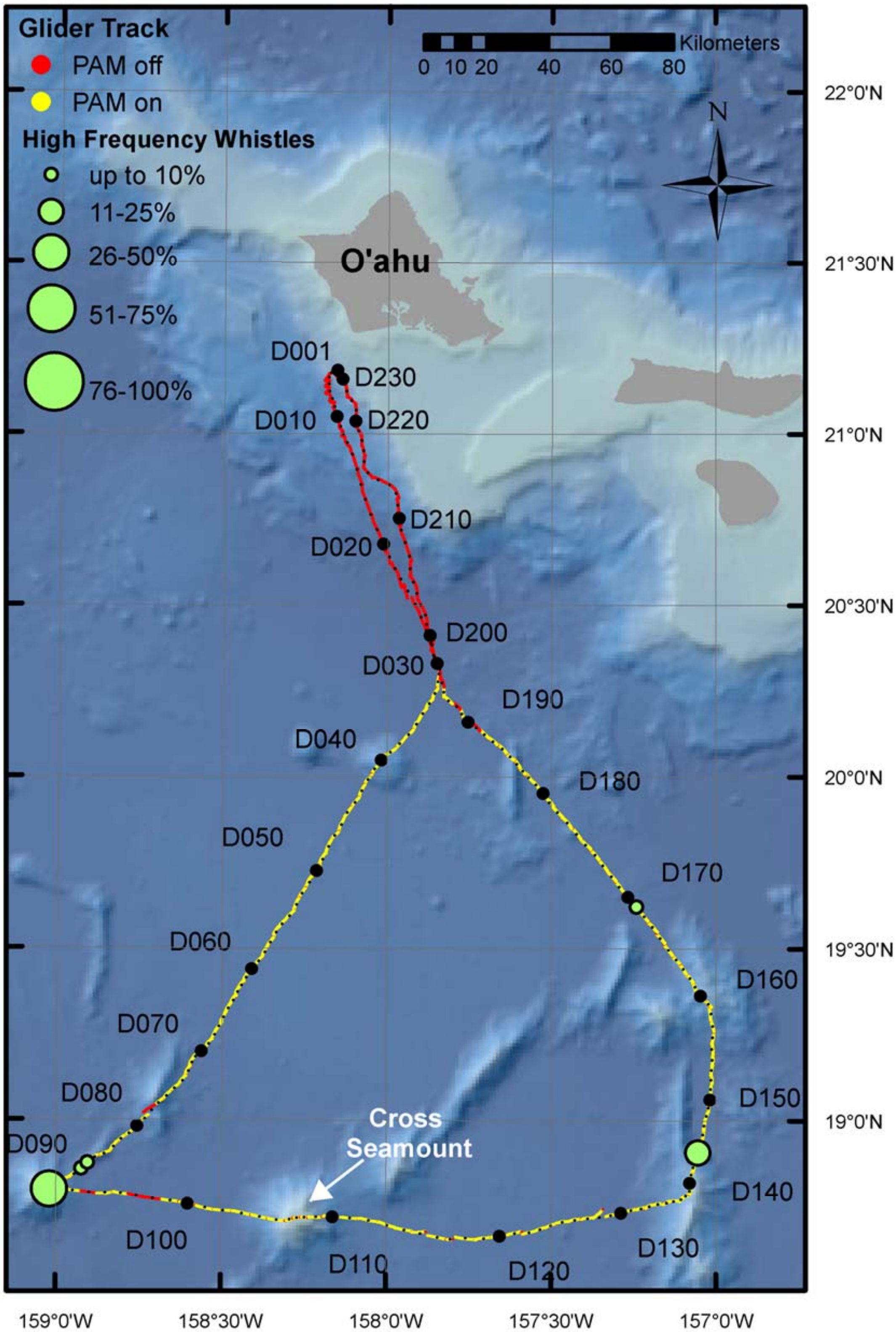

Figure 19: SG203 high-frequency whistle encounters. The circle size indicates percentage of recording time per dive with target signals.

Low- and High-frequency whistles

Twenty-two dives contained recordings of both low- and high-frequency whistles, classified as such because either both types of whistles or whistles that spanned a frequency range above and below 10 kHz were present (**Figure 20**).

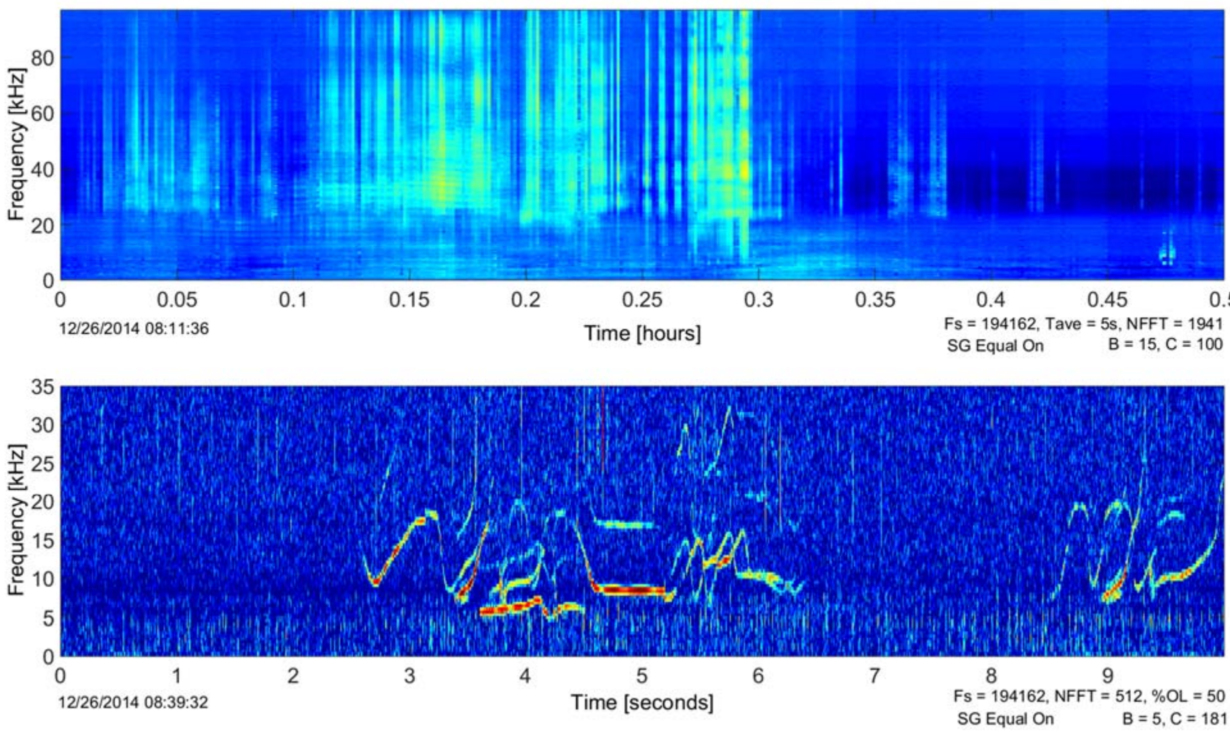

Figure 20: Low- and High-frequency whistles recorded with SG203 on 26 December 2014.

These whistles were spatially distributed throughout the deployment (**Figure 21**), over the abyssal plain and bathymetric features, aside from a one-week break in detections of low- and high-frequency whistles from 27 December 2014 to 2 January 2015 (south/southwest part of the survey area).

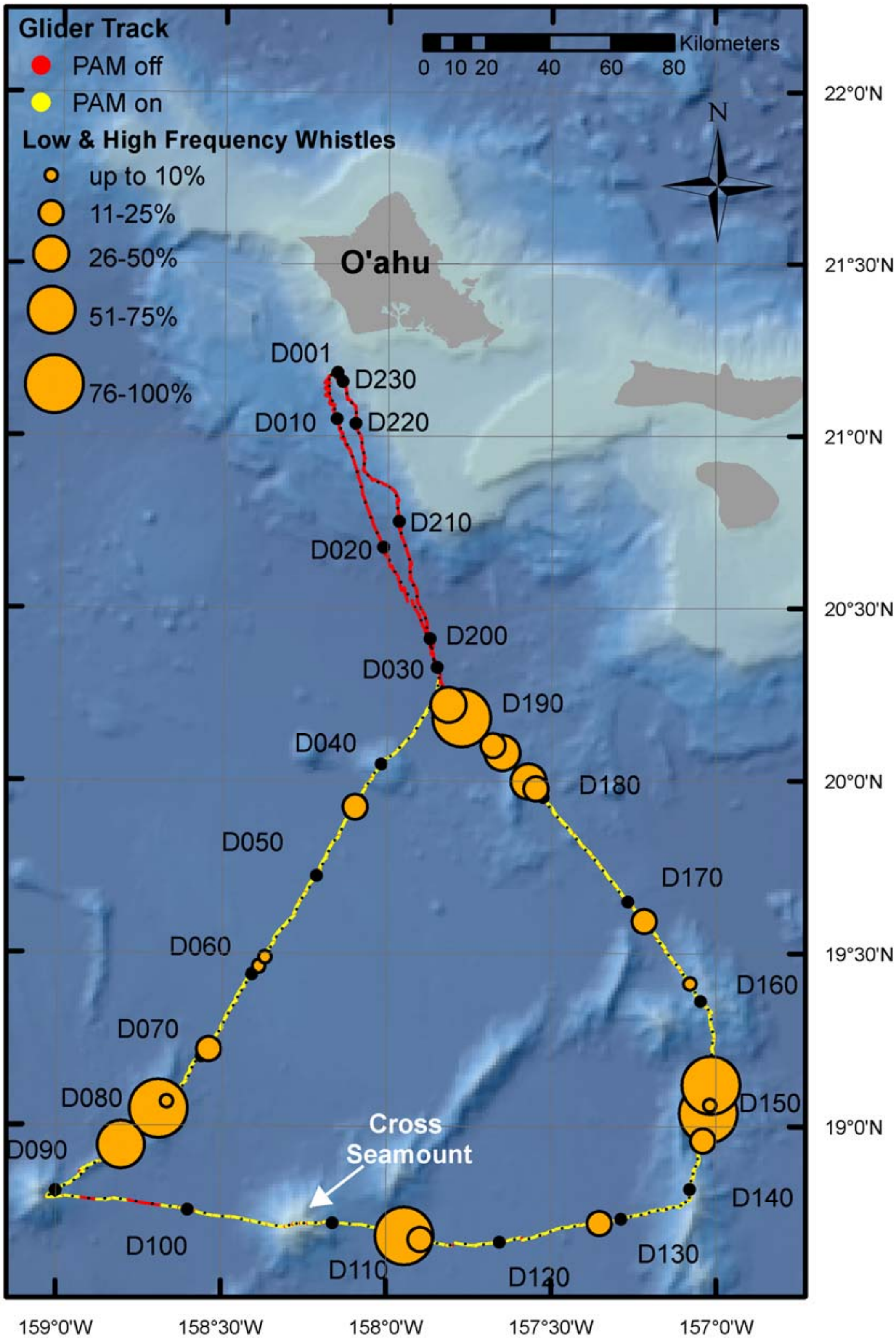

Figure 21: SG203 low- and high-frequency whistle encounters. The circle size indicates percentage of recording time per dive with target signals.

Echolocation clicks and burst pulses

Acoustic encounters that did not contain whistles, or signals that could not be identified to species level, were classified as echolocation clicks and burst pulses (**Figure 22**). Such encounters occurred on 29 individual glider dives, totaling 31.6 h of acoustic data.

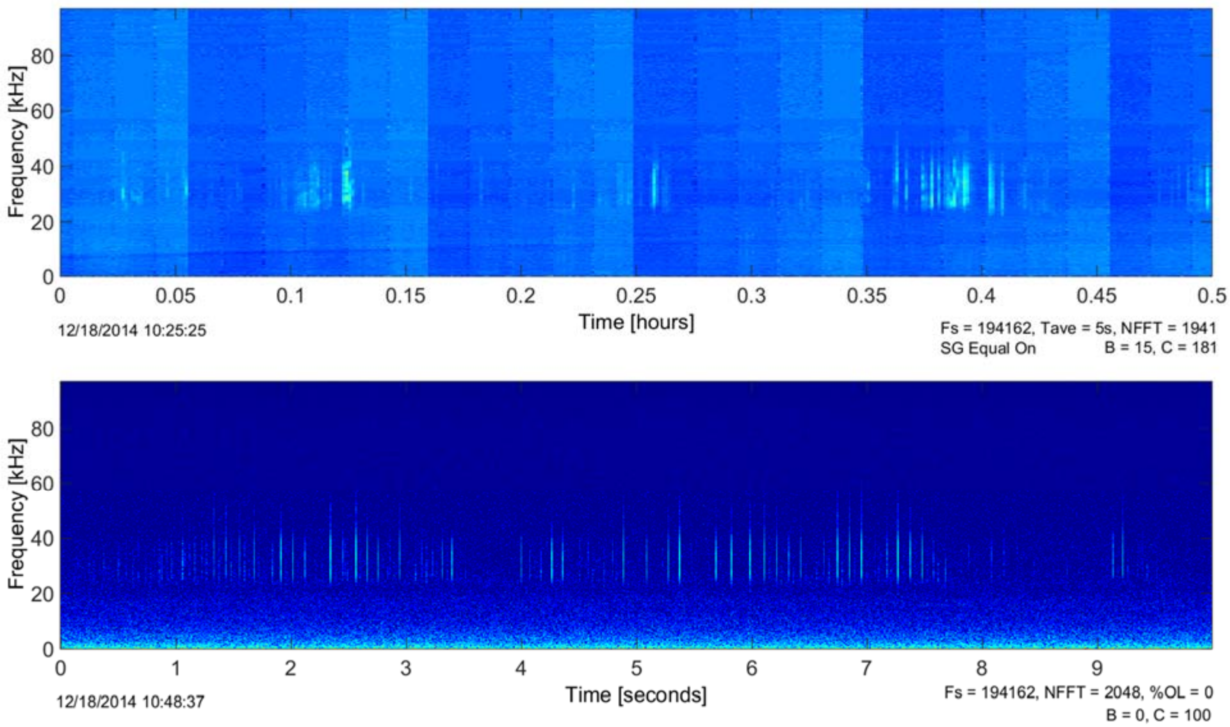

Figure 22: Echolocation click recorded with SG203 on 18 December 2014.

These recordings occurred in all areas of the survey (**Figure 23**), with the largest gap between encounters of just under 4 days, or 18 dives (27 to 31 December 2014). More recordings occurred over abyssal plains than over seamounts and ridges, but detections were made over both.

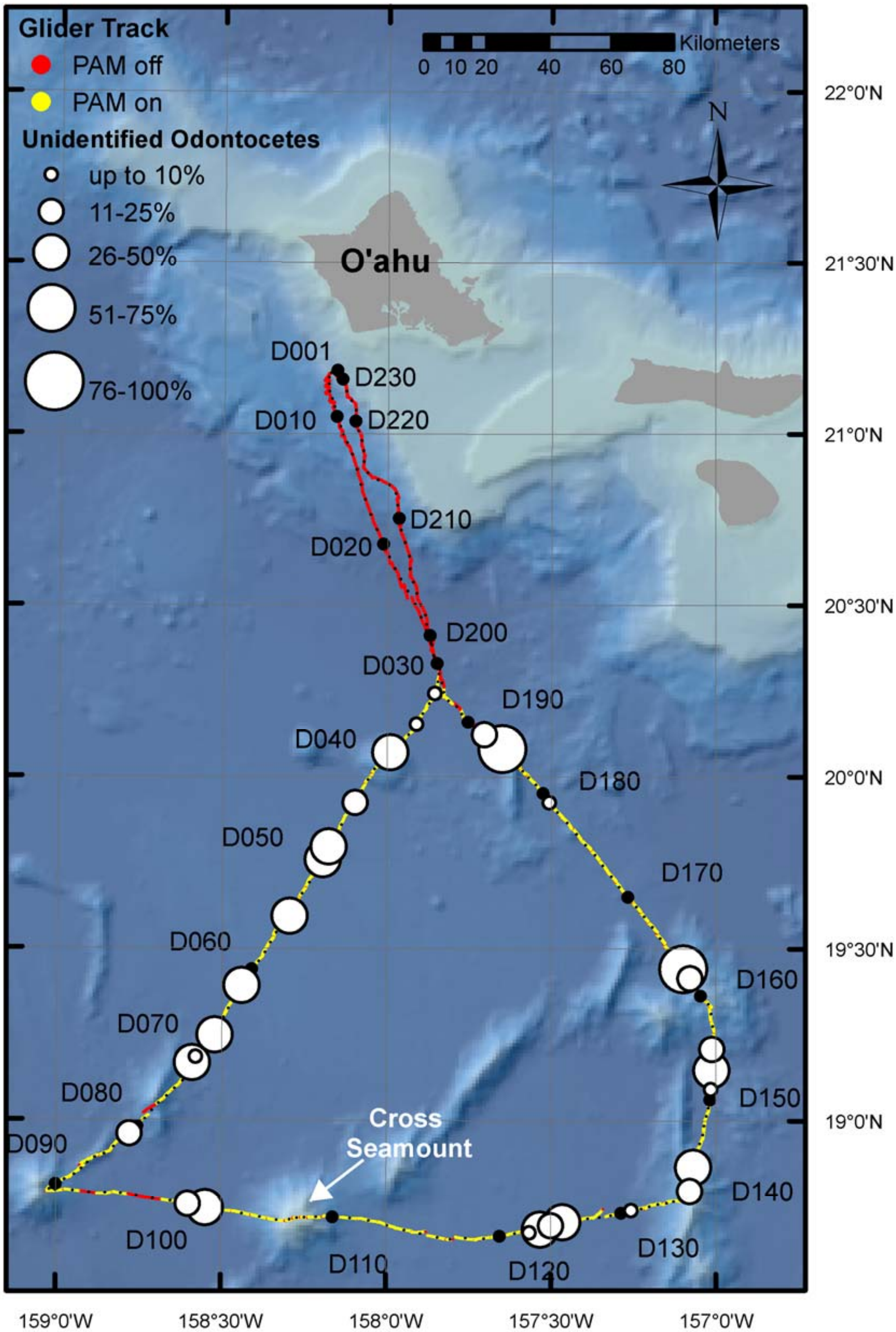

Figure 23: SG203 echolocation clicks and burst pulses encounters. The circle size indicates percentage of recording time per dive with target signals.

3.3 Mysticetes

Details on all mysticete detections can be found in **Appendix A**. Signals produced by Bryde's and right whales were not identified in this dataset.

Blue whale

Calls from northwestern Pacific blue whales (NWPBW; **Figure 24** and **Figure 25**) were recorded during 33 glider dives. Calls were recorded first on 22-24 December 2014 as the glider traveled south (**Figure 26**); these calls tended to be sporadic and of low signal-to-noise ratio (SNR). NWPBW calls were also recorded as the glider traversed Cross Seamount. Loud, longer sequences of calls were recorded toward the end of the survey (14 to 18 January 2015). In addition, potential blue whale D calls were also recorded (**Figure 25**). These were recorded only once in our dataset (17 January 2015) and were identified as D calls (and distinguished from other downsweeps from fin whales and sei whales) because they were the same approximate amplitude as blue whale calls occurring before and after the D calls.

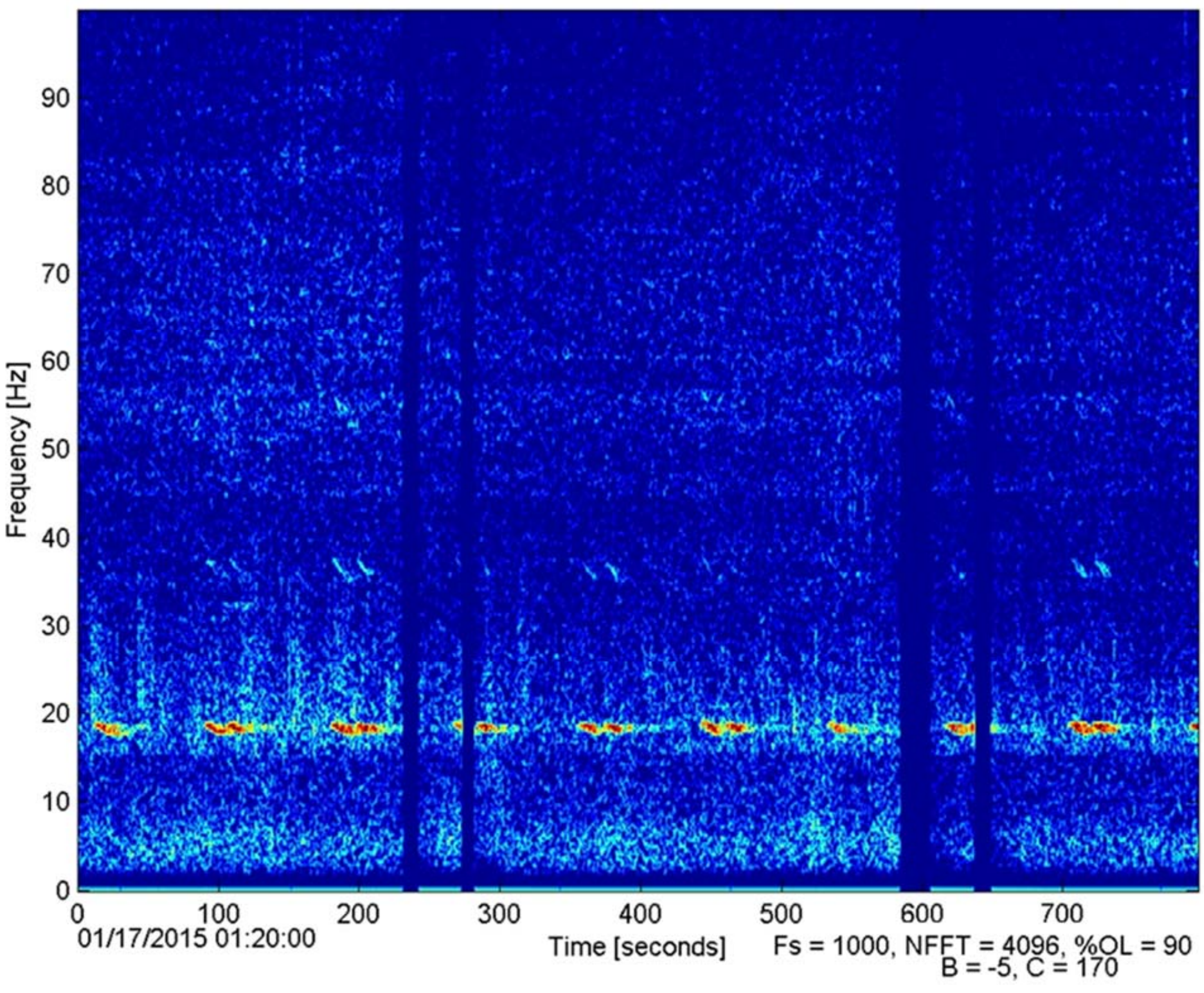

Figure 24: Blue whale calls recorded with SG203 on 17 January 2015.

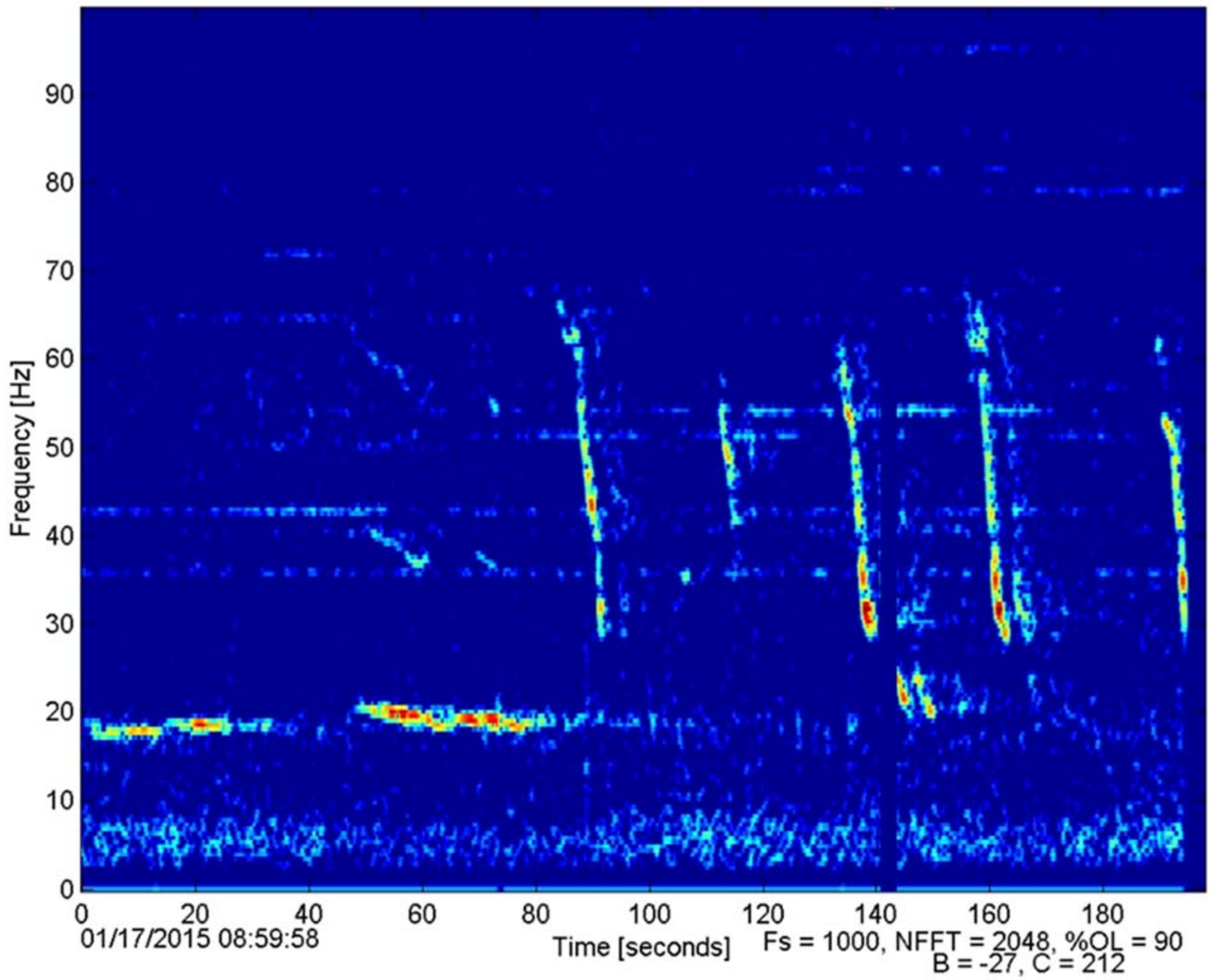

Figure 25: Blue whaled D calls recorded with SG203 on 17 January 2015.

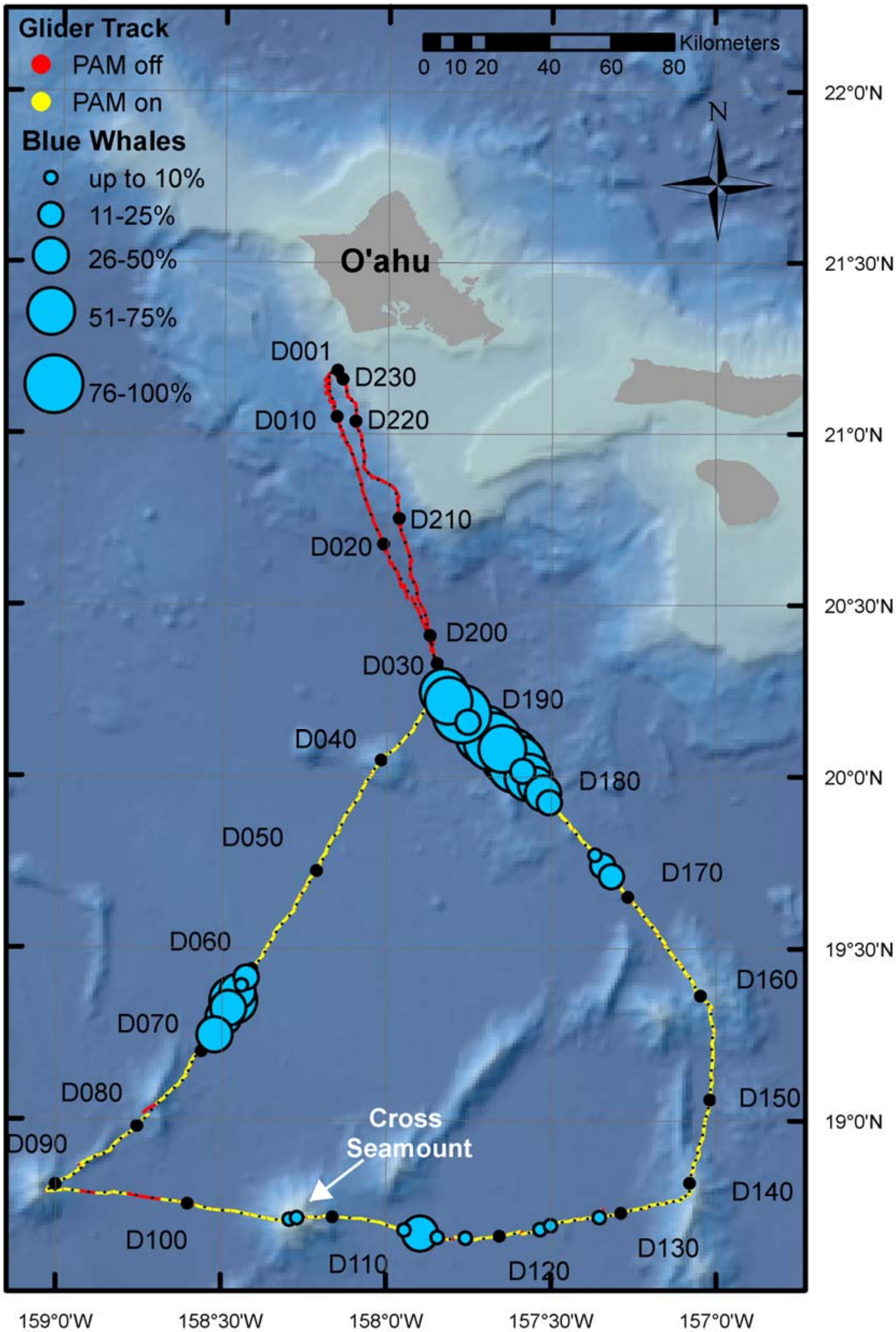

Figure 26: SG203 blue whale encounters. The circle size indicates percentage of recording time per dive with target signals.

Fin whale

Calls from fin whales (**Figure 27**) were recorded in nearly all dives during the survey (**Figure 28**). At least two types of calls were recorded. The first was the fairly stereotypic down-sweep centered at approximately 20 Hz which occurred in long series. The bandwidth of these calls was fairly constant. There was not sufficient time to do a rigorous analysis of the inter-pulse-intervals (IPI) of these calls, but the few measurements made (calls recorded on 17 December 2014) indicate the IPI varied between 24-31 s. A second type which was much broader band and centered a few Hz higher was also recorded and often overlapped the more typical 20 Hz pulses.

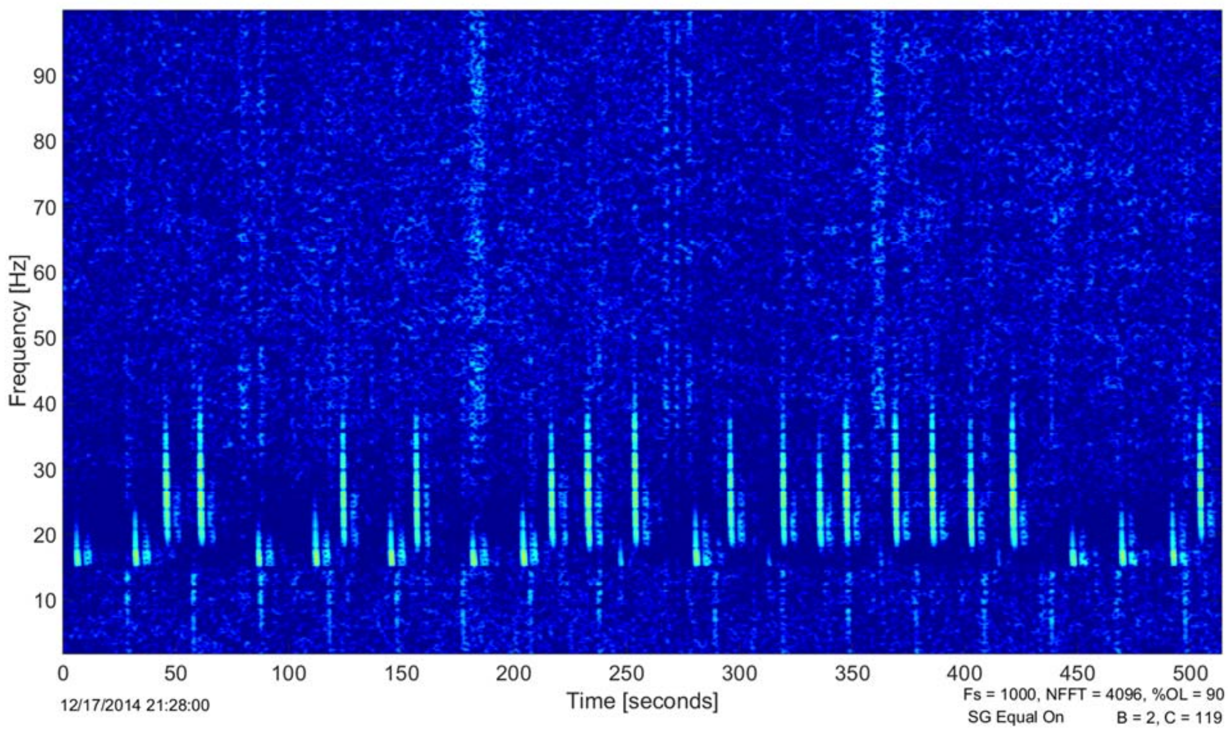

Figure 27: Fin whale calls recorded with SG203 on 17 December 2014

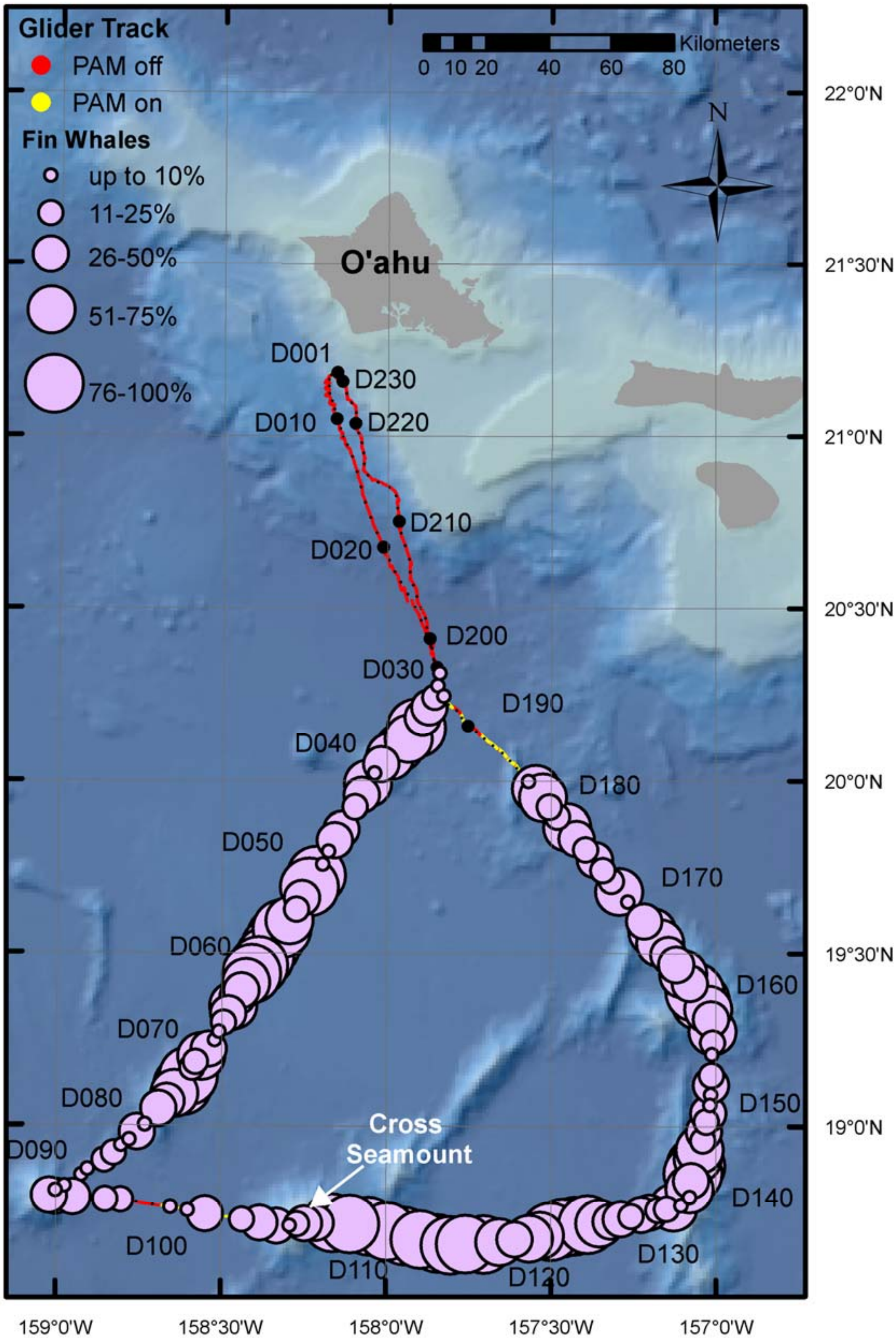

Figure 28: SG203 fin whale encounters. The circle size indicates percentage of recording time per dive with target signals.

Sei whale

Very short, low-frequency downsweeps that resemble sei whale calls (**Figure 29**) were recorded during the initial northeast to southwest, offshore portion of the survey (**Figure 30**). Calls occurred in groups of 5 to 9 calls with sounds sweeping from approximately 100 Hz down to 40 Hz with 5to 7 seconds between calls, and were recorded during 16 dives between 15 and 29 December 2014.

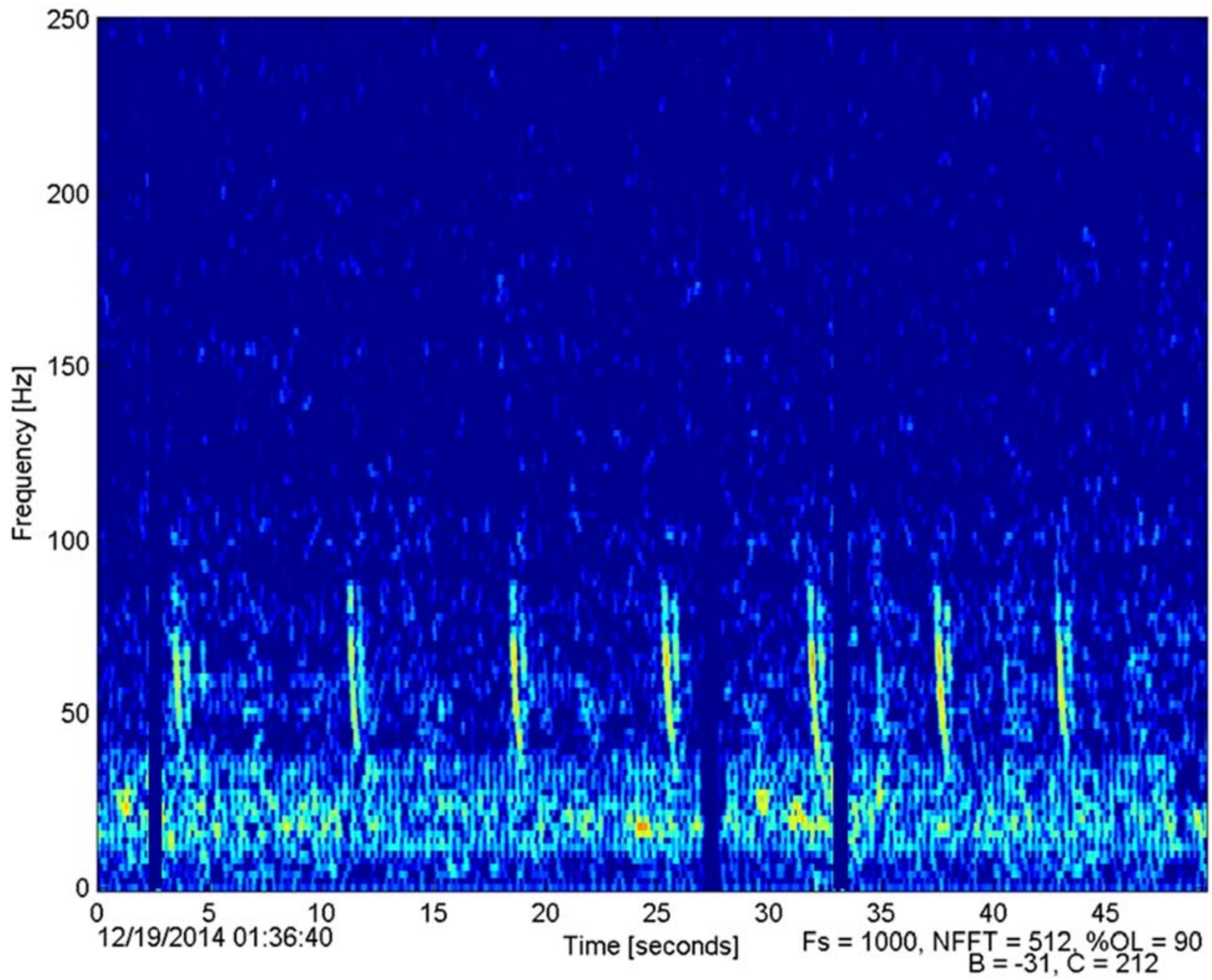

Figure 29: Sei whale calls recorded with SG203 on 29 December 2014.

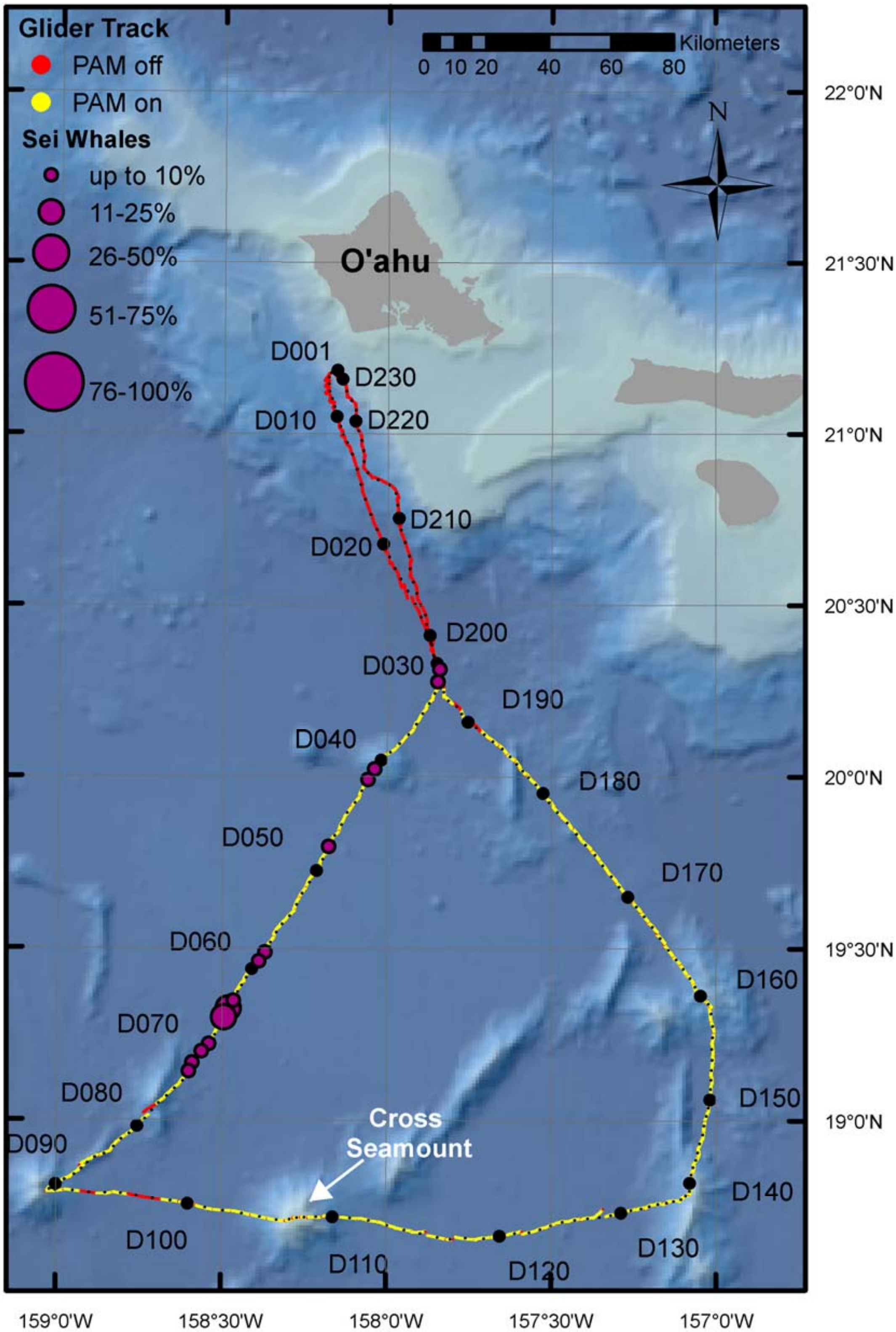

Figure 30: SG203 sei whale encounters. The circle size indicates percentage of recording time per dive with target signals.

Humpback whale

As expected, the songs of humpback whales (**Figure 31**) were recorded in nearly all glider dives (**Figure 32**). Sounds were complex, variable and ranged in frequency from approximately 30 Hz to more than 5 kHz. Typically, there was more than one whale singing at a time.

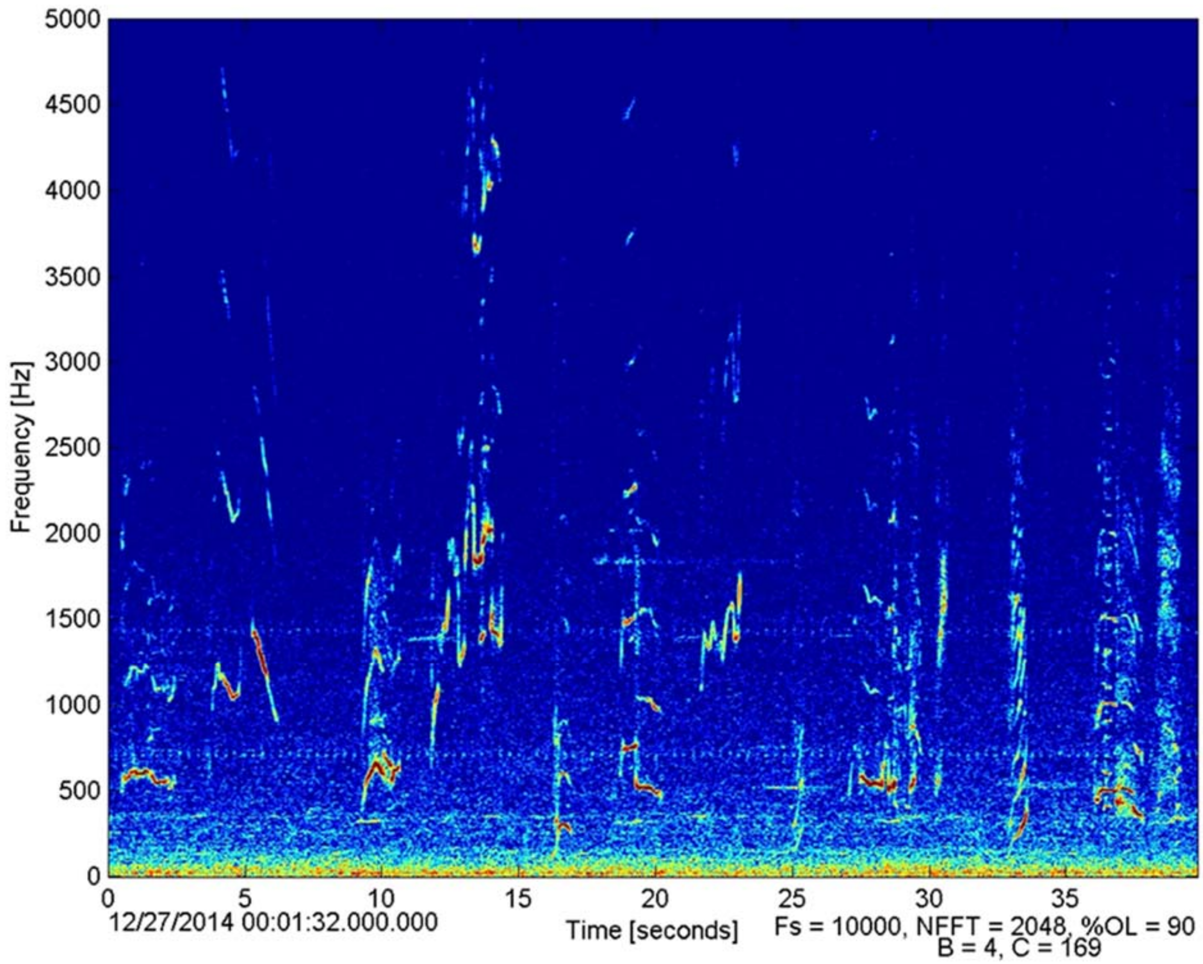

Figure 31: Humpback whale calls recorded with SG203 recorded on 27 December 2014.

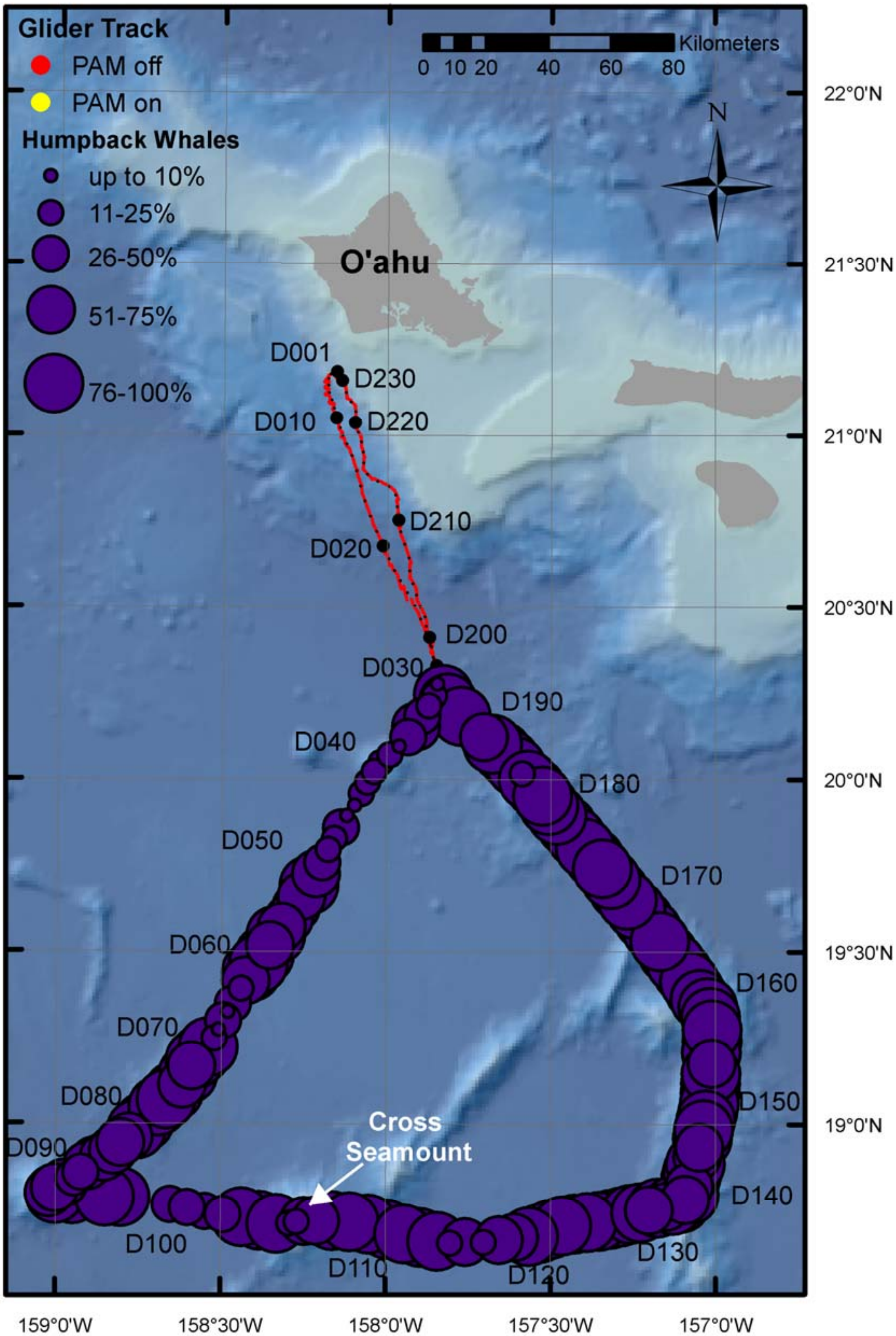

Figure 32: SG203 humpback whale encounters. The circle size indicates percentage of recording time per dive with target signals.

Minke whale

Minke whale boings (**Figure 33**) were also recorded in nearly all glider dives during which there was passive acoustic monitoring (**Figure 34**). Individual boings were typically 5 minutes apart, but later in the survey we recorded a few series of calls where boings overlapped.

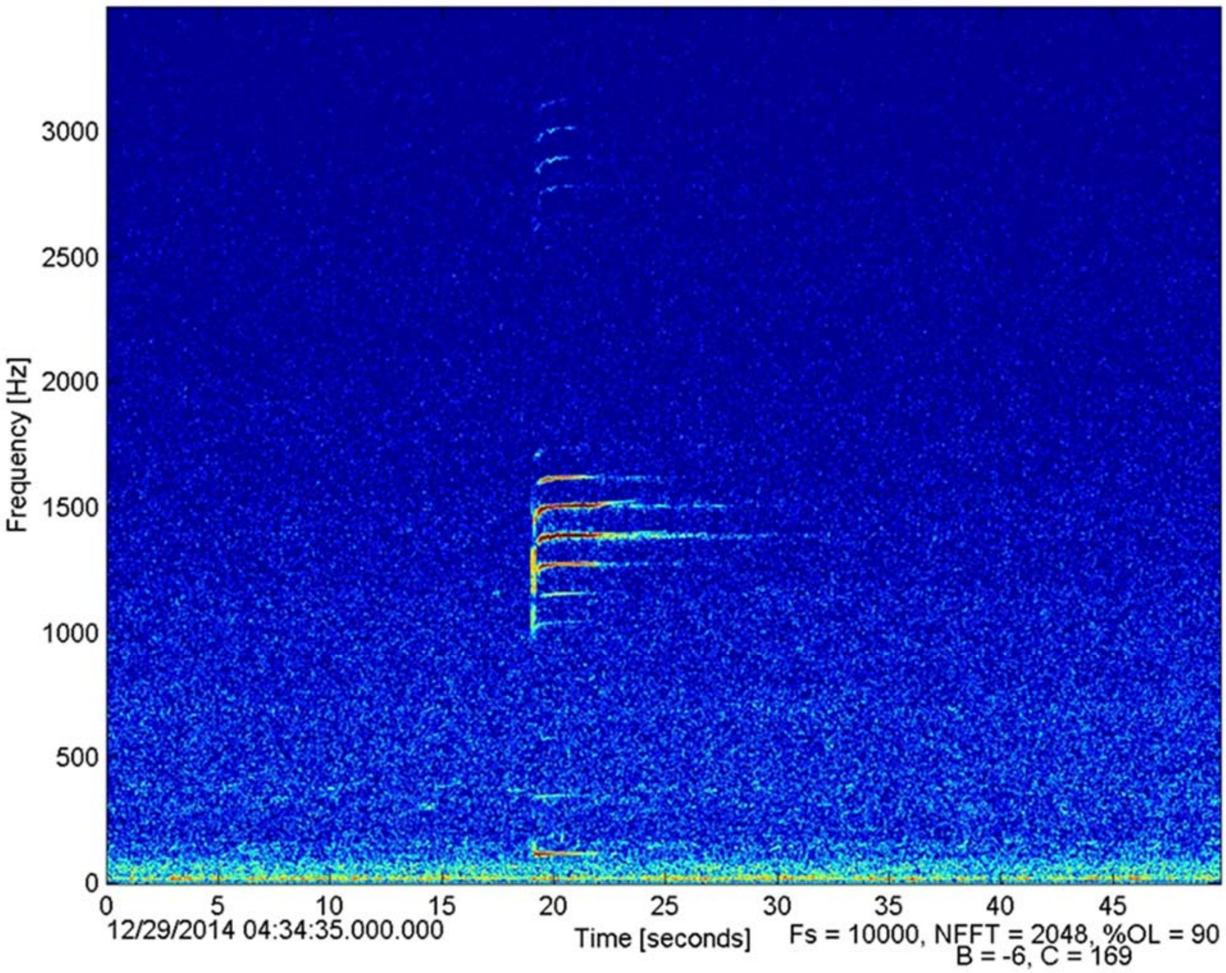

Figure 33: Minke whale boing call recorded with SG203 on 29 December 2014.

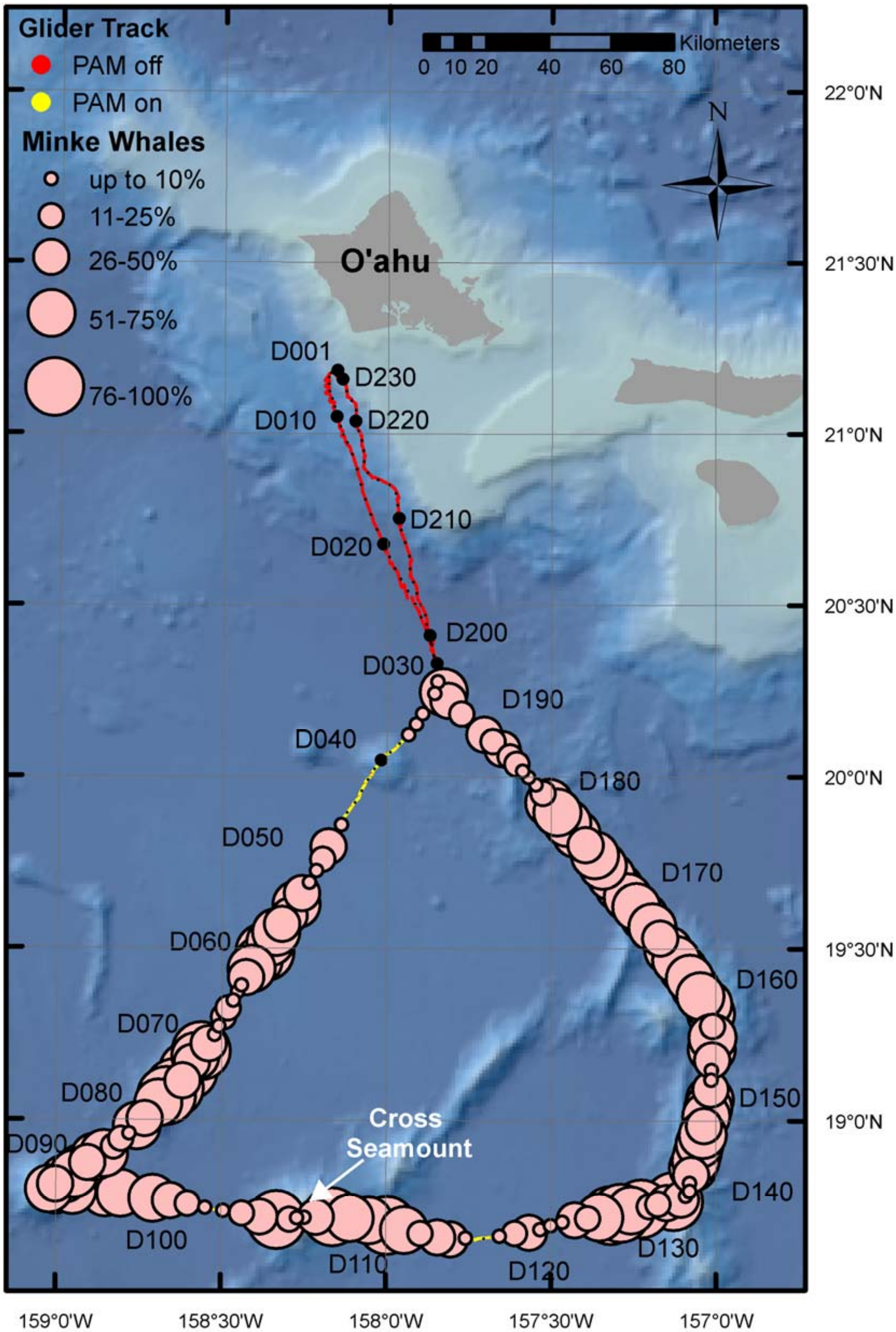

Figure 34: SG203 minke whale encounters. The circle size indicates percentage of recording time per dive with target signals.

3.4 Navy Sonar and Seismic Airgun Signals

Navy sonar

Sounds that were identified as coming from an active U.S. Navy sonobuoy (confirmed by COMPACFLT subject matter expert) were also recorded toward the end of the survey. Sounds consisted of three short upsweeping approximately 890 to 1,000 Hz frequency modulated signals approximately 2 seconds apart (**Figure 35**). Groups of signals occurred 25 seconds to 5 minutes apart and were recorded on 15 and 16 January 2015 during two dives (**Figure 36**).

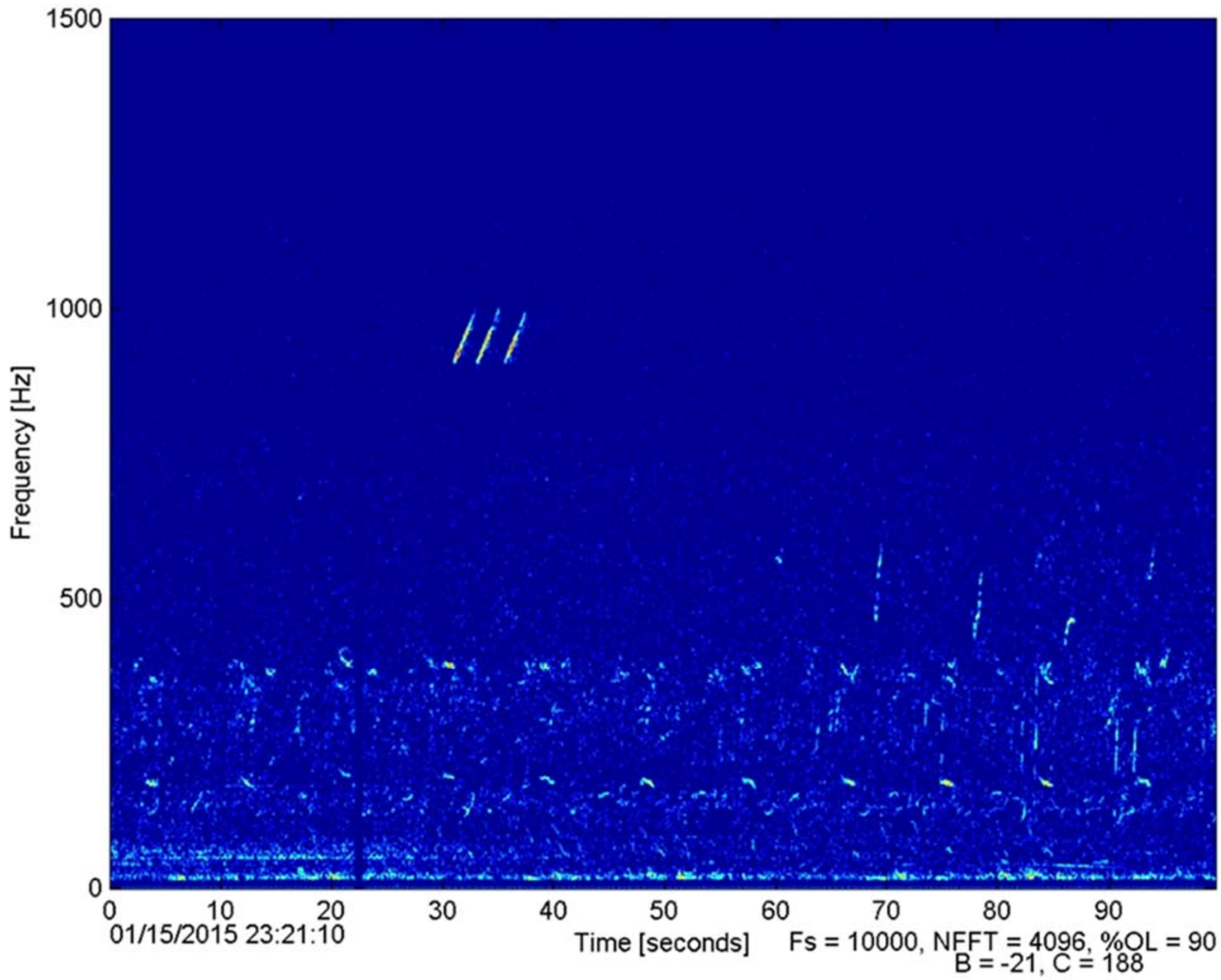

Figure 35: Active U.S. Navy sonobuoy sounds recorded with SG203 on 15 January 2015. The low-frequency NWPBW calls with harmonics and humpback whale song is also visible in the lower half of the spectrogram.

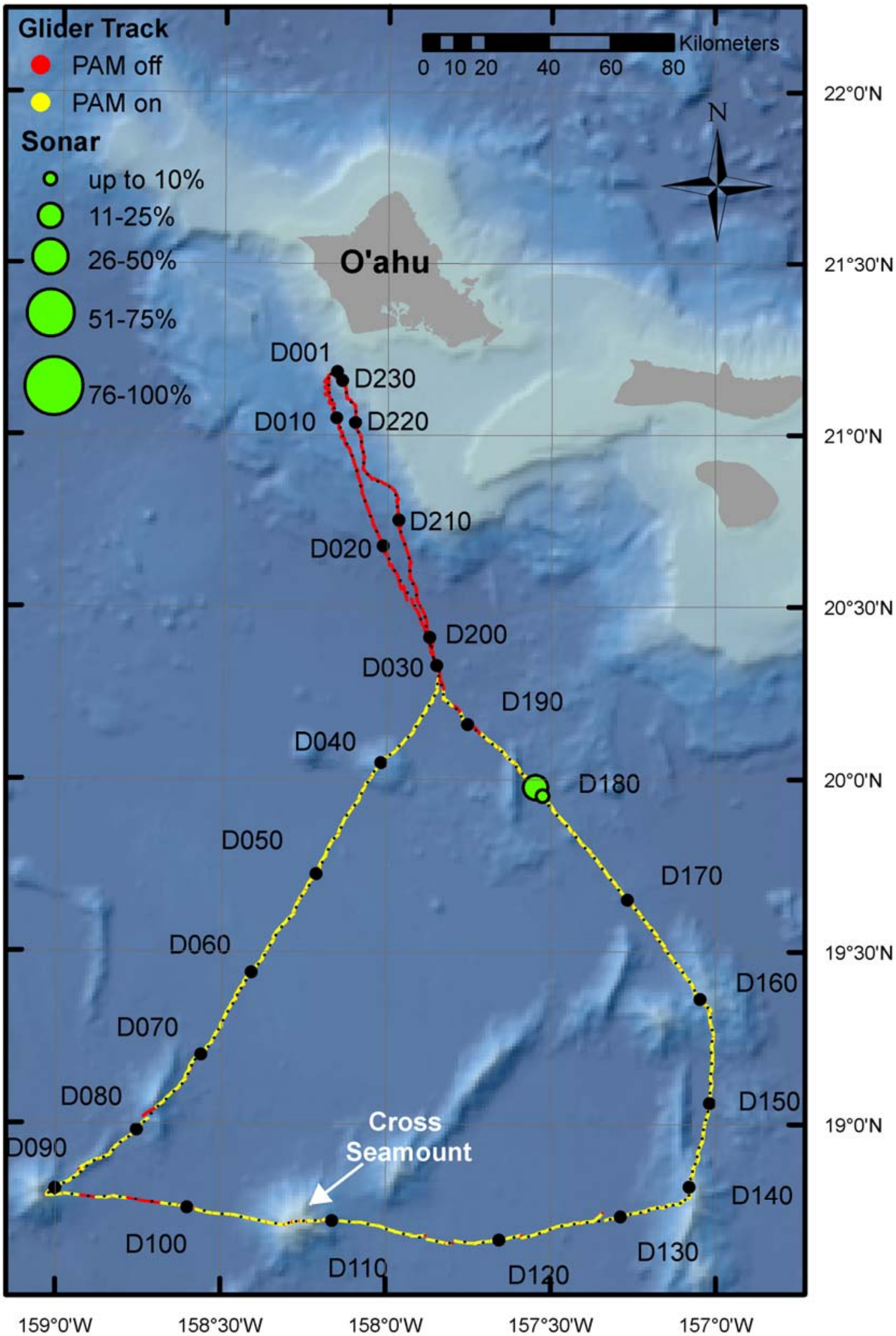

Figure 36: SG203 active sonobuoy encounters. The circle size indicates percentage of recording time per dive with target signals.

Seismic airgun

The sounds from seismic airguns (**Figure 37**) presumably in conjunction with a scientific survey were recorded during 34 dives in the southern portion of the survey between 23 December 2014 and 10 January 2015 (**Figure 38**). The time between airgun pulses was approximately 20 seconds.

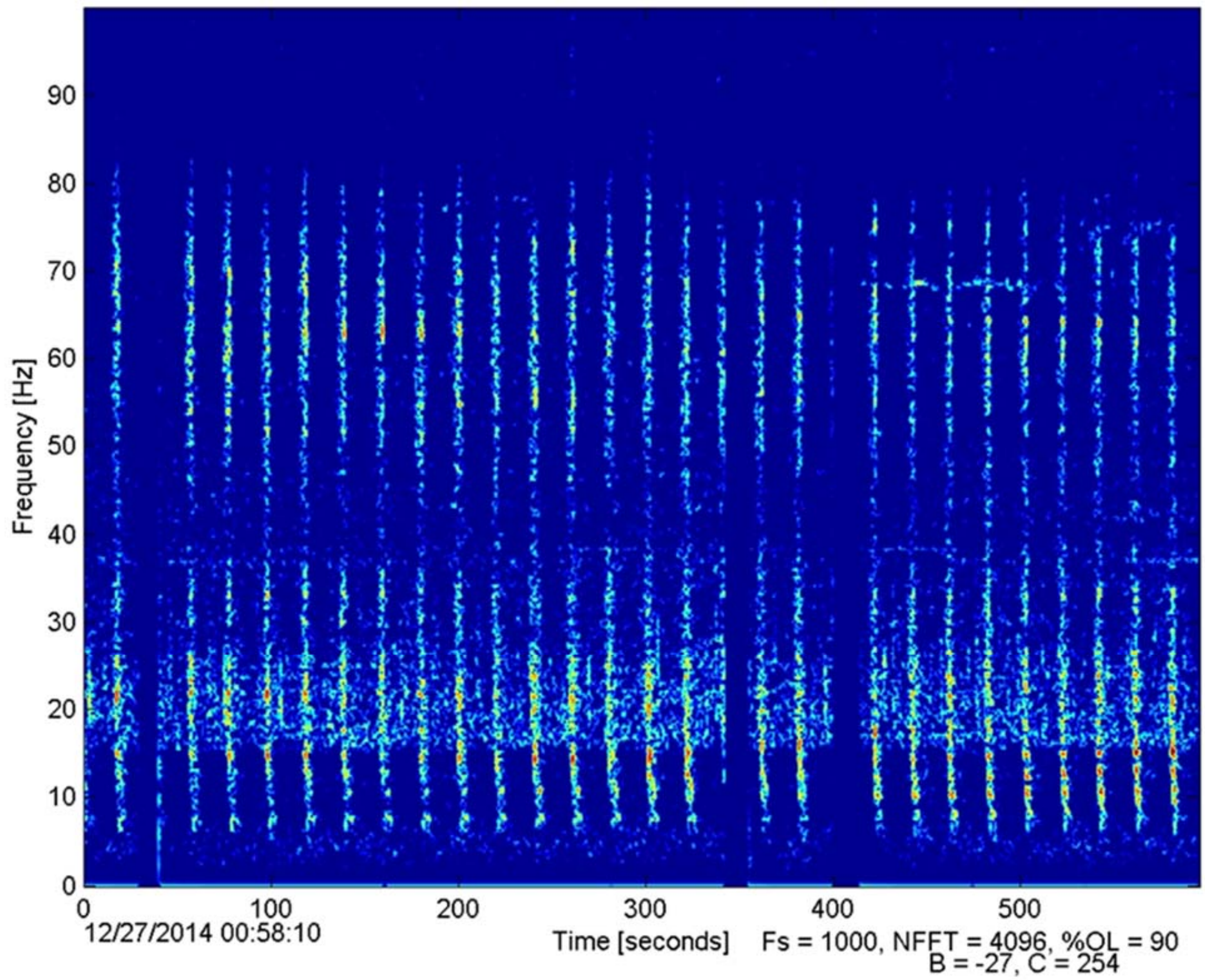

Figure 37: Seismic airgun signals recorded with SG203 on 27 December 2014.

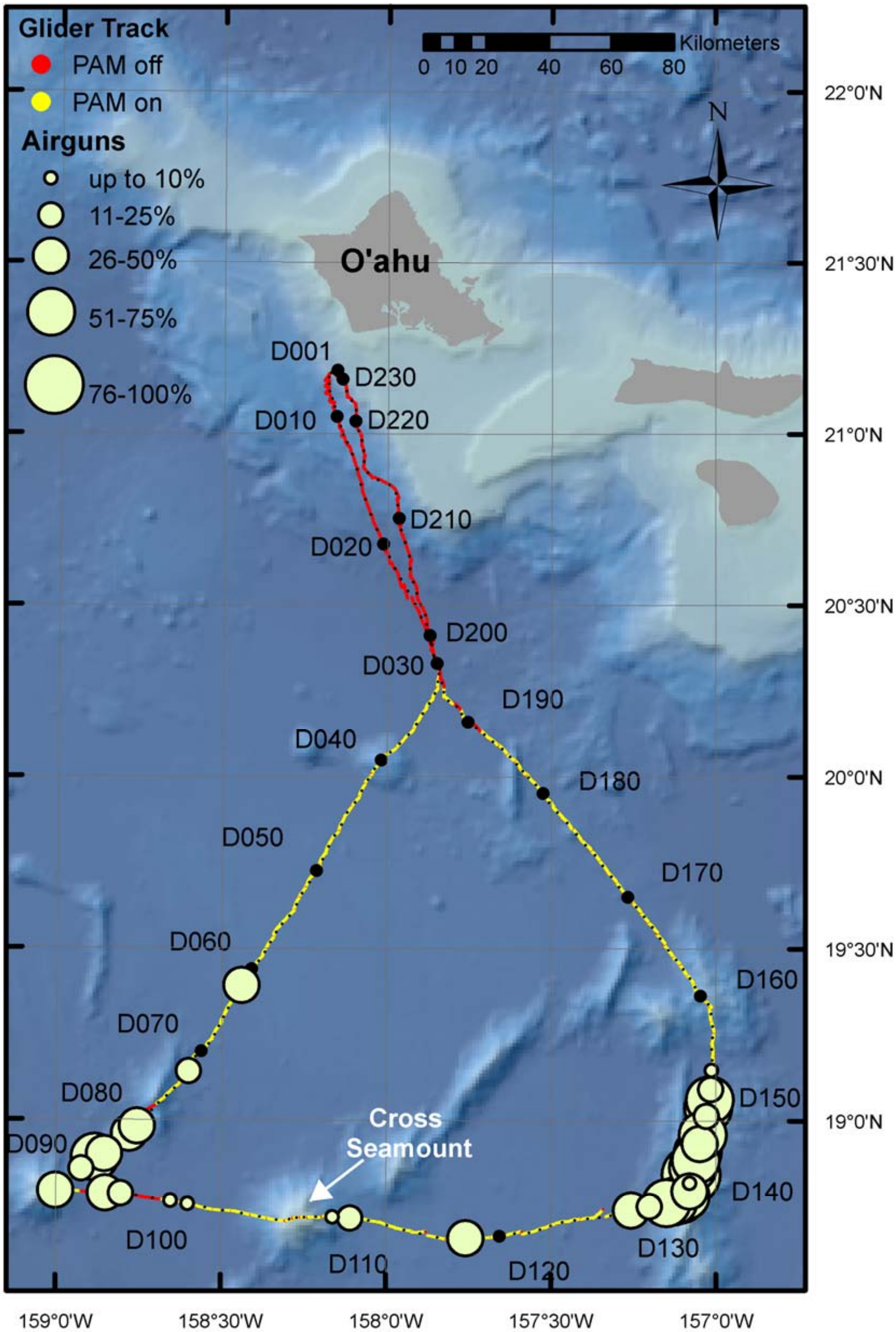

Figure 38: SG203 seismic airgun encounters. The circle size indicates percentage of recording time per dive with target signals.

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4. Discussion

Glider Performance

The HRC acoustic survey was very successful. The glider surveyed areas as far out as Bishop Seamount which is located approximately 180 nm west of Kona, Hawaii. These areas are difficult to access and thus not much is known about the abundance and distribution of cetaceans in these offshore areas. Few dedicated marine mammal surveys have been conducted in these waters to date and any additional effort improves the understanding and awareness of marine mammal occurrence in HRC (Barlow et al. 2004, McDonald et al. 2009, HDR EOC 2011). This survey demonstrated that autonomous underwater vehicles are useful tools to conduct acoustic monitoring efforts in these remote areas.

Even though the 6.4 level PAM board has been extensively tested on the bench and in short-duration trials, this was just the second acoustic Seaglider survey which exceeded one month of quasi-continuous data collection (Klinck et al. 2015). A total of 712 h of acoustic data was collected over a 33-day period. These long-duration trials are invaluable for improving these systems and are crucial for further development efforts. The long-term goal is to further extend the deployment duration to allow for 2-3 months of continuous acoustic data collection. There were no setbacks on this survey that would indicate that given greater battery capacity, additional data storage, and continued engineering refinement that extending the length of these surveys would not be achievable.

Environmental Data

An additional benefit in using gliders for marine mammal surveys is the collection of environmental data. The measured depth-averaged currents indicated that the glider can be safely operated in this part of the HRC. The currents information as well as the temperature profiles are useful for additional future analysis efforts on occurrence patterns of cetacean species in the HRC. The in-situ measured sound speed profiles can be used to describe the sound propagation conditions in the study area in detail. These data will be used in an ongoing project funded by the Office of Naval Research to develop and evaluate a framework for density estimation of cetacean species using slow moving underwater vehicles including gliders and floats. Information on local sound propagation conditions at the time of the acoustic data collection will be crucial for accurate density estimations of species of interest.

The Seaglider can be equipped with a suite of additional environmental sensors. For example, active acoustic sensors would provide information on prey fields which would be helpful for more comprehensive ecosystem studies (e.g., how the occurrence of cetaceans related to the availability of prey and oceanographic conditions).

Monitoring Questions

Which species of toothed whales (and especially beaked whales) occur in offshore areas of the HRC and what is their spatial distribution?

Due to the sample rate of acoustic data collected by the glider, odontocetes known to vocalize above 97 kHz could not be identified in this study. This included pygmy and dwarf sperm whales

(*Kogia spp.*). Further, little information exists on the vocalizations of pygmy killer whales (*Feresa attenuata*) so they were not identified in this analysis, although they may have been recorded.

Beaked whales. Recording of echolocation clicks of Blainville's beaked whales by the glider provided evidence of the presence of this species in HRC from December 2014 to January 2015. This species was predominantly detected offshore, over water depths greater than 4,000 m. However, one encounter occurred just 15 km off the coast of the Island of Oahu in 1,900 m water depth. Blainville's beaked whales are thought to be the most widespread and common of the beaked whale species in the HRC. Even though this species is rarely sighted compared to other odontocetes, Blainville's beaked whale echolocation clicks have been frequently recorded in Hawaiian waters in previous acoustic datasets (Baumann-Pickering et al. 2014). This emphasizes the value of passive acoustic monitoring for this elusive species. The low number of Blainville's detections overall matches the seasonal patterns reported in other acoustic studies (higher acoustic detection rates in late spring and early summer, and fewer detections from November to March; Baumann-Pickering et al. 2014). The spatial distribution of Blainville's detections in this study also matches previous studies, as there were no clicks recorded in the southern area of the deployment, where a long term recording made at Cross Seamount also did not contain any *M. densirostris* signals (McDonald et al. 2009).

We detected no Cuvier's beaked whales during the glider deployment. Traditionally, Cuvier's beaked whales are sighted more often than Blainville's beaked whales in visual surveys, likely due to their large body and blow size and breaching surface behaviors (Baird et al. 2013). However, they are less commonly identified in acoustic datasets than Blainville's beaked whales. Further, Cuvier's beaked whales exhibit seasonality of acoustic detections, with a peak in the fall months (Baumann-Pickering et al. 2014). Because our survey was in winter, it was not surprising no Cuvier's beaked whales were recorded.

The frequency modulated signals that were detected near Cross Seamount, and in other places, matched signals previously reported as the Cross Seamount beaked whale (Baumann-Pickering et al. 2013, McDonald et al. 2009). Recently, it has been hypothesized that these signals are made by ginkgo-toothed beaked whales (*Mesoplodon ginkodens*) as the sighting and stranding record for *M. ginkodens* overlaps with the spatial distribution of acoustic recordings of the signal (Baumann-Pickering et al. 2014).

Sperm whales. Sperm whale recordings were detected over a range of water depths and time periods, although there was a gap of sperm whale detections after the glider passed over Cross Seamount (1 to 14 January 2015). Sperm whales have been visually observed around the Hawaiian Island year-round, and are typically found seaward of the shelf break (Mobley et al. 2000).

Risso's dolphins. There were 11 total encounters of Risso's dolphins, which occurred over 11 different dives throughout the glider deployment. Risso's dolphin recordings occurred along much of the deployment track, except for the furthest south/southwest part of the survey track. However, all detections were still further offshore, and over deeper water, than previous visual surveys had found (Baird et al. 2013). Furthermore, the proportion of Risso's dolphin detections was more similar to what was reported by Au et al. (2013).

Other species. There were no killer whale vocalizations found in the acoustic records. Although they are a cosmopolitan species, they are much more common at high latitudes and in coastal regions than in tropical offshore areas (Visser and Bonoccorso 2003). Visual survey studies have reported they are infrequently sighted around the main Hawaiian Islands (Baird et al. 2003).

A previous acoustic study was conducted in December 2011 to January 2012 using the ALOHA Cabled Observatory, just north of Oahu, which identified low-frequency (<10 kHz) whistles as the most common signal recorded (Munger et al. 2012). That was not the case for the glider recordings, as only 23 h of signals containing only low-frequency whistles were recorded. The ALOHA Cabled Observatory recorded at a substantially deeper depth (4726 m) than the glider (Howe et al. 2011), which may have accounted for this difference. However, if the hours of low-frequency only whistle encounters are combined with the low- and high-frequency whistle group, to take into account instances where both low- and high-frequency whistles, or whistles spanning wide frequency ranges occurred, then that grouping would represent the most commonly recorded odontocete signal, with over 57 h. In this study, species that produced low-frequency whistles could be false killer whales, short-finned pilot whales, melon-headed whales, or rough-toothed dolphins. It is difficult to use visual sighting data on the spatial distribution of these species to help identify acoustic detections to the species level, as most of the visual surveys were done closer to shore. However, in visual surveys, these four species were all most commonly sighted in water deeper than 1,000 m (Baird et al. 2013) so it is quite likely these are the species recorded in the deep offshore waters of HRC. High-frequency-only whistles were much less common. This is likely because only two of the five species known to produce high-frequency whistles (pantropical spotted dolphin and striped dolphin) are regularly found in deep, offshore waters where the glider spent the majority of its time. The remaining three high-frequency whistle species are either found nearshore over much more shallow water (bottlenose dolphin, spinner dolphin, or are rarely sighted in the region (Fraser’s dolphin, Baird et al. 2013). Expert analysis of individual whistles may provide additional information the species level, but as vocal behavior in smaller delphinids can vary geographically, it is difficult to use classification systems or recordings from other regions (Frankel and Yin 2010).

Which species of baleen whales occur in offshore areas of the HRC and what is their spatial distribution?

Although numerous species of baleen whales were recorded during the glider survey, Bryde’s and right whale calls were not identified in our acoustic data. Very little is known of Bryde’s whale distribution in Hawaiian waters (Carretta et al. 2014) but this certainly seems to be suitable habitat for this species. The short, low-frequency tonal calls produced by Bryde’s whales (Heimlich et al. 2005a, Oleson et al. 2003a) may not have been identified because either Bryde’s whales were not vocalizing in this area or because there were many other whales vocalizing in the 20 to 200 Hz frequency band and these short tonal sounds were obscured by other signals. Right whales are extremely rare and have been reported in Hawaiian waters only a handful of times; in addition, their upsweeping calls can be easily confused with humpback whale sounds, so it is not surprising that we did not identify these sounds in our recordings. In addition, the analysts were conservative with species identifications and only annotated to species when there was sufficient acoustic evidence.

Blue whale. Blue whale vocalizations were detected during three time periods in the Seaglider survey: during the initial northeast to southwest leg, during the west to east leg, including while traversing Cross Seamount and most often toward the end of the experiment (January) during the southeast to northwest leg of the survey. Historically, very few visual sightings of blue whales have been recorded in the Hawaiian Islands (Carretta et al. 2014), but this species has often been identified in acoustic data, including that collected off Oahu and Midway Islands (Northrop 1971; Thompson and Friedl 1982). Analysts identified the recorded calls as northwestern Pacific calls, and the seasonal presence of this type of blue whale vocalization is similar to that reported by Stafford et al. in their Kaneohe dataset (Stafford et al. 2001, Fig. 6). Calling appeared to become more consistent and evolved into louder, continuous sequences resembling song after 15 January 2015. This may be due to more animals moving into the area in January, or it could be linked to seasonal hormonal changes and animals stabilizing their singing in a breeding display.

Fin whale. Historically, fin whales have been considered to be rare in Hawaiian waters (Carretta et al. 2014). However, sounds produced by fin whales have been seasonally recorded via numerous PAM assets in this region. In this study, the downsweeping calls from fin whales were quite common, and were recorded in December and January glider dives. Fin whale “singing” is likely a male breeding display (Croll et al. 2002) and may increase either as animals move south from their northern feeding grounds into Hawaiian waters or as breeding activity peaks. The results from this study agree with those reported by Oleson et al. (2014, Table 2) where fin whale song was recorded at their Hawaiian site southeast of the Big Island from November to March, and also results in McDonald and Fox (1999, Figure 2) and Moore et al. (1998, Site 9). The call types we recorded appear similar to those reported for both the eastern Pacific and the Gulf of California (Hatch and Clark 2004, Figure 1).

Sei whale. The sei whale is considered to be rare in Hawaiian waters based on reported sighting data and the species’ preference for cool, temperate waters. However, the downsweeping calls produced by sei whales have been recorded to the northeast of the Hawaiian Islands (Rankin and Barlow 2007b). The calls reported here as potential sei whale calls were only recorded offshore during the first portion of the survey and most closely resemble those reported by Rankin and Barlow (2007). However, many baleen whales make downsweeping calls, so these could also be a type of fin whale call (Širović et al. 2013) or (less likely) a Bryde’s whale call. However, given the concave structure of these downsweeps it is more likely they sei whale downsweeps (Ou et al. 2015, Figure 2).

Minke whale. Minke whales are known to occur seasonally around the Hawaiian Islands (Barlow 2003, Rankin and Barlow 2005), but because of their small size they are difficult to spot via traditional visual surveys. However, the very distinct boing sound that they produce makes them easy to identify acoustically (Rankin and Barlow 2005). Minke whale boings were recorded during December and January in nearly all dives during which there was passive acoustic monitoring. In Hawaiian waters, minke whale boing sounds have been detected near the Hawaiian Islands for decades, with detections by the U.S. Navy during February and March (Thompson and Friedl 1982) and at the ALOHA Cabled Observatory 100 km north of Oahu from October to May (Oswald et al. 2011). It is suspected that only sexually active males make boing calls for breeding purposes, similar to the humpback whale. Based on preliminary analysis of the recorded boing call duration, frequency and pulse repetition rate, it appears that the glider recorded “central” or “Hawaiian” boings. Recent surveys on the Pacific Missile Range Facility (PMRF) estimate 0.69-4.44 whales within the 3,780-square kilometer study area (Martin et al. 2015).

Humpback whale. As expected, the Seaglider recorded humpback whale song during both December and January and during all dives where there was passive acoustic monitoring. Humpback songs last 5 to 30 minutes and consist of complex, repetitive sounds that range from 25 Hz - 5 kHz (Payne and McVay 1971, Winn and Winn 1978). In most of the data, two or more singers were recorded simultaneously, likely because individuals will often sing for hours at a time. The function of singing is still unknown, but given that it is the males that sing and singing is most common during the winter breeding season it is likely related to breeding behavior.

Other non-biological sounds

U.S. Navy Active Sonobuoy There are no public sources of information on U.S. Navy active sonobuoy signals. The identity of these signals was confirmed by contacting the Navy; a COMPACFLT subject matter expert subsequently verified these as a signal from a U.S. Navy sonobuoy. No other information on these sounds was available.

Seismic airgun. The loud impulses produced by airguns are created as air, pressurized within cylinders, is released suddenly into the water (Dragoset 2000, Parkes and Hatton 1986). The expansion of this air mass and the following contraction and re-expansion create loud explosive sounds of very short duration and broad frequency which are used to probe rock layers beneath the seafloor. Typically, the sounds associated with both commercial and research airguns occur repetitively every 10 to 20 seconds over a time span of days to weeks, with occasional interruptions for such actions as turning the ship that tows the airgun array. In this survey, the Seaglider recorded sounds only during the southern portion of the survey, between 23 December 2014 and 8 January. We were unable to find any information on seismic surveys being conducted in the area during the glider survey.

Conclusions

A successful glider trial like the HRC survey demonstrate that mobile autonomous platforms can play an important role in future marine mammal monitoring efforts especially in inaccessible offshore areas. Advantages over traditional acoustic survey methods (towed arrays and moored recorders) include [a] increased spatial and temporal coverage of the observations, [b] improved detection range particularly for deep diving species including beaked whales, [c] capability of recording both infrasonic and ultrasonic signals, and [d] reduced survey costs.

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A

Details of All Acoustic Encounters Recorded by Glider SG203

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A. Details of All Acoustic Encounters Recorded by Glider SG203

This section includes a series of tables where encounter information is listed for each species acoustically identified in the glider data collected during the HRC survey. An encounter was defined as a period when target signals were present in the acoustic data and separated from other periods of signal detections by 30 or more minutes of silence. Note, however, that in other parts of this report we have summarized the acoustic data by glider dives, not encounters. Encounter data have been provided to enable direct comparison with line-transect studies conducted in the area.

A.1 Odontocetes

Beaked whale encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	4	11/12/2014 23:47:42	11/12/2014 23:53:38	Md	21.1781	-158.1754
2	65	23/12/2014 21:47:15	23/12/2014 22:49:30	Md	19.3250	-158.4802
3	79	26/12/2014 21:35:36	26/12/2014 21:54:32	Md	19.0032	-158.7322
4	103	31/12/2014 15:46:27	31/12/2014 15:57:27	CSBW	18.7298	-158.4363
5	106	01/01/2015 06:08:23	01/01/2015 06:48:41	CSBW	18.7116	-158.2919
6	107	01/01/2015 08:30:32	01/01/2015 11:14:26	CSBW	18.7164	-158.2688
7	127	05/01/2015 02:29:22	05/01/2015 02:43:12	Md	18.7156	-157.3876
8	127	05/01/2015 05:06:08	05/01/2015 05:13:35	CSBW	18.7156	-157.3876
9	128	05/01/2015 09:05:50	05/01/2015 09:22:31	CSBW	18.7198	-157.3521
10	172	14/01/2015 09:21:04	14/01/2015 09:30:39	Md	19.7103	-157.3162
11	193	18/01/2015 13:31:55	18/01/2015 13:41:43	CSBW	20.2214	-157.8141

*Md = *Mesoplodon densirostris* (Blainville's beaked whale); CSBW = Cross Seamount beaked whale

Sperm whale encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	39	18/12/2014 12:02:10	18/12/2014 12:57:45	Pm	20.0721	-157.9906
2	40	18/12/2014 16:36:48	18/12/2014 18:08:07	Pm	20.0490	-158.0181
3	41	18/12/2014 20:36:12	18/12/2014 22:02:45	Pm	20.0224	-158.0381
4	52	21/12/2014 02:56:20	21/12/2014 10:16:26	Pm	19.6608	-158.2570
5	53	21/12/2014 10:58:00	21/12/2014 11:35:31	Pm	19.6274	-158.2738
6	54	21/12/2014 12:20:41	21/12/2014 15:57:21	Pm	19.5943	-158.2948
7	55	21/12/2014 17:08:52	21/12/2014 17:25:36	Pm	19.5707	-158.3173
8	55	21/12/2014 20:13:03	21/12/2014 20:26:50	Pm	19.5707	-158.3173
9	56	21/12/2014 22:56:56	22/12/2014 01:22:45	Pm	19.5462	-158.3348
10	58	22/12/2014 02:25:34	22/12/2014 17:57:04	Pm	19.4891	-158.3696
11	71	25/12/2014 03:24:36	25/12/2014 03:48:26	Pm	19.1845	-158.5783
12	72	25/12/2014 07:30:25	25/12/2014 07:33:03	Pm	19.1672	-158.5896
13	72	25/12/2014 08:30:38	25/12/2014 10:11:43	Pm	19.1672	-158.5896
14	73	25/12/2014 12:09:20	25/12/2014 12:39:15	Pm	19.1425	-158.6001
15	73	25/12/2014 14:16:19	25/12/2014 14:38:49	Pm	19.1425	-158.6001
16	75	25/12/2014 23:32:59	26/12/2014 00:35:53	Pm	19.0917	-158.6425
17	76	26/12/2014 04:01:58	26/12/2014 04:43:05	Pm	19.0694	-158.6662
18	95	30/12/2014 02:04:43	30/12/2014 02:24:33	Pm	18.7864	-158.8516
19	96	30/12/2014 07:15:39	30/12/2014 09:12:09	Pm	18.7859	-158.8037
20	101	31/12/2014 04:41:20	31/12/2014 07:14:54	Pm	18.7451	-158.5478
21	102	31/12/2014 12:33:17	31/12/2014 12:38:52	Pm	18.7369	-158.4928
22	105	01/01/2015 03:22:12	01/01/2015 03:24:58	Pm	18.7107	-158.3304
23	106	01/01/2015 06:18:00	01/01/2015 06:29:00	Pm	18.7116	-158.2919

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
24	171	14/01/2015 02:06:25	14/01/2015 02:08:57	Pm	19.6795	-157.2922
25	178	15/01/2015 11:47:25	15/01/2015 12:35:06	Pm	19.8967	-157.4811
26	182	16/01/2015 08:05:05	16/01/2015 08:50:44	Pm	19.9993	-157.5686
27	182	16/01/2015 09:47:44	16/01/2015 09:48:50	Pm	19.9993	-157.5686
28	185	17/01/2015 00:48:20	17/01/2015 01:17:15	Pm	20.0587	-157.6247
29	185	17/01/2015 01:48:56	17/01/2015 01:53:40	Pm	20.0587	-157.6247
30	188	17/01/2015 16:23:42	17/01/2015 16:37:32	Pm	20.1237	-157.7044
31	193	18/01/2015 13:39:00	18/01/2015 21:11:41	Pm	20.2214	-157.8141

*Pm = *Physeter macrocephalus* (sperm whale)

Risso's dolphin encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	32	17/12/2014 04:52:41	17/12/2014 05:21:37	Gg	20.2773	-157.8456
2	42	19/12/2014 04:41:02	19/12/2014 05:10:57	Gg	19.9923	-158.0581
3	48	20/12/2014 07:08:38	20/12/2014 08:45:27	Gg	19.7963	-158.1773
4	52	21/12/2014 04:27:01	21/12/2014 05:32:58	Gg	19.6608	-158.2570
5	53	21/12/2014 08:47:17	21/12/2014 09:28:10	Gg	19.6274	-158.2738
6	72	25/12/2014 06:06:24	25/12/2014 07:08:36	Gg	19.1672	-158.5896
7	142	08/01/2015 05:50:00	08/01/2015 06:05:50	Gg	18.8645	-157.0679
8	143	08/01/2015 09:14:17	08/01/2015 10:02:48	Gg	18.8861	-157.0598
9	157	11/01/2015 04:15:31	11/01/2015 05:53:18	Gg	19.2753	-157.0087
10	168	13/01/2015 12:33:43	13/01/2015 13:51:08	Gg	19.5935	-157.2165
11	193	18/01/2015 15:25:00	18/01/2015 16:59:00	Gg	20.2214	-157.8141

*Gg = *Grampus griseus* (Risso's dolphin)

Low-frequency whistle encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	70	24/12/2014 21:50:12	24/12/2014 21:50:39	LFW	19.2005	-158.5608
2	81	27/12/2014 04:58:11	27/12/2014 05:54:01	LFW	18.9607	-158.7788
3	90	29/12/2014 00:33:05	29/12/2014 02:00:09	LFW	18.8119	-159.0017
4	91	29/12/2014 05:39:34	29/12/2014 07:07:55	LFW	18.7966	-159.0207
5	96	30/12/2014 07:20:10	30/12/2014 09:03:05	LFW	18.7859	-158.8037
6	99	30/12/2014 23:14:51	30/12/2014 23:25:39	LFW	18.7653	-158.6528
7	128	05/01/2015 05:46:16	05/01/2015 05:53:00	LFW	18.7198	-157.3521
8	129	05/01/2015 11:02:31	05/01/2015 15:00:02	LFW	18.7246	-157.3172
9	132	06/01/2015 00:21:56	06/01/2015 02:48:56	LFW	18.7442	-157.2254
10	132	06/01/2015 03:25:43	06/01/2015 04:54:57	LFW	18.7442	-157.2254
11	134	06/01/2015 13:07:26	06/01/2015 14:14:17	LFW	18.7578	-157.1740
12	135	06/01/2015 15:25:23	06/01/2015 17:30:23	LFW	18.7613	-157.1488
13	147	09/01/2015 04:20:04	09/01/2015 06:26:31	LFW	18.9853	-157.0345
14	158	11/01/2015 10:35:53	11/01/2015 11:54:18	LFW	19.3107	-157.0129
15	161	12/01/2015 03:17:09	12/01/2015 03:29:05	LFW	19.3897	-157.0625
16	169	13/01/2015 15:22:42	13/01/2015 17:42:51	LFW	19.6223	-157.2405
17	185	16/01/2015 23:53:16	16/01/2015 23:59:35	LFW	20.0587	-157.6247

*LFW = Low-frequency whistle

High-frequency whistle encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	87	28/12/2014 10:33:13	28/12/2014 11:05:44	HFW	18.8575	-158.9239
2	91	29/12/2014 08:34:07	29/12/2014 09:57:27	HFW	18.7966	-159.0207
3	144	08/01/2015 13:27:44	08/01/2015 14:29:33	HFW	18.9069	-157.0534
4	169	13/01/2015 17:59:38	13/01/2015 17:59:42	HFW	19.6223	-157.2405

*HFW = High-frequency whistle

Low- and high-frequency whistle encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	44	19/12/2014 11:00:09	19/12/2014 11:44:37	LHFW	19.9254	-158.0977
2	59	22/12/2014 12:53:18	22/12/2014 13:33:16	LHFW	19.4622	-158.3880
3	69	24/12/2014 18:04:52	24/12/2014 19:08:14	LHFW	19.2223	-158.5387
4	77	26/12/2014 07:10:42	26/12/2014 10:10:48	LHFW	19.0493	-158.6901
5	77	26/12/2014 10:55:43	26/12/2014 12:09:39	LHFW	19.0493	-158.6901
6	82	27/12/2014 11:06:19	27/12/2014 13:38:23	LHFW	18.9436	-158.8041
7	114	02/01/2015 11:40:44	02/01/2015 17:12:13	LHFW	18.6815	-157.9441
8	128	05/01/2015 09:55:38	05/01/2015 10:29:55	LHFW	18.7198	-157.3521
9	146	08/01/2015 22:43:51	08/01/2015 23:18:02	LHFW	18.9589	-157.0382
10	149	09/01/2015 13:21:35	09/01/2015 17:23:24	LHFW	19.0369	-157.0217
11	150	09/01/2015 20:22:59	09/01/2015 20:40:08	LHFW	19.0613	-157.0174
12	152	10/01/2015 04:27:04	10/01/2015 07:25:05	LHFW	19.1184	-157.0134
13	162	12/01/2015 06:41:47	12/01/2015 06:41:58	LHFW	19.4135	-157.0773
14	168	13/01/2015 13:51:10	13/01/2015 14:29:38	LHFW	19.5935	-157.2165
15	182	16/01/2015 05:14:22	16/01/2015 08:50:44	LHFW	19.9993	-157.5686

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
16	186	17/01/2015 06:50:50	17/01/2015 08:06:34	LHFW	20.0812	-157.6493
17	187	17/01/2015 09:24:15	17/01/2015 10:35:08	LHFW	20.1027	-157.6776
18	191	18/01/2015 04:26:24	18/01/2015 07:45:28	LHFW	20.1838	-157.7727
19	193	18/01/2015 13:31:00	18/01/2015 15:31:17	LHFW	20.2214	-157.8141

*LHFW = Low- and high-frequency whistle

Echolocation clicks and/or burst pulses encounters *

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	33	17/12/2014 05:56:32	17/12/2014 05:56:35	ECBP	20.2429	-157.8558
2	36	17/12/2014 21:04:02	17/12/2014 21:38:20	ECBP	20.1535	-157.9112
3	39	18/12/2014 10:15:54	18/12/2014 11:25:29	ECBP	20.0721	-157.9906
4	39	18/12/2014 14:13:27	18/12/2014 14:49:15	ECBP	20.0721	-157.9906
5	44	19/12/2014 12:35:46	19/12/2014 13:17:38	ECBP	19.9254	-158.0977
6	48	20/12/2014 08:54:12	20/12/2014 13:00:48	ECBP	19.7963	-158.1773
7	49	20/12/2014 14:03:34	20/12/2014 14:40:30	ECBP	19.7594	-158.1948
8	54	21/12/2014 13:54:32	21/12/2014 15:23:47	ECBP	19.5943	-158.2948
9	62	23/12/2014 05:09:37	23/12/2014 06:01:20	ECBP	19.3925	-158.4397
10	62	23/12/2014 06:46:46	23/12/2014 08:02:35	ECBP	19.3925	-158.4397
11	68	24/12/2014 10:28:34	24/12/2014 11:52:16	ECBP	19.2484	-158.5212
12	71	25/12/2014 04:13:41	25/12/2014 04:20:26	ECBP	19.1845	-158.5783
13	72	25/12/2014 08:13:54	25/12/2014 10:11:43	ECBP	19.1672	-158.5896
14	81	27/12/2014 07:45:11	27/12/2014 08:39:45	ECBP	18.9607	-158.7788
15	101	31/12/2014 04:41:20	31/12/2014 07:14:54	ECBP	18.7451	-158.5478
16	122	04/01/2015 00:58:35	04/01/2015 00:58:59	ECBP	18.6747	-157.5646

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
17	122	04/01/2015 01:35:00	04/01/2015 01:45:46	ECBP	18.6747	-157.5646
18	123	04/01/2015 06:45:27	04/01/2015 08:19:39	ECBP	18.6837	-157.5317
19	125	04/01/2015 13:32:39	04/01/2015 15:49:21	ECBP	18.7050	-157.4642
20	131	05/01/2015 19:59:42	05/01/2015 20:00:31	ECBP	18.7399	-157.2559
21	139	07/01/2015 11:24:11	07/01/2015 12:12:03	ECBP	18.7954	-157.0787
22	142	08/01/2015 04:24:43	08/01/2015 06:22:50	ECBP	18.8645	-157.0679
23	151	09/01/2015 23:16:12	09/01/2015 23:32:15	ECBP	19.0911	-157.0144
24	153	10/01/2015 09:10:18	10/01/2015 10:20:44	ECBP	19.1465	-157.0125
25	155	10/01/2015 21:20:18	10/01/2015 21:50:35	ECBP	19.2080	-157.0109
26	163	12/01/2015 08:28:51	12/01/2015 12:31:49	ECBP	19.4411	-157.0981
27	179	15/01/2015 16:26:32	15/01/2015 16:29:17	ECBP	19.9255	-157.5054
28	186	17/01/2015 03:32:19	17/01/2015 06:10:18	ECBP	20.0812	-157.6493
29	188	17/01/2015 14:42:47	17/01/2015 15:20:52	ECBP	20.1237	-157.7044

*ECBP = Echolocation clicks and/or burst pulses

A.2 Mysticetes

Blue whale encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	61	23/12/2014 02:08:11	23/12/2014 03:30:47	Bm	19.4154	-158.4256
2	63	23/12/2014 08:34:35	23/12/2014 10:06:31	Bm	19.3724	-158.4517
3	63	23/12/2014 12:22:45	23/12/2014 13:25:12	Bm	19.3724	-158.4517
4	64	23/12/2014 14:42:15	23/12/2014 16:28:16	Bm	19.3475	-158.4647
5	64	23/12/2014 17:07:36	23/12/2014 20:51:13	Bm	19.3475	-158.4647

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
6	65	23/12/2014 22:22:21	24/12/2014 01:35:41	Bm	19.3250	-158.4802
7	66	24/12/2014 02:10:12	24/12/2014 02:21:09	Bm	19.2987	-158.4944
8	66	24/12/2014 03:55:49	24/12/2014 04:39:28	Bm	19.2987	-158.4944
9	68	24/12/2014 10:22:25	24/12/2014 12:03:50	Bm	19.2484	-158.5212
10	106	01/01/2015 06:58:37	01/01/2015 07:07:54	Bm	18.7116	-158.2919
11	107	01/01/2015 08:56:27	01/01/2015 09:01:43	Bm	18.7164	-158.2688
12	115	02/01/2015 16:17:44	02/01/2015 19:16:06	Bm	18.6720	-157.8956
13	115	02/01/2015 20:03:58	02/01/2015 20:10:04	Bm	18.6720	-157.8956
14	116	02/01/2015 21:10:47	02/01/2015 21:13:53	Bm	18.6610	-157.8435
15	116	02/01/2015 21:52:19	02/01/2015 22:00:03	Bm	18.6610	-157.8435
16	116	02/01/2015 22:36:15	02/01/2015 22:37:58	Bm	18.6610	-157.8435
17	116	03/01/2015 00:13:48	03/01/2015 00:45:02	Bm	18.6610	-157.8435
18	118	03/01/2015 06:14:05	03/01/2015 06:55:11	Bm	18.6587	-157.7577
19	118	03/01/2015 08:16:50	03/01/2015 08:22:54	Bm	18.6587	-157.7577
20	123	04/01/2015 06:05:00	04/01/2015 06:35:14	Bm	18.6837	-157.5317
21	123	04/01/2015 07:38:35	04/01/2015 08:01:23	Bm	18.6837	-157.5317
22	124	04/01/2015 10:40:41	04/01/2015 11:02:15	Bm	18.6953	-157.4999
23	128	05/01/2015 09:56:08	05/01/2015 09:59:19	Bm	18.7198	-157.3521
24	172	14/01/2015 08:46:09	14/01/2015 09:36:00	Bm	19.7103	-157.3162
25	173	14/01/2015 10:20:00	14/01/2015 12:12:16	Bm	19.7421	-157.3423
26	174	14/01/2015 19:09:17	14/01/2015 19:23:15	Bm	19.7730	-157.3669
27	179	15/01/2015 17:13:03	15/01/2015 18:27:00	Bm	19.9255	-157.5054
28	180	15/01/2015 19:57:05	15/01/2015 22:04:03	Bm	19.9521	-157.5249
29	180	15/01/2015 22:39:36	15/01/2015 22:41:32	Bm	19.9521	-157.5249

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
30	181	16/01/2015 01:31:22	16/01/2015 03:08:19	Bm	19.9779	-157.5465
31	181	16/01/2015 04:03:05	16/01/2015 05:16:12	Bm	19.9779	-157.5465
32	182	16/01/2015 07:02:49	16/01/2015 12:25:21	Bm	19.9993	-157.5686
33	185	16/01/2015 17:17:02	17/01/2015 06:34:04	Bm	20.0587	-157.6247
34	187	17/01/2015 07:45:16	17/01/2015 17:51:55	Bm	20.1027	-157.6776
35	190	17/01/2015 23:32:51	17/01/2015 23:33:27	Bm	20.1596	-157.7536
36	191	18/01/2015 04:11:38	18/01/2015 07:45:37	Bm	20.1838	-157.7727
37	193	18/01/2015 13:36:32	18/01/2015 15:25:37	Bm	20.2214	-157.8141
38	194	18/01/2015 16:16:25	18/01/2015 21:05:01	Bm	20.2463	-157.8285
39	194	18/01/2015 22:04:16	18/01/2015 22:45:36	Bm	20.2463	-157.8285

*Bm = *Balaenoptera musculus* (blue whale)

Fin whale encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	31	17/12/2014 00:00:29	17/12/2014 00:24:37	Bp	20.3134	-157.8407
2	32	17/12/2014 01:00:49	17/12/2014 02:21:31	Bp	20.2773	-157.8456
3	33	17/12/2014 07:19:03	17/12/2014 07:33:46	Bp	20.2429	-157.8558
4	33	17/12/2014 08:29:29	17/12/2014 09:53:26	Bp	20.2429	-157.8558
5	34	17/12/2014 10:29:10	17/12/2014 10:33:22	Bp	20.2135	-157.8726
6	35	17/12/2014 16:51:54	17/12/2014 17:06:08	Bp	20.1845	-157.8920
7	35	17/12/2014 12:00:53	17/12/2014 18:00:55	Bp	20.1845	-157.8920
8	38	17/12/2014 19:08:19	18/12/2014 17:02:13	Bp	20.0966	-157.9616
9	40	18/12/2014 17:53:14	18/12/2014 18:26:01	Bp	20.0490	-158.0181
10	41	18/12/2014 19:24:39	18/12/2014 20:24:42	Bp	20.0224	-158.0381

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
11	41	18/12/2014 21:07:55	18/12/2014 22:13:59	Bp	20.0224	-158.0381
12	42	19/12/2014 00:52:21	19/12/2014 04:47:08	Bp	19.9923	-158.0581
13	43	19/12/2014 05:52:36	19/12/2014 06:16:55	Bp	19.9590	-158.0770
14	43	19/12/2014 07:07:20	19/12/2014 10:02:13	Bp	19.9590	-158.0770
15	44	19/12/2014 10:54:46	19/12/2014 11:48:51	Bp	19.9254	-158.0977
16	44	19/12/2014 13:29:49	19/12/2014 13:36:38	Bp	19.9254	-158.0977
17	44	19/12/2014 14:07:54	19/12/2014 14:13:17	Bp	19.9254	-158.0977
18	46	19/12/2014 21:08:59	19/12/2014 21:27:27	Bp	19.8596	-158.1390
19	46	19/12/2014 22:22:24	20/12/2014 00:33:04	Bp	19.8596	-158.1390
20	47	20/12/2014 01:22:34	20/12/2014 02:50:01	Bp	19.8279	-158.1584
21	47	20/12/2014 03:37:27	20/12/2014 04:20:39	Bp	19.8279	-158.1584
22	47	20/12/2014 04:59:57	20/12/2014 05:05:45	Bp	19.8279	-158.1584
23	48	20/12/2014 06:39:32	20/12/2014 06:44:45	Bp	19.7963	-158.1773
24	48	20/12/2014 09:29:40	20/12/2014 10:04:50	Bp	19.7963	-158.1773
25	51	20/12/2014 16:01:26	21/12/2014 04:57:13	Bp	19.6926	-158.2356
26	53	21/12/2014 08:31:29	21/12/2014 08:46:34	Bp	19.6274	-158.2738
27	53	21/12/2014 09:34:13	21/12/2014 09:46:22	Bp	19.6274	-158.2738
28	53	21/12/2014 10:58:52	21/12/2014 11:27:10	Bp	19.6274	-158.2738
29	56	21/12/2014 12:32:17	22/12/2014 12:52:07	Bp	19.5462	-158.3348
30	59	22/12/2014 13:42:10	22/12/2014 22:01:57	Bp	19.4622	-158.3880
31	61	22/12/2014 23:12:26	23/12/2014 05:51:13	Bp	19.4154	-158.4256
32	62	23/12/2014 06:57:11	23/12/2014 06:59:08	Bp	19.3925	-158.4397
33	62	23/12/2014 07:31:45	23/12/2014 07:34:45	Bp	19.3925	-158.4397
34	63	23/12/2014 10:07:26	23/12/2014 11:35:27	Bp	19.3724	-158.4517

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
35	64	23/12/2014 13:15:36	23/12/2014 19:06:09	Bp	19.3475	-158.4647
36	65	23/12/2014 19:38:08	23/12/2014 20:45:57	Bp	19.3250	-158.4802
37	65	23/12/2014 23:22:58	24/12/2014 00:01:44	Bp	19.3250	-158.4802
38	66	24/12/2014 02:07:29	24/12/2014 02:10:00	Bp	19.2987	-158.4944
39	66	24/12/2014 02:52:58	24/12/2014 04:05:10	Bp	19.2987	-158.4944
40	67	24/12/2014 05:38:33	24/12/2014 05:47:09	Bp	19.2726	-158.5084
41	67	24/12/2014 07:42:54	24/12/2014 07:51:21	Bp	19.2726	-158.5084
42	68	24/12/2014 10:07:45	24/12/2014 10:21:14	Bp	19.2484	-158.5212
43	68	24/12/2014 11:31:25	24/12/2014 11:36:25	Bp	19.2484	-158.5212
44	69	24/12/2014 15:54:50	24/12/2014 15:56:09	Bp	19.2223	-158.5387
45	69	24/12/2014 16:26:15	24/12/2014 19:05:09	Bp	19.2223	-158.5387
46	70	24/12/2014 19:53:04	24/12/2014 23:47:25	Bp	19.2005	-158.5608
47	71	25/12/2014 00:42:07	25/12/2014 00:47:59	Bp	19.1845	-158.5783
48	71	25/12/2014 01:54:08	25/12/2014 02:05:43	Bp	19.1845	-158.5783
49	71	25/12/2014 04:38:18	25/12/2014 04:51:01	Bp	19.1845	-158.5783
50	72	25/12/2014 05:52:16	25/12/2014 07:00:10	Bp	19.1672	-158.5896
51	72	25/12/2014 09:07:40	25/12/2014 09:19:42	Bp	19.1672	-158.5896
52	73	25/12/2014 11:10:07	25/12/2014 16:17:24	Bp	19.1425	-158.6001
53	74	25/12/2014 16:47:25	25/12/2014 20:50:38	Bp	19.1139	-158.6181
54	75	25/12/2014 21:22:11	26/12/2014 00:42:22	Bp	19.0917	-158.6425
55	76	26/12/2014 01:13:13	26/12/2014 03:31:58	Bp	19.0694	-158.6662
56	76	26/12/2014 04:21:05	26/12/2014 04:34:14	Bp	19.0694	-158.6662
57	76	26/12/2014 05:21:51	26/12/2014 07:14:12	Bp	19.0694	-158.6662
58	77	26/12/2014 07:58:09	26/12/2014 09:19:28	Bp	19.0493	-158.6901

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
59	77	26/12/2014 10:52:18	26/12/2014 11:41:15	Bp	19.0493	-158.6901
60	79	26/12/2014 18:12:08	26/12/2014 18:19:35	Bp	19.0032	-158.7322
61	79	26/12/2014 19:26:36	26/12/2014 19:46:31	Bp	19.0032	-158.7322
62	79	26/12/2014 21:42:55	26/12/2014 21:47:27	Bp	19.0032	-158.7322
63	80	26/12/2014 23:27:17	27/12/2014 00:38:29	Bp	18.9816	-158.7548
64	80	27/12/2014 01:48:55	27/12/2014 03:20:05	Bp	18.9816	-158.7548
65	81	27/12/2014 04:48:44	27/12/2014 04:51:26	Bp	18.9607	-158.7788
66	82	27/12/2014 10:43:18	27/12/2014 10:48:03	Bp	18.9436	-158.8041
67	83	27/12/2014 16:40:59	27/12/2014 17:42:51	Bp	18.9213	-158.8256
68	83	27/12/2014 18:27:51	27/12/2014 20:04:07	Bp	18.9213	-158.8256
69	84	27/12/2014 22:48:32	28/12/2014 00:08:32	Bp	18.9010	-158.8548
70	87	28/12/2014 10:10:00	28/12/2014 11:15:33	Bp	18.8575	-158.9239
71	87	28/12/2014 14:28:02	28/12/2014 14:36:48	Bp	18.8575	-158.9239
72	89	28/12/2014 20:09:58	28/12/2014 20:16:13	Bp	18.8249	-158.9742
73	89	28/12/2014 23:10:04	28/12/2014 23:23:16	Bp	18.8249	-158.9742
74	89	29/12/2014 00:04:17	29/12/2014 00:06:31	Bp	18.8249	-158.9742
75	90	29/12/2014 03:28:29	29/12/2014 03:38:33	Bp	18.8119	-159.0017
76	91	29/12/2014 06:04:28	29/12/2014 06:08:38	Bp	18.7966	-159.0207
77	91	29/12/2014 08:10:11	29/12/2014 08:19:45	Bp	18.7966	-159.0207
78	91	29/12/2014 09:26:08	29/12/2014 10:53:41	Bp	18.7966	-159.0207
79	92	29/12/2014 13:25:11	29/12/2014 17:53:17	Bp	18.7929	-159.0018
80	93	29/12/2014 19:15:09	29/12/2014 20:08:27	Bp	18.7930	-158.9494
81	95	30/12/2014 01:09:55	30/12/2014 01:23:15	Bp	18.7864	-158.8516
82	95	30/12/2014 04:41:26	30/12/2014 05:33:10	Bp	18.7864	-158.8516

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
83	96	30/12/2014 06:05:59	30/12/2014 06:24:15	Bp	18.7859	-158.8037
84	96	30/12/2014 07:00:06	30/12/2014 07:10:50	Bp	18.7859	-158.8037
85	96	30/12/2014 08:43:46	30/12/2014 09:44:19	Bp	18.7859	-158.8037
86	99	31/12/2014 00:11:09	31/12/2014 00:16:36	Bp	18.7653	-158.6528
87	100	31/12/2014 01:26:08	31/12/2014 02:16:38	Bp	18.7569	-158.6005
88	100	31/12/2014 04:26:09	31/12/2014 04:32:03	Bp	18.7569	-158.6005
89	101	31/12/2014 06:11:10	31/12/2014 07:40:39	Bp	18.7451	-158.5478
90	101	31/12/2014 09:46:25	31/12/2014 09:53:57	Bp	18.7451	-158.5478
91	103	31/12/2014 17:00:57	31/12/2014 17:36:01	Bp	18.7298	-158.4363
92	103	31/12/2014 19:41:22	31/12/2014 20:10:07	Bp	18.7298	-158.4363
93	104	31/12/2014 20:57:59	01/01/2015 00:18:11	Bp	18.7188	-158.3821
94	105	01/01/2015 01:11:29	01/01/2015 02:36:36	Bp	18.7107	-158.3304
95	105	01/01/2015 03:10:59	01/01/2015 04:44:32	Bp	18.7107	-158.3304
96	106	01/01/2015 05:16:12	01/01/2015 05:43:50	Bp	18.7116	-158.2919
97	106	01/01/2015 06:27:42	01/01/2015 06:35:17	Bp	18.7116	-158.2919
98	107	01/01/2015 08:42:23	01/01/2015 09:23:23	Bp	18.7164	-158.2688
99	108	01/01/2015 10:25:47	01/01/2015 11:06:11	Bp	18.7174	-158.2465
100	108	01/01/2015 11:40:55	01/01/2015 12:25:31	Bp	18.7174	-158.2465
101	109	01/01/2015 13:26:33	01/01/2015 15:09:43	Bp	18.7187	-158.2114
102	110	01/01/2015 17:22:26	01/01/2015 21:32:41	Bp	18.7189	-158.1619
103	114	01/01/2015 22:03:29	03/01/2015 03:04:09	Bp	18.6815	-157.9441
104	119	03/01/2015 04:15:02	03/01/2015 21:05:29	Bp	18.6573	-157.7027
105	121	03/01/2015 21:49:21	03/01/2015 22:59:41	Bp	18.6723	-157.6087
106	122	03/01/2015 23:53:49	04/01/2015 02:09:07	Bp	18.6747	-157.5646

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
107	122	04/01/2015 02:55:52	04/01/2015 05:10:14	Bp	18.6747	-157.5646
108	123	04/01/2015 05:45:21	04/01/2015 05:53:29	Bp	18.6837	-157.5317
109	125	04/01/2015 06:42:18	05/01/2015 05:18:43	Bp	18.7050	-157.4642
110	128	05/01/2015 05:52:54	05/01/2015 09:36:22	Bp	18.7198	-157.3521
111	129	05/01/2015 11:30:51	05/01/2015 11:34:20	Bp	18.7246	-157.3172
112	129	05/01/2015 12:42:07	05/01/2015 13:55:14	Bp	18.7246	-157.3172
113	129	05/01/2015 14:32:50	05/01/2015 14:40:16	Bp	18.7246	-157.3172
114	130	05/01/2015 16:26:05	05/01/2015 16:40:17	Bp	18.7318	-157.2872
115	130	05/01/2015 17:23:07	05/01/2015 17:25:07	Bp	18.7318	-157.2872
116	130	05/01/2015 18:01:24	05/01/2015 19:21:38	Bp	18.7318	-157.2872
117	131	05/01/2015 20:13:12	05/01/2015 21:32:40	Bp	18.7399	-157.2559
118	131	05/01/2015 23:07:16	05/01/2015 23:10:24	Bp	18.7399	-157.2559
119	132	06/01/2015 00:00:59	06/01/2015 01:25:10	Bp	18.7442	-157.2254
120	132	06/01/2015 02:56:06	06/01/2015 03:39:43	Bp	18.7442	-157.2254
121	133	06/01/2015 04:41:14	06/01/2015 05:07:27	Bp	18.7507	-157.2008
122	133	06/01/2015 05:59:18	06/01/2015 08:40:27	Bp	18.7507	-157.2008
123	134	06/01/2015 10:18:06	06/01/2015 10:22:28	Bp	18.7578	-157.1740
124	134	06/01/2015 11:03:35	06/01/2015 11:09:57	Bp	18.7578	-157.1740
125	134	06/01/2015 11:45:11	06/01/2015 11:52:03	Bp	18.7578	-157.1740
126	134	06/01/2015 12:41:20	06/01/2015 12:49:49	Bp	18.7578	-157.1740
127	134	06/01/2015 13:25:47	06/01/2015 13:44:52	Bp	18.7578	-157.1740
128	135	06/01/2015 16:03:44	06/01/2015 17:44:53	Bp	18.7613	-157.1488
129	135	06/01/2015 19:03:58	06/01/2015 19:08:32	Bp	18.7613	-157.1488
130	136	06/01/2015 20:10:54	07/01/2015 01:22:43	Bp	18.7655	-157.1271

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
131	137	07/01/2015 02:01:57	07/01/2015 02:40:19	Bp	18.7716	-157.1045
132	137	07/01/2015 04:02:28	07/01/2015 04:06:38	Bp	18.7716	-157.1045
133	139	07/01/2015 14:46:37	07/01/2015 15:10:26	Bp	18.7954	-157.0787
134	141	07/01/2015 23:26:06	07/01/2015 18:55:20	Bp	18.8431	-157.0734
135	141	08/01/2015 00:12:47	08/01/2015 01:47:02	Bp	18.8431	-157.0734
136	143	08/01/2015 02:26:27	08/01/2015 17:03:57	Bp	18.8861	-157.0598
137	145	08/01/2015 17:47:06	08/01/2015 18:03:31	Bp	18.9328	-157.0474
138	145	08/01/2015 18:41:06	08/01/2015 23:35:08	Bp	18.9328	-157.0474
139	146	09/01/2015 02:39:13	09/01/2015 03:05:25	Bp	18.9589	-157.0382
140	147	09/01/2015 04:08:30	09/01/2015 04:58:58	Bp	18.9853	-157.0345
141	147	09/01/2015 06:21:20	09/01/2015 07:49:22	Bp	18.9853	-157.0345
142	148	09/01/2015 08:33:20	09/01/2015 08:35:27	Bp	19.0135	-157.0275
143	148	09/01/2015 09:06:12	09/01/2015 10:10:33	Bp	19.0135	-157.0275
144	149	09/01/2015 14:51:36	09/01/2015 17:59:46	Bp	19.0369	-157.0217
145	150	09/01/2015 19:21:07	09/01/2015 19:30:27	Bp	19.0613	-157.0174
146	151	10/01/2015 00:14:28	10/01/2015 00:20:22	Bp	19.0911	-157.0144
147	151	10/01/2015 02:20:53	10/01/2015 02:35:28	Bp	19.0911	-157.0144
148	152	10/01/2015 04:38:33	10/01/2015 05:48:24	Bp	19.1184	-157.0134
149	152	10/01/2015 07:14:51	10/01/2015 07:20:11	Bp	19.1184	-157.0134
150	153	10/01/2015 08:26:48	10/01/2015 09:05:16	Bp	19.1465	-157.0125
151	155	10/01/2015 21:34:27	10/01/2015 21:46:50	Bp	19.2080	-157.0109
152	156	11/01/2015 02:32:28	11/01/2015 03:32:10	Bp	19.2419	-157.0081
153	157	11/01/2015 04:12:18	11/01/2015 06:44:42	Bp	19.2753	-157.0087
154	157	11/01/2015 07:24:28	11/01/2015 09:44:38	Bp	19.2753	-157.0087

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
155	158	11/01/2015 10:19:52	11/01/2015 11:17:02	Bp	19.3107	-157.0129
156	159	11/01/2015 13:33:31	11/01/2015 14:46:58	Bp	19.3392	-157.0216
157	161	11/01/2015 15:19:10	12/01/2015 08:46:40	Bp	19.3897	-157.0625
158	163	12/01/2015 10:05:45	12/01/2015 11:01:48	Bp	19.4411	-157.0981
159	163	12/01/2015 11:52:22	12/01/2015 14:01:36	Bp	19.4411	-157.0981
160	164	12/01/2015 15:41:34	12/01/2015 17:15:43	Bp	19.4681	-157.1192
161	164	12/01/2015 17:48:04	12/01/2015 18:30:44	Bp	19.4681	-157.1192
162	165	12/01/2015 20:06:16	12/01/2015 21:32:12	Bp	19.4971	-157.1431
163	165	12/01/2015 22:20:37	12/01/2015 23:16:08	Bp	19.4971	-157.1431
164	166	13/01/2015 00:06:26	13/01/2015 03:16:22	Bp	19.5307	-157.1673
165	166	13/01/2015 03:49:53	13/01/2015 03:53:12	Bp	19.5307	-157.1673
166	167	13/01/2015 04:33:12	13/01/2015 07:38:29	Bp	19.5633	-157.1916
167	167	13/01/2015 08:48:20	13/01/2015 08:53:34	Bp	19.5633	-157.1916
168	168	13/01/2015 10:02:48	13/01/2015 10:15:17	Bp	19.5935	-157.2165
169	168	13/01/2015 10:49:17	13/01/2015 13:47:07	Bp	19.5935	-157.2165
170	170	13/01/2015 23:09:08	13/01/2015 23:38:13	Bp	19.6506	-157.2668
171	171	14/01/2015 00:46:13	14/01/2015 05:04:04	Bp	19.6795	-157.2922
172	172	14/01/2015 05:53:57	14/01/2015 07:22:42	Bp	19.7103	-157.3162
173	172	14/01/2015 07:54:24	14/01/2015 08:31:59	Bp	19.7103	-157.3162
174	172	14/01/2015 09:09:10	14/01/2015 09:10:29	Bp	19.7103	-157.3162
175	173	14/01/2015 11:55:47	14/01/2015 13:08:28	Bp	19.7421	-157.3423
176	173	14/01/2015 13:44:52	14/01/2015 13:51:09	Bp	19.7421	-157.3423
177	174	14/01/2015 15:00:16	14/01/2015 18:23:15	Bp	19.7730	-157.3669
178	174	14/01/2015 18:53:51	14/01/2015 19:20:38	Bp	19.7730	-157.3669

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
179	175	14/01/2015 20:10:07	14/01/2015 21:20:12	Bp	19.8025	-157.3947
180	175	14/01/2015 23:23:52	14/01/2015 23:36:59	Bp	19.8025	-157.3947
181	176	15/01/2015 01:09:10	15/01/2015 03:52:15	Bp	19.8338	-157.4228
182	177	15/01/2015 05:03:20	15/01/2015 09:21:15	Bp	19.8669	-157.4511
183	178	15/01/2015 10:57:37	15/01/2015 11:29:46	Bp	19.8967	-157.4811
184	178	15/01/2015 12:41:34	15/01/2015 13:22:00	Bp	19.8967	-157.4811
185	179	15/01/2015 16:43:39	15/01/2015 16:50:50	Bp	19.9255	-157.5054
186	179	15/01/2015 18:24:24	15/01/2015 18:53:13	Bp	19.9255	-157.5054
187	180	15/01/2015 20:08:56	16/01/2015 00:25:21	Bp	19.9521	-157.5249
188	181	16/01/2015 01:06:22	16/01/2015 05:27:53	Bp	19.9779	-157.5465
189	182	16/01/2015 09:58:09	16/01/2015 10:45:51	Bp	19.9993	-157.5686
190	194	18/01/2015 20:25:24	18/01/2015 20:29:14	Bp	20.2463	-157.8285

*Bp = *Balaenoptera physalus* (fin whale)

Sei whale encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	31	17/12/2014 00:04:02	17/12/2014 00:12:34	Bb	20.3134	-157.8407
2	32	17/12/2014 05:10:48	17/12/2014 05:11:12	Bb	20.2773	-157.8456
3	41	18/12/2014 23:38:58	19/12/2014 00:54:37	Bb	20.0224	-158.0381
4	48	20/12/2014 09:07:50	20/12/2014 09:08:34	Bb	19.7963	-158.1773
5	58	22/12/2014 08:32:20	22/12/2014 08:37:48	Bb	19.4891	-158.3696
6	58	22/12/2014 09:18:55	22/12/2014 09:22:10	Bb	19.4891	-158.3696
7	58	22/12/2014 10:37:46	22/12/2014 11:01:13	Bb	19.4891	-158.3696
8	59	22/12/2014 13:20:38	22/12/2014 13:25:29	Bb	19.4622	-158.3880

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
9	64	23/12/2014 18:45:07	23/12/2014 18:49:23	Bb	19.3475	-158.4647
10	65	23/12/2014 19:40:12	23/12/2014 20:16:21	Bb	19.3250	-158.4802
11	65	23/12/2014 23:25:50	24/12/2014 00:02:05	Bb	19.3250	-158.4802
12	66	24/12/2014 00:57:20	24/12/2014 02:40:40	Bb	19.2987	-158.4944
13	69	24/12/2014 14:58:25	24/12/2014 15:06:16	Bb	19.2223	-158.5387
14	70	24/12/2014 19:30:45	24/12/2014 19:31:25	Bb	19.2005	-158.5608
15	70	24/12/2014 21:22:21	24/12/2014 22:11:36	Bb	19.2005	-158.5608
16	72	25/12/2014 06:09:33	25/12/2014 06:18:37	Bb	19.1672	-158.5896
17	73	25/12/2014 11:09:35	25/12/2014 11:15:02	Bb	19.1425	-158.6001

*Bb = *Balaenoptera borealis* (sei whale)

Humpback whale encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	32	17/12/2014 02:31:59	17/12/2014 03:11:43	Mn	20.2773	-157.8456
2	32	17/12/2014 04:00:01	17/12/2014 05:10:55	Mn	20.2773	-157.8456
3	33	17/12/2014 05:49:57	17/12/2014 08:43:54	Mn	20.2429	-157.8558
4	33	17/12/2014 09:20:32	17/12/2014 09:53:32	Mn	20.2429	-157.8558
5	34	17/12/2014 10:30:16	17/12/2014 11:42:59	Mn	20.2135	-157.8726
6	35	17/12/2014 12:51:28	17/12/2014 18:16:15	Mn	20.1845	-157.8920
7	36	17/12/2014 18:50:39	18/12/2014 03:58:03	Mn	20.1535	-157.9112
8	37	18/12/2014 04:32:13	18/12/2014 05:23:53	Mn	20.1232	-157.9352
9	38	18/12/2014 08:48:39	18/12/2014 09:04:51	Mn	20.0966	-157.9616
10	39	18/12/2014 11:35:22	18/12/2014 12:37:07	Mn	20.0721	-157.9906
11	39	18/12/2014 13:23:16	18/12/2014 14:09:31	Mn	20.0721	-157.9906

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
12	40	18/12/2014 15:57:09	18/12/2014 16:56:42	Mn	20.0490	-158.0181
13	40	18/12/2014 17:37:47	18/12/2014 17:57:18	Mn	20.0490	-158.0181
14	41	18/12/2014 19:22:53	18/12/2014 23:25:30	Mn	20.0224	-158.0381
15	41	19/12/2014 00:08:17	19/12/2014 00:09:55	Mn	20.0224	-158.0381
16	42	19/12/2014 01:30:23	19/12/2014 03:06:21	Mn	19.9923	-158.0581
17	42	19/12/2014 03:44:12	19/12/2014 04:28:56	Mn	19.9923	-158.0581
18	43	19/12/2014 06:54:33	19/12/2014 09:40:20	Mn	19.9590	-158.0770
19	44	19/12/2014 10:25:38	19/12/2014 10:45:36	Mn	19.9254	-158.0977
20	44	19/12/2014 11:38:52	19/12/2014 12:02:37	Mn	19.9254	-158.0977
21	44	19/12/2014 14:54:38	19/12/2014 14:56:17	Mn	19.9254	-158.0977
22	45	19/12/2014 16:12:32	19/12/2014 16:48:58	Mn	19.8948	-158.1204
23	46	19/12/2014 20:31:29	19/12/2014 23:40:22	Mn	19.8596	-158.1390
24	47	20/12/2014 01:38:12	20/12/2014 04:06:04	Mn	19.8279	-158.1584
25	48	20/12/2014 06:52:25	20/12/2014 06:53:59	Mn	19.7963	-158.1773
26	48	20/12/2014 07:25:25	20/12/2014 09:47:12	Mn	19.7963	-158.1773
27	48	20/12/2014 10:18:34	20/12/2014 10:19:58	Mn	19.7963	-158.1773
28	48	20/12/2014 10:55:50	20/12/2014 10:56:22	Mn	19.7963	-158.1773
29	49	20/12/2014 12:17:48	20/12/2014 15:19:44	Mn	19.7594	-158.1948
30	50	20/12/2014 16:38:00	20/12/2014 20:16:59	Mn	19.7266	-158.2140
31	51	20/12/2014 20:54:29	21/12/2014 06:56:05	Mn	19.6926	-158.2356
32	53	21/12/2014 08:10:48	21/12/2014 11:05:53	Mn	19.6274	-158.2738
33	54	21/12/2014 12:17:53	21/12/2014 16:07:13	Mn	19.5943	-158.2948
34	55	21/12/2014 17:11:25	21/12/2014 21:09:45	Mn	19.5707	-158.3173
35	56	21/12/2014 22:27:24	22/12/2014 02:14:26	Mn	19.5462	-158.3348

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
36	57	22/12/2014 03:27:53	22/12/2014 07:12:11	Mn	19.5176	-158.3528
37	58	22/12/2014 08:32:23	22/12/2014 12:36:08	Mn	19.4891	-158.3696
38	59	22/12/2014 13:32:28	22/12/2014 18:07:40	Mn	19.4622	-158.3880
39	60	22/12/2014 18:42:42	22/12/2014 21:57:36	Mn	19.4398	-158.4092
40	61	22/12/2014 23:02:20	23/12/2014 02:58:05	Mn	19.4154	-158.4256
41	62	23/12/2014 04:38:14	23/12/2014 05:41:34	Mn	19.3925	-158.4397
42	64	23/12/2014 15:37:42	23/12/2014 18:35:44	Mn	19.3475	-158.4647
43	65	23/12/2014 20:24:06	23/12/2014 20:36:24	Mn	19.3250	-158.4802
44	65	23/12/2014 21:09:43	23/12/2014 21:11:30	Mn	19.3250	-158.4802
45	65	23/12/2014 22:38:30	23/12/2014 23:26:06	Mn	19.3250	-158.4802
46	66	24/12/2014 00:56:46	24/12/2014 01:01:26	Mn	19.2987	-158.4944
47	66	24/12/2014 01:53:55	24/12/2014 04:05:28	Mn	19.2987	-158.4944
48	66	24/12/2014 04:38:17	24/12/2014 04:39:23	Mn	19.2987	-158.4944
49	67	24/12/2014 06:10:27	24/12/2014 07:27:54	Mn	19.2726	-158.5084
50	68	24/12/2014 10:54:28	24/12/2014 11:20:29	Mn	19.2484	-158.5212
51	68	24/12/2014 11:56:38	24/12/2014 12:10:36	Mn	19.2484	-158.5212
52	68	24/12/2014 12:53:32	24/12/2014 13:20:42	Mn	19.2484	-158.5212
53	69	24/12/2014 14:37:27	24/12/2014 18:42:09	Mn	19.2223	-158.5387
54	70	24/12/2014 19:32:46	25/12/2014 00:06:13	Mn	19.2005	-158.5608
55	71	25/12/2014 00:44:39	25/12/2014 04:48:17	Mn	19.1845	-158.5783
56	72	25/12/2014 05:53:49	25/12/2014 09:51:03	Mn	19.1672	-158.5896
57	73	25/12/2014 11:07:14	25/12/2014 15:35:30	Mn	19.1425	-158.6001
58	74	25/12/2014 16:21:51	25/12/2014 20:11:55	Mn	19.1139	-158.6181
59	75	25/12/2014 21:22:05	26/12/2014 06:48:25	Mn	19.0917	-158.6425

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
60	77	26/12/2014 08:06:02	26/12/2014 12:34:17	Mn	19.0493	-158.6901
61	80	26/12/2014 17:55:11	27/12/2014 08:52:37	Mn	18.9816	-158.7548
62	82	27/12/2014 09:47:56	27/12/2014 10:22:37	Mn	18.9436	-158.8041
63	82	27/12/2014 10:55:41	27/12/2014 14:17:21	Mn	18.9436	-158.8041
64	83	27/12/2014 15:09:47	27/12/2014 19:34:37	Mn	18.9213	-158.8256
65	84	27/12/2014 20:10:01	28/12/2014 04:52:50	Mn	18.9010	-158.8548
66	86	28/12/2014 06:10:19	28/12/2014 10:37:32	Mn	18.8743	-158.9047
67	87	28/12/2014 11:33:29	28/12/2014 14:17:11	Mn	18.8575	-158.9239
68	88	28/12/2014 15:39:47	28/12/2014 17:05:56	Mn	18.8401	-158.9449
69	89	28/12/2014 17:57:29	29/12/2014 00:08:00	Mn	18.8249	-158.9742
70	90	29/12/2014 01:15:04	29/12/2014 05:17:06	Mn	18.8119	-159.0017
71	91	29/12/2014 05:47:07	29/12/2014 10:21:29	Mn	18.7966	-159.0207
72	92	29/12/2014 11:35:52	29/12/2014 15:45:58	Mn	18.7929	-159.0018
73	93	29/12/2014 16:17:03	29/12/2014 20:15:58	Mn	18.7930	-158.9494
74	95	30/12/2014 04:41:45	30/12/2014 03:25:48	Mn	18.7864	-158.8516
75	96	30/12/2014 04:11:32	30/12/2014 09:59:30	Mn	18.7859	-158.8037
76	99	30/12/2014 20:04:39	31/12/2014 00:18:19	Mn	18.7653	-158.6528
77	100	31/12/2014 01:26:08	31/12/2014 04:18:17	Mn	18.7569	-158.6005
78	100	31/12/2014 05:01:14	31/12/2014 05:03:22	Mn	18.7569	-158.6005
79	101	31/12/2014 06:11:05	31/12/2014 08:54:51	Mn	18.7451	-158.5478
80	102	31/12/2014 11:00:33	31/12/2014 11:07:35	Mn	18.7369	-158.4928
81	102	31/12/2014 11:41:40	31/12/2014 11:50:02	Mn	18.7369	-158.4928
82	102	31/12/2014 12:27:20	31/12/2014 14:40:35	Mn	18.7369	-158.4928
83	103	31/12/2014 15:57:01	31/12/2014 19:38:51	Mn	18.7298	-158.4363

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
84	103	31/12/2014 20:11:52	31/12/2014 20:12:51	Mn	18.7298	-158.4363
85	104	31/12/2014 20:45:49	01/01/2015 00:09:20	Mn	18.7188	-158.3821
86	105	01/01/2015 01:11:05	01/01/2015 04:54:56	Mn	18.7107	-158.3304
87	106	01/01/2015 05:43:27	01/01/2015 05:48:20	Mn	18.7116	-158.2919
88	106	01/01/2015 06:29:57	01/01/2015 07:10:24	Mn	18.7116	-158.2919
89	107	01/01/2015 08:43:13	01/01/2015 08:59:21	Mn	18.7164	-158.2688
90	109	01/01/2015 10:32:58	01/01/2015 15:21:27	Mn	18.7187	-158.2114
91	113	02/01/2015 09:40:50	02/01/2015 07:18:18	Mn	18.6952	-157.9954
92	114	02/01/2015 07:51:18	02/01/2015 15:47:49	Mn	18.6815	-157.9441
93	115	02/01/2015 16:39:30	03/01/2015 00:58:58	Mn	18.6720	-157.8956
94	117	03/01/2015 02:12:24	03/01/2015 02:34:21	Mn	18.6554	-157.8045
95	118	03/01/2015 04:40:47	03/01/2015 07:54:17	Mn	18.6587	-157.7577
96	119	03/01/2015 09:56:10	03/01/2015 10:52:19	Mn	18.6573	-157.7027
97	119	03/01/2015 11:48:50	03/01/2015 12:50:29	Mn	18.6573	-157.7027
98	120	03/01/2015 14:30:33	03/01/2015 18:19:57	Mn	18.6645	-157.6548
99	121	03/01/2015 19:27:46	03/01/2015 22:36:07	Mn	18.6723	-157.6087
100	122	03/01/2015 23:58:09	04/01/2015 03:40:02	Mn	18.6747	-157.5646
101	123	04/01/2015 04:41:06	04/01/2015 13:54:50	Mn	18.6837	-157.5317
102	125	04/01/2015 14:47:17	04/01/2015 18:40:32	Mn	18.7050	-157.4642
103	129	04/01/2015 19:13:25	06/01/2015 03:25:00	Mn	18.7246	-157.3172
104	133	06/01/2015 05:11:34	06/01/2015 08:53:14	Mn	18.7507	-157.2008
105	134	06/01/2015 09:30:52	06/01/2015 18:40:23	Mn	18.7578	-157.1740
106	136	06/01/2015 19:25:51	07/01/2015 00:09:46	Mn	18.7655	-157.1271
107	137	07/01/2015 01:08:40	07/01/2015 05:21:54	Mn	18.7716	-157.1045

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
108	139	07/01/2015 06:47:33	07/01/2015 14:33:04	Mn	18.7954	-157.0787
109	141	07/01/2015 15:50:47	08/01/2015 06:03:07	Mn	18.8431	-157.0734
110	142	08/01/2015 06:45:56	08/01/2015 06:53:52	Mn	18.8645	-157.0679
111	143	08/01/2015 07:35:36	08/01/2015 11:34:47	Mn	18.8861	-157.0598
112	144	08/01/2015 12:36:12	08/01/2015 16:46:58	Mn	18.9069	-157.0534
113	145	08/01/2015 18:00:53	08/01/2015 21:27:09	Mn	18.9328	-157.0474
114	146	08/01/2015 22:42:46	09/01/2015 07:24:06	Mn	18.9589	-157.0382
115	151	09/01/2015 08:21:56	10/01/2015 13:50:33	Mn	19.0911	-157.0144
116	163	10/01/2015 15:32:27	14/01/2015 10:23:39	Mn	19.4411	-157.0981
117	175	14/01/2015 10:53:56	15/01/2015 09:45:40	Mn	19.8025	-157.3947
118	178	15/01/2015 10:18:32	15/01/2015 14:08:40	Mn	19.8967	-157.4811
119	179	15/01/2015 14:38:55	15/01/2015 19:05:37	Mn	19.9255	-157.5054
120	180	15/01/2015 19:58:41	16/01/2015 00:21:41	Mn	19.9521	-157.5249
121	181	16/01/2015 01:19:13	16/01/2015 05:59:56	Mn	19.9779	-157.5465
122	182	16/01/2015 06:30:02	16/01/2015 10:55:10	Mn	19.9993	-157.5686
123	183	16/01/2015 11:49:11	16/01/2015 12:25:51	Mn	20.0174	-157.5873
124	184	16/01/2015 17:21:10	16/01/2015 22:09:08	Mn	20.0380	-157.6053
125	186	16/01/2015 22:39:18	17/01/2015 08:06:37	Mn	20.0812	-157.6493
126	187	17/01/2015 08:37:38	17/01/2015 13:09:16	Mn	20.1027	-157.6776
127	188	17/01/2015 14:01:25	17/01/2015 17:25:31	Mn	20.1237	-157.7044
128	190	17/01/2015 23:32:19	17/01/2015 23:33:07	Mn	20.1596	-157.7536
129	191	18/01/2015 04:10:56	18/01/2015 07:01:08	Mn	20.1838	-157.7727
130	191	18/01/2015 07:31:43	18/01/2015 07:45:42	Mn	20.1838	-157.7727
131	193	18/01/2015 13:31:18	18/01/2015 22:56:47	Mn	20.2214	-157.8141

*Mn = *Megaptera novaeangliae* (humpback whale)

Minke whale encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	32	17/12/2014 05:01:25	17/12/2014 05:50:00	Ba	20.2773	-157.8456
2	35	17/12/2014 18:51:22	17/12/2014 18:52:49	Ba	20.1845	-157.8920
3	36	17/12/2014 20:30:48	17/12/2014 20:41:09	Ba	20.1535	-157.9112
4	36	17/12/2014 21:47:41	17/12/2014 21:48:04	Ba	20.1535	-157.9112
5	36	17/12/2014 22:21:59	17/12/2014 23:09:59	Ba	20.1535	-157.9112
6	36	17/12/2014 23:44:13	18/12/2014 00:05:37	Ba	20.1535	-157.9112
7	37	18/12/2014 02:44:43	18/12/2014 03:00:33	Ba	20.1232	-157.9352
8	37	18/12/2014 03:39:02	18/12/2014 04:49:08	Ba	20.1232	-157.9352
9	46	20/12/2014 00:37:28	20/12/2014 00:58:48	Ba	19.8596	-158.1390
10	48	20/12/2014 06:49:01	20/12/2014 11:41:47	Ba	19.7963	-158.1773
11	49	20/12/2014 12:24:57	20/12/2014 16:11:36	Ba	19.7594	-158.1948
12	50	20/12/2014 16:50:31	20/12/2014 17:09:35	Ba	19.7266	-158.2140
13	50	20/12/2014 17:47:33	20/12/2014 21:26:22	Ba	19.7266	-158.2140
14	56	20/12/2014 22:19:09	23/12/2014 02:01:25	Ba	19.5462	-158.3348
15	61	23/12/2014 03:11:13	23/12/2014 03:30:57	Ba	19.4154	-158.4256
16	62	23/12/2014 04:09:50	23/12/2014 04:13:17	Ba	19.3925	-158.4397
17	62	23/12/2014 06:53:06	23/12/2014 06:54:32	Ba	19.3925	-158.4397
18	63	23/12/2014 08:52:25	23/12/2014 09:14:40	Ba	19.3724	-158.4517
19	63	23/12/2014 12:38:00	23/12/2014 12:48:40	Ba	19.3724	-158.4517
20	64	23/12/2014 14:26:41	23/12/2014 14:27:40	Ba	19.3475	-158.4647
21	64	23/12/2014 16:49:39	23/12/2014 16:49:52	Ba	19.3475	-158.4647
22	64	23/12/2014 17:36:00	23/12/2014 17:36:10	Ba	19.3475	-158.4647
23	64	23/12/2014 19:10:40	23/12/2014 19:19:44	Ba	19.3475	-158.4647

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
24	65	23/12/2014 20:31:53	23/12/2014 20:53:50	Ba	19.3250	-158.4802
25	65	23/12/2014 21:48:55	23/12/2014 23:18:59	Ba	19.3250	-158.4802
26	65	24/12/2014 00:09:17	24/12/2014 00:20:00	Ba	19.3250	-158.4802
27	66	24/12/2014 00:58:59	24/12/2014 00:59:07	Ba	19.2987	-158.4944
28	66	24/12/2014 03:07:27	24/12/2014 03:18:12	Ba	19.2987	-158.4944
29	66	24/12/2014 03:58:51	24/12/2014 05:00:27	Ba	19.2987	-158.4944
30	67	24/12/2014 06:34:43	24/12/2014 06:34:54	Ba	19.2726	-158.5084
31	68	24/12/2014 11:24:30	24/12/2014 11:26:21	Ba	19.2484	-158.5212
32	69	24/12/2014 12:47:39	24/12/2014 17:40:33	Ba	19.2223	-158.5387
33	71	24/12/2014 18:12:58	25/12/2014 08:21:01	Ba	19.1845	-158.5783
34	72	25/12/2014 09:07:27	25/12/2014 09:07:37	Ba	19.1672	-158.5896
35	73	25/12/2014 10:00:58	25/12/2014 18:41:44	Ba	19.1425	-158.6001
36	75	25/12/2014 19:14:54	26/12/2014 08:01:27	Ba	19.0917	-158.6425
37	77	26/12/2014 09:11:55	26/12/2014 12:34:30	Ba	19.0493	-158.6901
38	79	26/12/2014 17:49:55	26/12/2014 20:17:21	Ba	19.0032	-158.7322
39	79	26/12/2014 20:58:27	26/12/2014 23:53:34	Ba	19.0032	-158.7322
40	80	27/12/2014 00:25:02	27/12/2014 03:52:51	Ba	18.9816	-158.7548
41	81	27/12/2014 05:05:56	27/12/2014 05:06:15	Ba	18.9607	-158.7788
42	81	27/12/2014 08:28:17	27/12/2014 09:08:45	Ba	18.9607	-158.7788
43	82	27/12/2014 09:55:14	27/12/2014 10:05:39	Ba	18.9436	-158.8041
44	82	27/12/2014 12:00:40	27/12/2014 12:03:48	Ba	18.9436	-158.8041
45	82	27/12/2014 12:45:04	27/12/2014 12:45:19	Ba	18.9436	-158.8041
46	82	27/12/2014 13:21:44	27/12/2014 14:52:30	Ba	18.9436	-158.8041
47	83	27/12/2014 15:41:20	27/12/2014 15:42:32	Ba	18.9213	-158.8256

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
48	88	27/12/2014 16:18:14	29/12/2014 20:15:48	Ba	18.8401	-158.9449
49	95	30/12/2014 00:58:49	30/12/2014 03:25:11	Ba	18.7864	-158.8516
50	96	30/12/2014 04:13:05	30/12/2014 09:59:11	Ba	18.7859	-158.8037
51	97	30/12/2014 14:44:11	30/12/2014 14:46:21	Ba	18.7788	-158.7565
52	99	30/12/2014 19:56:43	31/12/2014 01:31:57	Ba	18.7653	-158.6528
53	100	31/12/2014 02:15:36	31/12/2014 03:59:22	Ba	18.7569	-158.6005
54	100	31/12/2014 04:43:59	31/12/2014 05:17:05	Ba	18.7569	-158.6005
55	101	31/12/2014 06:12:13	31/12/2014 06:17:14	Ba	18.7451	-158.5478
56	102	31/12/2014 11:02:41	31/12/2014 11:03:07	Ba	18.7369	-158.4928
57	102	31/12/2014 13:24:35	31/12/2014 13:24:55	Ba	18.7369	-158.4928
58	103	31/12/2014 16:41:17	31/12/2014 17:16:18	Ba	18.7298	-158.4363
59	104	31/12/2014 18:25:31	01/01/2015 07:06:49	Ba	18.7188	-158.3821
60	107	01/01/2015 09:52:33	01/01/2015 09:53:02	Ba	18.7164	-158.2688
61	109	01/01/2015 11:43:48	01/01/2015 14:09:47	Ba	18.7187	-158.2114
62	109	01/01/2015 14:41:59	01/01/2015 15:20:51	Ba	18.7187	-158.2114
63	112	01/01/2015 17:22:34	02/01/2015 17:53:16	Ba	18.7092	-158.0520
64	115	02/01/2015 19:36:32	02/01/2015 20:59:37	Ba	18.6720	-157.8956
65	116	02/01/2015 21:37:04	02/01/2015 21:49:56	Ba	18.6610	-157.8435
66	116	02/01/2015 22:25:11	02/01/2015 23:31:39	Ba	18.6610	-157.8435
67	117	03/01/2015 00:04:42	03/01/2015 03:04:39	Ba	18.6554	-157.8045
68	117	03/01/2015 04:15:34	03/01/2015 04:16:36	Ba	18.6554	-157.8045
69	118	03/01/2015 05:16:25	03/01/2015 05:22:32	Ba	18.6587	-157.7577
70	120	03/01/2015 15:26:43	03/01/2015 15:29:00	Ba	18.6645	-157.6548
71	120	03/01/2015 17:29:50	03/01/2015 17:58:31	Ba	18.6645	-157.6548

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
72	121	03/01/2015 18:51:54	03/01/2015 21:41:52	Ba	18.6723	-157.6087
73	121	03/01/2015 22:23:38	03/01/2015 23:05:37	Ba	18.6723	-157.6087
74	122	03/01/2015 23:47:32	04/01/2015 01:53:08	Ba	18.6747	-157.5646
75	122	04/01/2015 03:07:33	04/01/2015 04:22:26	Ba	18.6747	-157.5646
76	123	04/01/2015 05:32:13	04/01/2015 05:40:04	Ba	18.6837	-157.5317
77	123	04/01/2015 07:49:05	04/01/2015 07:49:23	Ba	18.6837	-157.5317
78	123	04/01/2015 08:39:52	04/01/2015 09:10:22	Ba	18.6837	-157.5317
79	124	04/01/2015 10:50:07	04/01/2015 10:50:20	Ba	18.6953	-157.4999
80	124	04/01/2015 14:11:58	04/01/2015 14:13:52	Ba	18.6953	-157.4999
81	125	04/01/2015 18:45:41	04/01/2015 20:04:05	Ba	18.7050	-157.4642
82	126	04/01/2015 21:13:13	04/01/2015 21:17:40	Ba	18.7115	-157.4267
83	126	04/01/2015 21:56:35	04/01/2015 22:03:49	Ba	18.7115	-157.4267
84	127	04/01/2015 22:34:03	05/01/2015 04:45:00	Ba	18.7156	-157.3876
85	128	05/01/2015 05:25:02	05/01/2015 05:58:42	Ba	18.7198	-157.3521
86	128	05/01/2015 06:43:52	05/01/2015 07:33:25	Ba	18.7198	-157.3521
87	130	05/01/2015 08:04:41	06/01/2015 04:40:23	Ba	18.7318	-157.2872
88	133	06/01/2015 08:43:13	06/01/2015 09:39:30	Ba	18.7507	-157.2008
89	134	06/01/2015 11:26:52	06/01/2015 12:52:17	Ba	18.7578	-157.1740
90	134	06/01/2015 13:43:54	06/01/2015 13:47:36	Ba	18.7578	-157.1740
91	136	06/01/2015 14:26:42	07/01/2015 04:02:44	Ba	18.7655	-157.1271
92	137	07/01/2015 05:45:47	07/01/2015 05:51:29	Ba	18.7716	-157.1045
93	138	07/01/2015 07:48:36	07/01/2015 08:05:01	Ba	18.7813	-157.0903
94	139	07/01/2015 11:40:11	07/01/2015 11:40:27	Ba	18.7954	-157.0787
95	140	07/01/2015 15:46:23	07/01/2015 15:51:06	Ba	18.8187	-157.0782

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
96	140	07/01/2015 18:59:28	07/01/2015 18:59:48	Ba	18.8187	-157.0782
97	141	07/01/2015 21:26:54	07/01/2015 21:27:16	Ba	18.8431	-157.0734
98	144	07/01/2015 23:43:25	09/01/2015 07:06:40	Ba	18.9069	-157.0534
99	147	09/01/2015 07:43:04	09/01/2015 07:48:38	Ba	18.9853	-157.0345
100	149	09/01/2015 08:21:50	10/01/2015 02:31:41	Ba	19.0369	-157.0217
101	152	10/01/2015 03:38:58	10/01/2015 03:41:30	Ba	19.1184	-157.0134
102	152	10/01/2015 07:36:55	10/01/2015 07:56:35	Ba	19.1184	-157.0134
103	153	10/01/2015 09:31:18	10/01/2015 09:31:31	Ba	19.1465	-157.0125
104	154	10/01/2015 11:55:37	10/01/2015 13:55:36	Ba	19.1762	-157.0101
105	155	10/01/2015 15:32:33	11/01/2015 04:06:05	Ba	19.2080	-157.0109
106	157	11/01/2015 04:42:48	11/01/2015 04:43:02	Ba	19.2753	-157.0087
107	157	11/01/2015 05:57:11	11/01/2015 06:29:36	Ba	19.2753	-157.0087
108	157	11/01/2015 07:16:42	11/01/2015 08:55:52	Ba	19.2753	-157.0087
109	162	11/01/2015 09:27:06	13/01/2015 01:22:35	Ba	19.4135	-157.0773
110	168	13/01/2015 02:11:32	13/01/2015 21:37:11	Ba	19.5935	-157.2165
111	171	13/01/2015 22:12:23	14/01/2015 07:25:53	Ba	19.6795	-157.2922
112	174	14/01/2015 07:56:22	14/01/2015 21:46:28	Ba	19.7730	-157.3669
113	177	14/01/2015 22:25:02	15/01/2015 19:23:11	Ba	19.8669	-157.4511
114	180	15/01/2015 20:10:11	15/01/2015 20:47:43	Ba	19.9521	-157.5249
115	180	15/01/2015 21:33:07	15/01/2015 22:20:19	Ba	19.9521	-157.5249
116	180	15/01/2015 23:19:27	15/01/2015 23:19:39	Ba	19.9521	-157.5249
117	180	16/01/2015 00:36:51	16/01/2015 00:42:38	Ba	19.9521	-157.5249
118	181	16/01/2015 01:28:59	16/01/2015 01:29:05	Ba	19.9779	-157.5465
119	181	16/01/2015 02:09:12	16/01/2015 02:56:30	Ba	19.9779	-157.5465

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
120	181	16/01/2015 03:42:31	16/01/2015 03:42:50	Ba	19.9779	-157.5465
121	181	16/01/2015 05:37:24	16/01/2015 05:58:30	Ba	19.9779	-157.5465
122	182	16/01/2015 06:48:41	16/01/2015 06:54:13	Ba	19.9993	-157.5686
123	182	16/01/2015 08:40:03	16/01/2015 08:44:07	Ba	19.9993	-157.5686
124	183	16/01/2015 11:22:23	16/01/2015 11:55:33	Ba	20.0174	-157.5873
125	184	16/01/2015 19:34:53	16/01/2015 19:45:35	Ba	20.0380	-157.6053
126	184	16/01/2015 21:05:31	16/01/2015 21:52:08	Ba	20.0380	-157.6053
127	185	16/01/2015 22:38:29	16/01/2015 23:26:28	Ba	20.0587	-157.6247
128	185	17/01/2015 01:19:25	17/01/2015 02:44:57	Ba	20.0587	-157.6247
129	186	17/01/2015 03:19:28	17/01/2015 03:41:17	Ba	20.0812	-157.6493
130	186	17/01/2015 04:14:19	17/01/2015 04:14:47	Ba	20.0812	-157.6493
131	186	17/01/2015 04:57:20	17/01/2015 04:57:35	Ba	20.0812	-157.6493
132	186	17/01/2015 05:33:55	17/01/2015 08:06:28	Ba	20.0812	-157.6493
133	187	17/01/2015 08:36:50	17/01/2015 11:01:31	Ba	20.1027	-157.6776
134	187	17/01/2015 13:01:47	17/01/2015 13:06:51	Ba	20.1027	-157.6776
135	188	17/01/2015 14:09:01	17/01/2015 14:55:13	Ba	20.1237	-157.7044
136	188	17/01/2015 15:33:43	17/01/2015 17:47:54	Ba	20.1237	-157.7044
137	191	18/01/2015 04:16:27	18/01/2015 04:45:23	Ba	20.1838	-157.7727
138	191	18/01/2015 07:41:36	18/01/2015 07:45:36	Ba	20.1838	-157.7727
139	193	18/01/2015 13:36:25	18/01/2015 14:00:55	Ba	20.2214	-157.8141
140	194	18/01/2015 15:58:04	18/01/2015 22:55:11	Ba	20.2463	-157.8285

*Ba = *Balaenoptera acutorostrata* (minke whale)

A.3 Navy Sonobuoy and Seismic Airgun Signals

Active Navy Sonobuoy*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	180	15/01/2015 23:02:50	15/01/2015 23:21:58	SB	19.9521	-157.5249
2	180	16/01/2015 00:01:47	16/01/2015 00:04:08	SB	19.9521	-157.5249
3	181	16/01/2015 03:20:29	16/01/2015 05:26:13	SB	19.9779	-157.5465

*SB = Active Navy sonobuoy

Seismic airgun encounters*

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
1	62	23/12/2014 04:59:29	23/12/2014 07:36:10	Airgun	19.3925	-158.4397
2	73	25/12/2014 12:51:50	25/12/2014 13:35:20	Airgun	19.1425	-158.6001
3	80	27/12/2014 00:24:56	27/12/2014 01:53:23	Airgun	18.9816	-158.7548
4	81	27/12/2014 06:24:53	27/12/2014 08:53:31	Airgun	18.9607	-158.7788
5	84	27/12/2014 20:26:03	27/12/2014 22:33:42	Airgun	18.9010	-158.8548
6	85	28/12/2014 01:10:02	28/12/2014 02:53:32	Airgun	18.8900	-158.8828
7	85	28/12/2014 03:28:09	28/12/2014 04:32:02	Airgun	18.8900	-158.8828
8	87	28/12/2014 13:10:38	28/12/2014 13:53:28	Airgun	18.8575	-158.9239
9	92	29/12/2014 11:54:57	29/12/2014 13:38:37	Airgun	18.7929	-159.0018
10	95	30/12/2014 01:26:25	30/12/2014 03:11:12	Airgun	18.7864	-158.8516
11	95	30/12/2014 03:56:29	30/12/2014 04:40:36	Airgun	18.7864	-158.8516
12	96	30/12/2014 06:26:41	30/12/2014 06:56:06	Airgun	18.7859	-158.8037
13	96	30/12/2014 08:26:34	30/12/2014 08:55:16	Airgun	18.7859	-158.8037
14	99	30/12/2014 21:26:22	30/12/2014 22:02:44	Airgun	18.7653	-158.6528
15	100	31/12/2014 03:28:14	31/12/2014 04:03:17	Airgun	18.7569	-158.6005

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
16	110	01/01/2015 20:40:59	01/01/2015 20:55:16	Airgun	18.7189	-158.1619
17	111	01/01/2015 22:26:02	01/01/2015 23:10:18	Airgun	18.7159	-158.1087
18	111	02/01/2015 00:41:02	02/01/2015 00:55:25	Airgun	18.7159	-158.1087
19	118	03/01/2015 05:46:15	03/01/2015 08:01:03	Airgun	18.6587	-157.7577
20	131	05/01/2015 21:40:53	05/01/2015 23:18:42	Airgun	18.7399	-157.2559
21	133	06/01/2015 05:25:58	06/01/2015 05:59:11	Airgun	18.7507	-157.2008
22	135	06/01/2015 15:40:52	06/01/2015 19:22:15	Airgun	18.7613	-157.1488
23	136	06/01/2015 20:25:58	07/01/2015 00:09:48	Airgun	18.7655	-157.1271
24	137	07/01/2015 01:40:43	07/01/2015 05:22:05	Airgun	18.7716	-157.1045
25	138	07/01/2015 06:44:32	07/01/2015 09:54:52	Airgun	18.7813	-157.0903
26	139	07/01/2015 10:29:06	07/01/2015 13:19:43	Airgun	18.7954	-157.0787
27	140	07/01/2015 19:55:55	07/01/2015 20:22:00	Airgun	18.8187	-157.0782
28	141	07/01/2015 20:52:22	08/01/2015 00:52:43	Airgun	18.8431	-157.0734
29	142	08/01/2015 02:32:22	08/01/2015 03:54:25	Airgun	18.8645	-157.0679
30	142	08/01/2015 04:41:04	08/01/2015 06:39:03	Airgun	18.8645	-157.0679
31	143	08/01/2015 07:41:57	08/01/2015 08:54:57	Airgun	18.8861	-157.0598
32	143	08/01/2015 09:41:15	08/01/2015 10:50:34	Airgun	18.8861	-157.0598
33	144	08/01/2015 12:50:55	08/01/2015 16:20:22	Airgun	18.9069	-157.0534
34	145	08/01/2015 18:05:51	08/01/2015 20:18:29	Airgun	18.9328	-157.0474
35	146	08/01/2015 23:12:20	09/01/2015 01:55:33	Airgun	18.9589	-157.0382
36	148	09/01/2015 11:20:47	09/01/2015 12:20:20	Airgun	19.0135	-157.0275
37	149	09/01/2015 13:35:49	09/01/2015 17:20:02	Airgun	19.0369	-157.0217
38	150	09/01/2015 18:43:32	09/01/2015 21:55:21	Airgun	19.0613	-157.0174
39	151	09/01/2015 23:14:26	10/01/2015 00:05:26	Airgun	19.0911	-157.0144

Encounter [no.]	Dive [no.]	Start date [UTC] [dd/mm/yyyy hh:mm:ss]	End date [UTC] [dd/mm/yyyy hh:mm:ss]	Species ID/Label	Latitude [degrees N]	Longitude [degrees W]
40	151	10/01/2015 02:41:28	10/01/2015 02:49:58	Airgun	19.0911	-157.0144
41	153	10/01/2015 08:35:58	10/01/2015 08:50:33	Airgun	19.1465	-157.0125

*Airgun = Seismic airgun