February 2019

Cruise Report, Marine Species Monitoring & Lookout Effectiveness Study Submarine Commanders Course, February 2019 Hawaii Range Complex

Prepared for:
U.S. Pacific Fleet

Figure: Short-finned pilot whales sighted from U.S. Navy DDG during February 10-16, 2018 embark (Canadian frigate in background).

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ABSTRACT

To comply with the Endangered Species Act and the Marine Mammal Protection Act, the Navy is required to determine the effectiveness of the monitoring and mitigation techniques used during at-sea activities. As part of this compliance, a Marine Species Monitoring & Lookout Effectiveness Study evaluated the effectiveness of the Navy lookout team in sighting marine mammals and sea turtles by establishing "trials" in which trained Marine Mammal Observers (MMO) record a sighting of an animal or group before the lookout (LO) team. If the LO later observes the same animal(s), the trial is considered a successful trial. Similarly, if the LO observes an animal simultaneously as the MMO, the trial is also considered successful. If the LO does not detect the animal(s), the trial is considered unsuccessful. In this study, the MMO recorded 25 independent, marine mammal sightings, while the LO recorded 2 independent sightings. Two sightings were made by both teams. A second goal of this study was to obtain data to characterize the possible exposure of marine species to mid-frequency active sonar (MFAS). By collecting bearing and distance of the animal(s) to the vessel, the sound level to which a marine mammal may be exposed during an MFAS event can be determined. This study documented 10 sightings and 9 trials during periods with MFAS. In total, humpback whales and short-finned pilot whales comprised 60% of sightings, and the highest sighting rate occurred in the channel between the islands of Kauai and Niihau. This study documents the 19th event aboard a guided missile destroyer, and the data will be combined with future monitoring efforts to determine the effectiveness of Navy lookouts as a whole, rather than specific to each vessel.

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List of Acronyms and Abbreviations

°	degrees
%	percent
BSS	Beaufort Sea State
DDG	United States Navy guided missile destroyer
DMMO	data marine mammal observer
ESA	Endangered Species Act
ft	foot (feet)
GPS	global positioning system
hr(s)	hour(s)
HRC	Hawaii Range Complex
HST	Hawaii Standard Time
ICMP	Integrated Comprehensive Monitoring Program
LMMO	liaison marine mammal observer
LO	Navy lookout
m	meter(s)
min(s)	minute(s)
MFAS	mid-frequency active sonar
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
SCC	submarine command course
SMMO	survey marine mammal observer
U.S.	United States

SECTION 1 INTRODUCTION

In order to train with mid-frequency active sonar (MFAS), the United States (U.S.) Navy (Navy) has obtained a Letter of Authorization from the National Marine Fisheries Service under the Marine Mammal Protection Act (MMPA) and a Biological Opinion under the Endangered Species Act (ESA). The Navy conducts monitoring within Navy Range Complexes and testing ranges, guided by the Integrated Comprehensive Monitoring Program (ICMP), as required under the MMPA and the ESA (Department of the Navy 2010).

The ICMP provides the overarching framework for coordination of the Navy Marine Species Monitoring Program (Department of the Navy 2010). The ICMP outlines objectives for marine species monitoring and Navy-funded research relating to the effects of Naval training and testing activities on protected marine species (Department of the Navy 2010). The ICMP includes the following scientific objectives (Department of the Navy 2014):

1. monitor and assess the effects of Navy activities on protected marine species;
2. ensure that data collected at multiple locations is collected in a manner that allows comparison between and among different geographic locations;
3. assess the effectiveness and practicality of the monitoring and mitigation techniques; and
4. add to the overall knowledge base of protected marine species and the effects of Navy activities on these species.

In order to address these objectives, data would be collected through various means, including contracted vessel and aerial surveys, tagging, passive acoustic monitoring, and placing marine mammal observers (MMOs) aboard Navy warships. In accordance with objective 3 above, a study was initiated to determine the effectiveness of the Navy lookout (LO) team, including lookouts in the pilot house or on the bridge wings. Trained biologists are utilized for the study to collect data that would characterize the likelihood of detecting marine species in the field from a U.S. Navy guided missile destroyer (DDG). The University of St. Andrews, Scotland, under contract to the U.S. Navy, developed an initial protocol for use during this study. Necessary changes to the protocol were identified and made during prior cruises. Data collected are intended to be combined with current and future data in order to determine the effectiveness of Navy lookout teams as a whole, rather than specific to each vessel.

As part of this data collection effort, three U.S. Navy civilian MMOs (Dr. Michelle Bejder, Dr. Thomas Jefferson, and Dr. Cara Hotchkin) embarked on a DDG from February 16-22, 2019 during a Command Pacific Fleet Submarine Command Course (SCC) Exercise in the Hawaii Range Complex (HRC). These MMOs were stationed aboard a U.S. Navy guided missile destroyer, hereafter referred to as DDG-T. The goals of the monitoring and this study were to:

1. collect data to assess the effectiveness of the Navy lookout team; and
2. obtain data to characterize the possible exposure of marine species to MFAS.

SECTION 2 METHODS

MMO surveys were conducted on a not-to-interfere basis, which means that the MMOs would not replace required Navy LOs, would not dictate operational requirements or maneuvers, and would remove themselves from the bridge wings if necessary for DDG-T to accomplish its mission objectives. The exceptions would be if a marine mammal was sighted by the MMO within the shut-down zone during MFAS operations (200 yards, 183 meters [m]) and was not sighted by the Navy LO team, or if the vessel was in danger of striking the marine species. In these cases, the MMO would report the sighting to the Navy LO team for appropriate reporting and action. The initial protocol for data collection was developed by the University of St. Andrews and refined by the MMOs on subsequent embarks.

The MMO survey on DDG-T was conducted on the bridge wings (elevated 60 feet [ft; 18.29 m] above the waterline), with one MMO on each wing (called survey MMOs, or SMMOs). Because only three MMOs were available for this trip, the third MMO was responsible for recording data (data MMO or DMMO) reported by the two SMMOs and acting as the Liaison MMO (LMMO) to the starboard, port, and bridge crew lookouts. A modified rotation schedule was used to compensate for the reduced team size: all MMOs were on-effort for one hour and off-effort for one hour throughout the day. MMOs rotated positions for each on-effort period such that an MMO would be on effort for one hour on port, off effort for one hour, on effort for one hour as an SMMO on starboard, off effort for one hour, and on effort for one hour as DMMO/LMMO. While on effort, MMOs used naked eye and 7 x 50 magnification binoculars to scan the area from 10 degrees (°) on the opposite side of dead ahead to just aft of the beam. This equates to a 180° field in front of the ship that was covered by the MMOs, with a 20° overlap in the area forward of the trackline covered by both observers. If a marine mammal or sea turtle were visually detected by the SMMOs, information would be collected on both the sighting and concurrent operational parameters. Environmental data, such as sea state and cloud cover, were collected routinely. Sightings obtained first by the SMMOs before the Navy LO were considered "trials." If applicable, photographs were taken using a Canon EOS 7D digital camera with a 100 – 400 millimeter zoom lens. No photographs would be taken until the Navy LO had also made the sighting so as not to call attention to the sighting.

The track of the DDG-T would not be altered as result of the sightings. Therefore, the species identification level represents the best ability to recognize species-specific characteristics at a distance from the ship, without approaching the animals for study. The Liaison LMMO or SMMOs would report sightings made by the Navy bridge wing LOs and by the bridge team. After a sighting by the Navy LO or bridge team, the LMMO would query the personnel to clarify information on the sighting such as animals seen, bearing, distance, and time. All three MMOs would typically be equipped with a headset/two-way radio setup in order to maintain communications without leaving their posts, as well as to communicate sighting and effort data without cueing the Navy LOs to sightings. The DMMO would record all data and make initial determinations as to whether sightings were considered a duplicate, e.g., the same animal seen by two observers. The DMMO would also record effort-related events (e.g., begin effort, end effort, observer rotation, weather change) in addition to time, location, and weather information as per the protocol. At the time of events and sightings, a global positioning system (GPS) waypoint would immediately be taken by the DMMO such that the accurate time and location of the event/sighting would be recorded, with associated information to be appended. Effort and environmental information would be collected when the MMOs began effort, at each rotation, as weather changes occurred, and when the MMOs

went off effort. At the conclusion of each observation day, if any photographs were taken, they would be reviewed to assist with species identification.

SECTION 3 RESULTS

The MMO team spent 29 hours (hrs) and 36 minutes (mins) searching for marine species during the SCC training event over seven days (Table 1). During whole days out at sea (excluding the day of departure and the day of return, 16 and 22 February, respectively), approximately five hours per day were spent on effort. Table 1 shows the breakdown of the Beaufort Sea State (BSS), range of cloud cover and visibility as a total of the on-effort observation period. The majority of observation time was spent in a BSS of 1, 2, or 3 (77.64 percent [%]; Figure 1), also sightings were mostly distributed among BSS of 1-3 (Figure 2). Sightings occurred at every BSS except 4 throughout the observation period.

In total, 29 unique sightings (in which each sighting does not include subsequent re-sightings or separate sightings by the MMOs and LOs), comprising at least 178 individual marine mammals, were recorded during the seven days of observation. MMOs made 25 sightings independent of the Navy's LO team (Table 2). There were two sightings made concurrently by both the MMO and LO team. There were two sightings by the LO team independent of the MMOs.

Trials, or sightings in which the MMOs detected animals before or at the same time as the Navy LOs, were successfully conducted on six of the seven days. Not all of these sightings occurred during MFAS, as MFAS was not always present. Ten sightings and nine trials occurred over the periods when MFAS was present. The rate of trials averaged 0.85 trials per hour of effort across seven days of effort (Table 3). The sighting rate was highest on February 18, 19, 21, and 22 although February 22nd was only one hour of effort, when there were steady conditions including BSS of 2 or 3 and good to excellent visibility. This highest rate of sightings occurred in the channel between Kauai and Niihau (Figure 3).

Of the 29 sightings, humpback whales (*Megaptera novaeangliae*) and short-finned pilot whales (*Globicephala macrorhynchus*) were the species positively identified, accounting for 60% of individuals sighted. Unidentified large whales, cetaceans and dolphins together accounted for the remaining 40% of individuals sighted (Table 4). Ten sightings occurred while sonar was active.

Table 1. Effort Hours and Environmental Conditions

Date	Team Hours On-Effort	Time	Beaufort Sea State (range)	% Cloud Cover (range)	Visibility
16 Feb	3 hrs 4 mins	1230-1330, 1430-1535,1625-1724	0-2	15-95	Good to Excellent
17 Feb	5 hrs 1 min	0730-0831, 0929-1030, 1131-1232, 1330-1428, 1521-1621	3-6	25-87.5	Moderate to Excellent
18 Feb	5 hrs 30 mins	0715-0816, 0915-1045, 1145-1245,1346-1445, 1540-1640,	1-3	7.5-98	Excellent
19 Feb	5 hrs 1 min	0730-0830, 0931-1030, 1130-1230, 1330-1431, 1530-1630	2-4	15-90	Good to Excellent
20 Feb	5 hrs	0730-0830, 0931-1030, 1130-1230, 1329-1431, 1530-1630	1-2	0-42.5	Excellent
21 Feb	5 hrs	0730-0830, 0929-1030, 1140-1239, 1330-1430, 1530-1630	0-1.5	3-35	Excellent
22 Feb	1 hrs	0730-0830	0.5-2	5-15	Excellent
Total	**29hrs 36 mins**		**0-6**	**0-98**	**Moderate to Excellent**

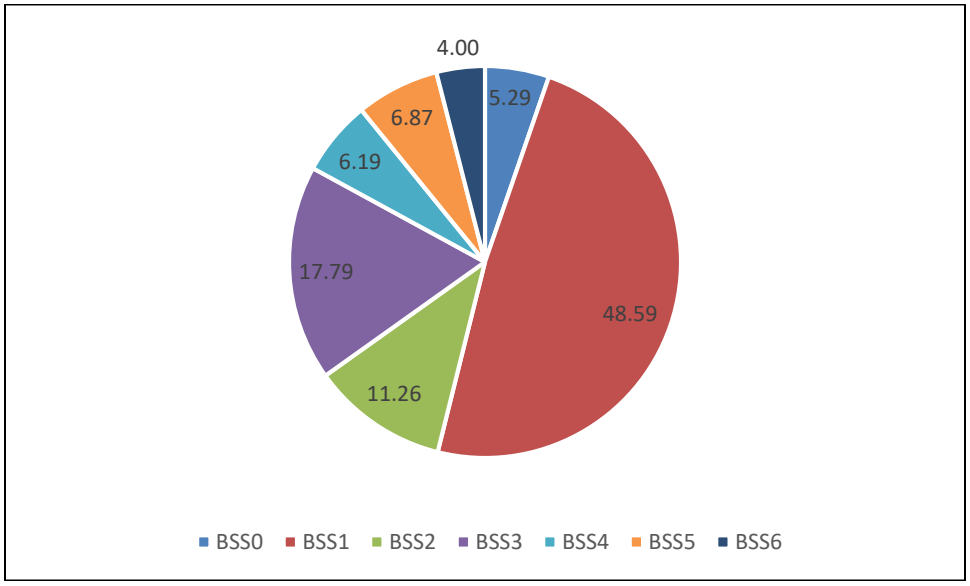

Figure 1. Total Percentage of Effort at Various Beaufort Sea States

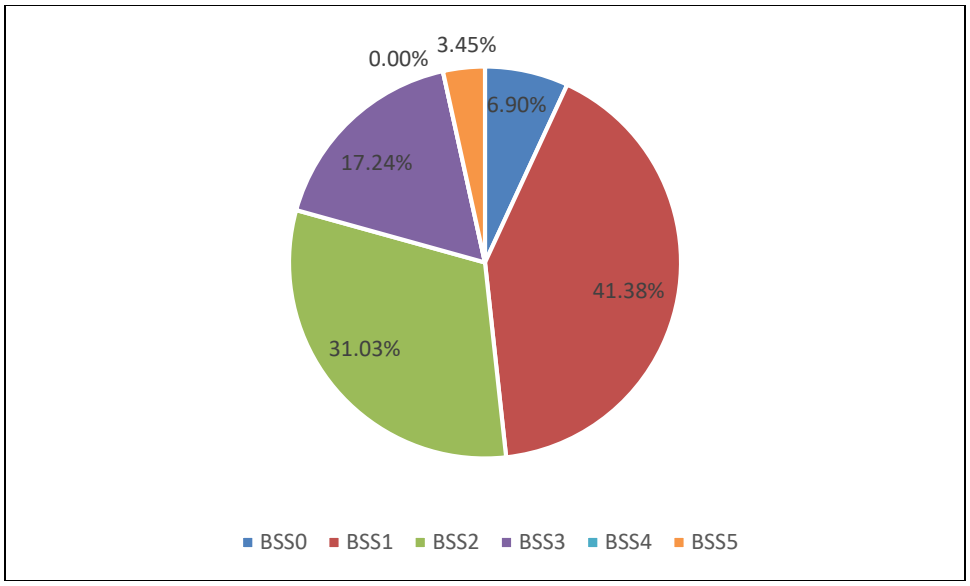

Figure 2. Total Percentage of Sightings at Various Beaufort Sea States

Table 2. Number of Sightings Made by MMO and LO Teams

Date	Independent MMO Sightings	Independent Navy LO Team Sightings	Sightings by both Teams
16 Feb	1	0	1
17 Feb	3	1	0
18 Feb	5	0	0
19 Feb	9	1	0
20 Feb	0	0	0
21 Feb	6	0	1
22 Feb	1	0	0
Total	**25**	**2**	**2**

Table 3. Hours of Effort, Sighting Rates, and Trial Rates

Date	Hours MMO Team Effort	# of Unique Sightings	Sightings/ Hour	# of Trials	Trials/Hour
16 Feb	3 hrs 4 mins	2	0.67	1	0.33
17 Feb	5 hrs 1min	4	0.8	2	0.4
18 Feb	5 hrs 30 mins	5	0.91	5	0.91
19 Feb	5 hrs 1 min	10	2	9	1.8
20 Feb	5 hrs	0	0	0	0
21 Feb	5 hrs	7	1.4	7	1.4
22 Feb	1 hrs	1	1.0	1	1.0
Cumulative	**29 hrs 36 mins**	**29**	**0.98**	**25**	**0.85**

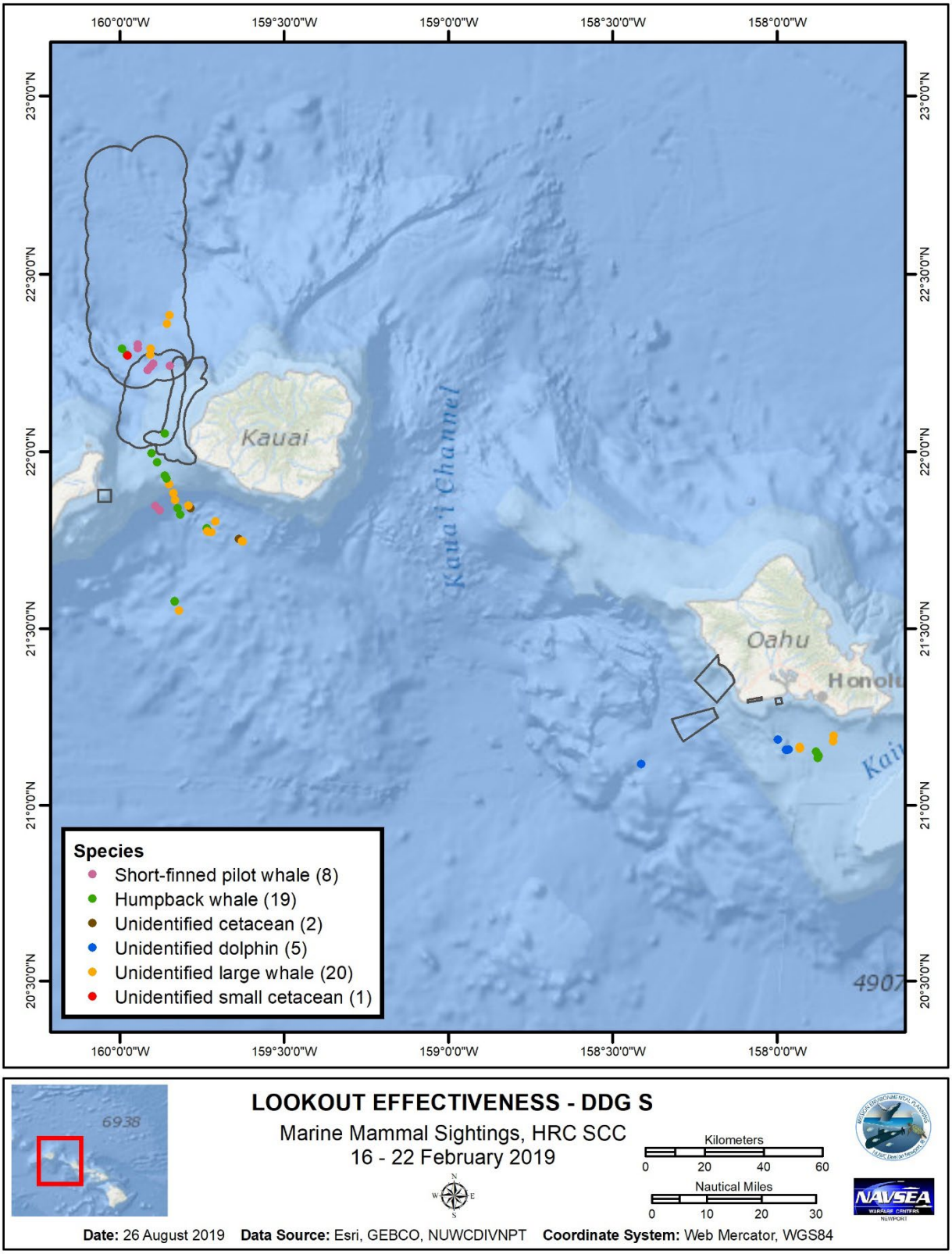

Figure 3. All Sighting and Resighting Locations During the February 2019 SCC

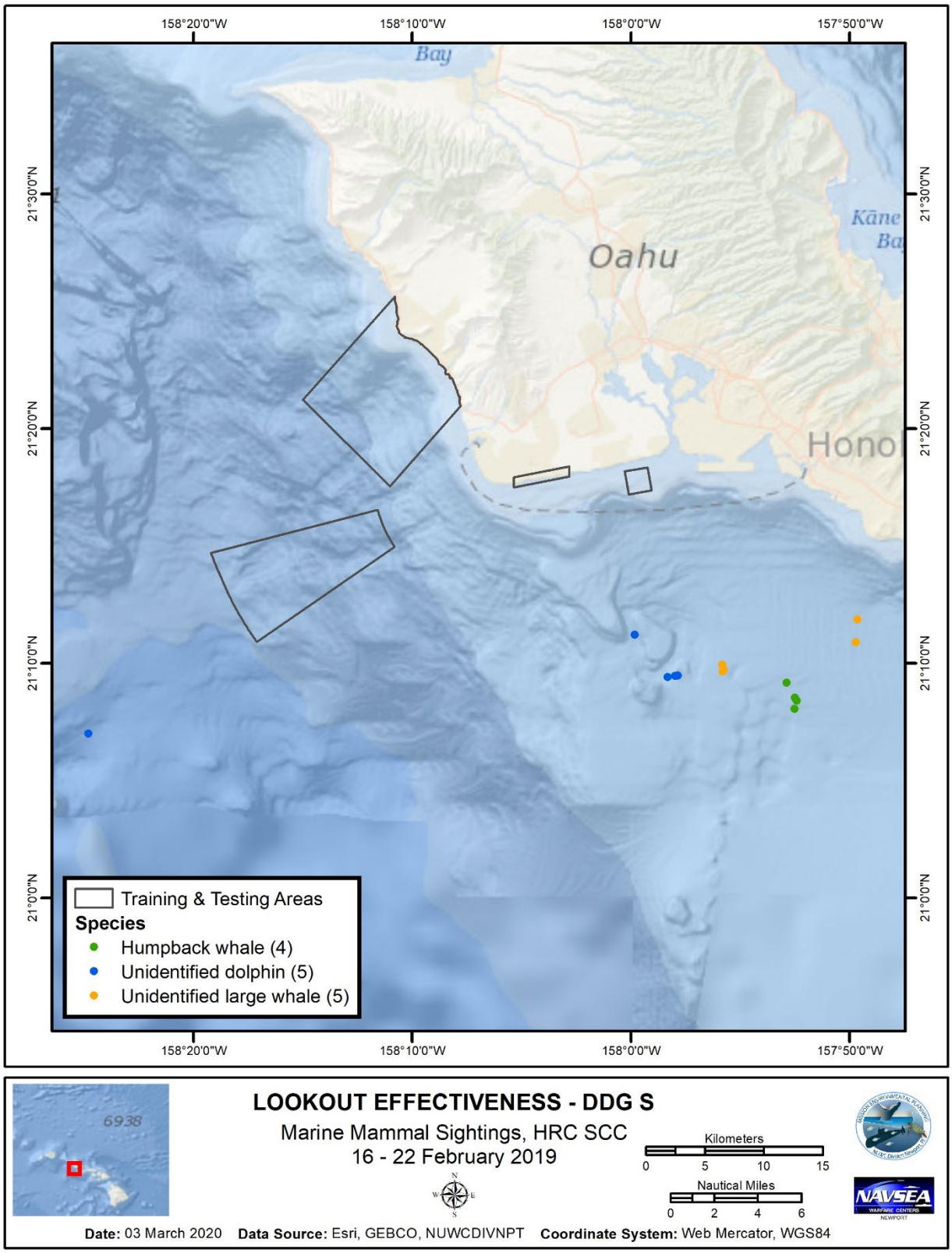

Figure 4. Oahu Sighting and Resighting Locations During the February 2019 SCC

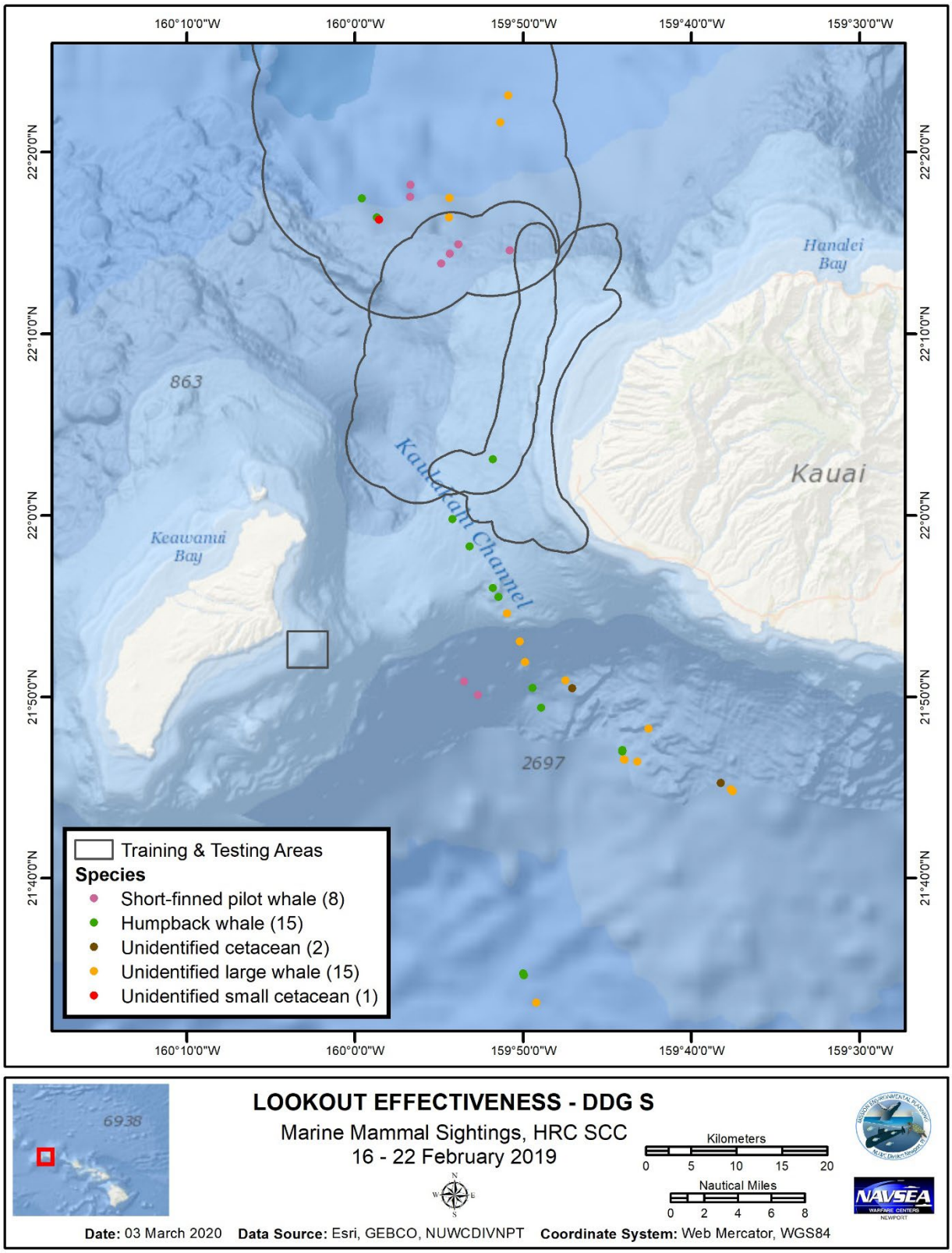

Figure 5. Kauai Sighting and Resighting Locations During the February 2019 SCC

Table 4. Marine Mammal Sightings

Data Category	Sighting 1	Sighting 2	Sighting 3	Sighting 4	Sighting 5	Sighting 6
Sighting Information						
Effort	ON	ON	ON	ON	ON	ON
Date	2/16/2019	2/16/2019	2/17/2019	2/17/2019	2/17/2019	2/17/2019
Time (HST)	15:24:59 15:31:16	16:26:38 16:28:00	10:02:56 10:05:00	10:09:53 10:12:00	12:24:34 12:32:02	16:05:05
Location	21.19782°N 157.82745°W	21.18695 °N 157.99715 °W	21.55175 °N 159.82015 °W	21.57697 °N 160.0430 °W	21.83483 °N 159.878 °W	21.77375 °N 159.72025°W
Detection Sensor	MMO	LO & MMO	MMO	MMO	MMO	Ship's crew
Species/Group	Unidentified large whale	Unidentified dolphin	Unidentified large whale	Humpback whale	Pilot whale	Unidentified large whales
Group Size (estimated range)	1	1	2	2	20	1
# Calves	0	0	0	0	1	0
Bearing (relative degrees)	355°	45°	5°	100°	270°	45°
Distance (m)	6666.67 m	300 m	1,333.33 m	100 m	1,333.33 m	9,000 m
Animal motion	None	Unknown	None	Parallel	Closing	None
Sighting Cue	Fluke	Body	Blow	Blow	Body	Blow
Behavior	Fluking	Unknown	Unknown	Travelling	Travelling	Unknown
Environmental Information						
Wave height (ft)	0-3 ft	0-3 ft	4-6 ft	4-6 ft	4-6 ft	4-6 ft
Visibility	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Beaufort Sea State	1	0	3	3	5	3
Cloud cover (%)	50%	50%	87.53%	87.53%	57.5%	65%
Glare (%)	10%	10%	0%	0%	0%	2.5%
Operational Information						
Sonar	OFF	ON	OFF	OFF	OFF	ON
Ship bearing (true)	177°	179°	325°	339°	320°	00°
Mitigation implemented	N	N	N	N	N	N
Comments		.	One blow larger than the other	LO spotted; cued by MMO	All juveniles; swim towards bow	lookouts were informed of sighting by crew

Table 4. (cont.) Marine Mammal Sightings

Data Category	Sighting 7	Sighting 8	Sighting 9	Sighting 10	Sighting 11	Sighting 12
Sighting Information						
Effort	ON	ON	ON	ON	ON	ON
Date	2/18/2019	2/18/2019	2/18/2019	2/18/2019	2/18/2019	2/19/2019
Time (HST)	8:05:53 8:16:01	9:18:08 9:24:07	12:38:45 12:43:00	12:44:48 12:45:00	16:15:37 16:29:00	8:26:00 8:30:00
Location	21.78423°N 159.73492 °W	21.7756 °N 159.73347 °W	21.84102 °N 159.78465 °W	21.84829 °N 159.79142 °W	21.75405 °N 159.63737 °W	21.80387 °N 159.70898 °W
Detection Sensor	MMO	MMO	MMO	MMO	MMO	MMO
Species/Group	Humpback whale	Unidentified large whale	Unidentified cetacean	Unidentified large whale	Unidentified cetaceans	Unidentified large whale
Group Size (estimated range)	2-5	2	6-12	1	1-10	1
# Calves	1	0	0	0	0	0
Bearing (relative)	340°	5°	320°	315°	270°	280°
Distance (m)	4000 m	8000 m	6666.67 m	20000 m	8000 m	10000 m
Animal motion	None	None	Closing	None	None	None
Sighting Cue	Blow	Blow	Splash	Blow	Splash	Blow
Behavior	None	None	Travelling	None	None	None
Environmental Information						
Wave height (ft)	0-3 ft	0-3 ft	0-3 ft	0-3 ft	0-3 ft	0-3 ft
Visibility	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Beaufort Sea State	3	3	1	1	1	4
Cloud cover (%)	15%	83%	95%	98%	22.5%	40%
Glare (%)	25%	10%	0%	0%	7.5%	2.5%
Operational Information						
Sonar	ON	ON	ON	ON	ON	ON
Ship bearing (true)	75°	83°	321°	322°	120°	155°
Mitigation implemented	N	N	N	N	N	N
Comments	.	.		.	.	

Table 4. (cont.) Marine Mammal Sightings

Data Category	Sighting 13	Sighting 14	Sighting 15	Sighting 16	Sighting 17	Sighting 18
Effort	ON	ON	ON	ON	ON	ON
Date	2/19/2019	2/19/2019	2/19/2019	2/19/2019	2/19/2019	2/19/2019
Time (HST)	15:35:59 15:52:34	15:47:52 15:52:34	15:55:49 16:02:00	15:59:36 16:07:54	16:03:56 16:07:54	16:18:55 16:21:00
Location	21.8234 °N 159.81543 °W	21.8842 °N 159.8366 °W	21.92497 °N 159.8577 °W	21.93333 °N 159.86334 °W	21.9714 °N 159.88625 °W	21.99667 °N 159.90334 °W
Detection Sensor	MMO	MMO	STBD LO	MMO	MMO	MMO
Species/Group	Short-finned pilot whales	Unidentified large whale	Humpback whale	Humpback whale	Humpback whale	Humpback whale
Group Size (estimated range)	1	1	1-2	6-7	1	1
# Calves	0	0	0	0	0	0
Bearing (relative)	350°	15°	45°	320°	45°	355°
Distance (m)	8000 m	8000 m	4000 m	20000 m	800 m	7500 m
Animal motion	None	None	None	None	Parallel	None
Sighting Cue	Blow	Blow	Body	Blow	Blow	Blow
Behavior	Flipper slapping	None	Tail slap	None	None	None
Wave height (ft)	0-3 ft	0-3 ft	0-3 ft	0-3 ft	0-3 ft	0-3 ft
Visibility	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Beaufort Sea State	2	2	2	2	2	2
Cloud cover (%)	30%	30%	30%	30%	30%	17.5%
Glare (%)	10%	10%	10%	10%	10%	2.5%
Sonar	OFF	OFF	OFF	OFF	OFF	OFF
Ship bearing (true)	350°	340°	330°	330°	330°	45°
Mitigation implemented	N	N	N	N	N	N
Comments			Starboard lookout alert MMO)	Possibly up to 3 pairs moving individually		

Table 4. (cont.) Marine Mammal Sightings

Data Category	Sighting 19	Sighting 20	Sighting 21	Sighting 22	Sighting 23	Sighting 24
Sighting Information						
Effort	ON	ON	ON	ON	ON	ON
Date	2/19/2019	2/19/2019	2/19/2019	2/21/2019	2/21/2019	2/21/2019
Time (HST)	16:20:35 16:21:00	16:28:29 16:29:00	16:29:00 16:31:00	9:29:33 9:35:05	9:35:51 9:37:00	9:39:28 9:52:18
Location	Unknown	22.05167 °N 159.86334 °W	22.05167 °N 159.86334 °W	22.29088 °N 159.9931 °W	22.27125 °N 159.97612 °W	22.29233°N 159.9451 °W
Detection Sensor	MMO	MMO	MMO	MMO	MMO	MMO
Species/Group	Humpback whale	Unidentified large whale	Humpback whales	Humpback whales	Unidentified small cetacean	Pilot whales
Group Size (estimated range)	1	1	1-3	2-3	8-14	35-60
# Calves	0	0	0	1	0	0
Bearing (relative)	60°	20°	20°	340°	40°	50°
Distance (m)	1000 m	8000 m	666.667 m	2000 m	4000 m	2666.667 m
Animal motion	None	None	None	Opening	Closing	Parallel
Sighting Cue	Blow	Blow	Blow	Blow	Body	Body
Behavior	Fluking	None	None	Travelling	None	Logging
Environmental Information						
Wave height (ft)	0-3 ft	0-3 ft	0-3 ft	0-3 ft	0-3 ft	0-3 ft
Visibility	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Beaufort Sea State	2	2	2	1	1	1
Cloud cover (%)	17.5%	17.5%	17.5%	7.5%	7.5%	7.5%
Glare (%)	2.5%	2.5%	2.5%	5%	5%	5%
Operational Information						
Sonar	OFF	OFF	OFF	OFF	OFF	OFF
Ship bearing (true)	45°	0°	0°	140°	130°	0°
Mitigation implemented	N	N	N	N	N	N
Comments	Went past beam immediately		.	.		3 small groups

Table 4. (cont.) Marine Mammal Sightings

Data Category	Sighting 25	Sighting 26	Sighting 27	Sighting 28	Sighting 29
Effort	ON	ON	ON	ON	ON
Date	2/21/2019	2/21/2019	2/21/2019	2/21/2019	2/22/2019
Time (HST)	11:50:09 11:57:29	12:29:13 12:35:32	13:34:18 13:35:00	16:22:59 16:30:06	08:03:37 08:05:00
Location	22.38535 °N 159.84807 °W	22.24867 °N 159.89743 °W	22.24318 °N 159.84658 °W	22.29118 °N 159.90617 °W	21.9714 °N 159.88625 °W
Detection Sensor	MMO	MMO	MMO	MMO	MMO
Species/Group	Unidentified large whale	Pilot whales	Pilot whales	Unidentified large whale	Humpback whale
Group Size (estimated range)	1	20-50	15-40	1	1
# Calves	0	0	0	0	0
Bearing (relative)	315°	320°	315°	45	45°
Distance (m)	10000 m	6666.667 m	800 m	5000 m	800 m
Animal motion	None	Opening	None	Closing	Parallel
Sighting Cue	Blow	Blow	Body	Body	Blow
Behavior	None	Travelling	Logging	Fluking	None
Wave height (ft)	0-3 ft	0-3 ft	0-3 ft	0-3 ft	0-3 ft
Visibility	Excellent	Excellent	Excellent	Excellent	Excellent
Beaufort Sea State	1	1	1	1	2
Cloud cover (%)	13%	5%	3%	8%	30%
Glare (%)	3%	0%	0%	5%	10%
Sonar	ON	ON	OFF	OFF	OFF
Ship bearing (true)	220°	225°	330°	179°	330°
Mitigation implemented	N	N	Y	N	N
Comments			Passed beam at 1335; not seen by LO; sonar powered down after alerted OOD		

SECTION 4 CONCLUSIONS

The goals of the lookout effectiveness monitoring effort are provided below, with a conclusion regarding each of the goals:

1. Collect data to assess the effectiveness of the Navy lookout team.

   This event is the nineteenth aboard a DDG in which data were collected to determine effectiveness; data will be combined with future monitoring efforts in order to determine the effectiveness of Navy lookouts as a whole, rather than specific to each vessel.

2. Obtain data to characterize the possible exposure of marine species to MFAS.

   Sighting information included the bearing and distance of the animal to DDG-T. This information can be used to determine the level of exposure a marine mammal may experience during an MFAS event.

SECTION 5 REFERENCES

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