August 2010

Cruise Report, Marine Species Monitoring & Lookout Effectiveness Study

Southeastern Antisubmarine Warfare Integrated Training Initiative (SEASWITI), March 2010

Jacksonville Range Complex

Prepared for:
United States Fleet Forces

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List of Acronyms and Abbreviations

ASW	antisubmarine warfare
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
SEASWITI	Southeastern Antisubmarine Warfare Integrated Training Initiative
SMMO	survey marine mammal observer
VHF	very high frequency
yd(s)	yard(s)

SECTION 1 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 and Endangered Species Act. The Atlantic Fleet Active Sonar Training (AFAST) Monitoring Plan, implemented 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:

1. Are marine mammals and sea turtles exposed to MFAS, especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?

2. If marine mammals and sea turtles are exposed to MFAS in the Northwestern Atlantic of Gulf of Mexico (or "AFAST study area"), do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?

3. If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses to various levels?

4. Are the Navy's suite of mitigation measures for MFAS (e.g., Protective Measures Assessment Protocol [PMAP], major exercise measures agreed to by the Navy through permitting) effective at avoiding TTS, injury, and mortality 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 fourth 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, 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 destroyer (DDG). The University of St. Andrews, Scotland, under contract to the U.S. Navy, developed an initial protocol for use during this study. Changes to the protocol were required during the initial implementation of this protocol. As such, the MMOs modified the protocol as necessary. The results gathered were the first attempt to implement this new protocol on a DDG; 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 (Ms. Amy Farak, Dr. Sean F. Hanser, Mr. Anurag Kumar, and Ms. Toni Mizerek) participated in a Southeastern Antisubmarine Warfare Integrated Training Initiative (SEASWITI) on 15-19 March 2010. These

MMOs were stationed aboard a DDG, hereafter referred to as DDG A. The goals of the SEASWITI 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.

SECTION 2 SEASWITI DESCRIPTION

SEASWITI is an event with up to two submarines and either two DDGs and one FFG or one CG, one DDG, and one FFG. SEASWITI events are a requirement to provide the necessary training to prospective submarine commanders in rigorous and realistic scenarios involving undersea warfare. The ships and their embarked helicopters would be conducting antisubmarine warfare (ASW) localization training using the AN/SQS-53, AN/SQS-56, and AN/AQS-13 or AN/AQS-22 dipping sonar. The submarine also periodically operates the AN/BQQ-10 sonar. Participants in this SEASWITI included DDG A, a CG, a FFG, maritime patrol aircraft (fixed-wing patrol squadron), helicopter antisubmarine squadron, submarines, torpedo recovery helicopter and boats, and range control for subsurface, surface, and air.

SECTION 3 METHODS

3.1. SHIPBOARD MONITORING

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 DDG A 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 (200 yards [yds], 183 meters [m]) and was not sighted by the Navy lookout 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 lookout team for appropriate reporting and action.

The initial protocol for data collection was provided by the University of St. Andrews and is included as Appendix A. This protocol was modified by the MMOs during an initial implementation during February 2010 in the Hawaii Range Complex. Additional changes were made as necessary during the event. The MMO survey on DDG A was conducted on the bridge wings (elevated 60 feet [ft; 20 m] above the waterline), with one MMO on each wing (called survey MMOs, or SMMOs). One MMO was stationed on the starboard bridge wing and acted as a liaison to the starboard lookout (called liaison MMO or LMMO). The fourth MMO was responsible for acting as a liaison with the port lookout, but also was responsible for recording data (data MMO or DMMO) reported by the two SMMOs and the LMMO. A rotation schedule was used, such that an MMO would be on effort for one hour on port, one hour as the LMMO on the flying bridge, one hour as an SMMO on starboard, and one hour as DMMO on port. 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 twenty-three sighting, environmental, and operational parameters. Sightings obtained first by the

SMMOs before the Navy lookout were considered to be "trials" unless the sighting was aft of the beam. If applicable, photographs would be taken using a Canon EOS 20D digital camera with a 100 – 400 mm zoom lens. No photographs would be taken until the Navy lookout had the sighting so as not to inappropriately call attention to the sighting. No opportunities arose during this effort for photographs.

The LMMO stationed on the starboard bridge wing reported sightings made by the Navy starboard lookout. Once the starboard 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 DMMOs for recording and to determine if the sighting was considered a duplicate.

The DMMO stationed on the port bridge wing recorded sightings made by the Navy port lookout, as well as record data collected by the SMMOs and the LMMO. For each event (e.g., begin effort, end effort, observer rotation, weather change) the DMMO recorded time, location, and weather information as per the protocol (Appendix A). At the time of an event, a waypoint was immediately taken so that the accurate time and location would be recorded. Associated information could then be added.

Usage of the software program WinCruz was attempted on 17 – 18 March to compare an alternate way to record data. In WinCruz, once a sighting is identified, the user inputs a single command and the program records the exact time and location. The program then prompts the data recorder to enter additional environmental, effort, and sighting data. Most of the required information is similar to the protocol (Appendix A), although some differences needed to be accounted for.

3.2. EQUIPMENT LIST & COMMUNICATIONS

Communication between DDG A officers and MMOs was accomplished during meals in the wardroom, a morning operational brief, and on the ship's bridge as required. The equipment used by the MMOs is included in Table 1. A complete list of all recommended equipment for future MMO opportunities is provided in Appendix B.

Table 1. Equipment Used during SEASWITI

Equipment	Quantity	Location
Hand-held marine VHF radio, with headsets	4	• SMMO on port wing • SMMO on starboard wing • LMMO on starboard bridge wing • DMMO on port bridge wing
Hand-held GPS	1	• GARMIN GPSmap 276C on starboard bridge wing
Audio data recorders with timestamp	3	• SMMO on port wing • SMMO on starboard wing • LMMO on starboard bridge wing
Binoculars (with reticle)	4	• SMMO on port wing (Fujinon 7 X 50) • SMMO on starboard wing (Fujinon 7 X 50) • LMMO on starboard bridge wing (Fujinon 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

SECTION 4 RESULTS

Effort and environmental information was collected when the MMOs began effort, at each rotation, as weather changes occurred, and when the MMOs went off effort. The MMOs spent approximately 27.5 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 82 hours of marine mammal shipboard monitoring. The DMMO was often observing when there were no data to record but this effort was not recorded and therefore not included. During the times that the vessel was entering or exiting Mayport, Florida, limited time was spent on effort because of the set-up and break-down procedures as well as allowing sailors to complete their tasks without interference. For whole days out at sea, approximately 7 hours per day were spent on effort. Sea conditions were less conducive for obtaining sightings on the afternoon of 17 March and most of 18 March because of winds (Table 2). MMOs were off effort for less than 3 hours during the course of the event because of rain on the afternoon of 17 March and the morning of 18 March.

Table 2. Effort Hours and Environmental Conditions during the Study

Date	Hours of Effort	Time	Beaufort Sea State (range)	% Cloud Cover (range, conditions)	Visibility (range)
15 Mar	4 h 21 min	1354-1359, 1419-1507, 1512-1703, 1802-1939	1-4	50-90	Good-excellent
16 Mar	6 h 37 min	0732-0746, 0901-1204, 1304-1315, 1458-1624, 1745-1928	2-4	30-90	Good
17 Mar	7 h 51 min	0733-1159, 1304-1404, 1425-1636, 1743-1757	2-4	90-100, occasional rain & windy	Moderate-good
18 Mar	7 h 57 min	0712-0813, 1011-1206, 1255-1700, 1820-1916	3-6	75-100, occasional rain & windy	Moderate
19 Mar	1 h 8 min	0710-0818	2	0, Cold & windy	Good
Total	**27 h 54 min**		**2-6**		

The MMOs recorded 4 independent sightings of marine mammals, that is, sightings not seen by the Navy lookout team (Table 3). Additionally, the Navy lookout team recorded 3 independent sightings, and 6 sightings were seen by both the MMOs and the Navy lookout team (Table 3). One species could be positively identified (*Stenella frontalis* or Atlantic spotted dolphin); no sea turtles were observed. One additional dolphin was seen as the vessel was leaving Mayport, Florida. 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.

Table 3. Number of Sightings, by Species

Species	Independent MMO Sightings	Independent Navy Lookout Team Sightings	Sightings by both Teams	Group Size (range)
Atlantic spotted dolphin (*Stenella frontalis*)	3	1	5	1-20
Unidentified dolphin	1	1	1	2
Unidentified whale	0	1	0	1
Total	**4**	**3**	**6**	

Reviewing the data qualitatively, poor sighting conditions were correlated with low sightings. On the days when number of sightings was the lowest (16 and 18 March), the wind speed and sea states were relatively greater than the remaining days with a greater number of sightings (Table 2, Table 4). All MMO sightings were available as trials. The most trials (5 of 6 sightings, or 83.3% of the sightings) as well as the highest rate of setting up trials (1.15 trials/hour) were recorded on 15 March (Table 4). The results of this study suggest that the rate of setting up trials is less than one trial every two hours during March off the east coast of Florida.

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

Date	Hours of Effort	# of Unique Sightings*	Sightings/ Hour	# of Trials	Trials/ Hour
15 Mar	4 h 21 min	6	1.38	5	1.15
16 Mar	6 h 37 min	2	0.30	1	0.15
17 Mar	7 h 51 min	5	0.64	4	0.51
18 Mar	7 h 57 min	0	0	0	0
19 Mar	1 h 8 min	0	0	0	0
Total	**27 h 54 min**	**13**	**0.46 (mean)**	**10**	**0.36 (mean)**

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

Locations and specific information related to each sighting are provided in Figure 1 and Table 5.

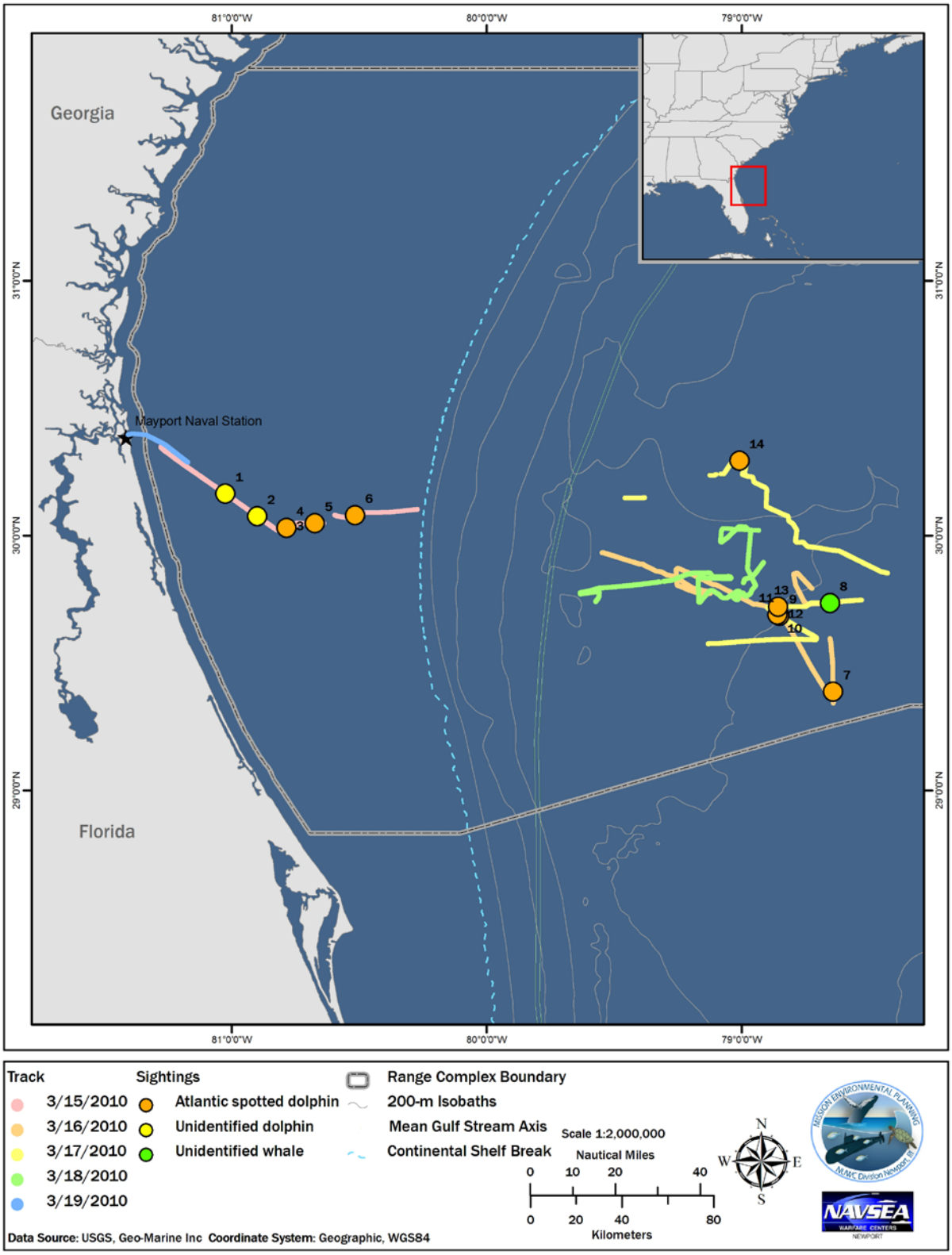

Figure 1. Vessel Locations at Marine Mammal Sightings

Table 5. Marine Species Sightings Data

Data Category	Sighting 1	Sighting 2	Sighting 3	Sighting 4	Sighting 5	Sighting 6	Sighting 7
Sightings Information							
Effort (on/off)	On	On	On	On	On	On	
Date	03/15/10	03/15/10	03/15/10	03/15/10	03/15/10	03/15/10	03/16/10
Time	1453	1529	1557	1558	1650	1828	1509
Location	JAX OPAREA	JAX OPAREA	JAX OPAREA	JAX OPAREA	JAX OPAREA	JAX OPAREA	JAX OPAREA
Detection Sensor	MMO & Bridge	Lookout	MMO	MMO & Lookout	MMO	MMO & Lookout	MMO
Species/Group	Unidentified dolphin	Unidentified dolphin	Unidentified dolphin	Atlantic spotted dolphin	Atlantic spotted dolphin	Atlantic spotted dolphin	Atlantic spotted dolphin
Group Size	2	2	2	1	3	3	15
# Calves							
Bearing (true)	110	10°	105°	80°	105°	96°	5° relative
Distance (yds)	100	1,013	244	20	67	20	20
Length of contact			10 sec				10-15 sec
Environmental Information							
Wave height (ft)	< 3 ft	< 3 ft	< 3 ft	< 3 ft	< 3 ft	< 3 ft	< 3 ft
Visibility	Excellent	Excellent	Excellent	Excellent	Excellent	Good	Good
BSS	2	1	1	1	1	3	3
% cloud cover	50%	90%	90%	90%	90%	90%	40%
Operational Information							
Sonar on/off	Off	Off					
Ship bearing (true)	130°	225°	75°	75°	95°	66°	
Animal motion	Closing	Parallel	Closing	Closing	Closing	Closing	Closing
Behavior	Bowriding						
Mitigation implemented	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Comments	animals approaching bow, assumed bowriding (could not see bow)	Animals closed from behind ship	animals approaching bow, assumed bowriding	assumed bowriding, MMO saw down through water	animals heading toward bow, assumed bowriding	animals heading toward bow, assumed bowriding	animals heading toward bow, came up from under ship

Data Category	Sighting 8	Sighting 9	Sighting 10	Sighting 11	Sighting 12	Sighting 13
Sightings Information						
Effort (on/off)	Off	On	On	On	On	On
Date	03/16/10	03/17/10	03/17/10	03/7/10	03/17/10	03/17/10
Time	1928	1017	1019	1019	1042	1623
Location	JAX OPAREA	JAX OPAREA	JAX OPAREA	JAX OPAREA	JAX OPAREA	JAX OPAREA
Detection Sensor	Lookout	MMO	MMO	Lookout	MMO & Lookout	Lookout
Species/Group	Unidentified whale	Atlantic spotted dolphin	Atlantic spotted dolphin	Atlantic spotted dolphin	Atlantic spotted dolphin	Atlantic spotted dolphin
Group Size	1	2	6	3	20	2
# Calves						
Bearing (true)	350°relative	5° relative	340° relative		30° relative	256°
Distance (yds)	12,000	10	200	10	10	3.33
Length of contact					15 sec	
Environmental Information						
Wave height (ft)		< 3 ft	< 3 ft	< 3 ft	< 3 ft	4 – 6 ft
Visibility		Good	Good	Good	Good	Moderate
BSS		2	2	2	2	4
% cloud cover		100%	100%	100%	100%	100%
Operational Information						
Sonar on/off	On					
Ship bearing (true)						256°
Animal motion	None	Closing	Closing		Closing	Parallel
Behavior	Dove	Bowriding	Jumping		Bowriding	Bowriding
Mitigation implemented	None					
Comments	Lookout saw fluke	Saw animal jump, then assumed bowriding		Could be a duplicate of sighting # 10. Lookout saw dolphins as they passed beam		

SECTION 5 CONCLUSION

5.1. MARINE SPECIES MONITORING AND LOOKOUT EFFECTIVENESS

The goals of the SEASWITI 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 aboard a DDG 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 DDG 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.

5.2. LESSONS LEARNED

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

5.2.1. Shipboard Monitoring

- Many dolphin sightings appeared to have come from the stern of the ship, as they suddenly appeared within close proximity of the ship. Recommendation is to consider having an MMO at the stern of the ship to potentially identify where the dolphins are coming from.

- From DDG A, we could not clearly see the bow, as it was obscured by the super structure of the ship. Any dolphins that approached the bow or were bowriding were difficult to follow thus it was difficult to accurately identify whether dolphins at the bow were new sightings or resightings.

- DMMOs attempted to use WinCruz to record effort and sightings information. This program has the potential to record sightings in a faster, more accurate, and more

efficient manner than recording data by hand. We had approximately 1.5 days to test and evaluate the program to determine if it might meet our needs in the future. During this time, we had multiple sightings and resightings and discovered which parts of WinCruz work well for us and which need reevaluation or changes.

- WinCruz is not able to record all necessary data fields, especially related to the trials. Need to set up strict rules to incorporate these data if we are going to use WinCruz for future effort.

- In situations where a MMO and a LO have a sighting at the same time, there is no easy way to indicate this in WinCruz. Currently, these are indicated as 2 separate sightings, and notes need to be entered into the comments field.

- The output from WinCrus needs to be smoothed in order to use the data. This extra effort needs to be reviewed to determine the cost-benefit of using the program.

- Although the radios indicated a full battery, they would run out of charge during on-effort periods. Recommend to recharged the radios nightly so that they are operable for the entirety of each day.

- DDG A was the first usage of the headsets attached to the radios. They were extremely useful, as it allowed for clear communication (wind reduction) and helped to prevent cueing the Navy lookout team.

- Attending daily ship operations brief 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.

- Designating a DMMO was effective in recording Navy LO data in addition to MMO data. This maintained consistency in recording applicable information.

- Given this first attempt to conduct the lookout effectiveness study on a DDG, it was determined that conducting the study on a DDG is possible. The upper gantry on the bridge wings (near the bigeyes) was most suitable for the SMMOs, as it allowed for the best view and separate from the Navy lookout team.

5.2.2. Operational Information

- An extension cord and power strip would be helpful to bring so that electronics can be charged at once and in one location. Additionally, it would provide additional locations where the computer can be set up (if using WinCruz) in case of inclement weather.

SECTION 6 ACKNOWLEDGEMENTS

We thank the officers and crew for their outstanding support and hospitality during this cruise. We also thank Mr. Jene Nissen (USFF), Ron Filipowicz (USFF contractor), and LT Matt Maples

(DESRON 24) for pre-cruise planning. We sincerely appreciate the support from Commodore John Kersch (DESRON 24), as he made us feel welcome and appreciated what we were doing for the Navy.

APPENDIX A LOOKOUT EFFECTIVENESS SURVEY PROTOCOL

Calibrating US Navy lookout observer effectiveness

Information for Marine Mammal Observers

Version 1.0

ML BURT, L THOMAS and OTHERS

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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 s 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 behaviour 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 analysed 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. Contact details for the St Andrews team are given in section 1.5.

1.5 Contact details

If anything is unclear, or the protocol can not be implemented, then do not hesitate to contact the support team at St Andrews University, Scotland. Note that the UK is 10 hours ahead of Hawaii.

NAME	TELEPHONE	EMAIL	FAX
Len Thomas	+44 1334 461801	len@mcs.st-and.ac.uk	+44 1334 461800
Eric Rexstad	+44 1334 461833	ericr@mcs.st-and.ac.uk	
Louise Burt	+44 1334 461805 +44 1334 478924 (H)	louise@mcs.st-and.ac.uk	
David Borchers	+44 1334 461843	dlb@mcs.st-and.ac.uk	

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^{o} starboard to abeam.
- Starboard observer: searches on the starboard side from about 5^{o} 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.**

FIELD	DESCRIPTION
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^o and angles go from 0-360^o.**
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	
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.

FIELD	DESCRIPTION
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*

CODE	COMMON NAME	SCIENTIFIC NAME
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).

APPENDIX A
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 synchronized 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.

APPENDIX B 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	Power down -6dB/Power down -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 12ooyds off port bow, closing on ship. Maneuvered to confirm bow riding and continued MFAS events.

APPENDIX B 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/dry bag	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: 3 • CG: 3
Misc. Supplies: zip ties, duct tape, electrical tape, rubber bands		