APPENDIX C Cruise Report, Marine Species Monitoring & Lookout Effectiveness Study: Submarine Commanders Course, February 2010, Hawaii Range Complex

Prepared for: Commander, Pacific Fleet

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List of Acronyms and Abbreviations

DMMO	data marine mammal observer
ft	foot (feet)
GPS	global positioning system
HRC	Hawaii Range Complex
km	kilometer(s)
LMMO	liaison marine mammal observer
m	meter(s)
MFAS	mid-frequency active sonar
MMO	marine mammal observer
nm	nautical mile(s)
NMFS	National Marine Fisheries Service
PMAP	Protective Measures Assessment Protocol
PMRF	Pacific Missile Range Facility
SCC	Submarine Commanders Course
SMMO	survey marine mammal observer
VHF	very high frequency
yd(s)	yard(s)

Introduction

In order to train with mid-frequency active sonar (MFAS), the United States (U.S.) Navy has obtained a permit from the National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act. The Hawaii Range Complex (HRC) Monitoring Plan, finalized in December 2008 for implementation in January 2009, was developed with NMFS to comply with the requirements under the permit. The monitoring plan and reporting will provide science-based answers to questions regarding whether or not marine mammals are exposed and reacting to Navy MFAS. The objectives of the monitoring plan are to address the following questions:

Are marine mammals and sea turtles exposed to MFAS at regulatory thresholds of harm or harassment? If so, at what levels and how frequently are they exposed?

1. If marine mammals and sea turtles are exposed to MFAS in the HRC, do they redistribute geographically in the HRC as a result of repeated exposure? If so, how long does the redistribution last?

2. If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses? Are they different at various levels?

3. What are the behavioral responses of marine mammals and sea turtles that are exposed to various levels and distances from explosives?

4. Are the Navy's suite of mitigation measures for MFAS and explosives (e.g., Protective Measures Assessment Protocol [PMAP], measures agreed to by the Navy through permitting and consultation) effective at avoiding harm or harassment of marine mammals and sea turtles?

In order to address these questions, data would be collected through various means, including contracted vessel and aerial surveys, tagging, passive acoustics, and placing marine mammal observers (MMOs) aboard Navy warships.

In a concerted effort to address the fifth question above, a study was initiated to determine the effectiveness of the Navy lookout team, including lookouts in the pilot house, on the bridge wings, on the fantail, and/or the forward lookout on the flying bridge. Trained biologists were utilized for the study to collect data that would characterize the likelihood of detecting marine species in the field from a U.S. Navy frigate (FFG). The University of St. Andrews, Scotland, under contract to the U.S. Navy, developed the protocol used for the study. The results gathered were the first attempt to implement this new protocol; therefore, recommendations for ways to improve the protocol are an important part in the outcome of this study. Data collected will be combined with future monitoring efforts 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, four U.S. Navy civilian MMOs (Amy Farak, Sean Hanser, Anurag Kumar, and Julie Rivers) participated in a Submarine Commanders Course (SCC) from 16-20 February, 2010. Additionally, other unit level training was conducted from 21-22 February during which additional data were collected. These MMOs were stationed aboard an FFG, hereafter referred to as FFG A. The goals of the SCC monitoring and this study were:

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

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

3. Achieve close coordination between the contracted aerial survey team, Navy aircraft on the range, range control, and the MMO team aboard FFG A to facilitate maximizing survey time and project safety.

SCC Description

SCC events are a requirement to provide the necessary training to prospective submarine commanders in rigorous and realistic scenarios involving anti-submarine warfare.

Participants in this SCC included FFG A, a destroyer, maritime patrol aircraft (fixed-wing patrol squadron), helicopter antisubmarine squadron, submarines, torpedo recovery helicopter and boats, and range control for subsurface, surface, and air.

Methods

Shipboard Monitoring

On the morning of 09 February, the Commander Pacific Fleet Environmental biologist, Naval Facilities Engineering Command Pacific MMO, survey aircraft pilot, and aerial principle investigator participated in a pre-sail brief for all vessel and aircraft participants in the SCC event. During the pre-sail, the details regarding airspace concerns were finalized, as discussed in Section 0. The purpose and function of the MMOs were presented at the pre-sail meeting. Additionally, an in-brief was provided to the commanding officer, executive officer, and operations officer aboard FFG A on 16 February.

MMO surveys were conducted on a not-to-interfere basis, which means that the MMOs would not replace required Navy lookouts, would not dictate operational requirements/maneuvers, and would remove themselves from the bridge wing if necessary for the FFG A to accomplish its mission objectives. The exceptions would be if a marine mammal was sighted by the MMO within the shut-down zone (200 yards [yds], 183 meters [m]) during MFAS and was not sighted by the lookout, or if the vessel was in danger of striking an animal. In these cases, the MMO would report the sighting to the Navy lookout team for appropriate reporting and action.

The protocol for data collection was provided by the University of St. Andrews and is included as Enclosure 1. This protocol was modified by the MMOs as necessary during the event. The MMO survey was conducted on the bridge wings (elevated 35 feet [ft; 10.7 m] above the waterline) and on the flying bridge of FFG A (elevated 45 ft [13.7 m] above the waterline), with one MMO on each wing (called survey MMOs, or SMMOs) and one MMO on the flying bridge to act as a liaison to

the forward lookout (called liaison MMO or LMMO). The fourth MMO was off effort which allowed for a rest period. A rotation schedule was used, such that an MMO would be on effort for an hour on port, an hour as the LMMO on the flying bridge, an hour as an SMMO on starboard, and an off effort hour to rest. While on effort, MMOs used naked eye and 7 X 50 magnification binoculars to scan the area from dead ahead to just aft of the beam.

If an animal was visually detected by the SMMOs, information would be collected on sighting, environmental, and sonar parameters. During the first three days (16-19 February), each SMMO collected sighting data through either use of sightings forms or voice data recorders. However, this method was determined to be inefficient, as logging the necessary information was distracting and resulted in losing the location of the animal. As such, the fourth MMO, who had been off effort during the rotation of the previous days, became a data recorder (DMMO) for all MMOs. If applicable, photographs would be taken using a Canon EOS 20D digital camera with a 100 – 400 mm zoom lens, however no opportunities arose.

In addition to collecting data on each sighting, the MMOs would alert the survey aircraft (Section 0), via a hand-held avionics very high frequency (VHF) radio (Section 0), to the location(s) of the animal(s) so that the aircraft could conduct a focal follow of the animal. If the aircraft was currently in a focal follow and another sighting was made, the aircraft would wait until the first focal follow was complete before heading to the second sighting. MMOs were not to inform the survey aircraft of the ships operations, particularly if MFAS was in use, so as to not bias any behavioral observations made by the survey aircraft.

The LMMO stationed on the flying bridge recorded sightings made by the Navy forward lookout. Once the forward lookout sighted an animal or was informed of a sighting by the bridge, the lookout would relay the approximate bearing, distance (estimated by eye), and animal group (whale or dolphin) to the LMMO. The LMMO would relay this information to the SMMOs to determine if the sighting was considered a duplicate. The information relayed by the LMMO would be recorded by each SMMO. However, as indicated above, data collected from 21-23 February were recorded by the DMMO rather than each SMMO.

A GARMIN etrex global positioning system (GPS) was used to take waypoints when sightings occurred or when observation effort changed. The GPS unit allowed the MMOs to obtain positional reports without needing to enter the pilot house. All MMOs maintained communications through hand-held VHF radios.

Aerial Monitoring

Aerial surveys were conducted during the SCC using similar methods as were used during the August 2008/09 and February 2009 surveys. The survey was undertaken by a contracted team aboard a twin-engine, fixed-wing Partenavia. The primary goals of the aerial monitoring were to locate and identify marine species before, during, and after the training event, and to monitor and report observations of their behavior. This included monitoring for any potentially injured or harmed marine species and any unusual behavior or changes in behavior, distribution, numbers, and species associations of animals observed during the training event.

The SCC involved multiple large naval vessels, submarines, and both fixed-wing (P-3) and rotary-wing (helicopter) aircraft. Thus, coordination of airspace use was paramount to the safety of all aircraft involved. In general, the airspace was divided into altitude strata, such that each aircraft

had a specific stratum assigned; helicopters were at the lowest stratum, the survey aircraft was in the middle stratum, and the P-3 was in the highest stratum. However, when the P-3 aircraft was required to fly at lower altitudes to satisfy mission requirements, the P-3, survey aircraft, and range control would coordinate to ensure each aircraft could safely maneuver to the other stratum. Each morning, the survey aircraft would communicate with range control to determine the location of FFG A and to verify the altitude in which they would enter the range. Radio communication between the aircraft and MMOs was also established and verified.

The schedule of events for the survey aircraft was to conduct pre-determined survey pattern on the day before and after the event to obtain animal presence and distribution data. The aerial team also surveyed the coastlines of Kauai, Ni'ihau, Lehua, and Kaula Islet on the day after the SCC. During the SCC (16-20 February), the survey aircraft flew elliptical, "race-track" shaped patterns in front of FFG A. The goal of this flight pattern is to visually cover an area extending from the shutdown zone 200 yds (182 m) in front of the ship out to 2500 yds (2273 m) and approximately 2 nautical miles (nm; 3.7 kilometers [km]) in width. The pilot manually flew this pattern and frequently had to adjust the pattern due to non-systematic and unpredictable changes in speed and headings of FFG A as it conducted training. This mode was to be maintained until a marine mammal/sea turtle sighting was made either by the aircraft or the shipboard MMOs, or until there was a potential conflict with naval airspace. In the event of a marine mammal/sea turtle sighting, the aircraft would cease the flight search pattern and begin circling the animal(s) sighted and initiate focal follow behavior mode.

In addition to this Navy cruise report focusing on shipboard activities, the aerial survey contractor (Dr. Joseph Mobley, University of Hawaii) will provide a comprehensive scientific report detailing their methods, observations, and recommendations.

Equipment List & Communications

The equipment used by the MMOs is included in Table 1. Communication between FFG A officers and MMOs was accomplished during meals in the wardroom, evening operational briefs, and on the ship's bridge as required. Additional equipment is recommended, as detailed in Section 0, Lessons Learned. A complete list of all recommended equipment for future MMO opportunities is provided in 0.

Table 1. Equipment Used During SCC

Equipment	Quantity	Location
Hand-held avionics VHF radio	**1**	**NAVFAC PAC Navy Technical Representative**
Hand-held marine VHF radio	**3**	• **SMMO on port wing** • **SMMO on starboard wing** • **LMMO on flying bridge**
Hand-held GPS	**3**	• **GARMIN etrex on flying bridge (16-20 Feb), then on port bridge wing (21-23 Feb)** • **GARMIN GPSmap 276C on starboard bridge wing** • **Trimble located on flying bridge (future use requires training and initial setup)**
Audio data recorders with timestamp	**3**	• **SMMO on port wing** • **SMMO on starboard wing** • **LMMO on flying bridge**
Binoculars (with reticle)	**4**	• **SMMO on port wing (Fujinon 7 X 50)** • **SMMO on starboard wing (Fujinon 7 X 50)** • **LMMO on flying bridge (Steiner 7 X 50)** • **DMMO on port wing (Steiner 7 X 50)**
Clipboards	**3**	• **SMMO on port wing** • **SMMO on starboard wing** • **LMMO on flying bridge**

Results

Shipboard Monitoring

Effort and environmental information was collected when the MMOs began effort, changed rotation, as weather changes occurred, and when the MMOs went off effort. The MMOs spent approximately 49.5 hours searching for marine species during the event (Table 2). Three people were vigilant during virtually all of the on effort hours; therefore this study comprised a total of just over 148 hours of marine species shipboard monitoring. During the days that the vessel was entering or exiting Pearl Harbor, less than two hours could be spent on effort. For all other days, at least 7.75 hours per day were spent on effort. Sea conditions were less conducive for obtaining sightings from 16-18 February, but they improved significantly after 18 February (Table 2).

Standards for reporting sun glare, wind direction, and swell direction had not been clearly determined before the cruise. These environmental variables were not collected in a consistent manner and therefore are not included in this report.

Table 2. Effort Hours and Environmental Conditions During the Study

Date	Hours of Effort	Time	Beaufort Sea State (range)	% Cloud Cover (range, conditions)
16 Feb	1 h 37 min	1653 – 1830	2 – 5	5 – 80, light rain
17 Feb	9 h 58 min	0712 – 1130, 1220 – 1732, 1805 – 1833	5 – 7	20 – 80
18 Feb	10 h 28 min	0705 – 1200, 1232 – 1730, 1815 – 1850	3 – 5	20 – 99, rain
19 Feb	10 h 38 min	0705 – 1201, 1236 – 1732, 1806 – 1852	1 – 3	10 – 60, light rain
20 Feb	7 h 51 min	0711 – 1148, 1500 – 1735, 1817 – 1856	1 – 4	3 – 30
21 Feb	7 h 45 min	0710 – 0754, 0817 – 0920, 1006 – 1107, 1144 – 1326, 1409 – 1450, 1512 – 1702, 1804 – 1848	0 – 3	5 – 40
22 Feb	1 h 5 min	0650 – 0755	2	8
Total	49 h 22 min		0 – 7	

Five marine mammal species were observed during the cruise; no sea turtles were observed (

Table 3Table 3). One dolphin species, *Stenella longirostris* or spinner dolphin, was seen as the vessel was leaving Pearl Harbor. The MMOs were not on effort at the time and were not able to record data on the sighting. Therefore, this sighting was not included in the total sightings count.

The MMOs recorded 18 independent sightings of marine mammals, that is, sightings not seen by the Navy lookout team (Table 3). Additionally, the Navy lookout team recorded 5 independent sightings, and 6 sightings were seen by both the MMOs and the Navy lookout team (Table 3). The aerial survey team alerted the MMOs to one pair of humpback whales before the MMOs could see it, which allowed the MMOs to set up a trial for the Navy lookout team as well as provided confirmed species identification. Three sightings were reported by the MMOs to the Officer of Deck, thus ending those sightings as trials.

Of the five species recorded, two were observed on the Barking Sands Underwater Range Expansion of the Pacific Missile Range Facility (PMRF): humpback whales (*Megaptera novaeangliae*) and striped dolphins (*Stenella coeruleoalba*) (**Figure**). An off effort sperm whale (*Physeter macrocephalus*) sighting occurred in the Kauai channel (between the islands of Kauai and Oahu) while the crew was evaluating the vessel's engines at full speed. A small pod (between four and eight individuals) of rough-toothed dolphin (*Steno bredanensis*) also was observed approximately 30 nm southwest of Oahu on the last full day at sea.

Table 3. Number of Sightings by Species

Species	Independent MMO Sightings	Independent Navy Lookout Team Sightings	Sightings by both Teams	Group Size (range)
Humpback whale (*Megaptera novaeangliae*)	5	2	4	1 – 2
Sperm whale (*Physeter macrocephalus*)	1	0	0	1
Striped dolphin (*Stenella coeruleoalba*)	1	0	1	20 – 25
Rough-toothed dolphin (*Steno bredanensis*)	1	0	0	4 – 8
Unidentified whale	10	3	1	1 – 3
Total	18	5	6	

The highest sightings rates occurred closer to Oahu (Table 4). The three sightings on 16 February occurred just after leaving Pearl Harbor, and the majority of sightings on 21 February were recorded between 1150 and 1430 when FFG A waited within a few nautical miles of Pearl Harbor for a rigid -hull inflatable boat to transport personnel to land.

Reviewing the data qualitatively, poor sighting conditions were correlated with low sightings. The two days with the worst sea states and weather conditions resulted in no sightings (Table 2, Table 4). When sightings were recorded, not all sightings resulted in trails due to the location of the sighting (behind beam). Overall, 41.4% of sightings resulted in trials, with a highest rate of setting up trials at 0.62 trials/hour (Table 4). The results of this study suggest that the rate of setting up trials is less than one trial/hour in February around Oahu and Kauai islands.

Table 4. Effort Hours, Sighting Rates, and Trial Rates

Date	Hours of Effort	# of Sightings*	Sightings/ Hour	# of Trials	Trials/ Hour
16 Feb	1 h 37 min	3	1.86	1	0.62
17 Feb	9 h 58 min	0	0	0	0
18 Feb	10 h 28 min	0	0	0	0
19 Feb	10 h 38 min	10	0.94	5	0.47
20 Feb	7 h 51 min	8	1.02	2	0.25
21 Feb	7 h 45 min	7	0.90	4	0.52
22 Feb	1 h 5 min	1	0.92	0	0
Total	49 h 22 min	29	0.81 (mean)	12	0.27 (mean)

** Number of sightings includes both MMO and Navy lookout team sightings combined*

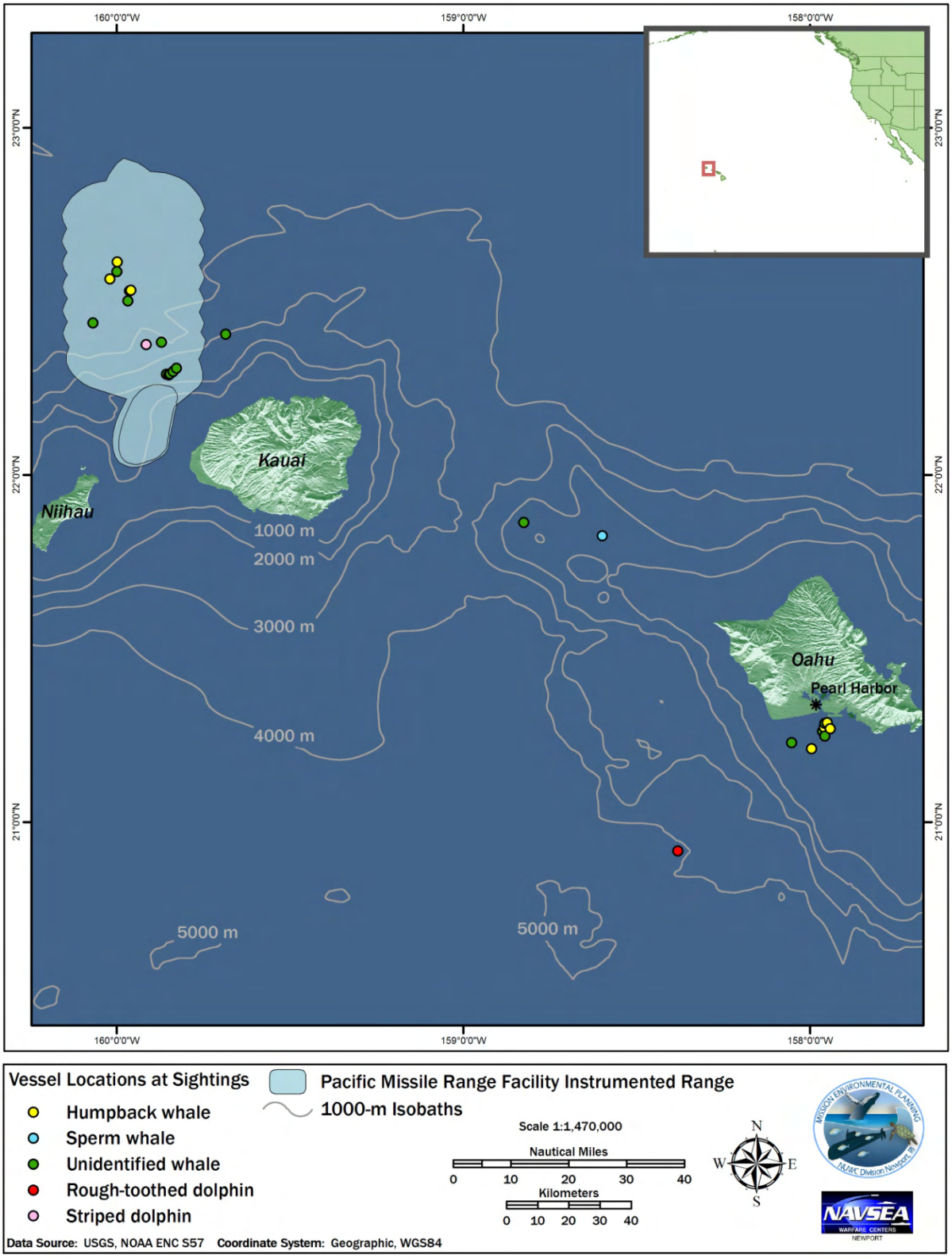

Figure 1. Vessel Locations at Marine Mammal Sightings

Aerial Monitoring

Sightings and focal follow information will be reported by the contractor under a separate report.

Conclusion

Marine Species Monitoring and Lookout Effectiveness

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

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

   The survey protocol developed by the University of St. Andrews required changes once implementation was attempted. Data was able to be collected that will feed into a spreadsheet in order to begin determining the effectiveness of the Navy lookouts. The survey was successfully implemented.

   This event is the first in which data was 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.

   Sightings information included the bearing and distance of the animal to FFG A. This information can be used to determine, if MFAS was in use, to what level the animal may have been exposed to MFAS. Reconstruction of the event and the determination of the possible exposures of marine species to MFAS will be completed under separate task. Obtaining the data needed to make these determinations was successful.

3. Achieve close coordination between the contracted aerial survey team, Navy aircraft on the range, range control, and the MMO team aboard FFG A to facilitate maximizing survey time and project safety

   Communication between the survey aircraft, MMOs, range control, and other aircraft was successful, maintaining safety of all participants.

Lessons Learned

Many lessons learned were noted for the SCC, and are separated into those for shipboard monitoring, aerial monitoring, and operational information below.

Shipboard Monitoring

- Each SMMO was originally responsible for recording his/her own data; however this resulted in missing and inconsistent reporting of data. Therefore, a DMMO is

recommended during these surveys to record all effort and sightings data. This allows for consistency in the data collected, as well as ensures that important information is not accidentally omitted. Additionally, it allowed the SMMOs to focus on the sightings and obtain better resighting information. Furthermore, use of a computer program such as WinCruz would also assist in collection of data. Recommend attempting to test applicability for this protocol. This would allow the data recorder to maintain multiple sightings at one time, and would reduce after-survey effort in logging sightings information. It also would allow MMOs to obtain a new bearing to sightings while the vessel was turning. However, maintaining a backup of the information on sightings forms is also recommended.

- Determining the bearing to the animal proved difficult in many circumstances. In order to obtain the bearing, the MMOs would need to reposition themselves behind either the bigeyes or theodolite. It is recommended that future surveys provide a 360° angleboard located at the MMOs position to more effectively determine bearing and eliminate confusion between port and starboard. Additionally, this would also reduce cueing the Navy lookout team that a sighting by the MMOs has occurred.

- The MMOs used hand-held VHF radios to relay sightings information. However, it also occasionally resulted in the bridge or forward lookout hearing the transmission, therefore cueing them of the sighting. Headsets that can be attached to the radios are recommended for future surveys so as to reduce cueing the Navy lookout team.

- Attending daily ship operations brief while at sea is highly recommended. It facilitates communication between the ship's officers and the MMOs and keeps the MMOs current on the daily operations of the ship.

- On the FFG, the MMOs could not see ship's display monitors that provided the ship location, as available on other vessels. Use of a portable GPS allowed for easier access to ship's locations, without needing to enter the bridge. Using a GPS that allows for marking waypoints is recommended, as a waypoint can be marked as soon as a sighting has occurred. Using the DMMO's GPS also reduces cuing of the Navy lookout team.

- MMOs used small audio recorders to note information on sightings. However, using the recorders relied on the SMMO remembering all data fields required. Use of the recorders as a backup for collecting data is recommended, but not for a primary means of data collection.

- The survey protocol developed by University of St. Andrews recommended the use of two-letter codes for the sighting cue, behavior, and the end of the track. However, the MMOs decided that remembering the cues would be more cumbersome than simply writing what the cue was. Using the codes should not be required during the survey. Codes can be applied afterwards during data consolidation.

- There are potentially two sources of distance and bearing estimates for a sighting: the Navy lookout team's estimate and the MMO's estimate. Sightings reported by the MMO need to clearly state the sources of the estimate. Distances and bearings reported by the Navy lookout team as well as reticle distances and bearings measured by the MMOs

should be reported for comparison. The sightings form should accommodate separate estimation of distance and bearing for the same sighting.

- Data was not entered into spreadsheet format nightly, resulting in increased post-event workload. Ideally, entering the data nightly would reduce workload and allow for potential problems to be rectified. However, the MMOs were quite often exhausted when data entry would have been possible (i.e. at night). This could have resulted in mistakes in data entry. If data is entered on the ship, recommend verifying the accuracy of the data post-event.

- MMOs tried a number of permutations using GPS units available. If allowed, two separate GPS units taking data is recommended. One recording the ship track, the other logging specific waypoints when marine species are observed. If the tracking unit is not able to display heading and speed, a third unit would be useful to display that information for the DMMO to note pertinent information on the sightings and effort forms.

- SMMO sightings were not always immediately reported to the DMMO, resulting in the DMMO logging the waypoint inconsistent with the time of sighting. SMMO sightings need to be reported to the DMMO immediately so that the DMMO can log location and time. One central clock should remain with the DMMO as the accepted time marker for data points.

- Communications between the MMOs need to be strictly defined and adhered to. When MMOs reported to the DMMO, the communication was not standard, leading to confusion and inefficiencies. It is recommended that the MMOs adhere to specific words such as "Starboard sighting" to cue the DMMO to note the time of the sighting and location of the ship. This allows the DMMO to easily record these data fields while potentially de-conflicting sighting data reported from multiple MMOs.

- SMMOs did not always clearly indicated when a trial initiated, creating confusion on who should note the trial. The SMMOs should clearly indicate when a trial is started. If the Navy lookout team is inadvertently cued, the SMMO should immediately notify the DMMO, so that the sighting is no longer a trial.

- MMOs attempted to stagger off effort during meal hours. However, the time allotted for meals is limited (one hour), and it was not possible to rotate MMOs. It is recommended that the MMOs go off effort and take meal breaks as a team. Taking a break as a DMMO also was a suitable rest period for MMOs. Ideally, a fifth MMO would allow for an actual break for each MMO during the day.

- Prior to embarkation, it is recommended that the MMOs conduct an equipment check to ensure they are set up properly, run through the protocol, and make sure assignments are understood before getting underway. The MMOs need to be prepared to be on effort immediately once the ship leaves port, as many species occur near the coast.

Aerial Monitoring

- It was extremely helpful to have a contracted aerial survey team present and available for communication during the event. This allowed for the aerial team to notify the MMOs of potential trials, as well as allowing the MMOs to request focal follows when the aerial team was arriving on range.

Operational Information

- On FFG A, the Navy lookouts were stationed in the pilot house and/or on the flying bridge. This allowed the SMMOs to record sighting information without cueing the Navy lookout team. However, other vessels maintain lookouts on the bridge wings, and therefore the protocol will need to be modified to accommodate this difference.

- Although the MMOs provided presentations at the pre-sail, to OPS prior to the event, and to the CO, XO and OPS on the transit day, relevant information about the study goals and affiliations of the MMOs were communicated down through the officer ranks. Many of the officers continued to be leery of MMO presence, as assumptions were made that the MMOs were environmental activists and not trying to help the Navy maintain MMPA compliance. Once the officers realized that the MMOs are working for the Navy, they felt more comfortable with MMO presence on their ship. It is highly recommended that the MMOs brief both senior and junior officers of the purpose of the survey prior to embarkation (e.g. during a meal in port) and that the MMOs are Navy civilians. Future efforts using contractors could be challenging, therefore, it is recommended that contractors are phased in over time, with at least one Navy biologist on board as the primary point of contact.

- The forward Navy lookouts were also frequently unaware of the MMO's purpose. It is recommended that a standardized brief is provided to the lookouts stating the purpose of the MMOs and what information should be provided to the LMMO.

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ENCLOSURE 1 - Lookout Effectiveness Survey ProtocoL

Calibrating US Navy lookout observer effectiveness

Information for Marine Mammal Observers

Version 1.0

ML BURT, L THOMAS and OTHERS

CONTENTS

1 INTRODUCTION

1.1 Aim of the project

The US Navy use lookouts (LO) to detect anything in the water, including marine mammals. Depending on the nature of the activity the vessel is engaged in, action may need to be taken if the animal is within certain ranges of the vessel. Therefore, it is important to be able to detect all animals that come within these ranges and also determine how far away the animals are with accuracy. Lookouts are positioned so that the waters all around the vessel can be searched. As well as dedicated lookouts, officers on the bridge may also be searching and acousticians may also be listening for vocalizations (although we assume that visual confirmation is required before the encounter is classed as a detection). We refer to all of these observers together as the "observation team" (OT). The aim of this project is to calibrate the OT effectiveness in terms of detecting and identifying marine mammals. Of particular interest is the probability of an animal getting within a defined range of the vessel without being sighted by the OT, as well as determining the accuracy of the OT (primarily the LO) in determining species group (whale, dolphin, etc.) group size and position. In order to achieve this, experienced marine mammal observers (MMO) are required to be searching and collecting information on marine mammals that both they and the LO detect.

Data will be collected to help quantify the effectiveness of the OT during Navy exercises in February 2010 using the protocol detailed in this manual. The protocol will then be revised, for use in a second exercise to take place later in 2010. Further iterations are expected thereafter.

1.2 Overview of analysis methods

Three statistical models are required to estimate the probability of an animal getting within a defined stand-off range without being detected by the OT: (1) a model of the probability that an animal, or group of animals, at the surface is detected by the OT as a function of the animal's position relative to the vessel; (2) a model of surfacing behavior of the animal/group; and (3) a model of animal/group movement. The data collected during the survey described here will be used to parameterize the first model. The latter two models will be parameterized from literature sources. To obtain parameters for the first model, the data required will be information on every surfacing of an animal (or group) detected by the MMOs and whether, or not, the OT saw it.

Since the action taken by the vessel once a sighting has been made depends on the distance recorded by the OT, and to some extent the species, we will also make an assessment of the accuracy of distance and species (or species group) determination – although the only data we have to compare this with are the distances and species recorded by MMOs, which may also not be error free. Therefore, while we can estimate

the magnitude of the differences between OT and MMO distances and species determinations, we cannot make statements about absolute accuracy of either.

1.3 Overview of survey methods

In order to obtain a realistic probability of detection of every surfacing for the OT, it is important that the OT search as usual. However, some additional information from the OT will be required: namely, information on every surfacing. Since this is not typically recorded, and we do not wish to interfere with the normal operation of the OT, we designate one of the MMOs to ensuring that this information is obtained (as detailed below). This MMO will be called the liaison MMO (LMMO) since they need to liaise with the OT. The other MMOs also search and record every surfacing, in such a way that the OT do not know what they are doing. To distinguish them from the LMMO, we refer to them as surveying MMOs (SMMOs).

With the SMMOs searching and recording every surfacing, a combination of line transect distance sampling (DS) and mark-recapture (MR) methods can be used to estimate the required probability of detection for each surfacing. These methods are frequently used in surveys of marine mammal surveys, but generally without the complication of recording each surfacing. The idea is that when the SMMOs detect an animal surfacing, they are setting up a "trial" for the OT, which can either result in the OT detecting that surfacing or not. The model assumes that probability of detection is a function of distance (both ahead and abeam of the ship), whether that group was sighted by the OT before and potentially other variables. Animals (or groups) that are more-or-less continually at the surface (such as large groups of dolphins) can be analyzed in a similar framework, but here the probability of detection is modelled as a continuous hazard rather than only when discrete surfacing occurs. The data required for continuously available animals is: when and where the SMMOs first detected them, regular updates on position, when and where the OT first detected them (if they did), when and where the OT lost contact with them and when and where the SMMOs lost contact with them.

The primary members of the OT are the dedicated LOs; however there are also observers on the bridge and possibly an acoustic 'observer', although the search effort for these observers will be variable depending on their other duties. Nevertheless, sightings information from these observers will also be required. We plan that the LMMO will be stationed next to the LO; hence it is important that other members of the OT communicate their detections to the LO so that the LMMO can record them. If this does not happen, it may be necessary to station an additional LMMO on the bridge, so they can record detections made by the bridge observers.

A key element of this method is that the OT must search as usual and search independently from the SMMOs. If the LO or other observers are aware of sightings made by the SMMOs, the premise of the analysis will break down.

Another key element is that the SMMOs must be able to determine if a detection of a surfacing they have made has been detected by the OT or not (i.e. was the trial a "success" or "failure"). The LMMO is responsible for communicating all OT detections to the SMMOs, who can then judge if this corresponds with to a detection they have made. Also, information about the timing and location of detections will be recorded (by the LMMO for OT detections and by the SMMO for SMMO detections) so that determination of which are duplicates can be refined offline, after the survey.

In addition to the detection probability information, SMMO observers will also provide information on species and group size with which to calibrate the OT.

The most important surfacings are those made before the OT detects the animals, and the first surfacing detected by the OT. Thereafter, repeat detections of the same animal/group by the OT are useful information for refining the detection function shape, and for gleaning information about surfacing rates, but do not bear directly on the main question we wish to answer. Hence, most effort by the SMMOs should go into detecting marine mammals before the OT has seen them, and determining whether each of these surfacings is detected by the OT. Once a group has been detected, the SMMOs should feel free to concentrate on searching for new animals/groups, unless tracking of already detected groups is straightforward. One of the two SMMOs should be searching for new groups, especially if the other SMMO is following a group. The SMMOs are encouraged to search with binoculars or big eye binoculars as much as possible.

1.4 Overview of the manual

This manual describes the survey protocol and sighting procedures of the various observers and details the data to be collected. It should be borne in mind that the protocol may need to be adapted if procedures are found to be infeasible.

2 SURVEY PROCEDURE

2.1 Search platforms

2.1.1 Frigate

The platforms available for observation on a frigate are the bridge, bridge wings (with Big Eyes installed), the upper bridge and the fantail (stern of the ship).

2.2 Observer configuration

2.2.1 OT

Dedicated LOs are positioned on the upper bridge and fantail with additional observers operating opportunistically on the bridge. An acoustic observer may also be available. We assume that the upper bridge LO will be the one primarily making confirmed sightings, and that all sightings by other members of the OT will be reported to them. Officers on

the bridge or in combat are responsible for entering marine mammal records into a log (Appendix B); this log will not be used in the current survey as it is not detailed enough for our purposes – instead the LMMO will keep detailed records (see below). All OT personnel should search independently of the SMMOs.

2.2.2 MMO

Three MMO are required; two on the bridge wings who are actively searching (SMMOs) and one with the navy LO on the upper bridge (the LMMO). The primary purpose of the MMO on the upper bridge is to record all detections and surfacings detected by the OT. The MMO should all be in contact with each other and also be aware of any sightings made by the OT.

It is anticipated that the MMOs will rotate positions, for example, port SMMO, starboard SMMO, LMMO, resting. If it is feasible, the fourth MMO could be stationed in the bridge in order to ensure that all bridge sightings are recorded.

It is also conceivable that the LMMO may sometimes be able to operate as an additional search platform, aiding the SMMOs, if they are able to stand behind the LO and hence not cue them with their sightings. This is something that will need to be determined on board the vessel.

Lastly, it may be useful to have a fourth MMO on duty, aiding the SMMOs as a data recorder. It is our hope that the SMMOs will be able to use audio recording devices to record data, rather than having to look down and record data on paper. Looking down greatly increases the chance of losing a tracked animal, missing sightings, etc. However, should it not be possible to obtain an audio recording device, or should its use not be feasible, then having a fourth MMO to transcribe SMMO data would be very valuable.

2.3 OT procedure

It is important that the OT search as usual and independently of the MMO. Having detected a marine mammal, the LO should report each surfacing of the group they detect to the LMMO. The LMMO will be positioned on the upper bridge will record this information. However, the LO should not alter their usual search behaviour in order to better detect repeat surfacings – they should carry on with whatever search behaviour they would use if the MMOs were not present.

If the bridge, or other member of the OT, detect an animal, they should inform the LO. This will both inform the LMMO who can record the information and allow the LO to track each surfacing. It is not necessary for the bridge or other observers to inform the LO of each surfacing they detect after the first one, if it is obvious it is of the same group, unless this is their normal procedure. As stated earlier, we are not focussed on repeat surfacings.

It is our understanding that LOs have access to a compass and this should be used to determine the angle from the trackline to the sighting if this is their usual method. Distances are estimated by eye.

2.4 SMMO procedure

The main functions of the SMMO are to detect and track marine mammals and determine whether sightings made by the OT and reported to them by the LMMO are duplicates with sightings they have made. The SMMOs should search from the vessel to the horizon using binoculars concentrating forward of the vessel to abeam. The search pattern is:

- Port observer: searches on the port side of the vessel from about 5° starboard to abeam.
- Starboard observer: searches on the starboard side from about 5° port to abeam.

On detecting an animal, they should attempt to record each surfacing until the animal goes abeam. Tracking an animal has three uses: it helps to identify any animals subsequently seen by the OT; species and group size can be more accurate (because animals and groups are seen more than once) and information on surfacing behaviour is required for the analyses. The MMOs will need to be in contact with each other and thus be aware of any sightings made by the OT which will help with duplicate identification; duplicate sightings are animals seen first by the SMMO and then by the OT (as reported by the LO via the LMMO).

If the OT detect an animal prior to the SMMO, then the SMMO should attempt to locate it to determine species and group size and then continue to track and record each surfacing (but see section 3.4, below). If the OT sighting occurs during SMMO tracking, the SMMO should continue to track the animal until it is lost, or goes abeam, and then attempt to locate the sighting made by the OT.

SMMO should primarily concentrate their search effort forward of abeam but if substantial numbers of animals approach the vessel from behind abeam (i.e. dolphins that can swim faster than the vessel) then it may be necessary to search behind abeam.

Angleboards should ideally be used to measure bearings to sightings relative to the ship and the binoculars should have reticles for use in calculating distances.

Each SMMO should record information into an audio recording device for later transcription on to a SMMO sighting form; alternatively a fourth MMO may be available to do real-time data transcription. Effort information should be recorded on an MMO effort form.

The SMMOs assess the duplicate status of each surfacing.

If there are too many animals in view for an SMMO to keep track of, the SMMO should choose a small number of trials (one or two) that they can track accurately and follow them until it is clear the OT has duplicated that target or the track ends.

2.5 LMMO

The primary function of the LMMO is to record information (section 4) on the first sightings of all the OT. Information on all subsequent sightings should also be recorded if possible. The LMMO will pass the information of sightings to the SMMOs as soon as possible to determine if the OT has duplicated as sighting made by the SMMOs. In some cases this will inform the SMMOs of animals not yet detected. The LMMO can also actively search for animals and inform the SMMOs of any sightings they make (so the SMMOs can use them to set up trials), as long as this does not cue the LO or compromise data recording.

3 SIGHTING PROTOCOL

This section relates to the procedure to be followed on detecting a marine mammal.

3.1 LO

On sighting a marine mammal, the LO should inform the LMMO giving all required information (see section 4) but in particular time of sighting, species, sighting angle, sighting distance and group size. The LO should also give the information for any subsequent sightings of the same group to the LMMO.

3.2 Bridge (or other OT member)

On sighting, or detecting, a marine mammal, the bridge should inform the LMMO – this may be via the LO if LMMO is not in direct contact with the bridge. Subsequent sightings of the same should also be passed to the LO, although it seems likely in practice that the primary responsibility for tracking already sighted groups within the OT will fall upon the LO.

3.3 SMMO

On sighting a marine mammal, the SMMO should

1. Collect and record the following information: time of sighting, species, sighting angle, sighting distance and group size. Other information (such as cue or behaviour) should be collected if there is time.

2. Attempt to track the animal, recording information on all subsequent sightings.

3. Assess duplicate status, maybe in consultation with the LMMO.

4. Inform the bridge of any animal within the operational standoff range of the vessel if active sonar operations are taking place.

3.4 Tracking priority

The first priority for SMMOs is to find and track animals before the OT see them, to set up trials for the OT. When the OT report a sighting (via the LMMO) of a new group they should determine whether it is a duplicate or not (i.e. something they were tracking already). A secondary priority is to track groups already seen by the OT, to determine resighting rates. With this in mind, the procedure for SMMOs on detecting an animal is as follows:

- On locating an animal, or group, attempt to track until the animal is lost or is a long way behind and unlikely to approach the vessel.

- If the OT detect an animal while both SMMOs are searching (i.e. not tracking anything), one SMMO should attempt to locate the OT sighting (to confirm species and group size) and continue to track it and record each surfacing. This will be necessary to determine how many surfacings the OT detect. The other SMMO should continue to search as setting up new trials is more important.

- If the OT detect an animal while one SMMO is engaged in tracking, that SMMO should determine whether the OT sighting is a duplicate or not. If it is, the SMMO should continue tracking the group while the other SMMO searches for new groups. If it is not, the SMMO should continue tracking their group, while the other SMMO attempts to track the group seen by the OT, if possible. If this is not possible, the other SMMO should revert to searching for new groups to track.

- If the OT detect an animal while both SMMOs are engaged in tracking, the SMMOs should continue determine if the OT sighting is a duplicate or not. In either case, they should continue tracking their groups until the track is finished or the group is sighted by the OT.

3.5 Group size definition

In the case of aggregated groups, the angle and distance measurement should be estimated to the geometric centre of the aggregation. A group can be thought of as the smallest unit that can be tracked as a unit. A convenient rule is, for example, to define a group as containing animals not more than 3 animal lengths from each other (this may depend on species). The group may exhibit the same swimming pattern and general behaviour although not necessarily with a synchronised surfacing pattern.

Difficulties may arise when animals are not in tight, easily defined clusters, but in loose aggregations whose boundaries and group size must be determined subjectively. In this

case, it is better to identify smaller, homogenous groups within the aggregation, and associate each with an angle, distance and group size.

Problems can also arise when a group is formed of animals swimming in a long line at relatively equal distances from each other (e.g. pilot whales). In this case, group boundaries can be taken at convenient discontinuities in the distribution.

Large groups of dolphins may comprise of several hundreds of animals. Often these groups are compact and form a single unit. Sometimes subgroups may form but may only last for a short time with frequent interchange of animals between groups. In this case, it is better to treat the whole group as a single unit. As these groups will have a continuous cue, it is not necessary to make continuous resightings, but only at appropriate intervals, say 5 minutes or perhaps more frequently close to the vessel.

If relatively stable subgroups can be identified, then the details for the first subgroup sighted should be recorded and then this subgroup should be followed. Include a comment that it is part of a larger aggregation, and if possible, how many other subgroups there are in the aggregation and group sizes. A duplicate sighting would occur if the OT detects the subgroup being tracked.

If a groups splits while being tracked, then one subgroup should be tracked. The groups sizes recorded should reflect that the group has split and is now smaller than the original sighting. The fact that the group has split should be recorded in the data. When tracking of the subgroup has finished, the SMMO should then try to relocate one of the other subgroups and track it.

3.6 Surfacing and availability

A surfacing is defined as any opportunity that an animal is available to be detected visually. This could be when the animals are at the surface or even below the surface if the water is clear enough.

Some animals may be intermittently available, for example if they are at the surface for a short time and then dive and then return to the surface. Others might be continuously available, for example large groups of dolphin schools which surface asynchronously. As ever, it is important to record the first sighting of these and as discussed in section 3.5, record the final sighting and, if feasible, at appropriate intervals such as every 5 minutes.

Some animals may provide both intermittent and continuous cues (i.e. a blow but then stays close to the surface and if the water is clear enough can still be seen). In this case, treat each discrete surfacing (ie. fluke, blow, body) as a resurfacing but include a comment that the animal is continuously available.

4 DATA COLLECTION

It is anticipated that data will be recorded onto audio recorders or paper forms and transcribed at the end of each day. The information collected by the OT is recorded by the LMMO onto a sightings form. Sightings by the SMMOs are recorded or transcribed onto a MMO sighting form. Forms for search effort and weather and other basic information are also provided. Note the form number and total number of forms (at the top of the paper form) is used to prevent forms being lost.

4.1 Sightings form

This form should be used to record all sighting information. All information is required upon initial sighting. Information needed for each resurfacing is indicated in bold.

FIELD	DESCRIPTION
SIGHTING #	**This is the number of each sighting and should be sequential.**
RESIGHTING #	**The number of times the object has been resighted. The initial sighting will have a resighting number of zero and subsequent resightings will be 1, 2, etc. Each resighting starts a new column on the sighting report form.**
RESIGHTING. STATUS	**D definite resightings (at least 90% likely to be the same animal or group)** **P possible resighting (more than 50% likely)** **R remote resighting (less than 50% likely)**
TIME	**Time of sighting.**
SPECIES CODE	**The five letter code used to identify the species. Refer to section 4.4. If a species is not listed, then include this information in the 'Comment' for the record.**
DURATION (if cue continuous)	**If the cue is continuous, then indicate the length of time, you were observing this sighting.**
ANIMAL (A) bearing	**Estimated angle of the bow of the ship to the sighting. A sighting dead ahead is 0° and angles go from 0-360°.**
SIGHTING DISTANCE	**Estimate of sighting distance in metres?**
GROUP SIZE	**Give the best estimate of group size, including calves. In mixed schools enter the number of each species.**
DUPLICATE SIGHT #	**Duplicate sighting number. This allows duplicate sightings to be cross-referenced.**
DUPLICATE TRIAL	**Indicate if this is a valid duplicate:** **Yes – sighting seen first by MMO** **No – sighting seen first by OT**
DUPLICATE STATUS	**Duplicate status of a sighting:** **D – definite duplicate (at least 90% likely to be the same animal)** **P – possible duplicate (more than 50% likely)** **R – remote change of being a duplicate (less than 50% likely)**
SHIP LATITUDE	
SHIP LONGITUDE	
SHIP (S) BEARING	

FIELD	DESCRIPTION
RELATIVE MOTION A/S & A'S BEARING	Indicates of the animal is opening away from the ship, closing towards the ship, or moving parallel to the ship's track. The heading of the animal relative to the ship should be recorded relative to the line of sight where 0° indicates the animal is heading directly away, 90° indicates the animal is heading from left to right, 180° - directly towards the ship, 270° - heading right to left.
DETECTION SENSOR	Observer who made the sighting: MMO + observer code LO Bridge Acoustic
NUMBER OF CALVES	Enter the number of calves in a group.
SIGHTING CUE	Indicator of cue which led to the sighting: BL - blow BW – bowride BY - body DV - dive FL – fluke up GL – glint of sunlight off body HS – head slap JU - jump /breach/spin PA – peduncle arch PP – porpoise PS – pectoral fin slap SL- slick, footprint or ring SN – spin SP - splash TS – tail slap WL – seabirds or other associated wildlife OT – other
BEHAVIOUR	BR – Breaching BW – Bow riding FD – Feeding FL - Fluking FS – Flipper slapping ML – Milling LO – Logging RE – Resting TR – Travelling TS – Tail slap VO - Vocalizing
END OF TRACK	Reason for stopping a track. BE - sighting behind the beam LO - sighting lost OB - sighting obscured NC - no change of the sighting with respect to the boat (this may happen if the sighting is far away) MA - sighting passed to other LO to follow OT – other
OPERATIONS INFORMATION	Were any mitigation measures implemented?
COMMENT	Any additional information.

4.1.1 Sighting number/Duplicate sighting number

The duplicate sighting number on the sightings form is the number given to the surfacing by the LMMO, and called down to the SMMOs. If the SMMOs think this is the same as a surfacing they sighted, they give write down the LMMOs sighting number under "DUPLICATE SIGHT #" on the form. Two types of duplicate sighting can be distinguished: those that represent valid trials for estimating the OT detection function and those that do not. Valid trials are where the SMMO saw the surfacing independently (for example because they were tracking the group) and then the LMMO radios down to inform the SMMO that a surfacing has been seen by the OT, and the SMMO determines it's the same as the one they just saw. In this scenario, "Yes" should be entered under "DUPLICATE TRIAL". By contrast, trials do not occur when the LMMO alerts the SMMOs to a surfacing that the OT have seen but the SMMOs had not previously seen, and then the SMMOs see the surfacing and record information on it. In this case, although it's a duplicate (because both OT and SMMO saw the surfacing), it is not a valid trial as the OT saw it first directed the SMMO to see it. Hence "No" should be entered under "DUPLICATE TRIAL".

This duplicate information should be recorded by the SMMO since they are making any duplicate assessment. It is not necessary for the LMMO to fill in this information. The LMMO just need to pass sighting numbers of OT sightings to the SMMO so that the SMMO can fill in the duplicate information on their forms.

4.1.2 Multi species sighting

When recording groups of mixed species, record the information on separate lines but assign the same sighting number.

4.1.3 High density regions

It is anticipated that in the region chosen for the survey, animal density will be low. However, if the density of animals is high, so that the assessment of duplicate status becomes difficult, then indicate this on the effort form (see section 4.2). Cross-referencing of duplicates may need to be reconsidered. If density of animals is high (i.e. detections occur more than once every few minutes), then the timing of sightings becomes critical.

4.2 MMO Effort/weather form

This form should be completed by the LMMO everytime an 'event' occurs, for example at the start/end of search effort, observer rotation, changes in the weather. If the density of animals is too high to make it difficult to assess duplicate status, then indicate this in the 'Event' field. Sometimes the weather will be too bad for searching, in which there will be no search effort.

FIELD	DESCRIPTION
EFFORT	Whether search effort is ON or OFF.
EVENT	Record the event: 1 – begin search effort 2 – stop search effort 3 – observer rotation 4 – weather change 5 – transect waypoint 6 – high animal density 7 – back to normal animal density 8 – end of day
TIME	Time of event
LATITUDE	
LONGITUDE	
Port MMO	MMO who is searching on port side of vessel.
Starboard MMO	MMO who is searching on starboard of vessel.
LMMO	MMO who is acting as liaison MMO.
SEA STATE	Beaufort Sea state on a scale of 0-7.
SONAR	Is sonar On or Off?
EXPLOSIVES	Are explosives in use: Yes or No.
VISIBILITY	General impression for spotting marine animals: B – Bad (<0.5km) P – Poor (0.5 – 1.5km) M – Moderate (1.5 – 10km) G – Good (10 - 15km) E – Excellent (<15km)
WAVE HEIGHT	Light (0 – 3ft) Moderate (4 – 6ft) Heavy (>6ft)
SWELL DIRECTION	
WIND DIRECTION	
WIND SPEED	
% GLARE	
% CLOUD COVER	

4.3 MMO Observer code form

This should be completed at the start of the survey and the observer codes decided. The heights are needed if reticle readings have to be converted to distances.

FIELD	DESCRIPTION
CODE	Two letter code for each observer.
NAME OF OBSERVER	Name of the observer
EYE HEIGHT	Eye height (in feet) of the observer (to be used for converting reticle estimates to distances).
PLATFORM HEIGHT	Height of SMMO platform (in feet) above sea level.

4.4 Table of species codes

CODE	COMMON NAME	SCIENTIFIC NAME
BALMU	Blue whale	*Balaenoptera musculus*
BALPH	Fin whale	*Balaenoptera physalus*
MEGNO	Humpback whale	*Megaptera novaeangliae*
BALAC	Minke whale	*Balaenoptera acutorostrata*
BALED	Bryde's whale	*Balaenoptera edeni*
BALBO	Sei whale	*Balaenoptera borealis*
BALMU	Blue whale	*Balaenoptera musculus*
BAL--	Unidentified rorqual	Balaenopteridae
WHALE	Unidentified whale	
ZIP--	Unidentified beaked whales	Ziphiid
MES--	Unidentified *Mesoplodon*	*Mesoplodon* spp.
MESDE	Blainville's beaked whale	*Mesoplodon densirostris*
ZIPCA	Cuvier's beaked whale	*Ziphius cavirostris*
INDPA	Longman's beaked whale	*Indopacetus pacificus*
PHYMA	Sperm whale	*Physeter macrocephalus*
KOGBR	Pygmy sperm whale	*Kogia breviceps*
KOGSI	Dwarf sperm whale	*Kogia simus*
KOG--	Unidentified pygmy/dwarf sperm whale	*Kogia* spp.
ORCOR	Killer whale	*Orcinus orca*
PSECR	False killer whale	*Pseudorca crassidens*
FERAT	Pygmy killer whale	*Feresa attenuata*
PEPEL	Melon-headed whale	*Peponocephala electra*
GLOMA	Short-finned pilot whale	*Globicephala macrorhynchus*
TURTR	Bottlenose dolphin	*Tursiops truncatus*
STEAT	Pantropical spotted dolphin	*Stenella attenuata*
GRAGR	Risso's dolphin	*Grampus griseus*
STELO	Spinner dolphin	*Stenella longirostris*
STECO	Striped dolphin	*Stenella coeruleoalba*
STEBR	Rough-toothed dolphin	*Steno bredanensis*
LAGHO	Fraser's dolphin	*Lagenodelphis hosei*
DOLPH	Unidentified dolphin	
CET--	Unidentified cetacean	
CHEMY	Green turtle	*Chelonia mydas*
EREIM	Hawksbill turtle	*Eretmochelys imbricata*
DERCO	Leatherback turtle	*Dermochelys coriacea*
CARCA	Loggerhead turtle	*Caretta caretta*
LEPOL	Olive ridley turtle	*Lepidochelys olivacea*
TURTL	Unidentified turtle	
MONSC	Hawaiian monk seal	*Monachus schauinslandi*

5 OTHER ACTIVITIES

5.1 Final cruise report

At the end of the cruise a brief report which contains a general evaluation of the survey (i.e. suitability of vessel, platform locations, search procedure, sighting protocol,

equipment, general operation etc.) would be helpful. Perhaps include a summary of the survey data collected (number of miles/km searched, number of sightings of each species) and any problems that have occurred, any adaptations to the protocol that may have been implemented or if any new species codes have been added. This information will be useful to refine survey methods for the next survey and in the analysis of the data.

5.2 And finally!

Have a good time and enjoy the survey! Don't forget you can contact the St Andrews team at any time (time difference allowing).

EQUIPMENT LIST

LO Equipment

Each LO should have the following equipment, which are all provided:

- Compass for measuring sighting angle
- 7x50? binoculars for searching
- Big Eyes for group size
- Headsets or other means of communicating with bridge

MMO Equipment

Each MMO should have the following equipment:

- 7x50? Binoculars with reticles
- Compass (provided on platform)
- GPS or synchronised digital watch
- Radios (handheld or headsets to communicate with other MMO)
- Clipboard
- Pencils
- MMO sighting forms
- MMO effort/weather forms (LMMO only)
- Equipment to communicate with bridge
- Crib sheet for converting reticles to distances?
- Crib sheet of species codes
- Audio recording device, if possible, for recording sightings without needing to look down to paper survey form. Automatic time stamp, if possible.

LO DATA – DAILY MARINE MAMMAL LOG

The following table describes the data recorded in the LO 'Daily marine mammal log'.

FIELD	DESCRIPTION
A. DTG	Date and time of sighting DDHHMM Z MMM YY
B. Species/Type of mammal	Types are Whale/Dolphin/Porpoise/Seal/Sea lion/Turtle/Generic (i.e. unknown)
C. Number of mammals	Number
D. Calves	Yes/No
E. Initial detection source	Visual/Aural
F. Initial bearing/range	Bearing in degrees (true)/ Range in yards
G. Unit position	Latitude DDMMSS N/S and Longitude DDDMMSS E/W
H. Unit course/speed	Course in degrees (true)/ Speed in knots
I. Last known bearing/range	Bearing in degrees (true)/ Range in yards
J. Total time visually observed	Time in minutes
K. Wave height	Wave height in feet
L. Visibility	Visibility in nautical miles
M. MFAS status	No/Yes or On/Off
N. MFAS action taken	Powerdown -6dB/Powerdown -10dB/Shutdown/None
The following fields are completed if MFAS was transmitting when a mammal was sighted and subsequently powered down/shut down, or course changed.	
O. Duration of action	Minutes
P. Maneuver conducted	Turn STBD/Turn PORT
Q. Degrees of course change	Degrees
R. Range action taken	Range in yards
S. Action impact	Tactical degradation assessment – examples: None Slight - degraded ASW screen integrity when ship manoeuvred to open whales Moderate – lost contract when power reduced Significant – engagement interrupted when MFAS as shutdown
T. Narrative of observation	Examples: Dolphins sighted at 1200yds off port bow, closing on ship. Manoeuvred to confirm bow riding and continued MFAS operations.

RECOMMENDED EQUIPMENT LIST FOR MMO SHIPBOARD SURVEYS

Equipment	Quantity	Location
Hand-held marine VHF radio	**3**	• **SMMO on port wing** • **SMMO on starboard wing** • **LMMO**
Hand-held GPS	**3**	• **SMMO on port wing** • **SMMO on starboard wing** • **DMMO** • **Recommend GPS unit used be consistent; still determining best-suited GPS available**
Audio data recorders with timestamp	**3**	• **SMMO on port wing** • **SMMO on starboard wing** • **LMMO**
Binoculars (with reticle)	**4**	• **SMMO on port wing** • **SMMO on starboard wing** • **LMMO** • **DMMO** **Recommend all binoculars be Fujinon 7 X 50 for consistency.**
Digital watch with seconds showing	**4**	• **SMMO on port wing** • **SMMO on starboard wing** • **LMMO** • **DMMO**
Angle board	**3**	• **SMMO on port wing** • **SMMO on starboard wing** • **LMMO**
Camera	**2**	• **SMMO on port wing** • **SMMO on starboard wing**
Clipboards	**4**	• **SMMO on port wing** • **SMMO on starboard wing** • **LMMO** • **DMMO**
Pelican case/drybag	**Ship dependent**	**One container at each MMO location is necessary. Depending on the type of vessel, the number of containers/bags needed may vary.** • **FFG: 3, one each for starboard bridge wing, port bridge wing, and flying bridge** • **DDG: 2** • **CG: 2**
Misc. Supplies: zip ties, duct tape, electrical tape, rubber bands		