FY20 Summary Report on the Collaborative Beaked Whale Cruise off Baja California, Mexico

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EXECUTIVE SUMMARY

This report summarizes the field effort from 15 – 28 November, 2020, to locate and document a species of beaked whales that had previously only been acoustically detected. While the species of interest was again recorded on acoustic drift buoys, a previously undescribed species of beaked whale was unexpectedly encountered instead. This new species has external morphological characteristics and a new echolocation pulse type that do not match any previously observed or recorded species and therefore may represent a newly described species. In addition to this species of beaked whale, we encountered and photographed three species of dolphin as well as humpback whales, and recorded two other species of beaked whales on the acoustic recorders.

ACRONYMS

BW43	Beaked whale echolocation pulse with 43 kHz center frequency
BWB	Beaked whale echolocation pulse recorded off Baja
DASBR	Drifting Acoustic Spar Buoy Recorders
eDNA	environmental DeoxyriboNucleic Acid
NMFS	National Marine Fisheries Services
SSCS	Sea Shepherd Conservation Society

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14. ABSTRACT
This report summarizes the field effort from 15 – 28 November, 2020, to locate and document a species of beaked whales that had previously only been acoustically detected. While the species of interest was again recorded on acoustic drift buoys, a previously undescribed species of beaked whale was unexpectedly encountered instead. This new species has external morphological characteristics and a new echolocation pulse type that do not match any previously observed or recorded species and therefore may represent a newly described species. In addition to this species of beaked whale, we encountered and photographed three species of dolphin as well as humpback whales, and recorded two other species of beaked whales on the acoustic recorders.

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1. Introduction

Echolocation pulses from an unknown species of beaked whale were first described by Baumann-Pickering et al. (2013) based on recordings made off Southern California, largely in the US Navy's Southern California Offshore Range. These pulses have peak frequency of 43.4 kHz, a duration of 395 µs, an inter-pulse interval (IPI) of 0.217 s and, like other beaked whales, have a frequency upsweep (Baumann-Pickering et al. 2013). These pulses, known as BW43 based on their peak frequency, had previously only been recorded off Southern California (including far offshore at Hoke Seamount) (Baumann-Pickering et al. 2014; Keating et al. 2017), however, in 2018 many BW43 signals were also identified from the US Mexico border southward to mid-Baja California (Figure 1). Based on the limited geographic range of BW43 signals and the overlap of this range with the limited range of Perrin's beaked whale (*Mesoplodon perrini*, known only from strandings in Southern California), Baumann-Pickering et al. (2014) proposed that BW43 may be produced by Perrin's beaked whale. To date, this has never been validated with a recording made near a confirmed sighting or DNA sample.

Figure 1 - Map of DASBR deployments (red tracks) from the 2018 NMFS acoustic survey, with BW43 detections marked as yellow diamonds. Four waypoints are also identified with purple squares; those were the planned locations for DASBR deployments in the current effort.

An expedition was planned for November, 2020, off Baja California, Mexico in the area of the highest BW43 detections from 2018 (Figure 1) with a primary goal of visually and acoustically detecting the BW43 beaked whale, and getting a genetic sample via biopsy or environmental DNA (eDNA) sample if possible. Secondary goals included (1) evaluating the anchorage at Las Islas San Benito to determine if that might be a good sheltered base for this and future efforts in the area, and (2) opportunistically photographing baleen whales, particularly migrating humpback whales (*Megaptera novaeangliae*) off the northwestern tip of Baja Sur.

2. Methods

A collaborative expedition was planned between Mexico- and US-based researchers and the Sea Shepherd Conservation Society (SSCS) for November 2020, a month of relatively calm seas in the area of interest. SSCS donated the use of the R/V Martin Sheen, an 63.9-foot sailboat, as the live-aboard research platform. The cruise plan included a departure from Ensenada Harbor on 14 November, and the deployment of four Drifting Acoustic Spar Buoy Recorders (DASBRs) at the four waypoints in Figure 1 during the transit down to Islas San Benito and Bahia Tortugas. If weather was good, some days would be spent between waypoints 1 and 2 in order to visually search for beaked whales. Once weather conditions deteriorated, the ship would continue transiting south to waypoints 3 and 4, and on to Islas San Benito. A personnel transfer was planned for 21 November at Bahia Tortugas; this allowed for a few days of concentrated effort on photographing migrating humpback whales in the area. Weather conditions would determine where the remainder of the effort was focused, with a return to Ensenada Harbor no later than 30 November, retrieving the DASBRs along the way.

There were four DASBRs onboard, each with a multi-channel SoundTrap ST4300 recorder (made by Ocean Instruments http://www.oceaninstruments.co.nz/), an HTI-92-WB hydrophone, and an HTI-96-min hydrophone. The stereo hydrophones (at ~140 and 145 m depths) allowed for horizontal localization of acoustic signals. These could sample continuously to 288 kHz for up to seven days (Figure 2). Two additional single-channel SoundTrap ST300HF systems were available for shorter-term recordings and were attached to smaller spar buoys at depths of 10 m, which could easily be deployed when a group of beaked whales was encountered. These had radio-frequency location tags attached that allowed the vessel to track the buoys up to 4 km away.

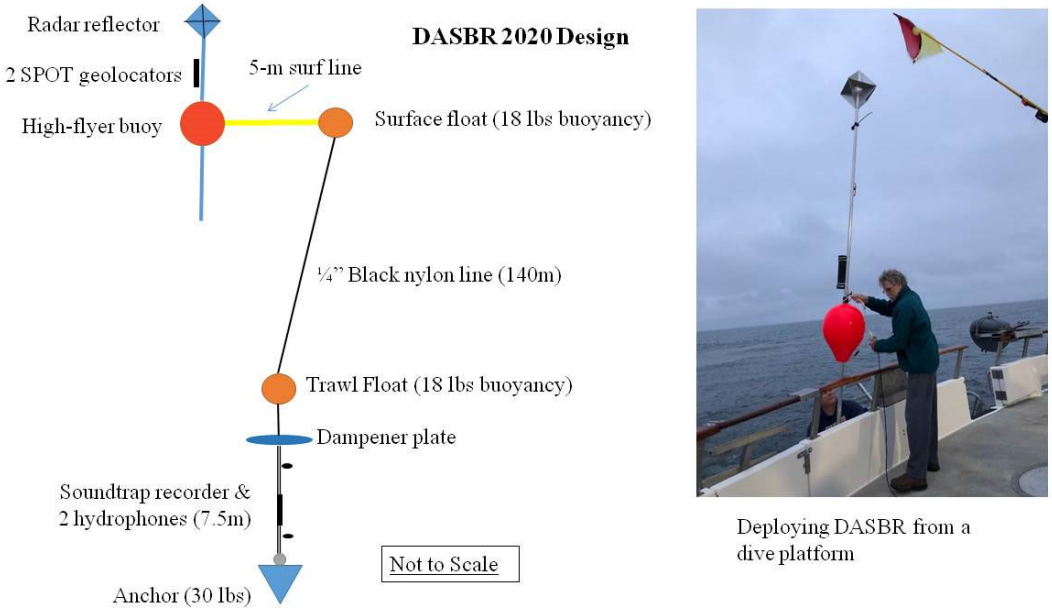

Figure 2 - Diagram of the DASBR highlighting each of the components, including the Soundtrap recorder and two hydrophones.

Three visual observers were stationed on the foredeck of the vessel from sunrise (approximately 6:00 PST) to sunset (approximately 17:30 PST) every day that weather conditions allowed for visual observations. Observers were stationed on the port and starboard sides to visually scan abeam of the ship, while a third observer scanned from -90 to 90 degrees at the fore of the ship. Observer positions were rotated every half hour, and the weather conditions were updated at each half hour rotation time. When an individual or group of cetaceans was observed, sighting information was recorded including the start time, start latitude and longitude, species, best estimate of group size (including a minimum, maximum, and best size estimate), group behavior, and any other behavioral observations. Photographs were taken of individual dorsal fins (for dolphins) or flukes (for humpback whales) when possible. For all species other than beaked whales, once the species and group size had been confirmed and photographs had been taken, the sighting was terminated with a final time and position update. Beaked whale groups were followed for as long as possible, with the panga (25-foot fiberglass fishing boat) deployed when possible to get close to the group for photographs and biopsy or eDNA samples.

3. Results and Discussion

The expedition took place from 15 – 28 November 2020, with six crew members from SSCS, two observers from Mexico and three observers/acousticians from the US. DASBRs were deployed a total of 6 times; four at-or-near the pre-determined waypoints from Figure 1, and two in proximity to the sighting location of the beaked whale group (see below).

All marine mammal sightings are reported in Table 2. A total of 31 groups were observed, including three confirmed species of delphinid (common dolphins [*Delphinus delphis,* Dd or Dsp]; bottlenose dolphins [*Tursiops truncatus*, Tt]; and Pacific white-sided dolphins [*Lagenorhynchus obliquidens,* Lo]), one confirmed species of baleen whale (humpback whales, Mn), and one group of beaked whales (recorded as UBW, or unidentified beaked whales). A high concentration of common and Pacific white-sided dolphins were encountered near Bahia Tortugas, although some groups of common dolphins were also encountered in open waters throughout the expedition. A catalog of 18 unique humpback whale flukes was developed, and the photographs were uploaded to Happywhale (happywhale.com, Cheeseman et al. in press), an online repository for humpback whale flukes with an internal matching algorithm that matches fluke photographs from all over the world. At least 12 individuals were matched within the Happywhale catalog, with most whales observed along the west coast of the US and down to Mexico. One humpback whale had been observed as far south as Nicaragua earlier in 2020, and another had been observed as far north as the Aleutian Islands in Alaska in 2004 and again in Hawaii in 2019.

Table 1 – DASBR deployment information.

DASBR Drift #	DASBR/Buoy	Recorder Type/ID	Deployment Time	End Recording Time	Recording Duration
1	4	ST4300-G-128	11/16/20 14:26	11/21/20 8:42	4.75
2	8	ST4300-K-256	11/17/20 0:48	11/21/20 20:07	4.80
3	Pole	ST300HF	11/17/20 15:00	11/17/20 23:56	0.40
4	Pole	ST300HF	11/17/20 17:30	11/17/20 23:29	0.25
5	5	ST4300-F-128	11/17/20 19:02	11/18/20 20:20	1.05
6	7	ST4300-I-128	11/17/20 19:26	11/18/20 20:05	1.03
7	7	ST4300-I-128	11/19/20 1:02	11/22/20 0:14	2.97
8	5	ST4300-F-128	11/19/20 16:07	11/22/20 19:43	3.15
9	Pole	ST300HF	11/27/20 0:00	11/27/20 0:53	0.04

Table 2 - Sighting Table for 15 – 27 November, 2020 marine mammal sightings. Note the * indicates that this group was initially thought to be dolphins but was most likely the unidentified beaked whale group. NR = Not Recorded.

Date	Start Time	Latitude	Longitude	Sighting	Species	Est Size Min	Est Size Max	Est Size Best
11/15/20	14:37	31 50.58	-116 37.95	1	Tt	2	4	2
11/15/20	16:36	31 43.76	-116 46.48	2	Mn	3	4	3
11/16/20	7:06	30 03.00	-117 00.31	1	UMC	1	1	1
11/16/20	7:50	30 00.91	-116 59.19	2	Dd	10	20	15
11/17/20	6:08	29 33.16	-116 24.18	1	UD*			
11/17/20	6:15	29 33.13	-116 24.15	2	UBW	3	5	3
11/20/20	6:24	28 06.34	-115 25.04	1	UW	1	1	1
11/20/20	11:27	27 51.23	-115 08.95	2	Mn	2	2	2
11/20/20	11:27	27 51.21	-115 08.95	3	Mn	2	2	2
11/20/20	11:35	27 50.71	-115 09.63	4	Mn	3	3	3
11/20/20	11:56	27 49.66	-115 11.08	5	Dsp	5	5	5
11/20/20	13:27	27 47.10	-115 07.95	6	Lo	2	2	2
11/20/20	14:52	27 42.73	-115 01.43	7	Lo	50	75	65
11/20/20	15:17	27 37.85	-114 54.86	8	Mn	5	6	5
11/20/20	15:48	27 38.71	-114 56.41	9	Dc	200	300	250
11/21/20	6:46	27 39.46	-114 55.25	1	Dsp	40	65	50
11/21/20	8:17	27 44.05	-115 03.18	2	Mn	1	1	1
11/21/20	10:47	27 48.30	-115 07.82	3	Mn	2	2	2
11/21/20	10:55	27 48.83	-115 08.16	4	Mn	5	5	5
11/24/20	9:32	29 14.22	-117 01.80	1	Dsp	5	5	5
11/24/20	12:55	NR	NR	2	UD	20	60	40
11/25/20	8:24	NR	NR	1	UD	40	100	80
11/25/20	9:03	NR	NR	2	UD	100	300	200
11/25/20	14:55	NR	NR	3	UD	5	10	7
11/26/20	8:10	NR	NR	1	Mn	1	1	1
11/26/20	11:26	NR	NR	2	ULW	1	1	1
11/26/20	13:05	NR	NR	3	Mn	2	2	2
11/26/20	14:20	NR	NR	4	ULW	1	2	2
11/26/20	15:42	NR	NR	5	UC	1	3	3
11/26/20	15:54	NR	NR	6	Mn	1	1	1
11/27/20	14:44	NR	NR	1	UD	20	100	60

3.1 Beaked whale sighting

On 17 November 2020, at 6:08 in the morning, what was first thought to be a small group of delphinids was observed just as the visual observers were coming on deck for the day. The sighting location was over an undersea ridge with a water depth of ~900 m and a steep slope (Figure 5). The R/V Martin Sheen was asked to circle the area slowly as the group disappeared shortly after being sighted. Just as the vessel was about to resume its original track, the group surfaced again at 6:15 and was identified as a group of 3 – 5 (later confirmed as 3 animals) beaked whales. This group continued to surface near the vessel for brief periods of 1-2 minutes, with intermittent dives of 5-11 minutes. The two smaller acoustic buoys with single channel Soundtraps were deployed at ~6:30 and XX, and a diver entered the water at ~6:43 to record underwater video of the group. At ~6:50, the group of beaked whales started moving away from the ship, and so the panga was deployed to try to get closer to the group for a biopsy or eDNA sample. The group was approached in the panga at three additional surfacings, but we were unable to get close enough for a biopsy sample or any additional photographs before the group dove on what was likely their long, deep, foraging dive. Water samples were taken at the dive footprints of each of the final three dive locations for eDNA (Figure 3). The two DASBRs were deployed after the encounter was completed (Table 1). The panga and R/V Martin Sheen circled the area for three more hours to try and observe the animals surfacing after their long foraging dive, but the whales were not observed again. The smaller recording buoys were recovered at the end of the day, but no acoustic detections of any beaked whales were found. The DASBRs recorded overnight, and were recovered the next day. It was determined that a new beaked whale pulse type was recorded within 8 hours of our sighting and within a few kilometers; additional pulses of this type were also recorded later in these deployments (Figure 4), as well as on other DASBR deployments throughout the trip (Figure 5). In addition, detections of the BW43 click type (Figure 5) and Cuvier's beaked whales (*Ziphius cavirostris*) were also recorded (Figure 4 and 6) during the trip.

Figure 3 – Water sample taken at the last dive location of the BWB group for an eDNA sample.

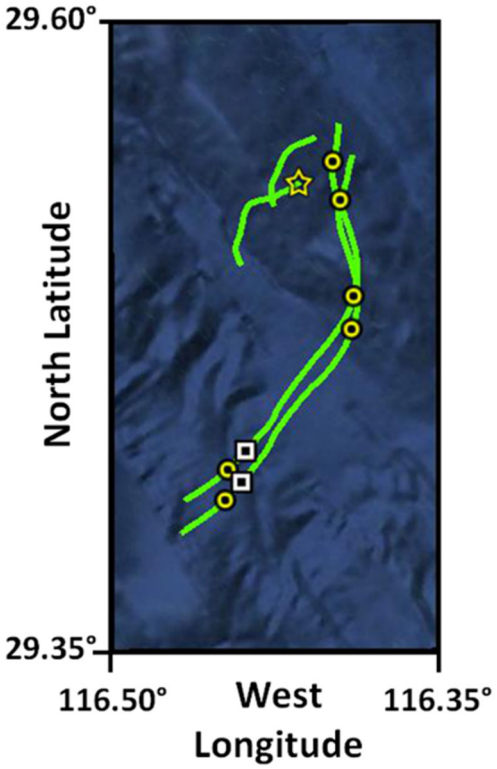

Figure 4 – The location of the encounter with the BWB beaked whale on November 17, 2020 (yellow star), along with the drift tracks of the four acoustic recorders (green lines), and recording locations of the BWB echolocation pulses on 17-18 November 2020 (yellow circles). Detections of a Cuvier's beaked whale are also included (white squares).

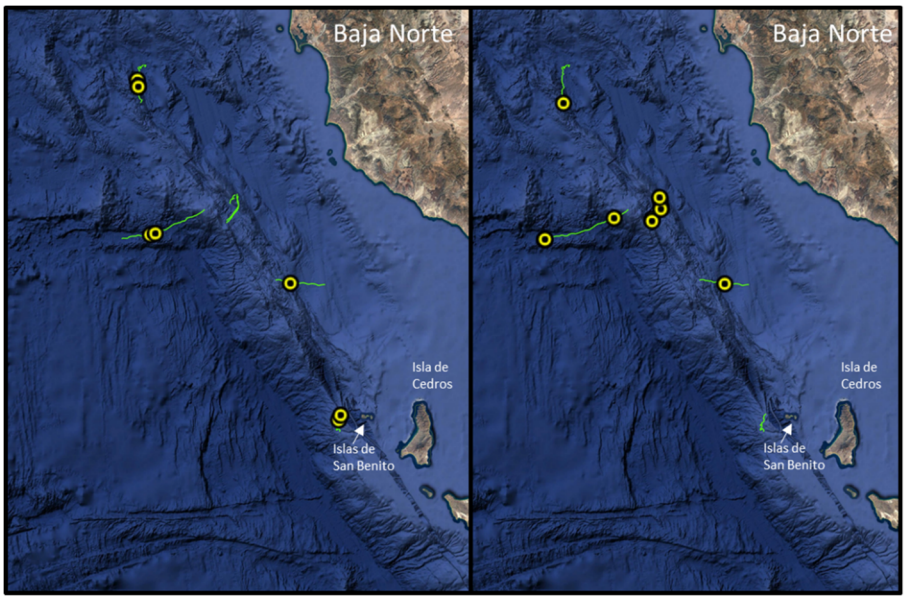

Figure 5 – DASBR drift tracks (in green, identical on both plots) with BW43 detections (left plot) and BWB detections (right plot) from 16-27 November, 2020.

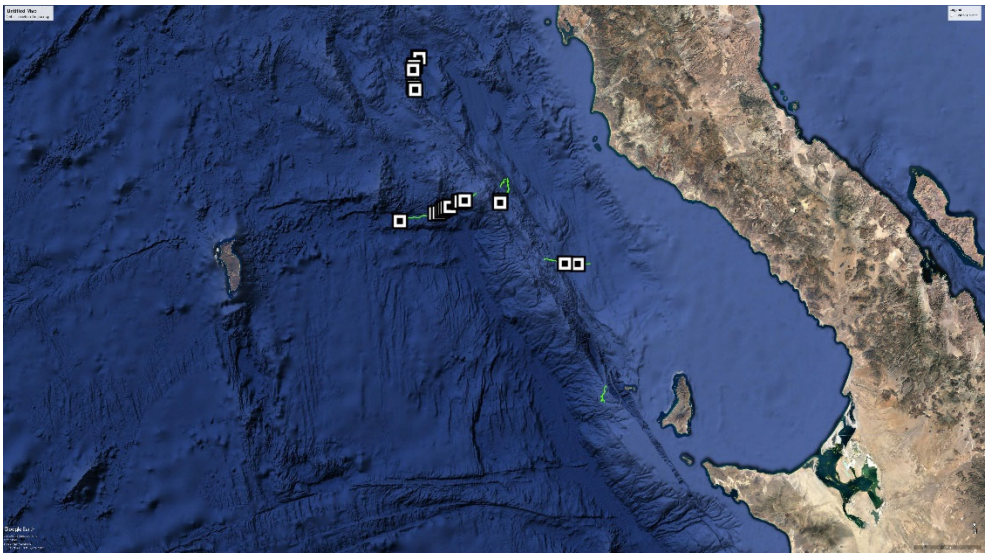

Figure 6 – DASBR drift tracks in green, with detection location of Cuvier's beaked whales in white squares.

Upon review of the photographs (Figure 7), it was determined that the beaked whale group was not Perrin's beaked whales, as was expected, nor did their color patterns and teeth location match that of any other described beaked whales. The erupted teeth in the male were at the midway point along the lower rostrum and were fairly small. The animals had falcate dorsal fins and short beaks, and were relatively small (~4 -5 m length). They had dark grey-brown shading along the dorsal side from the tip of the rostrum all the way back along the body, with a darker "cape" line extending down the midline of the body and lighter grey coloring along the entire ventral surface. The eye area was dark, with a dark band of color extending from the eye and over the head behind the blowhole (Figure 8).

The echolocation pulse, although it initially appeared to be similar to the BW43 pulse in that they have a similar peak frequency of about 40 kHz, was found to be distinct with the inclusion of two additional peaks (at about 23 kHz and 12 kHz) and a "notch" at about 30 kHz. The inter-pulse interval (IPI) was 0.2 s, and the click duration was about 250 ms (Figure 8). See Barlow et al. (in prep) for more details on the morphology and echolocation pulse and a comparison with other beaked whale species.

The combined evidence of the external morphology and the new echolocation pulse type recorded in temporal and spatial proximity of the sighting led us to the conclusion that this may be a previously undescribed species of beaked whale. For now, we are referring to it as BWB (BW Baja). The results of the eDNA samples are on hold until the NMFS genetics labs can reopen; they are currently closed due to COVID-19 restrictions. An initial check of the 2018 NMFS DASBR data has revealed that BWB echolocation pulses were also present in those recordings and were misclassified as BW43. It is also possible that some of the pulses classified as BW43 or BW40 in Baumann-Pickering et al. (2013) were also BWB clicks that were misclassified. A review of these previous data is warranted to determine the potential extent of the distribution of BWB beaked whales. In addition, it is possible that BWB strandings

have occurred along the Baja peninsula and as far south as mainland Mexico; an investigation of beaked whale skulls that have been recovered in Baja should be conducted to determine if a skull exists for this species that could serve as a holotype. If this whale has a similar distribution as the BW43 beaked whale, it could extend into southern California waters and also be present on active Navy ranges. In fact, some of the detections of BWB clicks from the 2018 effort did occur on the extended southern California Navy range complex. Therefore, trying to identify this species and get additional data is of critical importance.

Figure 7 – Photographs of the unidentified *Mesoplodon* species encountered off Baja, Mexico on 17 Nov 2020. Unique markings include the darker band from the eyes across the head, dark lip line, lighter ventral coloring extending up the side of the body with a darker lateral band, and lighter coloring in front of and behind the dark eye area. The tooth in the male is located midway along the moderately arched jaw, and the dorsal fin is falcate (Taken from Barlow et al. submitted).

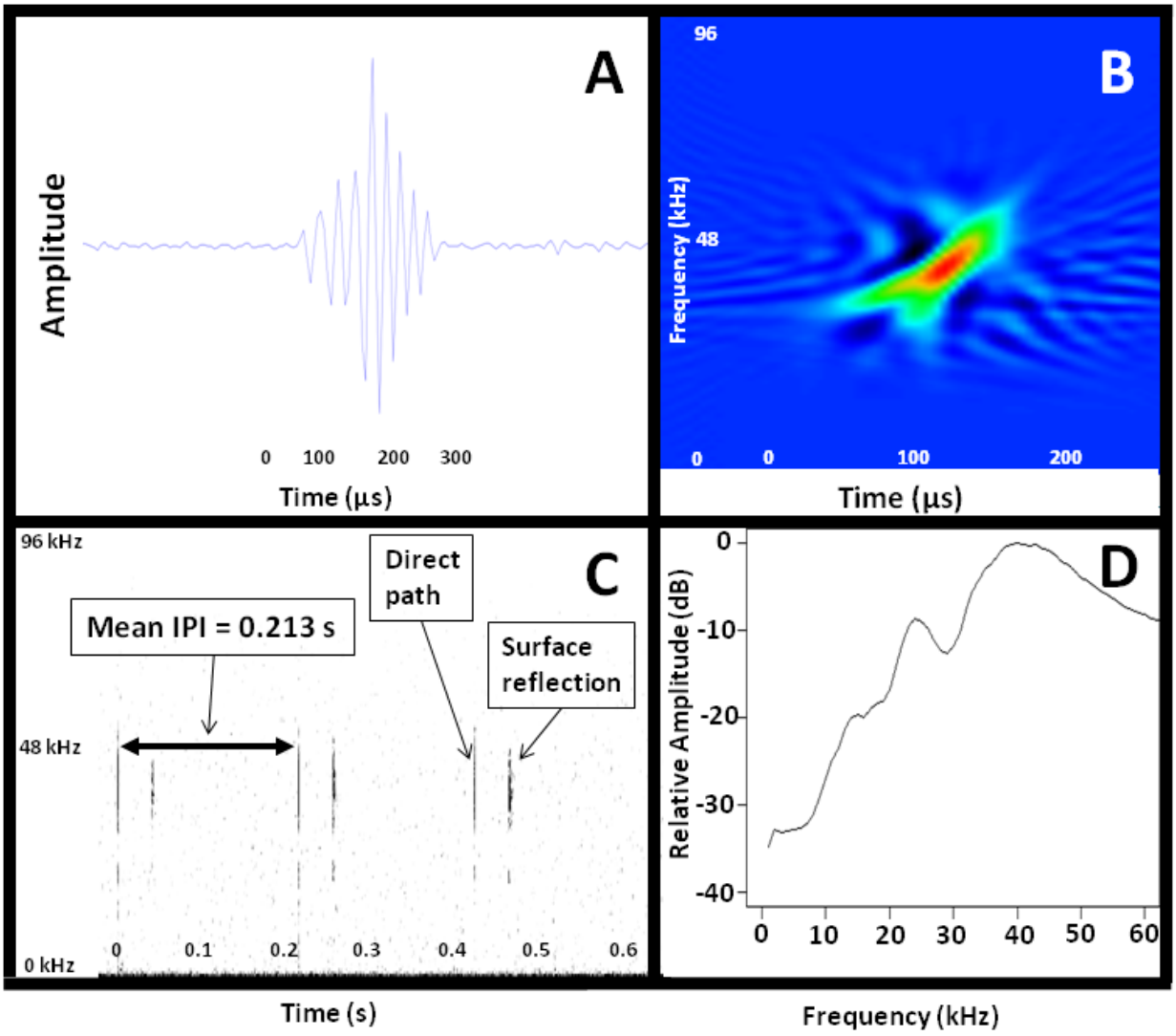

Figure 8 – Acoustic characteristics of the BWB echolocation pulse recorded in the vicinity of the beaked whale sighting. Waveform and Wigner-Ville transformation for a typical high-SNR pulse are given in panels A & B (respectively). The spectrogram (C) illustrates three strong echolocation pulses with surface reflections, a typical inter-pulse-interval (IPI), a primary frequency peak at ~39 kHz, and a secondary frequency peak at ~23 kHz. The frequency spectrum (D) was calculated as the mean of 403 pulses from the first encounter of drift 6 (Table 1) with a 288-pt FFT size (1 ms) and a resolution of 1 Hz. Panel D also shows a primary frequency peak at ~39 kHz, and a secondary frequency peak at ~23 kHz (Taken from Barlow et al. submitted).

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