Final Report

Vessel-based Marine Mammal Survey on the Navy Range off Kauai in Support of Passive Acoustic Monitoring and Satellite Tagging Efforts: 1–9 February 2014

Submitted to:

Naval Facilities Engineering Command Pacific
for Commander, U.S. Pacific Fleet
under Contract No. N62470-10-D-3011, CTO KB22,
issued to HDR, Inc.

Prepared by

Mark H. Deakos, HDR, Inc., Honolulu, HI
Michael F. Richlen, HDR, Inc., Honolulu, HI


Photo taken under NMFS permit# 16239

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HDR

Honolulu, HI

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Rough-toothed dolphins (*Steno bredanensis*) off Kauai. Photo taken by Jessica Aschettino under National Marine Fisheries Service permit no. 16239 issued to Dan Engelhaupt.

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Richlen, M.F.

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14. ABSTRACT

HDR vessel-based visual monitoring for marine mammals was conducted 1-9 February 2014 in conjunction with Cascadia Research Collective (CRC) satellite-tagging and real time acoustic monitoring by the Marine Mammal Monitoring on Navy Ranges (M3R) team. These efforts were to aid species-validation projects conducted in and around the Pacific Missile Range Facility (PMRF) instrumented range, northwest of Kauai in the Hawaii Range Complex (HRC). The monitoring survey was conducted prior to the commencement of the U.S. Navy's Submarine Commanders Course (SCC) that took place 17-21 February 2014, which included the use of mid-frequency active sonar. The R/V Searcher large-vessel survey contributed to the visual validation of four species (bottlenose dolphin, Blainville's beaked whale, rough-toothed dolphin, and short-finned pilot whale) that were acoustically detected by the M3R team. On two occasions, the R/V Searcher vectored the tagging boat towards sightings that were not detected acoustically by the M3R team, resulting in the successful deployment of two satellite tags. Eighty-one percent (n=25) of the marine mammal sightings aboard the R/V Searcher were either on the range, or within 1 km of the range perimeter; 13 of those 24 sightings were identified to species: bottlenose dolphin (n=6), short-finned pilot whale (n=4), Blainville's beaked whale (n=1), and rough-toothed dolphin (n=2). Eight of the sightings were visual validations of acoustic detections made by the M3R team, of four different species: Blainville's beaked whale, short-finned pilot whale, rough-toothed dolphin, and bottlenose dolphin. A total of 1,970 photographs was taken of three different species for photo-identification. The majority (63 percent) were taken of short-finned pilot whales, followed by rough-toothed dolphins (31 percent), and bottlenose dolphins (6 percent). The sightings per unit effort (SPUE) for marine mammals excluding humpback whales was 0.42 sightings per hr or 0.03 sightings per km of effort. Sea states ranged from 1 to 5, and sightings were made almost equally in BSS 2, 3, and 4.

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Abbreviations and Acronyms

BARSTUR	Barking Sands Tactical Underwater Range
BSS	Beaufort Sea State
BSURE	Barking Sands Underwater Range Expansion
GPS	global positioning system
hr(s)	hour(s)
HRC	Hawaii Range Complex
HST	Hawaii Standard Time
ICMP	Integrated Comprehensive Monitoring Plan
km	kilometer(s)
km^2	square kilometer(s)
m	meter(s)
M3R	Marine Mammal Monitoring on Navy Ranges
MFAS	Mid-Frequency Active Sonar
MSO	Marine Species Observer
NAVFAC	Naval Facilities Engineering Command
NMFS	National Marine Fisheries Service
PMRF	Pacific Missile Range Facility
RHIB	rigid-hulled inflatable boat
SCC	Submarine Commanders Course
SPAWAR	Space and Naval Warfare Systems Command
SPUE	Sightings Per Unit Effort
U.S.	United States
XBT	Expendable Bathythermograph

1. Introduction

HDR vessel-based visual monitoring for marine mammals occurred from 1 through 9 February 2014 in conjunction with another contracted satellite-tagging effort and real time acoustic monitoring by the Naval Undersea Warfare Center Marine Mammal Monitoring on Navy Ranges (M3R) team. These efforts were to aid species-validation projects conducted in and around the Pacific Missile Range Facility (PMRF) instrumented range, northwest of Kauai in the Hawaii Range Complex (HRC). The monitoring survey was conducted prior to the commencement of the United States (U.S.) Navy's Submarine Commanders Course (SCC) that took place 17 through 21 February 2014. SCC are multi-unit training events that provide the necessary preparation for submarine commanders by using rigorous and realistic scenarios involving anti-submarine warfare, including the use of mid-frequency active sonar (MFAS).

As part of the compliance requirements of the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973, the U.S. Navy developed the Integrated Comprehensive Monitoring Plan (ICMP) (DoN 2010). The ICMP applies to those activities on U.S. Navy training ranges and operating areas for which the U.S. Navy sought and received incidental take authorizations. In order to support the U.S. Navy in meeting regulatory requirements for monitoring established under the Final Rules and to provide a mechanism to assist with coordination of program objectives under the ICMP, vessel surveys have been undertaken. Primary goals for vessel surveys at HRC have been to gather data on habitat use and movements of marine mammals near PMRF, provide species verification for acoustic detections under the M3R program, and deploy satellite tags prior to specific training events.

The February 2014 survey, concurrent with M3R and satellite-tagging efforts, was conducted to assist in answering the following monitoring question:

- What are the spatial-movement and habitat-use patterns (e.g., island-associated or open-ocean, restricted ranges versus large ranges) of species that are exposed to MFAS, and how do these patterns influence exposure and potential responses?

To help answer this question, the survey was structured around three objectives:

1. Visually validate marine mammal acoustic detections reported by PMRF Barking Sands Underwater Range Expansion (BSURE) and Barking Sands Tactical Underwater Range (BARSTUR) hydrophone array monitoring team.
2. Increase the number of satellite tags deployed on priority species by communicating the location of high-priority marine mammal sightings to the satellite-tagging team, which will operate concurrently.
3. Obtain photographs to conduct photo-identification for species identification and confirmation and to support photo-identification catalogs for odontocetes in Hawaii under another contracted effort, which are used for generating abundance estimates via mark-recapture techniques and understanding individual movement patterns.

High-priority species for this monitoring effort included beaked whales (Cuvier's beaked whale [*Ziphius cavirostris*] and *Mesoplodon* spp.), sperm whale (*Physeter macrocephalus*), false killer whale (*Pseudorca crassidens*), killer whale (*Orcinus orca*), melon-headed whale (*Peponocephala electra*), and pygmy killer whale (*Feresa attenuata*). Medium-priority species were the short-finned pilot whale (*Globicephala macrorhynchus*), Risso's dolphin (*Grampus griseus*), blue whale (*Balaenoptera musculus*), sei whale (*Balaenoptera borealis*), Bryde's whale (*Balaenoptera edeni*), minke whale (*Balaenoptera acutorostrata*), and rough-toothed dolphin (*Steno bredanensis*), as well as other small dolphin species. Low-priority species were the spinner dolphin (*Stenella longirostris*) and humpback whale (*Megaptera novaeangliae*).

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 # N62470-10-D-3011) supported by HDR.

2. Methods

The PMRF hydrophone range is located about 27 kilometers (km) southwest of Kauai across the Kaulakahi Channel and extends north approximately 75 km past Kauai. PMRF is instrumented with 219 bottom-mounted hydrophones that allow for passive acoustic monitoring capabilities in real-time and/or with recorded acoustic data, to detect and localize vocalizing marine mammals or other sources of sound (e.g., Tiemann et al. 2006). The PMRF hydrophone range is composed of three range systems: the Shallow Water Training Range (SWTR), the BARSTUR, and the legacy and refurbished BSURE off the northwest side of Kauai (**Figure 1**).

Random, non-systematic surveys were conducted from 1 through 9 February 2014, primarily focused on and around PMRF. Priorities were given to: (1) surveying in water conditions that were conducive to seeing marine mammals and allowing the rigid-hulled inflatable boat (RHIB) to deploy tags (Beaufort Sea State [BSS] < 4); (2) surveying as much on the PMRF hydrophone range as appropriate BSS would allow; and (3) focusing more effort on deep-water areas deeper than 500 meters (m) to increase the probability of encountering higher-priority deep-water species, such as beaked whales. Although the priority was to survey the area on or near PMRF, when the survey vessel was unable to work on the range, surveys focused in areas with calm sea conditions, south of the range near where the satellite-tagging team could operate.

The survey vessel was the M/V *Searcher*, a 29.3-m ship with a range capability of 6,500 km, top speed of 16.7 km/hour, and a flying bridge height of 7.3 m above the water (**Figure 2**). Fujinon Big Eye (25 × 150) binoculars were deck-mounted on the port and starboard sides of the flying bridge. A recorder station was set up in the center of the flying bridge equipped with a laptop computer running the *Mysticetus* (www.mysticetus.com) data-collection software connected to a GlobalSat BT-368i Bluetooth Global Positioning System (GPS), a backup Garmin 76c GPS unit for recording the ship's tracks, and a very-high-frequency marine radio and cell phone for communication with the M3R acoustic and tagging teams, as well as the M/V *Searcher* bridge crew.

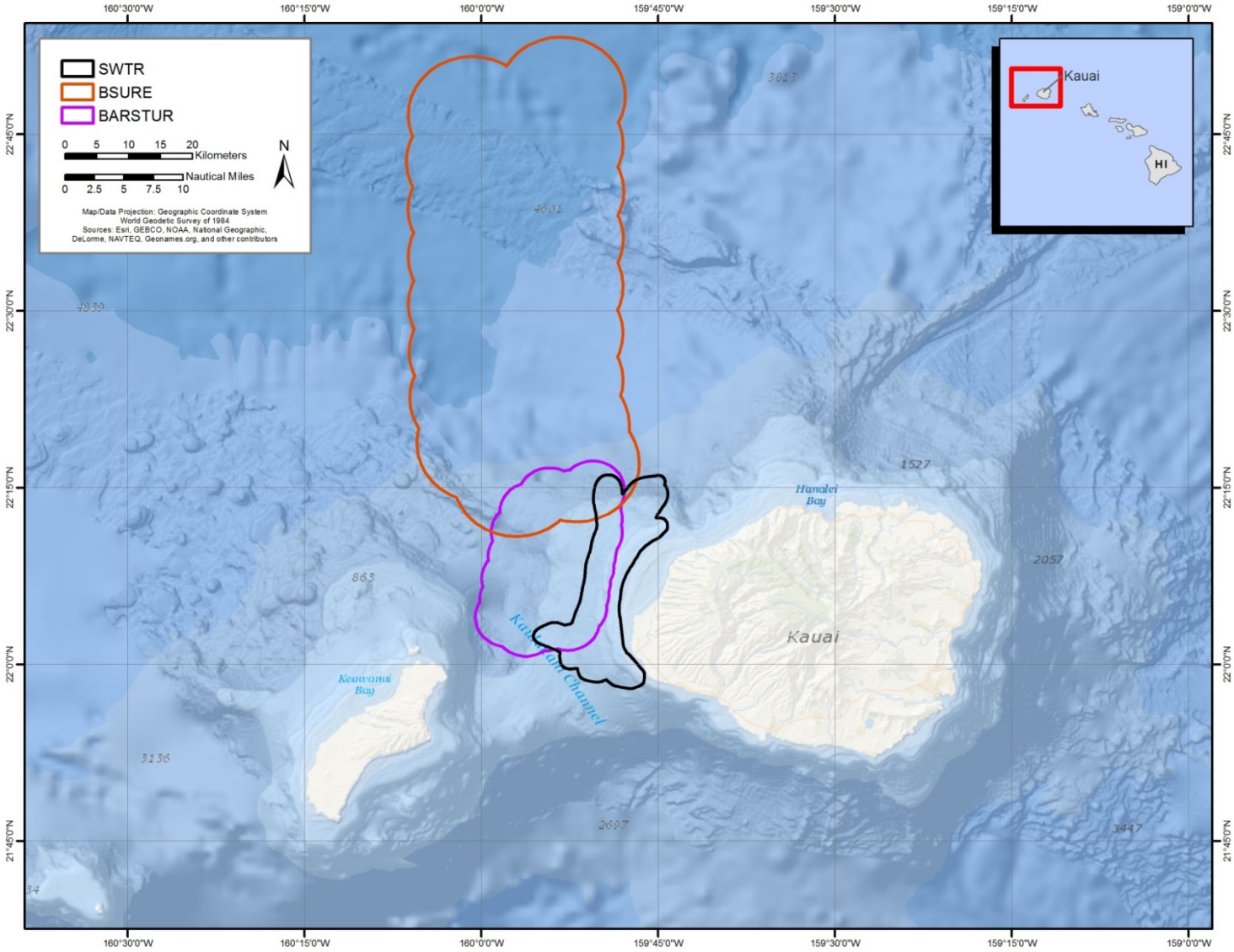

Figure 1. Area off Kauai showing the location of the instrumented hydrophone ranges at PMRF where the monitoring effort took place.

The scientific team aboard the M/V *Searcher* consisted of a core group of six marine species observers (MSOs), experienced in identification of Pacific marine mammal and sea turtle species (**Table 1**). All MSOs were responsible for taking photographs during sighting encounters for species verification and photo-identification purposes.

Table 1. Observers and roles.

Observer	Affiliation	Role(s)
Jessica Aschettino	NAVFAC Pacific	MSO and XBT
Joel Bell*	NAVFAC Atlantic	MSO
Mark Deakos	HDR, Inc.	Cruise Leader and MSO
Dan Engelhaupt	HDR, Inc.	MSO
Morgan Richie	NAVFAC Pacific	MSO and XBT
Michael Richlen	HDR, Inc.	MSO
Julie Rivers*	CPF	MSO
Suzanne Yin	HDR, Inc.	MSO

*Participated for a portion of the cruise.

Key: CPF = Commander, U.S. Pacific Fleet; MSO = Marine Species Observer; NAVFAC = Naval Facilities Engineering Command; XBT = Expendable Bathythermograph.

All heavy research equipment (e.g., Big Eye binoculars) was loaded and mounted on the M/V *Searcher* in Honolulu (Oahu) on 22 January 2014. On 31 January 2014, the M/V *Searcher* transited from Honolulu to Port Allen on Kauai, where the scientific team embarked on the morning of 1 February 2014. MSOs immediately began searching for marine mammals while the M/V *Searcher* transited to PMRF. At the end of each survey day, the M/V *Searcher* returned to an anchorage spot in Waimea Bay (northeast side of Kauai).

In order to maximize marine mammal encounters farther north on PMRF, each morning, the crew of the M/V *Searcher* began transiting north from its anchorage spot before sunrise in order to take advantage of lighter winds and better sighting conditions at first light. Each day at 0700 Hawaii Standard Time (HST), the M3R team was contacted to obtain an overview of the marine mammals that were being detected acoustically on the range, and the ship's course was adjusted towards sightings within the ship's range, in an attempt to visually validate the species of those acoustic detections. When access to PMRF was limited due to poor sighting conditions (e.g., high sea states, inclement weather), deep-water areas off the range with conditions suitable for sighting marine mammals (e.g., BSS less than 4) took priority over more shallow, inshore areas.

The survey was conducted using an observation team of six individuals with an occasional seventh observer entering the rotation. Dedicated observers on the port and starboard Big Eyes scanned a 90-degree sweep from the front of the ship to its beam when searching for new sightings, but scanned 180 degrees when attempting to resight animals. Observers rotated every 40 minutes from the port position, to the recorder position, and ending on the starboard position. During each rotation, the recorder updated the observer positions and environmental

conditions. The recorder also scanned 180 degrees ahead of the vessel (beam to beam) using naked eye to ensure full coverage of those areas close to the boat that were not visible to the observers using Big Eyes. The recorder also used 7 x 50 hand-held Fujinon reticle-binoculars to search for possible marine mammal sightings closer to the vessel.

This random, non-systematic survey was structured to optimize encounter rates with marine mammal species that are known to be more sensitive to U.S. Navy training activities.

Sighting data were collected during daylight hours between 0700 and 1800 (HST) when weather conditions permitted (e.g., no heavy rain, BSS <6). The recorder operating *Mysticetus* was responsible for recording observer positions, visibility, environmental data (e.g., BSS and average swell height), and sighting information (e.g., observer; bearing; reticle; cue; species; minimum, maximum, and best estimates of group size; photographer; camera used; and photographs taken of the sighting; as well as any additional notes). *Mysticetus* was programed to continuously record the track of the ship using the attached GPS.

Because one of the primary goals of this survey was to validate species identification for marine mammals detected acoustically by the PMRF hydrophones and the M3R team, humpback whale sightings were largely ignored other than for training MSOs who were less familiar with entering sightings into *Mysticetus*. Humpback whale sightings are not included in this report.

The approach was to use acoustic detections from PMRF's M3R hydrophone system to locate marine mammals. The M3R team would provide the Cruise Leader with the location where a marine mammal was acoustically detected, and the ship was then re-directed to that area to visually confirm the species. Additionally, sightings were photographed for photo-identification studies and the tagging boat was notified if there was a potential tagging opportunity. Opportunistic sightings were made *en route* to acoustic detection areas in order to maximize survey effort. other than In this report, only sightings made by the Searcher that were visual validations of an M3R acoustic detection are discussed. Details on the acoustic detections from the M3R team can be found in Baird et al. (2015).

Oceanographic data were collected using an expendable bathythermograph (XBT) data acquisition system (Lockhead Martin, Sippican). Collections were done opportunistically during the survey or following selected marine mammal sightings. Two MSOs with knowledge of XBT operations were also responsible for coordinating the XBT requirements during marine mammal sightings. The XBT data were provided to Steve Martin (SPAWAR Systems Center Pacific) to assist with estimating the sound pressure levels from sonar that marine mammals may be exposed to. These data are being provided in a separate report (Baird et al. 2014).

Another contracted effort was tasked with carrying out all marine mammal tagging activities. Each day, the tagging team launched a RHIB from Kikiaola Harbor on Kauai. As with the M/V *Searcher*, the tagging team made contact with the M3R team first thing in the morning to get the locations of localized acoustic detections on the range. The tagging team also contacted the M/V *Searcher* for an update of the boat's position and surrounding sea conditions. Details of the tag data were provided in a separate report completed by another contracted effort (Baird et al. 2015).

3. Results

More than 74 hours (hr) of "on-effort" observation were conducted during the 9 days of surveying, covering a total distance of 933 km (**Figure 2, Table 2**). Sixty-three percent of this time (approximately 47 hr) was spent working directly with the M3R team while on PMRF (**Table 2**).

Table 2. Summary of monitoring effort.

Day	Total Distance On Effort (km)	Total Time On Effort (hours)	Total Time On Effort Working with M3R Team on PMRF (hours)
1 February 2014	113	9.03	4.90
2 February 2014	104	8.77	6.75
3 February 2014	100	9.37	8.65
4 February 2014	105	8.78	6.13
5 February 2014	26	1.97	0.95
6 February 2014	108	9.12	8.40
7 February 2014	122	8.33	1.90
8 February 2014	141	9.93	1.37
9 February 2014	114	9.12	7.97
Total	**933**	**74.40**	**47.07**

A total of 31 cetacean groups (excluding humpback whales) were sighted (**Figure 3**, **Table 3**). Sightings were comprised of five confirmed species (Blainville's beaked whale [*Mesoplodon densirostris*], bottlenose dolphin [*Tursiops truncatus*], rough-toothed dolphin, short-finned pilot whale, and spinner dolphin), and four categories of unidentified species groups (unidentified large mysticete, *Mesoplodon* spp., unidentified cetacean, and unidentified small dolphin) (see **Appendix A** for selected photos). Eighty-one percent (*n*=25) of the marine mammal sightings were either on the range or within 1 km of the range perimeter; 13 of those 24 sightings were identified to species: bottlenose dolphin (*n*=6), short-finned pilot whale (*n*=4), Blainville's beaked whale (*n*=1), and rough-toothed dolphin (*n*=2). Eight of the sightings were visual species-validations of acoustic detections made by the M3R team, of four different species: Blainville's beaked whale, short-finned pilot whale, rough-toothed dolphin, and bottlenose dolphin.

The most frequent sightings during the total survey effort (excluding humpback whale) were unidentified cetaceans (*n*=8; 26 percent), followed by bottlenose dolphin (*n*=7; 23 percent), short-finned pilot whale (*n*=5; 16 percent), rough-toothed dolphin (*n*=4, 13 percent), spinner dolphin (*n*=2; 7 percent), unidentified *Mesoplodon* spp. (*n*=2; 7 percent), Blainville's beaked whale (*n*=1; 3 percent), and unidentified large mysticete (*n*=1; 3 percent) (**Table 4**).

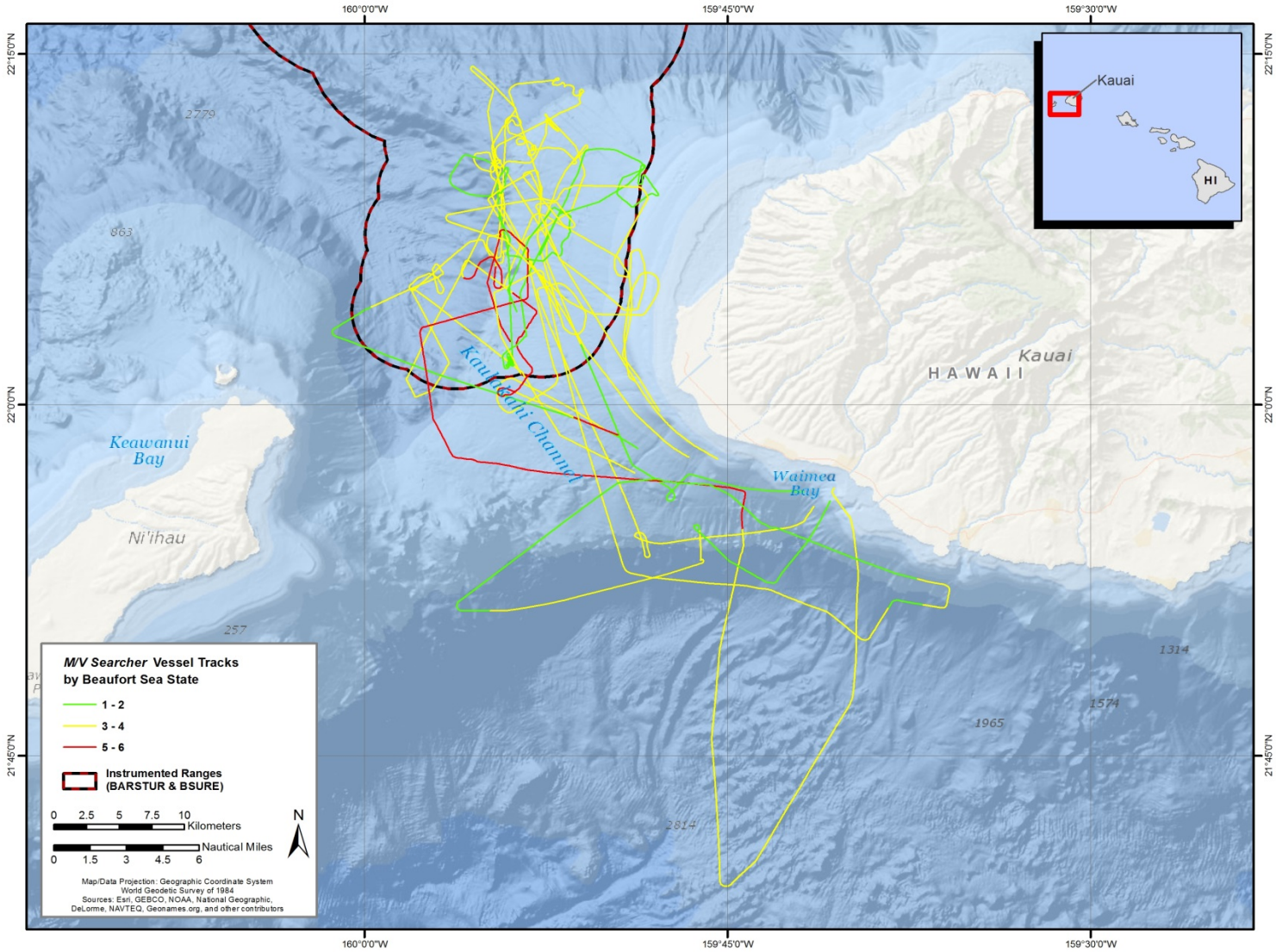

Figure 2. Ship tracks by Beaufort Sea State for the M/V *Searcher* on and near PMRF during 1–9 February 2014.

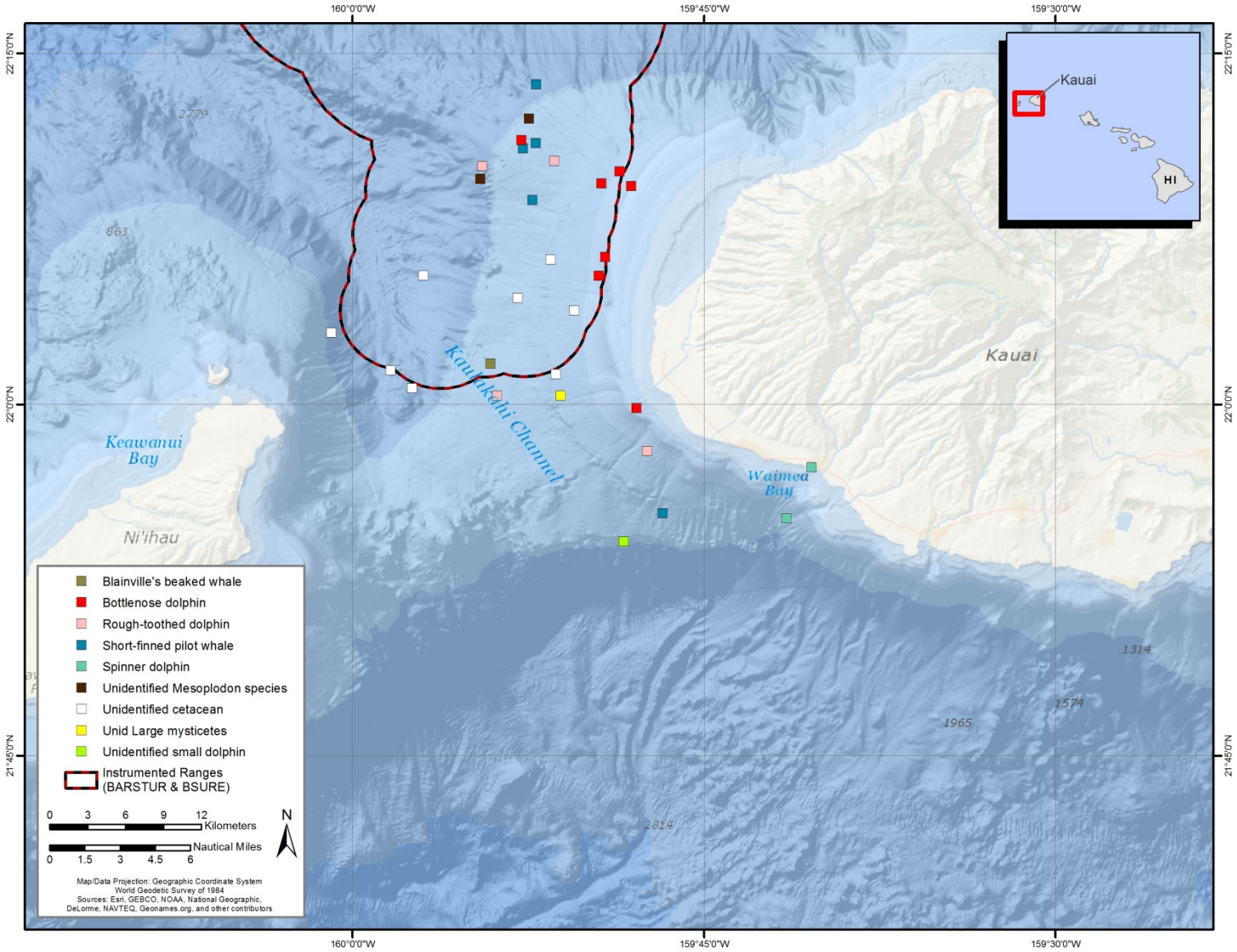

Figure 3. Marine mammal sightings recorded on and near PMRF during 1-9 February 2014.

Table 3. Summary of sightings.

Sighting No.	Date	Time	BSS	Species	Count			Latitude	Longitude	Dist. From Ship (km)	Depth (m)	Total Photos	M3R Visual Validation	Tags Deployed
					Low	High	Best							
1	02/01/14	9:11	3	*Gm*	30	40	35	21.92258	159.77944	3.50	887	-	-	-
2	02/01/14	9:36	4	*USD*	1	1	1	21.90243	159.80694	0.27	1164	-	-	-
3	02/01/14	10:29	4	ULW	2	2	2	22.00640	159.85194	5.35	535	-	-	-
4	02/01/14	10:42	3	UC	1	1	1	22.02163	159.85530	4.24	540	-	-	-
5	02/01/14	11:21	3	UC	1	1	1	22.07580	159.88240	2.75	700	-	-	-
6	02/01/14	11:50	3	UC	2	2	2	22.06707	159.84216	1.20	424	-	-	-
7	02/01/14	13:57	4	*Gm*	40	50	45	22.22799	159.86925	0.10	1331	568	-	Yes
8	02/02/14	9:50	3	UC	1	1	1	22.01175	159.95748	2.75	1171	-	-	-
9	02/02/14	10:17	4	UC	1	1	1	22.02443	159.97299	1.79	1222	-	-	-
10	02/02/14	11:42	4	*Sb*	23	30	25	22.16965	159.90775	0.80	1149	573	-	-
11	02/02/14	12:38	4	*Msp*	2	3	2	22.20351	159.87449	0.10	759	-	Yes	-
12	02/03/14	7:38	4	UC	1	1	1	22.10333	159.85918	2.48	588	-	-	-
13	02/03/14	13:57	3	UC	1	1	1	22.09184	159.94965	1.20	1698	-	-	-
14	02/03/14	14:52	2	UC	1	2	2	22.05125	160.01497	2.75	1122	-	-	-
15	02/04/14	7:37	2	*Sl*	10	15	13	21.95538	159.67344	0.84	<10m	-	-	-
16	02/04/14	8:03	2	*Sb*	2	3	2	21.96694	159.79037	3.31	388	24	-	-
17	02/04/14	11:02	4	*Sb*	4	5	4	22.17350	159.85637	0.10	660	13	Yes	-
18	02/04/14	11:16	4	*Gm*	15	20	17	22.18236	159.87875	1.79	731	486	Yes	-
19	02/04/14	11:18	4	*Tt*	30	40	35	22.18827	159.87975	1.79	739	21	Yes	-
20	02/04/14	11:32	4	*Gm*	7	10	9	22.18623	159.86954	0.41	717	-	-	-
21	02/04/14	15:20	3	*Sb*	10	12	15	22.00645	159.89713	2.75	718	-	-	-
22	02/05/14	9:18	4	*Tt*	3	3	3	21.99756	159.79800	0.10	127	-	-	-
23	02/06/14	8:12	2	*Tt*	9	12	14	22.16604	159.80987	0.10	379	33	-	-
24	02/06/14	8:17	2	*Tt*	3	5	3	22.15560	159.80162	1.86	159	-	Yes	-
25	02/06/14	9:02	2	*Tt*	14	17	15	22.15741	159.82275	1.06	446	43	Yes	-

Sighting No.	Date	Time	BSS	Species	Count			Latitude	Longitude	Dist. From Ship (km)	Depth (m)	Total Photos	M3R Visual Validation	Tags Deployed
					Low	High	Best							
26	02/06/14	11:14	2	*Md*	2	2	2	22.02924	159.90162	1.27	746	-	Yes	Yes
27	02/06/14	14:44	2	*Msp*	1	2	2	22.17062	159.909	1.11	3946	-	Yes	-
28	02/08/14	12:26	2	*Sl*	15	40	25	21.91890	159.69147	2.07	542	-	-	-
29	02/09/14	7:52	2	*Gm*	12	20	15	22.14569	159.87200	0.10	729	182	Yes	Yes
30	02/09/14	10:46	3	*Tt*	2	3	2	22.09165	159.82484	1.92	328	-	-	-
31	02/09/14	11:00	3	*Tt*	7	10	8	22.10508	159.82010	1.52	235	27	Yes	-

Key: *Gm Globicephala macrorhynchus; Md = Mesoplodon densirostris; Msp = Mesoplodon species; Sb = Steno bredanensis; Sl = Stenella longirostris; Tt = Tursiops truncatus;* UC = Unidentified Cetacean; ULW = Unidentified Large Mysticete; USD = Unidentified Small Dolphin

Table 4. Summary of sightings of marine mammals by species.

Species	Number of Sightings	Number of Individuals	Percentage of Total Sightings	Percentage of Total Individuals
Blainville's beaked whale	1	2	3.2	0.7
Bottlenose dolphin	7	80	22.6	26.3
Mesoplodon spp.	2	4	6.5	1.3
Rough-toothed dolphin	4	46	12.9	15.1
Short-finned pilot whale	5	121	16.1	39.8
Spinner dolphin	2	38	6.5	12.5
Unidentified cetacean	8	10	25.8	3.3
Unidentified large mysticete	1	2	3.2	0.7
Unidentified small dolphin	1	1	3.2	0.3
Total	**31**	**304**	**100%**	**100%**

A total of 1,970 photos were taken of three different species to be provided to another contracted effort for photo-identification processing. The majority (63 percent) were taken of short-finned pilot whales, followed by rough-toothed dolphins (31 percent), and bottlenose dolphins (6 percent).

The sightings per unit effort (SPUE) was calculated as the total number of marine mammal sightings (*n*=31) divided by the total survey effort (74.40 hr or 933 km). The SPUE for marine mammals without humpback whales was 0.42 sightings per hr or 0.03 sightings per km of effort. The BSS ranged from 1 to 5 and sightings were made almost equally in BSS 2, 3, and 4 (**Table 3**).

The tagging team covered 1,287 km of on-effort trackline in 66 hours over the 10 days of surveys (Baird et al., 2015). They encountered 26 non-humpback sightings (7 of which were low-priority spinner dolphins). Of the non-humpback sightings, 13 (50 percent) were on the PMRF, of which 6 were cued by M3R and 2 by the M/V *Searcher*. Sixteen (62 percent) of the sightings were identified to species. Twelve tags were deployed on four species, data were obtained from 11 of the 12 tags (one tag was non-functional). Tags were successfully deployed on six short-finned pilot whales, two rough-toothed dolphins, two bottlenose dolphins, and one Blainville's beaked whale. The tag that did not transmit any data was deployed on a second Blainville's beaked whale. Details of the tagging effort are presented in a separate, independent report (Baird et al. 2015).

4. Discussion

The M/V *Searcher* vessel surveys provided valuable support by visually validating acoustic detections of four species by the M3R team. Weather conditions allowed for the M/V *Searcher* to be on the range and in communication with the M3R team during 63 percent of on-effort

surveying, equivalent to 47 hr. The remainder of the time, the Searcher was either south of the range due to poor sea conditions or surveying was continuing after 1600 (HST) when the M3R team was required to vacate the building and was no longer in contact.

The SPUE for non-humpback sightings equated to 0.42 sightings per hr. This was comparable to an SPUE of 0.40 sightings per hr (39 non-humpback sightings over 96 hr of effort) from a 2012 survey conducted on PMRF with the USNS *Sioux*, a 69-m U.S.Navy ship used for towing, salvage, and diving operations (HDR 2012). This sighting rate is also similar to that of the tagging boat with 26 non-humpback sightings over 66 hours of visual surveying (0.39 sightings per hr; Baird et al. 2015); however the primary objectives and the areas worked by each group are not directly comparable. The most frequently confirmed species sighted from the M/V *Searcher* was bottlenose dolphin, followed by short-finned pilot whale and rough-toothed dolphin. This was similar to the *Sioux* survey, which mostly encountered rough-toothed dolphins and short-finned pilot whales, followed by equal sightings of Blainville's beaked whales, sperm whales, and spinner dolphins.

The M/V *Searcher* also added value in identifying cetacean sightings that were either off the range or not acoustically detected by the M3R acoustic team. On two occasions the M/V *Searcher* located animals that were not acoustically detected by the M3R team and successfully vectored the tagging team to the animals. This resulted in two tags being deployed on pilot whales. The tagging team successfully deployed 11 working satellite tags in comparison to their previous effort in which they deployed only 3 tags (Baird et al. 2012). Poorer weather during the 2012 survey may have played a role in many fewer tags deployed.

One benefit that the M/V *Searcher* provided was a greater visual radius due to the platform height above the water (i.e., height of the flying bridge). With an average eye height of an MSO on the M/V *Searcher* at 7.3 m, the horizon is visible to a distance of 9.7 km compared to the average height of an MSO's eye above the water's surface on the RHIB of 2.1 m, which will put the visual horizon at a distance of 5.2 km for the RHIB. The horizon on the M/V *Searcher* is visible nearly 1.8 times farther than on the RHIB. Assuming you could see all marine mammals in that visual radius, MSOs on the M/V *Searcher* would cover a visual area of 296 square kilometers (km^2) compared with a visual area of only 85 km^2 for the RHIB. This suggests the M/V *Searcher* has a searchable area 3.5 times larger than that of the RHIB.

In addition to the MSO height advantages, MSOs on the M/V *Searcher* were using Big Eye binoculars for scanning. According to a land-based (i.e., shore station) monitoring report (Deakos et al. 2014) that compared the detection capability across different optic platforms (e.g., Big Eye binoculars, hand-held binoculars, and naked eye), MSOs using Big Eye binoculars detected marine mammals at distances almost two times further than hand-held binoculars, and six times farther than with naked eye.

Therefore, the combination of the additional MSO elevation and the use of Big Eyes should substantially increase marine mammal detection capabilities. Unfortunately, on two occasions when the M/V *Searcher* was assisting the tagging boat in locating high-priority beaked whales known to be in the immediate area, the animals were never observed. One possible explanation for this would be that the M/V *Searcher* is causing these very cryptic animals to move away

subsurface, out of sighting range. However, given that beaked whales have been observed surfacing directly next to boats twice as big as the M/V *Searcher* (see HDR 2012), it is unlikely that the animals were avoiding the M/V *Searcher*.

5. Conclusions

The 9 days of vessel survey support successfully contributed to the visual validation of four species acoustically detected by the M3R team (bottlenose dolphin, Blainville's beaked whale, rough-toothed dolphin, and short-finned pilot whale). The M/V *Searcher's* higher observation platform and MSO access to Big Eye binoculars for scanning, provided a valuable tool to the tagging team by significantly increasing the searchable area for species of priority either cued by the M3R team or independent of acoustic localization, and remaining with the sighting until the RHIB was able to arrive on the scene and work the animals. The use of the M/V *Searcher* in a support capacity was also beneficial in providing the tagging team with environmental condition updates both on and off PMRF to assist in directing their efforts more effectively. In conclusion, the M/V *Searcher* survey was successful in meeting its three objectives: 1) to visually validate marine mammal acoustic detections reported by the M3R team, 2) to increase the number of satellite tags deployed, and 3) to contribute photo-identification images to supplement another contracted effort that is building a photo-identification catalog for odontocetes in Hawaii.

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7. References

Baird, R.W., D.L. Webster, J.M. Aschettino, D. Verbeck, and S.D. Mahaffy. 2012. *Odontocete Movements off the Island of Kaua'i: Results of Satellite Tagging and Photo-identification Efforts in January 2012*. Prepared by Cascadia Research Collective Prepared for US Pacific Fleet, submitted to NAVFAC PAC by HDR Environmental, Operations and Construction, Inc. August 2012.

Baird, R.W., A.N. Dilley, D.L. Webster, R. Morrissey, B.K. Rone, S.M. Jarvis, S.D. Mahaffy, A.M. Gorgone and D.J. Moretti. 2015. *Odontocete Studies on the Pacific Missile Range Facility in February 2014: Satellite-Tagging, Photo-Identification, and Passive Acoustic Monitoring*. Prepared for Commander, U.S. Pacific Fleet, submitted to Naval Facilities Engineering Command, Pacific by HDR Environmental, Operations and Construction, Inc. 24 April 2015.

Baird, R.W., S.W. Martin, D.L. Webster, and B.L. Southall. 2014. *Assessment of Modeled Received Sound Pressure Levels and Movements of Satellite-Tagged Odontocetes Exposed to Mid-Frequency Active Sonar at the Pacific Missile Range Facility: February 2011 Through February 2013*. Prepared for U.S. Pacific Fleet, submitted to NAVFAC PAC by HDR Environmental, Operations and Construction, Inc. 30 May 2014.

Deakos, M.H., R.K. Uyeyama, M.F. Richlen, and J.M. Aschettino. 2014. *Guam Marine Species Monitoring Survey, Shore Station Feasibility Study*. Report prepared for Commander, U.S. Pacific Fleet. Submitted to Naval Facilities Engineering Command (NAVFAC) Pacific EV2 Environmental Planning, Pearl Harbor, Hawaii under Contract No. N62470-10-D-3011, Task Order KB23, issued to HDR Inc., Honolulu, Hawaii. Submitted by HDR Inc., Honolulu, HI. 24 March 2014.

DoN (Department of the Navy). 2010. United States Navy Integrated Comprehensive Monitoring Program. 2010 update. U.S. Navy, Chief of Naval Operations Environmental Readiness Division, Washington, DC.

HDR. 2012. *Vessel-based Marine Mammal Survey off Kaua'i, 11-19 January 2012: Trip Report*. Report prepared for Commander, U.S. Pacific Fleet. Submitted to Naval Facilities Engineering Command (NAVFAC) Pacific, Honolulu, Hawaii, under Contract No. N62470-10-D- 3011, Task Order KB 14, issued to HDR Inc., San Diego, California. 30 July 2012.

Tiemann, C.O., S.W. Martin, and J.R. Mobley, Jr. 2006. Aerial and acoustic marine mammal detection and localization on Navy ranges. *IEEE Journal of Oceanic Engineering*, 31:107-119.

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Sample Marine Mammal Photos

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APPENDIX A: Sample Marine Mammal Photos

Figure A-1. Sighting #7 - 1 February 2014 - Short-finned pilot whales (photo by Suzanne Yin, NMFS permit no. 16239).

Figure A-2. Sighting #10 - 2 February 2014 - Rough-toothed dolphins (photo by Michael Richlen, NMFS permit no. 16239).

Figure A-3. Sighting #17 - 4 February 2014 - Rough-toothed dolphin (photo by Suzanne Yin, NMFS permit no. 16239).

Figure A-4. Sighting #18 - 4 February 2014 - Short-finned pilot whale (photo by Jessica Aschettino, NMFS permit no. 16239).

Figure A-5. Sighting #19 - 4 February 2014 - Bottlenose dolphin - (photo by Jessica Aschettino, NMFS permit no. 16239).

Figure A-6. Sighting #23 - 6 February 2014 - Bottlenose dolphins (photo by Jessica Aschettino, NMFS permit no. 16239).

Figure A-7. Sighting #25 - 6 February 2014 - Bottlenose dolphin (photo by Jessica Aschettino, NMFS permit no. 16239).

Figure A-8. Sighting #29 - 9 February 2014 - Short-finned pilot whale - (photo by Jessica Aschettino, NMFS permit no. 16239).

Figure A-9. Sighting #31 - Bottlenose dolphin - 9 February 2014 (Photo by Jessica Aschettino, NMFS permit no. 16239).

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