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INTERNATIONAL WHALING COMMISSION

# SIGHTINGS AND ACOUSTIC RECORDS OF RIGHT WHALES COLLECTED IN SOUTH GEORGIA (ISLAS GEORGIAS DEL SUR) WATERS JANUARY-FEBRUARY 2018

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"*If I were asked what made the greatest impression on me in South Georgia, without any hesitation I should say that it was the wind. Before any of the wonderful sights of the bird and animal world there comes the memory of days when out on deck we could hardly hear one another shouting, when the whole surface of the sea was lifted into the air and flung forward in a blinding sheet of spindrift, and, worst of all, the recollection of lonely watches through long black nights when one's only companion was the soul-destroying shriek of wind in the shrouds.*"

Niall Rankin, Antarctic Isle, 1951

## INTRODUCTION

The South Georgia/Islas Georgias del Sur marine ecosystem is globally recognised as a biodiversity hotspot, and its waters are one target of a growing krill fishery. Today, southern right whales are the most commonly seen whale in these waters, slowly returning after four centuries of exploitation (Moore et al. 1999; Richardson et al. 2012). Right whales that feed in South Georgia /Islas Georgias del Sur (SG) waters in summer have been linked, through photo-identification, stable isotope and satellite telemetry, to the wintering ground at Península Valdés in Argentina (Best et al. 1993; Moore et al. 1999; Rowntree et al. 2001; Valenzuela et al. 2009; Zerbini et al. 2016). The Península Valdés calving ground has had notably high calf mortalities in the last decade, the cause of which is unknown (Rowntree et al. 2013). A growing body of evidence hypothesizes that SG environmental conditions directly influence the low latitude population dynamics of these whales, suggesting foraging success is a primary factor influencing reproductive rates (Leaper et al. 2006; Seyboth et al. 2016). We set out to conduct baseline surveys of right whales in SG waters (Fig. 1) spanning their period of peak occurrence in summer months. The survey was designed to investigate right whale genetic diversity, population connectivity with

calving areas, health status, prey sources, acoustic behaviour and habitat use in relation to the krill fishing within the sustainable-use South Georgia and South Sandwich Islands (Islas Georgias del Sur y Islas Sandwich del Sur) Marine Protected Area (MPA).

Over the next 12 months the project is intended to deliver a series of key conservation and management related outcomes: (1) integration of telemetry, acoustic, stable isotope and oceanographic data to identify key areas of whale habitat use and foraging patterns in the South Georgia marine ecosystem; (2) investigation of whale prey and habitat use in relation to the fishery and to key oceanographic features in order that right whales can be considered in spatial krill fishery management plans and ecosystem model development; (3) investigation of migratory connections between SG waters and calving grounds off Argentina, Brazil and South Africa using photographs and genetics, linking individuals to long-term sightings records and reproductive histories; (4) description of whale health and body condition to infer habitat quality during the feeding season and improve understanding of the causes of calf mortality associated with this feeding ground; (5) first description of acoustic repertoire of southern right whales on their feeding grounds.

## METHODS

### Study site

The voyage was conducted on the R/V *Song of the Whale* (owned and managed by Marine Conservation Research), which departed from Stanley in the Falkland Islands/Islas Malvinas on Monday 22nd January. The vessel sailed to the north coast of SG where it worked for 19 days (28th January to 16th February, Fig. 2) before returning to Stanley on Wednesday 21st February (a total of 31 days sailing). There were eight researchers onboard and three crew members. All data collection was carried out under permit RAP/2017/017 issued by the Government of South Georgia and the South Sandwich Islands (Islas Georgias del Sur y Islas Sandwich del Sur) following review and approval of all data collection approaches by the BAS Animal Welfare and Ethics Review Board (review #1040).

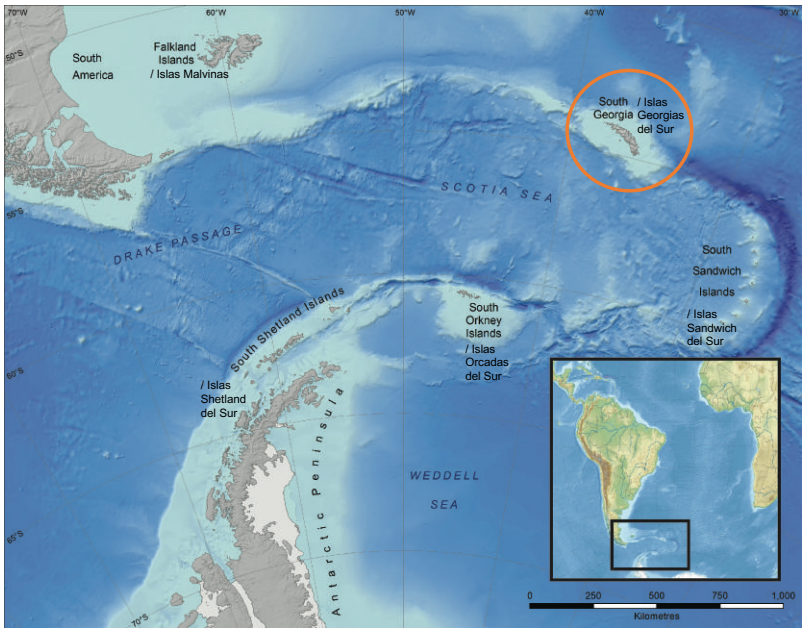


**Fig 1.** Location of field survey. For vessel tracks, see Fig. 2.

**Visual observations and image collection**

Visual observations were carried out by two observers from the deck and one from a raised platform (A-frame) near the stern of the vessel during daylight hours when the boat was underway and when conditions allowed. Data were collected on vessel speed and heading, wind speed and direction, sea state, weather conditions and visibility using the Logger data collection software[1]. These data were updated every hour, or if sea state or visibility conditions changed. Visual effort was classified into different categories depending on the information being used to select the vessel track. For much of the time around SG, the vessel track was chosen based on acoustic detections and so could not be considered as random searching.

When cetaceans were sighted, data were recorded on species identity, group size (minimum, maximum and likely number of individuals), GPS position, vessel speed and heading, and animal bearing from the ship. Sightings for which species identification was not possible were classified to the lowest taxonomic level possible.

Photographs were taken from all right whale sightings in order to identify individuals (Payne et al. 1983; Kraus et al. 1986; Patenaude and Baker 2001). When possible, photographs for species and individual identification purposes were attempted for all baleen whale species (Hammond 1990).

Prior to and during the expedition we also promoted the collection of SG southern right whale images within the International Association of Antarctic Tour Operators tourist and naturalist cruise-going community via informative lectures, circulation of leaflets and through social media outlets, requesting submission of any right whale images to www.happywhale.com for subsequent matching with the catalogue.

**Passive acoustic monitoring and tracking of Southern right whales**

DIFAR sonobuoys (Ultra Electronics HIDAR units) were used to acoustically locate and track southern right whales in real time, and to record their vocalisations. DIFAR sonobuoys contain an omnidirectional acoustic pressure sensor and two orthogonal acoustic vector sensors that are directional in the horizontal plane (Greene et al. 2004; McDonald 2004). Sonobuoy signals were received by VHF radio onboard the research vessel, digitised, recorded, processed using PAMGuard (Gillespie et al. 2008), and the DIFAR bearings to calls resolved as described by Miller et al. (2015; 2016). Continuous recordings were made at a sample rate of 48,000 samples per second, and data from all buoys were monitored visually and aurally by an on-duty acoustician for the full duration of each deployment.

VHF signals were received using a Procom CXL 2-3LW/s omnidirectional antenna tuned to the 137-150MHz frequency band giving a gain of 3dBd. The antenna was initially mounted at the top of the mast at a height of 33m, giving an effective reception range to the sonobuoys of around 20km. Problems with the mast head fitting meant that the antenna had to be moved to a fiberglass pole with a height to the base of the antenna of 9.4m. This reduced the effective reception range to 12km. A standard marine band VHF at the masthead gave less good reception at 12km than the lower dedicated antenna, despite the height advantage. Reception ranges of around 20km appear to be the maximum for this type of sonobuoy suggesting that this reception range is limited by the power of the signal rather than the height of the antenna. Sonobuoys were deployed in up to around 35 knots of wind. In higher wind

[1] The Logger software was developed by the International Fund for Animal Welfare (IFAW) to promote benign and non-invasive research

speeds background noise levels were considered too high for effective monitoring. Sonobuoy hydrophones were deployed to either 30m or 140m depending on the water depth. Hydrophones were deployed to 140m whenever the depth of water was greater than 200m, otherwise they were deployed to 30m.

Buoys were primarily deployed either overnight to allow the vessel to move to areas where right whales had been detected by the commencement of visual observations in the morning, or in response to right whale sightings to enable the acoustic tracking and recording of right whale vocalisations. As the vocalisations of southern right whales had not previously been described on their feeding grounds, it was necessary to characterise their acoustic repertoire, and attempt to differentiate them from humpback whales, which are also present in SG waters. This was achieved when acoustic bearings could be followed until the animals were located visually, or when the bearings to received calls could be lined up with known whale locations during a sighting.

A towed array hydrophone containing two Benthos AQ4 elements with sensitivity up to around 30kHz at 7.7m spacing was also deployed 100m astern of the vessel on passage between the Falkland Islands/Islas Malvinas and SG. This enabled an acoustic survey of the passage route to be conducted and also, close to SG, indicated where sonobuoys could be deployed if vocalisations of interest were detected on the towed array. Continuous recordings were made using PAMGuard (Gillespie et al. 2008) at a sample rate of 96,000 samples per second.

One sonobuoy (number 22) was deployed directly above a moored sonovault recorder installed by BAS in order to compare received signals.

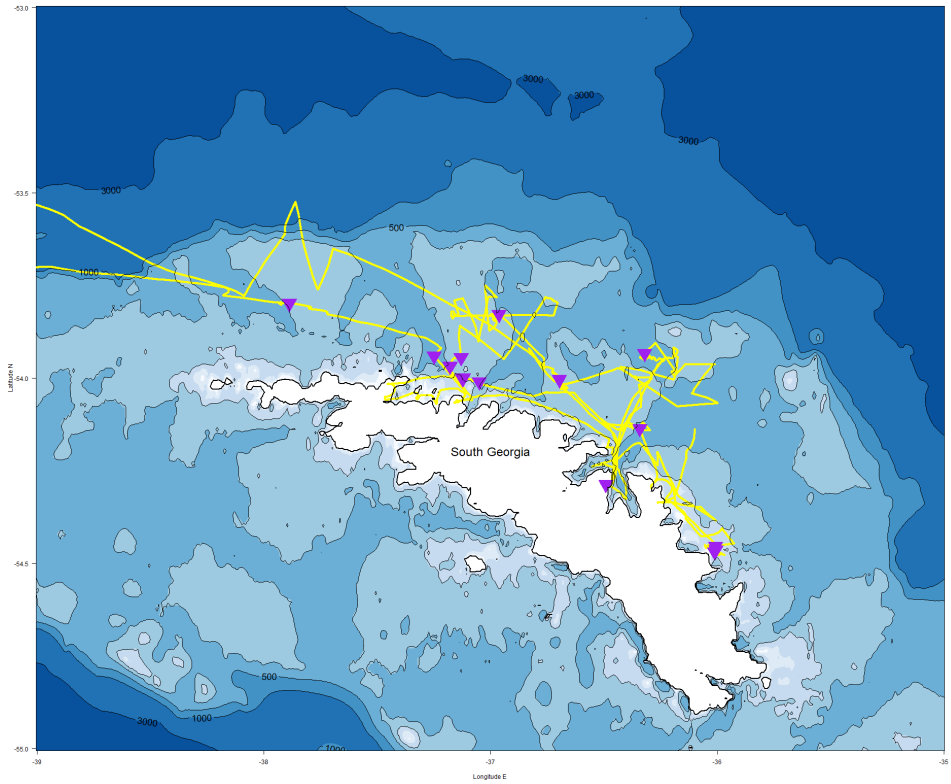


**Figure 2.** Vessel tracks (yellow lines) and southern right whale visual sightings (purple triangles).

**Biopsy sample collection**

Skin biopsy samples, for genetic, isotopic and hormone analysis, were collected using small, stainless steel biopsy darts deployed from a crossbow (Lambertsen 1987) or a Paxarm modified veterinary capture system (Krützen et al. 2002). During biopsy collection operations, one or two trained biopsiers were stationed on the bow of the vessel in order to maximize sampling opportunities. After a biopsy attempt, darts and/or samples were retrieved via tether system reel or a dip net. Skin biopsy samples were divided into subsamples for genetics, stable isotope and hormone analysis, and stored in 95% ethanol or frozen at -80°C, respectively.

**Other data collection**

Two unmanned aerial vehicles (UAV; APH-22 and Inspire-1) were brought onto the vessel for the purposes of collecting calibrated whale overhead images for body condition analysis and collection of microbiome samples. Unfortunately, weather conditions never permitted safe deployment of these UAV and no samples or images were collected. The cruise plan was designed to facilitate the deployment of satellite monitored positioning tags on up to 12 right and 6 humpback whales, yet no tags could be deployed due to prolonged periods of high wind and seas.

The BAS Western Core Box cruise (JR17002) was in operation December to January 2017/18 in western SG waters and collected samples of a range of zooplankton. These have been stored frozen for the purposes of isotope analysis and results will be compared with right whale skin isotopes to identify right whale feeding sources.

One krill swarm was visually observed near the sea-surface during the survey period and a sample was collected by dip net for subsequent isotope analysis.

**RESULTS AND DISCUSSION**

Within the 19-day period spent in the vicinity of SG (including arrival and departure days), there were 76 hours of time (during a total of 12 days at sea) during which conditions were suitable for visual observations, either searching for or working with whales. One day was spent in harbour for logistical reasons, and six additional days of strong winds prevented any research work.

In total, there were 36 cetacean sightings throughout the survey, including transit leg observations (see Table 1). Right whales were sighted 15 times (an estimated 31 right whales), and 1,617 images were collected during right whale encounters. These images yielded 21 right whale photo-identifications (left and right sides). Work is now underway to assess the body condition of the whales sighted during the cruise. Analysis of right whale sightings data in relation to oceanographic features is also in progress.

Humpback whales were sighted twice, and 209 images were collected. None of the humpback whales presented the ventral side of their fluke and so only dorsal images were collected. One sighting of three individual Antarctic blue whales yielded 45 photographs. There were sufficient high-quality images for the identification of two whales in the group. Cross-reference of these photographs with the Antarctic blue whale catalogue did not result in matches. Additionally, 190 fin whale images were collected. The fin whale images were taken in poor light conditions and so were not of sufficient quality for matching.

Three opportunistic right whale sightings from tourist vessels yielded high-quality photos and were submitted to happywhale.com. These opportunistic images are being

matched against our catalogue. Image matching is also currently underway with the catalogues from right whale calving grounds in Argentina, Brazil and South Africa (V. Rowntree, M, Sironi, K. Groch and E. Vermeulen, pers. comm.).

Biopsy sampling was attempted seven times on six right whales and one humpback whale. Four biopsy samples were collected (from three right whales and one humpback whale). One sample was not large enough to be divided and was retained for genetic analysis only, and the other three provide sufficient tissue for both stable isotope and genetic analysis. No sample provided sufficient blubber for hormone analysis. Genetic and isotope work will be carried out at the University of St Andrews and the British Antarctic Survey, respectively, later in the year.

| **Scientific name** | **Common name** | **Total individuals** | **Total sightings** | **Mean group size** | **Group size range** | **Photo-ID collected?** |
|---|---|---|---|---|---|---|
| **Mysticetes** | | | | | | |
| *Eubalaena australis* | Southern right whale | 31 | 15 | 2.1 | 1-7 | Y |
| *Megaptera novaeangliae* | Humpback whale | 6 | 2 | 3 | 2-4 | Dorsal only |
| *Balaenoptera physalus* | Fin whale | 7 | 1 | 7 | 5-9 | Y (too dark for good ID) |
| *Balaenoptera musculus intermedia* | Antarctic blue whale | 3 | 1 | 3 | 3 | Y |
| *Balaenoptera bonaerensis* | Probable Antarctic minke whale | 1 | 1 | 1 | 1 | N |
| Unidentified mysticete | | 5 | 4 | 1.25 | 1-2 | N |

**Table 1.** Total individuals, group sizes and sightings for each species encountered in South Georgia waters

Twenty-seven sonobuoys were deployed between January 25$^{th}$ and February 17$^{th}$ in the western approaches to SG and in locations around the northern coastline and shelf. All of the 27 buoys deployed functioned correctly. Southern right whales were detected on 19 buoys (Fig. 3), the most commonly heard call types being upcalls <200 Hz (Fig. 4), and also some gunshots (Fig. 5). Both of these have previously been described from North Pacific and North Atlantic right whales on calving and feeding grounds and southern right whales on calving grounds (Mellinger et al. 2007; Munger et al. 2008; Parks et al. 2011; Matthews et al. 2014; Soldevilla et al. 2014; Širović et al. 2015; Webster et al. 2016; Crance et al. 2017; Dombroski et al. 2017). In addition to right whales, Antarctic blue whales, fin whales, humpback whales, sperm whales and killer whales were also acoustically detected on the sonobuoys (see Table 2). A total of 85.5 hours of recordings were made, and around 3,500 calls were clipped and processed to calculate their bearings. In addition to deploying sonobuoys to search for whales, some buoys were deployed close to groups in order to match visual and acoustic observations. Most of the right whale sightings were located based on following acoustic bearing lines from the sonobuoys. Call rates were generally low, with periods of silence of several hours, making triangulation using multiple buoys

challenging. Nevertheless, the system demonstrated that acoustics substantially increases encounter rates. Further analyses are underway to describe the characteristics of southern right whale vocalisations around SG.

During part of the study period a geophysical survey using an airgun array was being conducted from the RRS Discovery to the north of SG including the Maurice Ewing bank. Regular pulses at 10s intervals were detected on a number of buoys and will be analysed to compare received levels with distance and relative orientation to the airgun array.


## ACKNOWLEDGEMENTS

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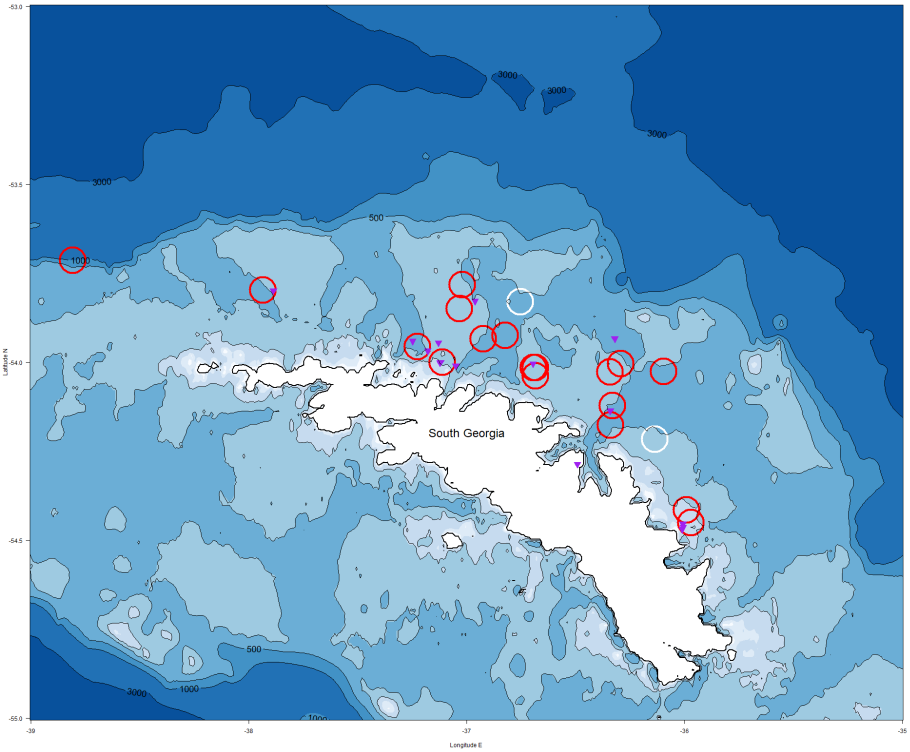


**Figure 3**. Locations of sonobuoys where right whales were detected (red circles) or no detections (white circles). Purple triangles indicate right whale sightings.

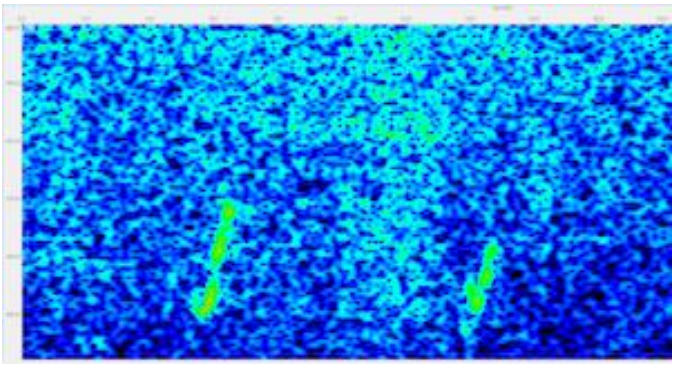

**Figure 4.** Sonogram of right whale upcalls

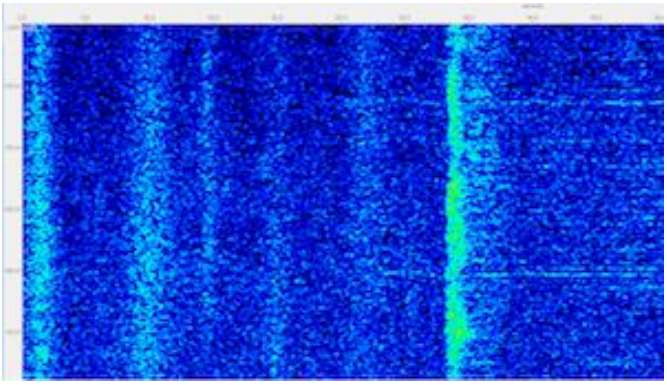

**Figure 5.** Sonogram of right whale gunshot

| Buoy number | Sonobuoy Start Time | Latitude | Longitude | Duration (hh:mm) | Right whale | Humpback whale | Blue whale 26Hz | Blue whale FM call | Fin whale | Sperm whale | Seismic air gun | Killer whale |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 25/01/2018 15:24:21 | -52.7022 | -47.8751 | 02:29 | - | - | Definite | - | Definite | - | - | - |
| 2 | 27/01/2018 02:22:21 | -53.3378 | -42.7595 | 03:04 | - | - | Definite | Definite | - | - | - | - |
| 3 | 28/01/2018 02:03:45 | -53.4142 | -39.5345 | 03:18 | - | - | Definite | - | Definite | - | - | Probable |
| 4 | 29/01/2018 09:06:50 | -54.0148 | -36.693 | 04:44 | Definite | Definite | - | - | - | - | - | - |
| 5 | 03/02/2018 12:10:41 | -54.1765 | -36.3399 | 01:31 | Probable | - | - | Definite | - | - | - | - |
| 6 | 04/02/2018 08:17:00 | -54.216 | -36.1359 | 03:35 | - | - | Definite | Definite | - | - | - | - |
| 7 | 05/02/2018 12:56:57 | -54.4151 | -35.9904 | 01:01 | Definite | - | Definite | Definite | - | - | Definite | - |
| 8 | 05/02/2018 14:05:32 | -54.4503 | -35.9705 | 05:29 | Probable | - | Definite | Definite | - | - | Definite | - |
| 9 | 06/02/2018 13:56:38 | -54.122 | -36.3317 | 05:39 | Probable | Probable | Definite | Definite | - | - | - | - |
| 10 | 06/02/2018 19:38:07 | -54.0269 | -36.342 | 06:03 | Definite | Probable | Definite | Definite | - | - | - | - |
| 11 | 07/02/2018 04:26:41 | -54.0255 | -36.0958 | 03:57 | Probable | - | Definite | Definite | Definite | - | - | - |
| 12 | 09/02/2018 00:21:40 | -54.0038 | -36.2926 | 02:56 | Definite | Probable | Definite | Definite | - | - | Definite | - |
| 13 | 09/02/2018 04:11:56 | -54.0152 | -36.6848 | 04:24 | Definite | - | Definite | - | - | - | Definite | - |
| 14 | 09/02/2018 05:51:51 | -53.9247 | -36.8244 | 02:45 | Definite | - | Definite | Definite | - | - | Definite | - |
| 15 | 09/02/2018 11:36:59 | -53.7827 | -37.0201 | 06:03 | Definite | Definite | Definite | Definite | - | Probable | Definite | - |
| 16 | 09/02/2018 14:27:10 | -53.8487 | -37.0337 | 06:03 | Definite | Definite | Definite | Definite | Definite | Probable | Definite | - |

| Buoy number | Sonobuoy Start Time | Latitude | Longitude | Duration (hh:mm) | Right whale | Humpback whale | Blue whale 26Hz | Blue whale FM call | Fin whale | Sperm whale | Seismic air gun | Killer whale |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | 09/02/2018 21:55:25 | -53.8306 | -36.7553 | 06:02 | - | Definite | Definite | Definite | - | Definite | Definite | - |
| 18 | 10/02/2018 05:37:36 | -53.9345 | -36.9233 | 02:56 | Probable | Probable | Definite | Definite | - | - | Definite | - |
| 19 | 12/02/2018 11:37:58 | -54 | -37.1129 | 03:47 | Definite | - | - | - | - | - | - | - |
| 20 | 12/02/2018 16:44:37 | -54.0387 | -36.6855 | 01:11 | Definite | - | - | Definite | - | - | - | - |
| 21 | 16/02/2018 15:41:00 | -53.9563 | -37.2263 | 01:38 | Definite | Probable | - | Definite | - | - | - | - |
| 22 | 16/02/2018 21:34:17 | -53.7978 | -37.9347 | 00:57 | Definite | Probable | Definite | Definite | Definite | - | - | - |
| 23 | 17/02/2018 02:32:50 | -53.7135 | -38.8081 | 00:58 | Definite | - | Definite | - | - | - | Definite | - |
| 24 | 17/02/2018 07:14:02 | -53.6988 | -39.6601 | 01:13 | - | - | Definite | - | - | - | Definite | - |
| 25 | 17/02/2018 12:52:49 | -53.3924 | -40.4107 | 01:12 | Probable | - | Definite | - | - | - | Definite | - |
| 26 | 17/02/2018 18:18:37 | -53.0927 | -41.0736 | 01:27 | - | - | Definite | - | - | - | Definite | - |
| 27 | 17/02/2018 21:53:15 | -52.8229 | -41.3668 | 00:57 | - | - | Definite | - | - | - | Definite | - |

**Table 2.** Sonobuoy deployments and species detections

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