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Summary Report on the 2023 Collaborative Beaked Whale Cruise off Baja California, Mexico

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In September 2023, a third multi-week expedition was conducted off the coast of Baja California, Mexico to relocate the unknown species of beaked whales encountered in 2020 as well as look for the BW43 beaked whale. Daily non-systematic searches were carried out close to shore off Bahia San Quintín. Only two beaked whale sightings occurred, one of possible Cuvier's beaked whales (*Ziphius cavirostris*) and one of Baird's beaked whales (*Berardius bairdi*). Both species were also detected acoustically, in addition to one detection of BW43 echolocation pulses. In addition to the beaked whales, many other species were also encountered, including short-beaked common dolphins (*Delphinus delphis*), Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), bottlenose dolphins (*Tursiops truncatus*), blue whales (*Balaenoptera musculus*), Bryde's whales (*Balaenoptera edeni*), and gray whales (*Eschrichtius robustus*).

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EXECUTIVE SUMMARY

In September 2023, a third multi-week expedition was conducted off the coast of Baja California, Mexico, to relocate the unidentified species of beaked whales encountered in 2020 as well as look for the BW43 beaked whale. Daily, non-systematic searches were carried out close to shore off Bahia San Quintín. Unfortunately, weather conditions became too poor to observe and to survey further offshore of Baja. Only two beaked whale sightings occurred, one of possible Cuvier's beaked whales (*Ziphius cavirostris*) and one of Baird's beaked whales (*Berardius bairdii*). Both species were also detected acoustically, in addition to one detection of BW43 echolocation pulses. In addition to the beaked whales, many other species were also encountered, including killer whales (*Orcinus orca*), short-beaked common dolphins (*Delphinus delphis*), Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), bottlenose dolphins (*Tursiops truncatus*), blue whales (*Balaenoptera musculus*), Bryde's whales (*Balaenoptera edeni*), humpback whales (*Megaptera novaeangliae*), and gray whales (*Eschrichtius robustus*).

ACRONYMS

BW	Beaked whale
DASBR	Drifting acoustic spar buoy recorder
GPS	Global positioning system
US Navy	United States Navy
SWFSC	Southwest Fisheries Science Center

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1. INTRODUCTION

In 2018, a series of acoustic recordings were made using Drifting Acoustic Spar Buoy Recorders (DASBRs) along the Baja California, Mexico, peninsula during the SWFSC California Current Ecosystem Survey (Simonis et al. 2020). Several detections of the beaked whale echolocation pulse called BW43 were made; it is unknown what species makes this pulse, but it's hypothesized to be Perrin's beaked whale (*Mesoplodon perrini*; Baumann-Pickering et al. 2013), which has never been identified at sea and has only been described from a handful of strandings in southern and central California (Dalebout et al. 2002). These findings led to an expedition in 2020 to acoustically and visually link and identify the BW43 species (Barlow et al. 2021; Henderson et al. 2021). However, the expedition found a potentially new species of beaked whale that produces a similar but unique echolocation pulse, termed the BWB pulse (Barlow et al. 2021). Another expedition was conducted in 2021 in the same offshore area, as well as closer to shore near Bahia San Quintín where deep basins with complex bathymetry are found relatively close to shore (Henderson et al. 2022). During this expedition, multiple sightings were made of Cuvier's beaked whale (*Ziphius cavirostris*) and at least one *Mesoplodon* that could not be identified to species; acoustic detections were also made of both Cuvier's beaked whale and BW43 echolocation pulses. This effort was still unable to link a *Mesoplodon* species to the BW43 or BWB pulses. Here we report on a third expedition to the same region off Baja California, Mexico, in September 2023 during which we attempted to locate both *Mesoplodon* species and get photographs, acoustic detections, and DNA samples to confirm the species' identifications. This work supports the U.S. Navy as this region is part of the greater Navy Southern California Range Complex. For the U.S. Navy to conduct accurate impact assessments as part of their Environmental Impact Statement analyses, it is critical to know what species are present in the area, their population sizes and distributions.

2. METHODS

A collaborative expedition was conducted from September 6-16, 2023 on board the charter vessel the *Azteca*, based out of the Ensenada Harbor. The vessel surveyed in deep waters towards the nearshore region west of San Quintín; the focus of the effort remained there, as no effort could be conducted further offshore due to poor weather conditions. DASBRs were deployed repeatedly throughout the area in order to acoustically survey the region. When weather conditions became too poor for visual observations, the vessel worked closer to shore and anchored off Bahía San Quintín. Five DASBRs were available for deployment with GPS trackers and radio frequency location tags that could be deployed for periods of several days, each with a single-channel SoundTrap recorder (made by Ocean Instruments http://www.oceaninstruments.co.nz/) set to record at 576 kHz, continuously.

Seven visual observers conducted continuous visual observations from sunrise (at approximately 6:30 PDT) to sunset (at approximately 19:00 PDT). Observers rotated through four positions monitoring 360 degrees around the ship in half-hour shifts at each location, with the other observers on standby. The front position was equipped with a pair of mounted, 25 x 150 mm bigeye binoculars that were used to scan the water in calm conditions and for species identification of distant sightings. When an individual or group of marine mammals was initially observed, the start time, start latitude and longitude, species, an estimate of group size (including a minimum, maximum, and best size estimate), group behavior, and any other behavioral observations were recorded on a tablet computer using a custom-made Access database. Photographs were taken of all individuals 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. For beaked whale sightings, a DASBR would be deployed after the first or second sighting. Due to the long intervals between surfacings for beaked whales (5-30 minutes), the vessel would remain in the area of the initial sighting of beaked whales for at least 30 minutes, with all observers helping to visually search the area in order to locate the whales upon their next surfacing. A beaked whale sighting was terminated if a group was not resighted after at least 60 minutes of monitoring. A 7 m panga was available to approach beaked whale groups to obtain biopsies and additional photographs when conditions allowed.

3. RESULTS

Due to poor weather conditions for much of the planned period, a shortened expedition took place from September 6 – 16, 2023. The *Azteca* initially transited directly to the area off Bahia San Quintín, where deep basins and complex bathymetry occur only 22 km from shore (Figure 1). However, due to poor weather conditions that inhibited beaked whale visual sightings, the *Azteca* spent four days surveying this area before seeking shelter in Bahía San Quintín for a day (10 September). During these first four days of effort, two groups of beaked whales (Baird's beaked whales and likely Cuvier's beaked whales) were observed, but we were never able to approach closely for photographs or biopsies. Both species were also detected acoustically on the DASBRs. In addition, a group of killer whales (*Orcinus orca*) was encountered, which was an unusual species for this area. While in Bahia San Quintín, three gray whales (*Eschrichtius robustus*) were observed in the shallow waters of the bay (Figure 2). Photographs confirmed that at least one of the whales had been previously observed in the bay (Cárdenas Hinojosa, unpublished data). The next two days were spent back on the water searching the deep basins off Bahía San Quintín and deploying DASBRs in the area. The vessel then returned to the bay for another day (13 September) due to bad weather and to refuel. Two more days of surveys in the nearshore deep waters were conducted, with no additional beaked whale sightings, although one acoustic detection of the BW43 echolocation pulses was obtained. Ultimately, the weather prohibited additional survey effort in the area and the expedition was terminated. The full survey effort, including DASBR tracks, beaked whale sightings, and acoustic detections, is depicted in Figure 3.

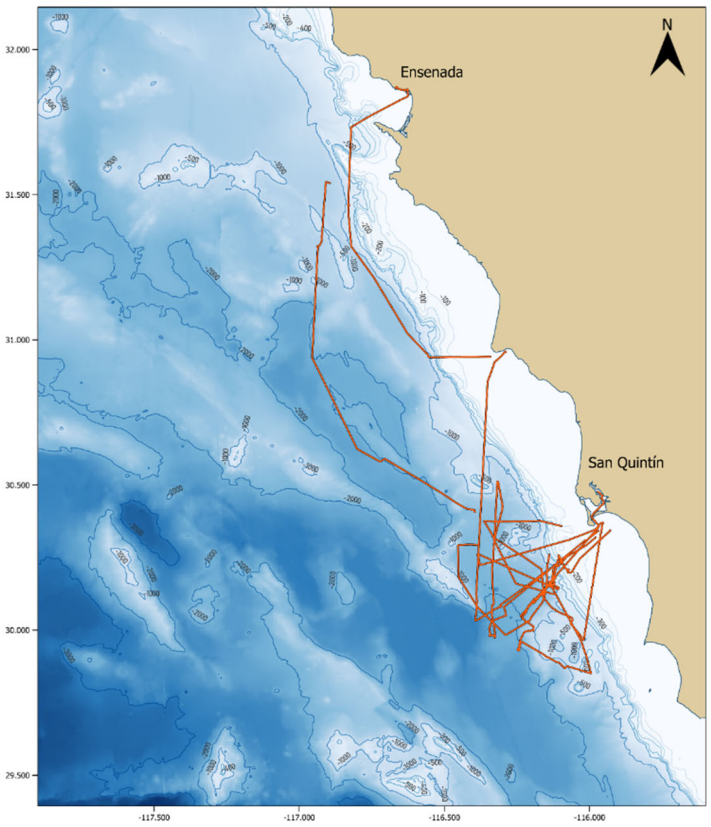

Figure 1. *Azteca* vessel track for 6-16 September 2023.

3.1 SIGHTING DATA

There was a total of 42 cetacean sightings during the expedition (Table 1); only two of these were beaked whales (Figures 2 and 3). One of the beaked whale sightings was likely Cuvier's beaked whales (UnIDBW), although no photographs were obtained and so species could not be confirmed, while the other was a group of Baird's beaked whales (Bba). This group was observed for two hours and four surfacings, with shallow dive periods of 15-25 minutes between sightings; however, the panga was unable to reach the group to obtain photographs usable for individual identification before they initiated their deep foraging dive. Other species observed included killer whales (Oo), common dolphins (*Delphinus delphis*, Dd or Dsp), Pacific white-sided dolphins (*Lagenorhynchus obliquidens*, Lo), bottlenose dolphins (*Tursiops truncatus*, Tt), blue whales (*Balaenoptera musculus*, Bm), Bryde's whales (*Balaenoptera edeni,* Be), gray whales (*Eschrichtius robustus*, Er), humpback whales (*Megaptera novaeangliae*, Mn), and several unidentified large whales (UnMyst, UnLgCet) and unidentified dolphins (UnDelph) (Table 1). Most of the sightings were encountered along the continental slope and in deep waters ranging from 1,000 to 2,000 m (Figure 2).

Table 1. Sighting information for all cetacean encounters. Beaked whale sightings are in bold.

Date	Start Time	End Time	Start Dec Lat	Start Dec Long	Species	Est Size Best
06-Sep-23	15:43:22	15:53:21	30.5804	-116.722	Dd	250
07-Sep-23	6:58:54	6:59:53	30.2951	-115.98	UnDelph	30
07-Sep-23	7:56:56	10:05:35	30.1993	-116.075	Oo	5
07-Sep-23	8:41:36		30.2313	-116.092	Dd	550
07-Sep-23	11:00:37	11:23:14	30.1555	-116.137	Be	1
07-Sep-23	11:43:49	11:50:46	30.1502	-116.128	Be	1
08-Sep-23	7:09:45		30.2442	-116.086	Dd	30
08-Sep-23	7:27:30		30.221	-116.116	Be	1
08-Sep-23	9:12:10	9:15:06	30.0514	-116.077	Dd	100
08-Sep-23	9:53:22	9:54:41	29.977	-116.036	Lo	20
08-Sep-23	11:41:52	11:43:05	29.8693	-116.084	Dd	15
08-Sep-23	12:38:51		29.926	-116.176	UnDelph	
08-Sep-23	**13:12:23**	**14:25:52**	**29.9553**	**-116.237**	**UnIDBW**	**1**
08-Sep-23	14:10:43		29.9359	-116.246	Be	1
08-Sep-23	**15:08:20**	**16:51:59**	**29.9965**	**-116.215**	**Bba**	**10**
08-Sep-23	17:17:48	17:18:32	30.0834	-116.21	UnLgCet	1
08-Sep-23	17:37:48	17:58:26	30.1029	-116.192	Bm	1
08-Sep-23	18:01:01		30.1165	-116.172	Dd	100
08-Sep-23	18:04:09		30.122	-116.167	UnMyst	1
08-Sep-23	18:05:39		30.1246	-116.165	Be	1
08-Sep-23	18:12:41	18:13:01	30.137	-116.154	UnMyst	1
08-Sep-23	18:13:17	18:15:43	30.1381	-116.153	Be	1
09-Sep-23	6:47:29		30.2588	-116.076	Lo	18
09-Sep-23	7:40:44	7:41:09	30.1803	-116.172	UnMyst	1
09-Sep-23	13:51:13	13:54:45	30.3876	-116.324	Dd	20
09-Sep-23	15:45:23	15:47:15	30.3981	-116.305	Dd	30

Date	Start Time	End Time	Start Dec Lat	Start Dec Long	Species	Est Size Best
09-Sep-23	15:54:03	15:54:57	30.3797	-116.31	Dsp	50
09-Sep-23	16:37:39	16:39:15	30.2908	-116.319	Dsp	30
11-Sep-23	7:13:06	7:18:03	30.3672	-116.133	UnDelph	100
11-Sep-23	13:43:44	13:45:41	30.0222	-116.065	Bm	2
12-Sep-23	7:04:46	7:05:01	30.3745	-116.228	UnDelph	8
12-Sep-23	14:26:13	14:26:29	30.0597	-116.189	Be	1
13-Sep-23	9:12:01	9:53:27	30.3828	-115.988	Er	1
14-Sep-23	7:28:55	7:31:36	30.4074	-115.98	Tt	20
14-Sep-23	7:46:09	8:00:03	30.3847	-115.99	Er	2
14-Sep-23	10:24:47	10:25:16	30.1193	-116.175	UnDelph	5
15-Sep-23	7:17:53	7:18:35	30.2421	-116.098	Dd	50
16-Sep-23	7:20:41	7:28:26	30.9398	-116.498	Lo	20
16-Sep-23	7:38:12		30.9392	-116.54	Dd	100
16-Sep-23	7:48:47	7:54:15	30.9461	-116.556	Be	1
16-Sep-23	12:45:24	12:50:04	31.4626	-116.828	Dd	30
16-Sep-23	16:43:53	16:43:59	31.8431	-116.625	Mn	1

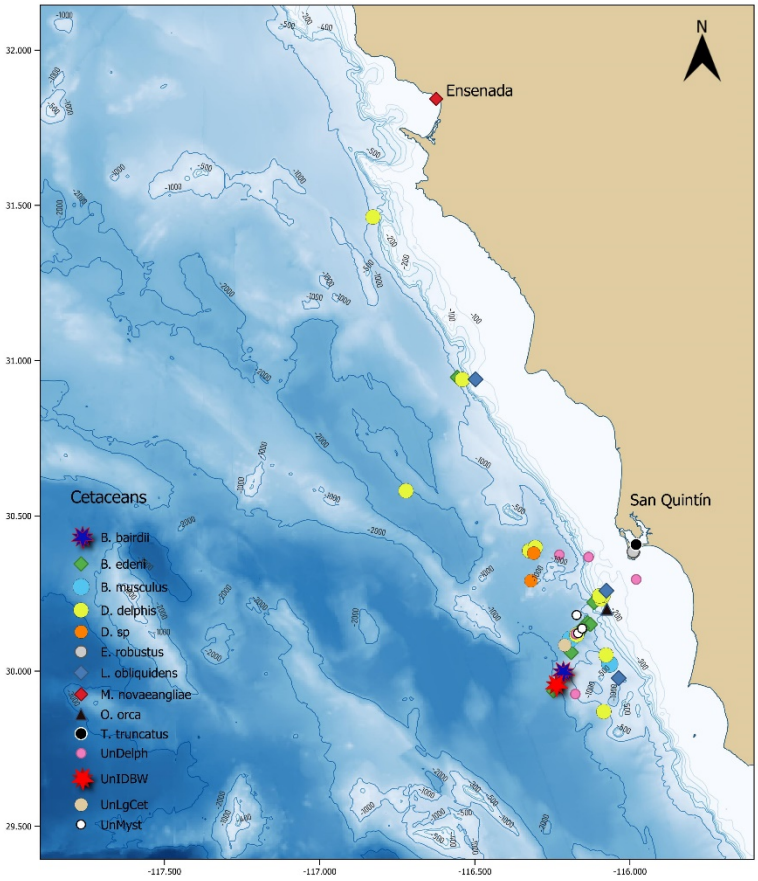

Figure 2: Distribution of the sightings observed during September 2023.

3.2 ACOUSTIC DATA

Drifting acoustic recorders were deployed eight times, for durations of 40 min – 3.3 days (Table 2). Beaked whales were acoustically detected on five of the eight drifts (Figure 3). Cuvier's beaked whale echolocation pulses were detected 15 times, Baird's beaked whales were detected twice, and BW43 pulses were detected once; there was also one detection of *Kogia* sp. (Table 3). No detections occurred in conjunction with a beaked whale sighting, so no sightings and detections could be directly linked as being the same animal(s). Many detections of dolphins occurred; however, their times and locations were not noted. An abundance of dolphin echolocation clicks, primarily at night, impeded our ability to detect beaked whale echolocation pulses at those times. Some beaked whale acoustic detections may have been missed for that reason.

Table 2. Drifting acoustic recorder deployment and recovery times (PDT) and durations.

DASBR Drift #	DASBR #	Deployment Time	Recovery Time	Recording Duration (days)
1	1	9/6/23 18:48	9/7/23 14:05	0.8
2	1	9/8/23 08:40	9/9/23 11:19	1.1
3	4	9/8/23 13:45	9/8/23 14:25	0.04
4	4	9/8/23 16:51	9/9/23 10:05	0.7
5	1	9/11/23 09:07	9/12/23 09:12	1.0
6	3	9/11/23 09:41	9/14/23 16:30	3.3
7	2	9/11/23 12:10	9/14/23 14:08	3.1
8	1	9/14/23 10:35	9/15/23 09:59	1.0

Table 3. Acoustic detection times and locations for beaked whales and *Kogia*.

Drift	Det ID	Species	Start Time (PST)	End Time (PST)	Lat	Long	# clicks
1	1	ZC	9/7/2023 4:57	9/7/2023 4:58	30.30948	-116.397	3
1	2	ZC	9/7/2023 5:40	9/7/2023 5:43	30.30141	-116.401	10
1	3	ZC	9/7/2023 8:09	9/7/2023 8:14	30.28865	-116.396	14
2	1	ZC	9/8/2023 13:50	9/8/2023 14:03	30.09893	-116.172	22
2	2	BB	9/8/2023 17:09	9/8/2023 18:07	30.10348	-116.2	231
5	1	ZC	9/11/2023 11:12	9/11/2023 11:33	30.36733	-116.365	18
5	2	ZC	9/11/2023 13:57	9/11/2023 13:57	30.36831	-116.353	11
6	4	BB	9/12/2023 20:30	9/12/2023 20:40	30.10032	-116.404	173
6	6	ZC	9/13/2023 20:34	9/13/2023 20:56	29.7468	-116.44	43
6	7	BW43	9/14/2023 13:03	9/14/2023 13:19	29.57528	-116.356	11
6	8	Kogia	9/14/2023 5:41	9/14/2023 5:42	29.6256	-116.442	450
7	1	ZC	9/11/2023 15:29	9/11/2023 15:49	30.13164	-116.176	62
7	2	ZC	9/11/2023 22:34	9/11/2023 22:50	30.1429	-116.209	18
7	3	ZC	9/12/2023 1:29	9/12/2023 1:38	30.14138	-116.225	11
7	4	ZC	9/12/2023 11:00	9/12/2023 11:04	30.18391	-116.281	6
7	5	ZC	9/12/2023 13:32	9/12/2023 13:50	30.19074	-116.284	9
7	6	ZC	9/12/2023 18:54	9/12/2023 18:59	30.1577	-116.3	23

Drift	Det ID	Species	Start Time (PST)	End Time (PST)	Lat	Long	# clicks
7	7	ZC	9/13/2023 19:09	9/13/2023 19:10	29.97599	-116.371	3
7	8	ZC	9/14/2023 2:58	9/14/2023 3:19	29.89012	-116.421	19

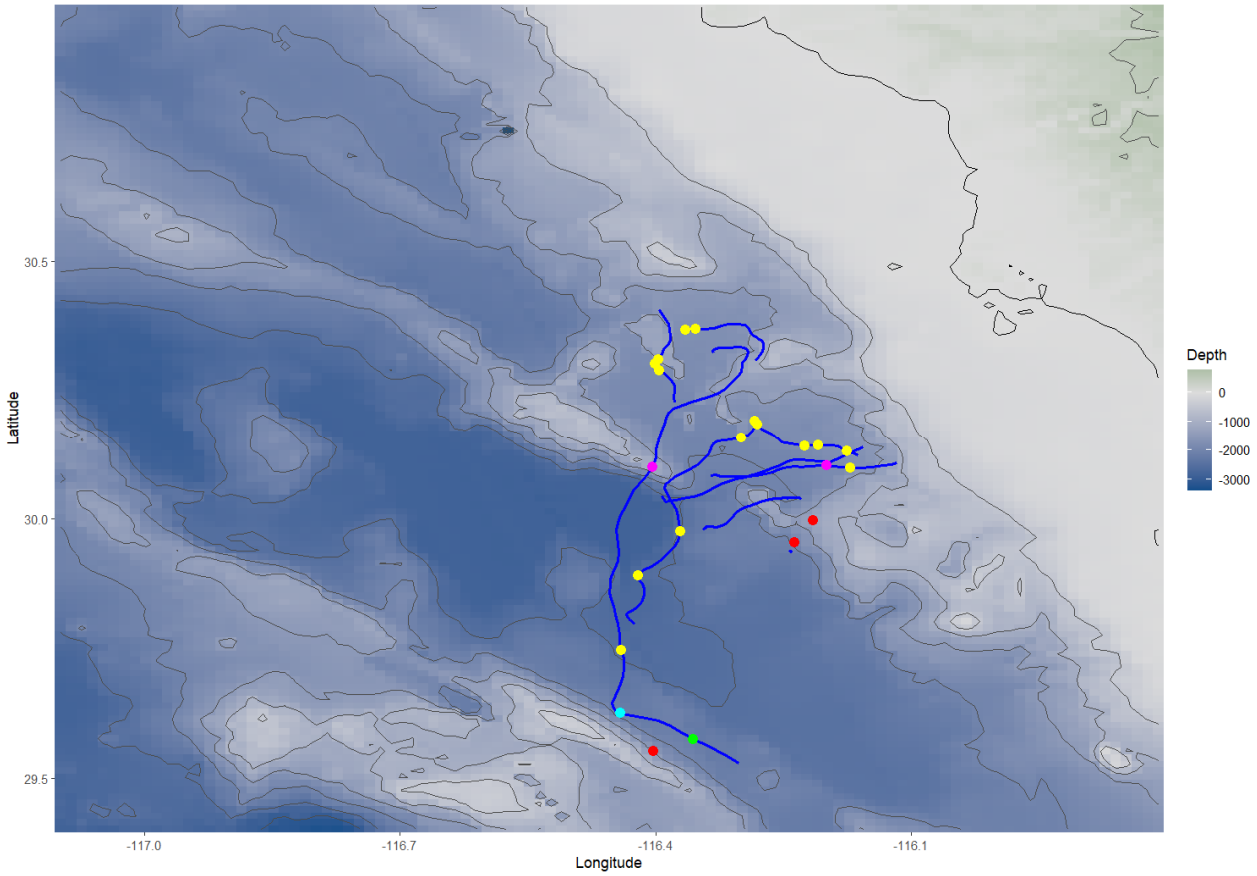

Figure 3. DASBR tracks (blue), beaked whale sightings (red), and acoustic detections from Cuvier's beaked whale (yellow), Baird's beaked whale (magenta), BW43 (green), and Kogia (cyan) during September 2023.

4. DISCUSSION

This expedition was the third in a series designed to locate and identify the beaked whale species that produce BW43 and BWB echolocation pulses. The region off Baja California, Mexico was chosen based on the high number of acoustic detections made by SWFSC in 2018 (Simonis et al. 2020). These beaked whale surveys have all been conducted in the fall as that was historically the period of best weather for the area. Unfortunately, in all three years the weather has proven to be a challenge, as the excellent conditions necessary for visually locating beaked whales have not been found. However, the three years of surveys have started to provide some information on these and other cetacean species in the area.

First, the deep waters just offshore of Bahia San Quintín do appear to be an important habitat for Cuvier's beaked whales, as at least four confirmed sightings and 20 acoustic detections have occurred in that area over three years, with two additional sightings off Ensenada. For all beaked whale sightings, there has been a sighting per day of effort rate of 0.32 over 38 days of effort in four years, with a far higher acoustic detection rate of 1.32 detections per day of effort. Furthermore, satellite-tagged Cuvier's beaked whales have been tracked through that nearshore, deep-water habitat as they traveled south from the Channel Islands (e.g., Schorr et al. 2020). The bathymetry in that area is complex, with a number of seamounts and ridges that are known to provide good foraging habitat for beaked whales. There were also sightings of a few unidentified *Mesoplodon* species in the same area in 2021, including one acoustic detection of BW43 echolocation pulses (Henderson et al. 2022). However, there may be some niche partitioning occurring between different species of beaked whales as more acoustic detections of BW43 and BWB echolocation pulses have occurred further offshore along the ridge to the west of San Quintín Basin (Barlow et al. 2021, Henderson et al. 2021, 2022). It may be that the *Mesoplodon* species in this region prefer deeper waters or a steeper slope than is found on the eastern side of San Quintín Basin.

Second, no beaked whales of any species were seen or acoustically detected during a short, three-day survey effort in June of 2022 (Cárdenas Hinojosa and Henderson, unpublished data). While that survey was brief, this may begin to provide some insight about beaked whales seasonal presence in this area. Future work at other times of the year will help to determine any seasonality that may exist in beaked whale distributions in this region. During an ongoing effort using a panga to survey for beaked whales at San Quintín and Ensenada, two Cuvier´s beaked whales encounters occurred in winter (December 2022 and February 2023) offshore of Ensenada, and another occurred in the summer (July 2023) offshore of San Quintín. Furthermore, a group of Baird´s beaked whales were also sighted in the same area in July 2023 (Cárdenas Hinojosa, unpublished data).

Third, a number of Bryde's whales have been observed in this region over the last three years of surveys. In addition to the nine sightings on the longer surveys, during the ongoing effort with panga, 16 sightings of this species were recorded in San Quintín Basin, mainly in July and August 2023 (Cárdenas Hinojosa, unpublished data). While Bryde's whales are widely distributed globally in tropical and sub-tropical waters, they are one of the less well-known rorquals, and are often found far offshore where visual surveys are rare (e.g., Helble et al. 2016). The proximity of this basin to shore and the possible frequent occurrence of this species may provide an opportunity to study these animals more closely.

Fourth, in addition to the lesser-known Bryde's whales, blue whales and humpback whales have also been sighted repeatedly in the waters west of northern Baja California, Mexico, during this effort. Six blue whales were observed on the longer surveys, while 12 sightings occurred during the panga effort. Similarly, 19 sightings of humpback whales occurred during the longer surveys in the fall, while 2 sightings were made via panga in May and July, likely of members of the Mexican population. During the sighting in May the humpback whales were observed to be feeding. Sightings and photographs in this region further understanding of seasonal occurrence and migration behavior and help provide insight into connectivity between populations found in southern California and Mexican waters (Jorge Urbán and Anelio Aguayo 1987; Mate et al. 1999; Calambokidis et al. 2000, 2009).

Finally, at least three gray whales were observed in the shallow waters of Bahia San Quintín. One of these whales had also been observed in May, July, and August in 2023 in the bay (Cárdenas Hinojosa, unpublished data), and at least one gray whale was observed in the bay in November 2021 (Henderson et al. 2022). Eastern North Pacific gray whales migrate seasonally along the west coast of North America, foraging from the Pacific Northwest to the Bering Sea in the summer and breeding in the warm lagoon waters of Mexico in the winter (Calambokidis et al. 2002; Rojas-Bracho et al. 2003). The gray whales in Bahia San Quintín may be taking advantage of the safety of the shallow waters to rest along their migration and are probably foraging opportunistically because the body conditions of the whales were not emaciated. Alternatively, the bay may be an over-summering habitat for some whales. More photo-id work throughout the year will provide more information on when and how gray whales are using the bay.

The DASBRs with vertical arrays of two hydrophones (used on our previous surveys) were not available on loan for this survey. Although our effort this year showed that DASBRs with single-channel Soundtrap recorders can be effective for detecting beaked whales and were faster to deploy and retrieve, these were less effective at detecting beaked whales when many dolphin echolocation clicks were present. Previously, by having two hydrophones at 100-150 m depth and by estimating bearing angles to sound sources, beaked whale echolocation pulses were more conspicuous because they were all from below the hydrophones' depths whereas the vast majority of dolphin clicks were coming from above. If possible, vertical arrays with two hydrophones should be included in future acoustic surveys of beaked whales. Improved software may, in the future, allow better detection of beaked whales in the presence of dolphins and could be used to re-analyze our recordings to detect more beaked whales.

While the waters off northern Baja California, Mexico appear to be a region utilized by a remarkable diversity of beaked whales (including Ziphius, Berardius and potentially five species of Mesoplodon [*M. densirostris, M. peruvianus, M. ginkgodens, M. perrini, and M. hotaula*]), the weather conditions (e.g., Beaufort sea state at 3 or higher, swell height 1-2 m) in the area have made visual surveys difficult. Additional future efforts may need to be conducted from a larger vessel that can allow for around-the-clock acoustic survey with a towed array, even in rough waters, to identify where best to search for BW43 and BWB beaked whales when weather conditions are amenable.

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