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U.S. Navy
HAWAII
UNDERSEA WARFARE EXERCISE
After Action Report
13-15 November 2007

SUBMITTED TO
Office of Protected Resources, National Marine Fisheries Service

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Abstract

This report presents an analysis of the effectiveness of the mitigation and monitoring measures as required under the Biological Opinion on the U.S. Navy's Proposed Undersea Warfare Training Exercises In the Hawaii Range Complex From January 2007 to January 2009

AND

Discussion of the nature of effects on marine mammals, if observed, under the National Defense Exemption (NDE) from the requirements of the Marine Mammal Protection Act (MMPA) for Mid-Frequency Active Sonar

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EXECUTIVE SUMMARY

- This report summarizes marine mammal sightings and provides an assessment of mitigation effectiveness for the U.S. Navy's Undersea Warfare Training Exercise conducted by the USS Tarawa Expeditionary Strike Group (ESG) from 13 to 15 November 2007 within the offshore waters of Hawaii.
- Over 216 hours of visual survey were conducted by U.S. Navy lookouts assigned to3 Mid-Frequency Active Sonar (MFAS)-equipped surface ships over the entire course of the exercise (3 days x 24 hrs/day = 72 hrs x 3 ships = 216). Of the 216 hours, 77 hours of MFAS time was reported from all sources including hull-mounted AN/SQS-53C, helicopter dipping sonar, and DICASS sonobuoys. These hours are reflective of MFAS use by various units including three MFAS-equipped ships geographically dispersed throughout the entire exercise area, and are not an indication of consecutive and continuous use.
- There were no sightings of marine mammals within NDE safety zones by U.S. Navy ships during USWEX 08-1. Sea states were high during some of the exercise period which may have limited sightings of smaller marine mammals.
- A dedicated USWEX monitoring program, separate from, but complimentary to the exercise participants, was used during USWEX 08-1. Two civilian (i.e. non-Navy) science teams conducted aerial surveys and a shipboard survey for marine mammals before, during, and after USWEX 08-1.
    - A pre- and post-exercise aerial survey was conducted by a civilian science crew from 11 to 12 November and 15 to 17 November. Over 17 hours of survey time was conducted, involving a linear distance of approximately 1,701 nm, as well as a circumnavigation survey around Oahu and Molokai. There were 26 marine mammal sightings, but only six of these sightings were at sea with the remaining 20 observed nearshore. There were no observations of any stranded or floating dead marine mammals.
    - A civilian science based research vessel conducted a visual monitoring survey for cetaceans and sea turtles from 11 to 17 November 2007. A total of 66 hours and approximately 492 nm were visually surveyed over seven days with a total of eight cetacean groups sighted. One whale was followed and observed during a time when it could have been exposed to MFAS transmission, but no unusual behavior was observed by the trained marine mammal observers on the research vessel.
- Based on the lack of marine mammal sightings from U.S. Navy lookouts during USWEX 08-1, the U.S. Navy's USWEX Environmental Assessment/Overseas Environmental Assessment (EA/OEA) acoustic modeling appears to very conservatively over-estimate the amount of potential acoustic exposures, including those to ESA-listed species. The degree of variability and over-predictive nature inherent within the acoustic impact model is based largely on the significant natural variability within the science of at-sea marine mammal surveys used to derive density estimates, and other model limitations.

INTRODUCTION

This report is presented to fulfill U.S. Navy and U.S. Pacific Fleet written reporting requirements conditional to the 23 January 2007 National Defense Exemption (NDE) from the Requirements of the Marine Mammal Protection Act (MMPA) for Certain DoD Military Readiness Activities that Employ Mid-Frequency Active Sonar (MFAS) or Improved Extended Echo Ranging Sonobuoys. In addition, these NDE mitigation measures are included in the 26 September 2007 *Biological Opinion (BO) on the U.S. Navy's Proposed Undersea Warfare Training Exercises (USWEX) In The Hawaii Range Complex From January 2007 to January 2009*. This report fulfills both the NDE and BO reporting requirements.

Language from USWEX BO (NMFS 2007).

5. Within 120 calendar days of completing an exercise the U.S. Navy shall provide the Chief, Endangered Species Division, Office of Protected Resources (with a copy provided to the Assistant Regional Administrator for Protected Resources in NMFS' Pacific Islands Regional Office) with a written report that shall include the following information:

a. Summary of the exercise (starting and ending date of the exercise, number of ships and aircraft involved in the exercise, and number of hours passive and active sonar was used during the exercise)

b. Specific mitigation measures Navy implemented during exercise;

c. Number of fin whales, humpback whales, sei whales, and sperm whales that (i) **had been detected within 500, 1,000 and 2,000 yards of a sonar dome during an active transmission** and (ii) the Navy's estimate of number of fin whales, humpback whales, sei whales, and sperm whales that had been exposed to MFAS at received levels equal to or greater than 173 dB and 190 dB.

d. Reports of the activity or activities that fin whales, humpback whales, sei whales, and sperm whales had been observed to exhibit while they were within 500, 1,000, and 2,000 yards of a sonar dome that was actively transmitting during exercise. (for example, a report should not identify "playing"; it should identify the behavior that allowed the observer to conclude the animal was "playing")

Reports of observations shall identify date, time, and visual conditions associated (for example, if the observation is produced from a helicopter, the report should identify the speed, vector, and altitude of the airship; the sea state, and lighting conditions) with observation; and how long an observer or set of observers maintained visual contact with a marine mammal;

e. an evaluation of the effectiveness of those mitigation measures at avoiding exposing endangered whales to ship traffic and endangered whales to mid-frequency active sonar. This evaluation shall identify the specific observations that support any conclusion U.S. Navy reaches about the effectiveness of the mitigation measures;

f. an evaluation of monitoring program's ability to detect marine mammals that occur within 500, 1,000, and 2,000 yards of a sonar dome, during an active transmission (or close enough to an exercise to be exposed to mid-frequency sonar at received levels equal to or greater than 173 dB re 1 $\mu Pa^2 \cdot s$) with specific evidence that supports any conclusions U.S. Navy reaches.

REPORT ORGANIZATION

This report contains only unclassified material, provides information and analysis for Undersea Warfare Exercise (USWEX) 08-1, and is submitted in fulfillment of NDE and BO written requirements.

The report is organized by section in the following order:

Section 1- Exercise Summary: provides exercise specific information including the starting and ending dates, the number of ships and aircraft participating, and the number of hours of MFAS used from all emitters.

Section 2- Biological Observations: provides an overview of marine mammal observations, and post-exercise derived remote sensing of potential oceanographic conditions.

Section 3- Mitigation Assessment: provides an estimated number of marine mammals observed during USWEX 08-1 potentially affected or not affected by Anti-submarine Warfare (ASW) operations, noting the nature of any observed effects where possible. Under the BO, this analysis is focused on marine mammal observations within 2,000 yards of a MFAS transmission. In addition, Section 3 assesses the effectiveness of the NDE and BO mitigation and monitoring measures required during the exercise with regard to power down and shut down zones when marine mammals are sighted within the vicinity of ships using MFAS.

Appendix A: lists the 29 NDE mitigation measures.

Appendix B: presents results of an aerial monitoring survey.

Appendix C: presents results of a ship monitoring survey.

BACKGROUND

USWEXs are ASW exercises conducted by the U.S. Navy's Carrier Strike Groups (CSG) and Expeditionary Strike Groups (ESG) while in transit from the west coast of the United States to the western Pacific Ocean. As a combined force, submarines, surface ships, and aircraft conduct ASW against submarine targets representing an opposing force. Submarine targets include real submarines, target drones that simulate the operations of an actual submarine, and virtual submarines interjected into the training events by exercise controllers. The primary event of each exercise involves between one to five surface ships equipped with sonar, with one or more helicopters, and a P-3 aircraft searching for one or more submarines.

Prior to the exercise marine species awareness training was provided to exercise participants. A Letter of Instruction (LOI) which reiterated the applicable NDE mitigation measures was also distributed to participants and explains procedures for reporting marine mammal sightings discussed in Section 2. The NDE measures are presented in **Appendix A**.

MFAS use by surface ships and aviation assets (dipping sonar and DICASS sonobuoys) is captured and added to the total sonar hours reported in this document. MFAS on Los Angeles-class (SSN) submarines is seldom used in tactical training scenarios.

SECTION 1 EXERCISE SUMMARY

EXERCISE PARTICIPANTS

USWEX 08-1 was conducted from 13 to 15 November 2007, and involved the USS Tarawa ESG (**Table 1 and Figure 1**). Participating units included ESG assigned ships (surface combatants, amphibious transport ships, submarines, and supply ships), and MFAS-equipped opposition forces (including submarines). Two SQS-53C MFAS-equipped ships and one SQS-56 MFAS-equipped ship participated in USWEX 08-1. However, there was minimum MFAS use by non-ESG assigned platforms because of either tactical considerations for surface ships and submarines or lack of MFAS capability (amphibious transport ships, supply ships). There were between two to four ASW-capable helicopters with dipping sonar available for training during the exercise on any given day, depending on maintenance availability. The number of helicopters used in any given exercise event is driven by tactical and training objectives. Depending upon the training scenario there were also one or two P-3 maritime patrol aircraft participating.

MITIGATION MEASURES FOLLOWED

All 29 mitigations measures as stated in the 23 January 2007 NDE (**Appendix A** were adhered to during USWEX 08-1. Those NDE measures include specific details for personnel training, established lookout and watchstander responsibilities, specific operating procedures, and described coordination and reporting requirements. Observation data from Navy lookout sightings for USWEX 08-1 is described in Section 2.

Total MFAS Use

During USWEX 08-1, a total 77 hours of MFAS time was reported from all sources including hull mounted, helicopter dipping, and DICASS sonobuoys. Key caveats to the derivation of this total are presented in Section 3.

Table 1. Exercise summary for USWEX 08-1 conducted within Hawaiian water from 13 to 15 November 2007.

Participants	Event Name	Dates	MFAS Use Reported (hours)
USS Tarawa ESG	USWEX 08-1	13-15 Nov 2007	77 hrs
Number of MFAS equipped surface ships:			3
Estimated number of ASW helicopters:			2-4: upper estimate assumes no helicopters down for maintenance; not all helicopters used at same time

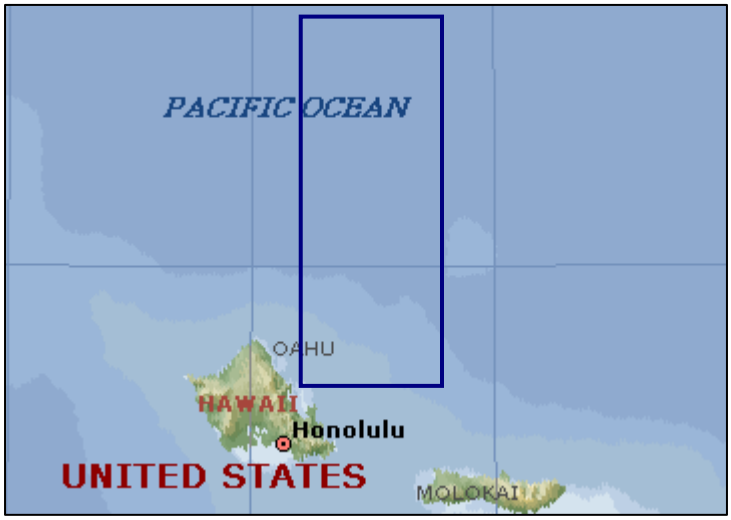

Figure 1. Approximate USWEX 08-1 area. Note: this area represents regions with U.S. Navy visual survey during exercise and does not imply full operational area. Base figure from Microsoft Encarta Map: http://encarta.msn.com/encnet/features/mapcenter/map.aspx

SECTION 2 BIOLOGICAL OBSERVATIONS

Section 2 provides an overview of marine mammal observations that require reporting under the Terms and Conditions of the National Marine Fisheries Service BO (NMFS 2007).

The biological summary in this section includes counts of the total numbers of marine mammals sighted and species guilds, estimates of the number of marine mammals observed within 2,000 yards of sonar source during MFAS transmission, and a science-based discussion on the likely species present in Hawaii during the time of year of this exercise.

USWEX 08-1 BIOLOGICAL OBSERVATIONS

There were no marine mammal sightings by USWEX participants.

Figure 1 shows the approximate area covered by U.S. Navy exercise participants using ship-board lookouts during USWEX 08-1. Given the time of year this exercise occurred (November) likely ESA species present in Hawaii include humpback whales, sei whales, and sperm whales. Blues whales are rare, with only one confirmed fall/winter sighting in Hawaiian waters. Fin whales are not present in high densities, but appear to be seasonal migrants.

MARINE MAMMAL SURVEYS

A dedicated USWEX monitoring program, separate from but complementary to the observations conducted by the exercise participants, was used during USWEX 08-1. Two civilian (non-Navy) science teams conducted aerial surveys and a ship survey for marine mammals before, during, and after USWEX 08-1. Results are described below and in more detail in **Appendix B** and **C**.

Aerial survey- Aerial surveys were performed in support of USWEX 08-1 on November 11 and 12 and from 15 to 17, 2007 (**Figure 2** and **Appendix B**). The purpose of these surveys was to detect, locate, and identify all marine mammals and sea turtles observed within a 2,384 square mile (6,174 km^2) grid; and during circumnavigation of the islands of Oahu and Molokai. For marine mammal species, additional observation time was spent characterizing behavior at the time of sighting. Target species were observed on two of the five survey days, primarily corresponding to those days with more favorable seastate conditions. Some species (e.g., sea turtles) were more easily detected during circumnavigation. For marine mammal species, additional observation time was spent characterizing behavior at the time of sighting. Aerial survey effort comprised of 17 hours of survey time and involved a linear distance of approximately 1,701 nm (3,150 km). A total of 26 sightings of five identified species (green sea turtles, short-finned pilot whales, Hawaiian spinner dolphins, bottlenose dolphins, and Hawaiian monk seals) and four unidentified species (*Stenella* species, unidentified turtle, dolphin, and whale) were recorded. Based on behavioral observation of the marine mammal species, no indications of distressed or unusual behavior were documented. The circumnavigation survey (Nov. 15) yielded no evidence of stranded or near stranded animals.

Ship survey- A civilian research vessel visual survey for cetaceans and sea turtles was conducted from 11 to 17 November 2007 in Hawaiian waters East and Northeast of Oahu (**Figure 3** and **Appendix C**). The purpose of these surveys was to monitor, identify, and report surface behavior of marine mammals observed before, during, and after the scheduled training exercise; particularly any injured or harmed marine mammals and/or any unusual behavior or changes in behavior, distribution, and numbers of animals. Another goal was to attempt to remain within view of any opportunistically encountered Navy vessels while conducting surveys and focal sessions. The ship survey effort was focused in a designated

survey box approximately 30 nm wide by 70 nm long (~55 km by ~130 km). To meet the survey's goals, systematic line-transect surveys and focal animal behavior sessions were conducted. The ship survey effort focused on priority species including beaked whales, and federally listed species (e.g., sperm, blue, fin, humpback, and sei whales). Experienced marine mammal observers conducted visual observations in the Survey Box using the naked eye, handheld binoculars, and two sets of "Big Eyes" binoculars. The primary objectives were to collect location data and scan samples of behavior of all cetaceans encountered, and to locate, in particular, priority cetaceans for the purposes of conducting focal behavior follows. Another objective was to collect bathythermograph (XBT) data during the survey.

The survey totaled 66 hours and covered a distance of 492 nm (911 km). Most (90% or 817 km) consisted of line transect survey effort, 57 nm (105 km) of which occurred while Navy vessels were within view. A total of 34 nm (7 % of 63 km) of the total 492 nm consisted of focal animal observations. Navy vessels were opportunistically encountered on 13 and 14 November and were within view for a total of 8 hours at distances of over 3 nm (5.6 km). Beaufort (Bf) sea state ranged from 1 to 6, with most observations conducted in a Bf 5 (40%), followed by Bf 3 (27%) then Bf 4 (23%). A total of eight cetacean groups were sighted during the entire seven-day cruise. No sea turtles were sighted. Five cetacean species were confirmed during the entire survey period: sei whales, Brydes' whale, humpback whales, Risso's dolphins, and spinner dolphins. One unidentified small whale was observed and considered to be a probable Cuvier's beaked whale. In addition, a small group of medium-sized delphinids (considered to be probable pygmy killer whales) were sighted. A total of two sightings of sei whales were made on two different days. Extended focal follows were conducted on four cetacean sightings: a single sei whale, a single Bryde's whale, a group of three subadult sei whales, and a group of three humpback whales. Focal sessions ranged in duration from 50 - 145 minutes, with the longest continuous observation session of 145 minutes occurring with a single sei whale. Because sei and Bryde's whales can easily be confused, the survey team stayed with these focal animals until a positive identification was made and documented with photographs and detailed survey observations on natural history characteristics by senior observers. This included the first verified sighting of a Bryde's whale in the main Hawaiian Islands and sightings of a rare sei whale and subadult sei whales.

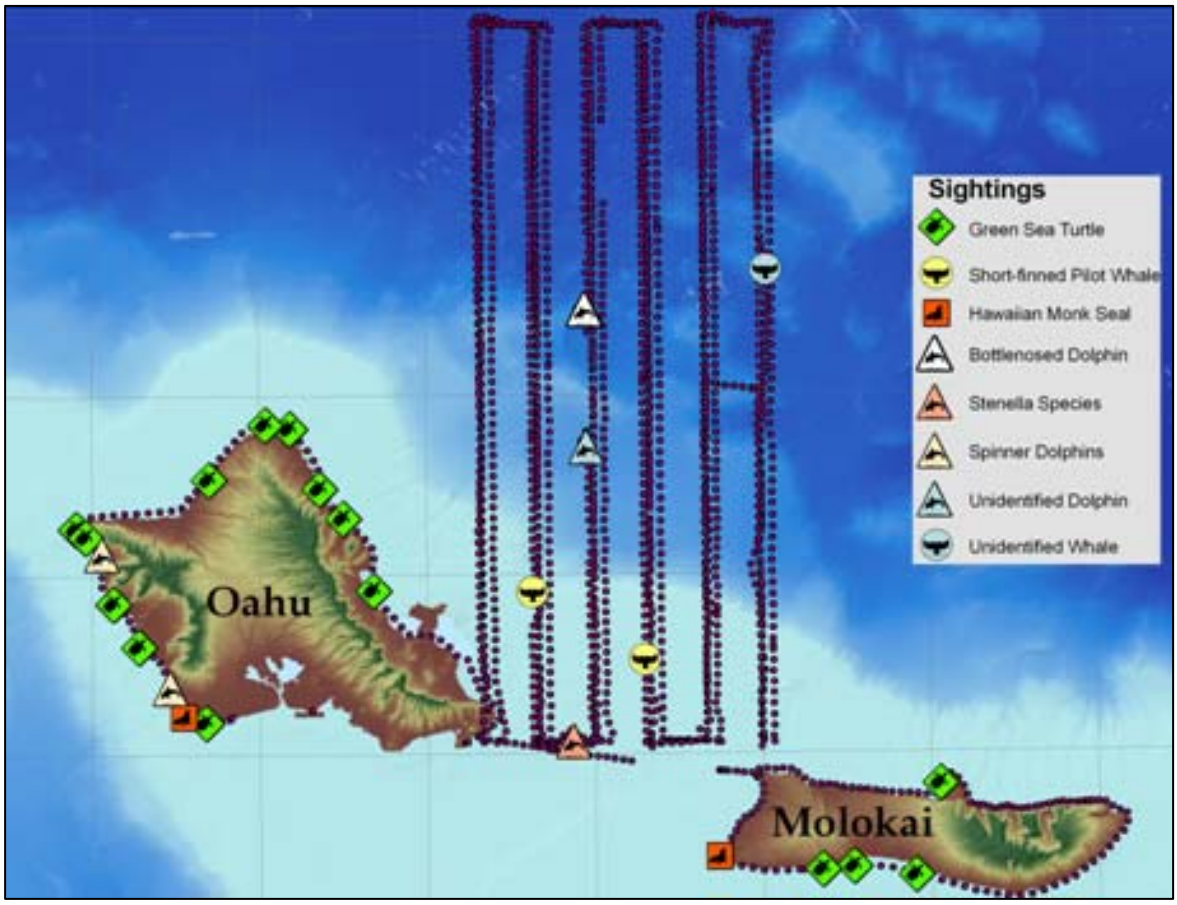

Figure 2. Plot of marine mammal sightings conducted by civilian aerial survey during 11-12 and 15-17 November 2007.

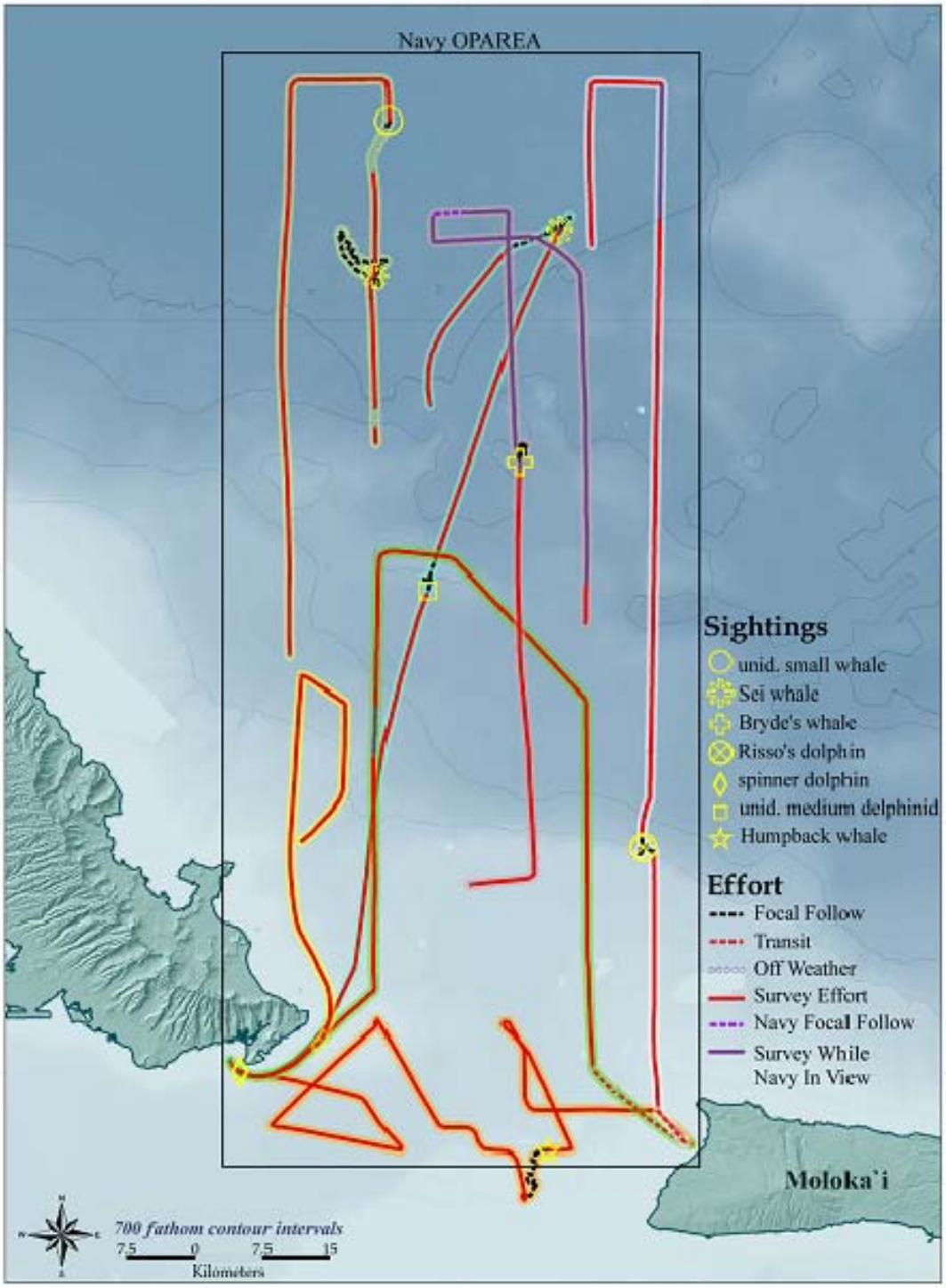

Figure 3. Plot of marine mammal sightings conducted by civilian ship survey during11-17 November 2007.

SECTION 3 MITIGATION ASSESSMENT

USWEX 08-1 ASSESSMENT

OVERVIEW

The NDE calls for the U.S. Navy to submit a report to NMFS that includes a discussion of the nature of any effects or lack of effects based on modeling results and marine mammal sightings. In addition, the BO Terms and Conditions require a report that evaluates the mitigation measures and details results from the U.S. Navy's exercise monitoring and reporting program. In this case, the mitigation measures under the BO are the NDE measures, therefore the discussion is presented together in this section.

This section provides an assessment of the effectiveness of the mitigation and monitoring measures. The section includes discussion of observations during MFAS transmission, limitations of passive sonar detection, other effects (i.e. vessel strikes), comparison of pre-exercise acoustic model impact predictions with actual USWEX 08-1 observations, and NDE and BO conclusions.

ASW proceeds slowly and requires careful development of a tactical frame of reference over time. Data is integrated from a number of sources and sensors. Once MFAS is turned off for a period of time, turning it back on later does not usually allow a commander to simply continue from the last frame of reference. Lost MFAS time not only equates to lost exercise time, but has a broader, overall impact on the tempo and development of a "tactical picture" shared among exercise participants as they train toward the goal of improving ASW skills in general.

Mitigation measures were designed to minimize interactions between marine mammals and Navy assets employing MFAS levels that have potential to result in a Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS) as described in DoN 2007. Navy ships were not tasked nor expected to maintain contact with marine mammals sighted for purposes of monitoring requirements. To do so would have unnecessarily interfered with military readiness activities and ma result in concerns that Navy ships were intentionally harassing marine mammals.

MFAS TRANSMISSION

As in any review of the operational aspects of U.S. Navy ASW operations using MFAS, specific source levels, numbers of sources, and frequencies of sonars used during USWEX 08-1 are classified since this information provides potential adversaries with critical tactical data. The following discussion is focused on the 1) amount of time spent visually searching the ocean for marine mammals, 2) the amount of time conducting MFAS (as required to be reported under the NMFS BO), and 3) a discussion of individual events when MFAS was active and marine mammals were spotted within 2,000 yards.

1) Visual sighting effort: Visual sighting effort by ship for USWEX 08-1 can be approximated given the numbers of days this major exercise occurred (3 days), the number of hours per day (24 hours), the normal standard operating procedure for all vessels to have at least 3 lookouts on watch and scanning the ocean at all times (24/7), and the presence of 3 MFAS-equipped vessels. Therefore, 216 hours of MFAS surface ship visual survey effort for marine mammals occurred during USWEX 08-1 (3 days x 24 hrs/day = 72 hrs x 3 ships = 216). This accounts for time conducting both MFAS and non-MFAS events .

2) MFAS use: During USWEX 08-1, 77 hours of MFAS time were reported from all sources including hull-mounted 53C, helicopter dipping sonar, and DICASS sonobuoys (**Table 1**). These hours are reflective of MFAS use by various units geographically dispersed over the entire exercise area (**Figure 1**), and are not an indication of consecutive and continuous use (i.e. NOT 77 hours/24 hours (per day) = 3.2

days; A closer approximation would have to account for potential concurrent use by several units including up to three MFAS ships and aviation units).

It should be noted that MFAS is only used for a relatively small subset of any given major exercise. A USWEX's major focus is short-duration undersea warfare training. Seventy-seven hours of MFAS use represents less than 36% of the total ship visual observation effort (77/216 = 36%). In addition, total active sonar hours, as presented in this report, represent a sum of the total MFAS time from a number of individual training events during USWEX 08-1. Individual units record when MFAS is first used at the beginning of a training event and the time the event is finished. The sonar "on period" is conservative in that it does not account for the time MFAS is to in transmit mode due to tactical or maintenance reasons. Therefore, based on standardized reporting protocols the number of MFAS hours does not represent actual total sonar ping hours. Furthermore, during periods when there is an active transmission, MFAS puts sound into the water at discrete intervals. Sonar signals are not a continuous source of acoustic energy. A surface ship sonar signal consists of a pulse (i.e. ping) significantly less than one to two seconds long with time between successive pings as much as 30 seconds (NMFS 2007). During typical active sonar use, MFAS is silent for the vast majority of the time. This was the case for USWEX 08-1.

Biological Observations During MFAS: The civilian research vessel marine mammal survey described previously and in **Appendix C** followed a Bryde's whale on 13 November while a U.S. Navy ship was visible from the survey ship. However, based on MFAS reports from exercise participants on 13 November, there were NO MFAS transmissions from the ship observed by the survey authors.

There was another exercise participant not visible to the survey ship along a different bearing that did conduct two hours of MFAS transmission on 13 November at approximately the same time as the Bryde's whale sighting. This MFAS-equipped vessel was approximately 50 nm away. Using a VERY CONSERVATIVE approach to open ocean sonar propagation derived from Urick 1983, an estimation of potential transmission loss and therefore potential receive level (RL) at the whale can be made:

TL = 10Log(Range in meters) + 30 + (absorption coefficient in dB/meter x Range in meters)

(see: http://www.fas.org/man/dod-101/navy/docs/es310/SNR_PROP/snr_prop.htm)

Given the nominal 235 dB source level for U.S. Navy hull mounted MFAS and based on the formula above, estimated RL at the animal under observation by the survey ship may have been around 141 dB. It should be noted that this calculation would potentially represent the maximum RL and is not reflective of actual real world oceanographic conditions and their effects on propagation on the 13th. However, no adverse or unusual behavior by the Bryde's whale was observed by the trained marine mammal observers on the civilian survey ship.

3) MFAS Events: There were no instances of MFAS having to be powered down or secured due to sightings of marine mammals within NDE safety zones.

PASSIVE SONAR

Passive sonar involves acoustic listening to underwater sounds and does not involve transmitting active sound into the water column. Passive sonar use is driven by the tactical nature of an ASW or training event, and should be employed whenever possible. Given the nature of passive sonar technology and underwater sound propagation, localizing or determining range and absolute position of a marine mammal is generally not possible or exceedingly difficult with any single ship-based passive sonar.

Also, there is no current technology on U.S. Navy MFAS-equipped ships to easily localize marine mammals in real time using passive detection.

In addition, passive sonar can only detect marine mammals that are actually vocalizing (i.e. making underwater sound as part of communication and echolocation). Marine mammals do not always vocalize based on individual needs at a particular moment, species-level foraging and mating strategies, and other oceanographic or biological factors. Depending on oceanographic conditions and animal source levels, when marine mammals do vocalize, sounds can easily travel 1 to several 10s of kilometers (km) (0.5 nautical mile (nm) to 10s of nm) for some mid-to-low frequency animals, and 10s to 100s of km for very low frequency baleen whales (i.e. blue and fin whales). These ranges demonstrate that even if the marine mammal vocalization can be detected, it does not mean the mammal is necessarily close to a ship or bottom-mounted range hydrophone.

MODELING ESTIMATES APPLICABLE TO USWEX 08-1

For the USWEX EA/OEA (DoN 2007) an estimate of potential acoustic exposures to marine mammals was generated in support of the NEPA process. **Table 2** lists possible marine mammal species occurring in Hawaii based solely on *estimated* distribution and abundance, but does not take into account potential seasonal distribution. This table highlights the ESA-listed species described in the USWEX BO (NMFS 2007), and shows estimated potential acoustic exposures derived from acoustic impact modeling (DoN 2007 USWEX EA/OEA). **Table 2** shows estimated marine mammal acoustic exposures from model-derived calculations based on estimated marine mammal densities, operational parameters, sound transmission loss, and potential energy accumulated based strictly on pre-exercise acoustic impact modeling (DoN 2007). The exercise-specific model estimated total potential exposures over two years of Hawaii USWEXs. Extrapolating for a single exercise as in Table 2 estimates 5,153 Level B potential exposures for all marine mammals (5,116 sub-TTS Level B, 37 TTS Level B).

Given that no marine mammals were visually sighted during USWEX 08-1, no assessment of species exposures can be made, but in comparison with pre-exercise predictions, it's apparent that pre-exercise predictions are exceedingly high and not reflective of actual animal occurrence in the USWEX 08-1 exercise area during November. This is evidenced by the lack of U.S. Navy ship sightings (n= 0 over 3 days) and low at-sea sightings by concurrent civilian science surveys (ship based: n= 9 sightings over 7 days, however, 2 of these 9 sightings were made close to shore where U.S. Navy exercise participants did not travel; aerial based: n= 6 sightings, of which 1 was coastal).

FINAL NDE AND BO ASSESSMENT

1) All measures promulgated in the 23 January 2007 *Mid-Frequency Active Sonar Mitigation Measures during Major Training Exercises or within Established DoD Maritime Ranges and Established Operating Areas* (NDE) were implemented before and during USWEX 08-1.

2) In addition to the above assessment of the NDE, the BO calls for a report that evaluates the effectiveness of the U.S. Navy's exercise mitigation measures. The three categories of measures (Personnel Training, Lookout and Watchstander Responsibilities, and Operating Procedures), as outlined in the NDE, are effective in detecting and responding appropriately to the presence of marine mammals, when visually observed. Fleet commanders and ship watch teams continue to improve individual awareness and enhance reporting through various pre-exercise conferences, lessons learned, and after action reports. The NDE safety zones are adhered to and vessels apply mitigation when marine mammals are visually observed within a zone. The U.S. Navy acknowledges that this discussion does not account for potential marine mammal species not visually observed, which is a difficult determination even within the marine mammal scientific survey community. Deep diving animals, if exposed, may not be exposed to significant sound levels for long periods of time, given the moving nature of ship MFAS use and the limited pings from lower power aviation deployed MFAS systems (dipping sonar, sonobuoys). For instance, during a one hour dive by a beaked whale or sperm whale, a MFAS ship moving at a nominal 10

knot speed would cover about 10 nm from its original location, well beyond ranges predicted to have significant exposures. For cryptic, hard to spot species when at the surface such as beaked whales, real-time detection is difficult given any U.S. Navy or non-Navy science tool presently available.

3) NMFS (2007) USWEX BO Terms and Conditions require the U.S. Navy to estimate the number of ESA-listed marine mammals that may have been exposed to received energy level equal to or greater than 173 dB and 190 dB re 1 $\mu Pa^2 \cdot s$. No estimate can be provided given lack of marine mammal observations from MFAS transmitting ships.

There was a single instance when a Bryde's whale was under direct and continuous observation by observers on board a civilian marine mammal research vessel while MFAS transmission was occurring during USWEX 08-1. At the time of this observation, the research vessel observed a Navy ship in the area. Post-exercise analysis revealed that the ship observed by the research vessel was not transmitting MFAS. However, additional post-exercise analysis indicated that ships not observed by the research vessel were transmitting resulting in a potential exposure of this Bryde's whale to a received level of approximately 141 dB re 1 $\mu Pa^2 \cdot s$. No adverse or abnormal behavioral reactions were noted by the marine mammal observers on board the research vessel.

4) From **Table 2**, a single USWEX would be expected to potentially expose 1,884 ESA-listed marine mammals from all MFAS sources to potential Level B exposures based solely on pre-exercise predicted impact models. However, no potential ESA-listed marine mammals were actually observed during USWEX 08-1 at ranges that may have exposed them to Sound Exposure Level (SEL) greater than 173 dB and 190 dB re 1 $\mu Pa^2 \cdot s$. Humpback whales had the largest pre-exercise predicted exposures, yet November is early for their summer migration to the Hawaii wintering ground. While there was a single humpback whale sighting by the civilian ship visual survey, the location of this sighting was significantly greater than 50 nm from the nearest MFAS use during USWEX 08-1. Given one confirmed humpback shale sighting, the low population density early in the humpback whale season, their typical shallow-water distribution, and the at-sea distances between exercise participants, it is improbable that humpback whales were exposed to MFAS during USWEX 08-1. Blue whales and fin whales in Hawaii are rarer and likewise were potentially not present in the waters north of Oahu during USWEX 08-1 and likely not exposed (**Figure 1**).

5) For all of USWEX 08-1 marine mammal sightings from pre, during, and post-exercise civilian monitoring, there was no obvious indication or report that any animal behaved in a manner not associated with normal movement, or foraging.

Data Limitations and Improvements

There is no information from which to assess how many, if any, animals not observed by Navy lookouts may or may not have been exposed to MFAS received levels greater than 173 dB and 190 dB re 1 $\mu Pa^2 \cdot s$.

Data collection needed to address this question will be reviewed as they become available for potential incorporation into future exercises, although this remains a problematic science issue for even non-Navy marine mammal surveys. Real-time passive sonar systems used by the U.S. Navy, and to some degree by most of the marine mammal science community, lack the ability to automatically classify detected species, although there is substantial academic research into improving this capability. Most current passive data sets rely on extensive post-collection analysis by skilled subject matter experts to conclusively establish species identification. In addition to species classification, range detection using moving passive acoustic systems on U.S. Navy ships is limited in real time to the typical 8-10 knot speeds at which many ASW training events occur. Indeed, if passive range detection of any submerged contacts (submarines or marine mammals) was more advanced and easier, then there would be less tactical reliance on active sonar systems. Also, non-vocalizing marine mammals cannot currently be detected using passive systems.

The U.S. Navy continues conducting robust and realistic exercises, and development of long-term range complex monitoring plans. The goal of these plans is to integrate multiple tools such as surveys in an

effort to generate better assessments of marine mammal occurrence and possible MFAS effects, or lack thereof. In accordance with the USWEX BO, data collection needs to address unresolved questions regarding likely area-specific species composition and the potential for alternative detection technologies to be incorporated into future exercises as the U.S. Navy's exercise monitoring program evolves.

Table 2. Total estimated annual exposures based on pre-exercise modeling for MFAS sonar from DoN 2007 (USWEX EA/OES) based on six exercise per year ((*left two columns*), and estimated exposures per exercise (estimated total exposures divided by six) (*right two columns*).

Species	Occurrence Status Within Hawaiian Waters	Annual USWEX potential exposures n =6 exercises (DoN, 2007)		Estimated singe exercise exposures	
		Level B Sub TTS	Level B TTS	Level B Sub TTS	Level B TTS
ESA-listed					
Blue whale	Rare	0	0	0	0
Fin whale	Rare	48	0	8	0
Humpback whale	Seasonal, Nov-Apr	10,273	49	1,712	8
Sei whale	Rare	21	0	4	0
Sperm whale	Regular, Year round	905	3	151	1
Non-ESA listed				0	0
Blainville's beaked whale	Regular, Year round	285	1	48	0
Bottlenose dolphin	Regular, Year round	775	7	129	1
Bryde's whale	Regular, Year round	96	0	16	0
Cuvier's beaked whale	Regular, Year round	1,490	6	248	1
Dwarf sperm whale	Regular, Year round	2,182	12	364	2
False killer whale	Regular, Year round	109	2	18	0
Fraser's dolphin	Regular, Year round	2,045	20	341	3
Killer whale	Infrequent, Year round	71	1	12	0
Longman's beaked whale	Regular, Year round	85	0	14	0
Melon-headed whale	Regular, Year round	408	2	68	0
Minke whale	Seasonal, Nov-Apr	0	0	0	0
Pygmy killer whale	Regular, Year round	106	2	18	0
Pygmy sperm whale	Regular, Year round	839	5	140	1
Pantropical spotted dolphin	Regular, Year round	2743	26	457	4
Risso's dolphin	Regular, Year round	276	2	46	0
Rough-toothed dolphin	Regular, Year round	2,832	41	472	7
Short-finned pilot whale	Regular, Year round	1,849	12	308	2
Spinner dolphin	Regular, Year round	1,957	18	326	3
Striped dolphin	Regular, Year round	1,303	13	217	2
Monk seal	Regular, Year round	0	0	0	0
TOTAL:		30,699	222	**5,116**	**37**

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NMFS, 2007. Biological Opinion (BO) on the U.S. Navy's Proposed Undersea Warfare Training Exercises (USWEX) In The Hawaii Range Complex From January 2007 to January 2009- 26 September 2007. Office of Protected Resources, National Marine Fisheries Service, Silver Springs, MD.

APPENDIX A- NDE MEASURES

NDE

NDE mitigation measures include:

I. General Maritime Protective Measures: Personnel Training:

1. All lookouts onboard platforms involved in ASW training events will review the NMFS approved Marine Species Awareness Training (MSAT) material prior to use of mid-frequency active sonar.
2. All Commanding Officers, Executive Officers, and officers standing watch on the bridge will have reviewed the MSAT material prior to a training event employing the use of MFAS.
3. Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).
4. Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, Lookouts will complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not preclude personnel being trained as lookouts counted as those listed in previous measures so long as supervisors monitor their progress and performance.
5. Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

II. General Maritime Protective Measures: Lookout and Watchstander Responsibilities:

6. On the bridge of surface ships, there will always be at least three people on watch whose duties include observing the water surface around the vessel.
7. In addition to the three personnel on watch noted previously, all surface ships participating in ASW exercises will have at all times during the exercise at least two additional personnel on watch as lookouts.
8. Personnel on lookout and officers on watch on the bridge will have at least one set of binoculars available for each person to aid in the detection of marine mammals.
9. On surface vessels equipped with MFAS, pedestal mounted "Big Eye" (20x110) binoculars will be present and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.
10. Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).
11. After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook.
12. Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

III. Operating Procedures

13. A Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order will be issued prior to the exercise to further disseminate the personnel training requirement and general marine mammal protective measures.

14. Commanding Officers will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

15. All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) will monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

16. During MFAS operations, personnel will utilize all available sensor and optical systems (such as Night Vision Goggles to aid in the detection of marine mammals.

17. Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

18. Aircraft with deployed sonobuoys will use only the passive capability of sonobuoys when marine mammals are detected within 200 yards of the sonobuoy.

19. Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

20. Safety Zones - When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 1,000 yards of the sonar dome (the bow), the ship or submarine will limit active transmission levels to at least 6 dB below normal operating levels.

    (i) Ships and submarines will continue to limit maximum transmission levels by this 6 dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

    (ii) Should a marine mammal be detected within or closing to inside 500 yards of the sonar dome, active sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level. Ships and submarines will continue to limit maximum ping levels by this 10 dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

    (iii) Should the marine mammal be detected within or closing to inside 200 yards of the sonar dome, active sonar transmissions will cease. Sonar will not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

    (iv) Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the Officer of the Deck concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.

    (v) If the need for power-down should arise as detailed in “Safety Zones” above, Navy shall follow the requirements as though they were operating at 235 dB - the

normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 sonar was being operated).

21. Prior to start up or restart of active sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.

22. Sonar levels (generally) – The ship or submarine will operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

23. Helicopters shall observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.

24. Helicopters shall not dip their sonar within 200 yards of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards after pinging has begun.

25. Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW operations involving active mid-frequency sonar.

26. Increased vigilance during major ASW training exercises with tactical active sonar when critical conditions are present.

Based on lessons learned from strandings in Bahamas 2000, Madeiras 2000, Canaries 2002, and Spain 2006, beaked whales are of particular concern since they have been associated with MFAS operations. Navy should avoid planning major ASW training exercises with MFAS in areas where they will encounter conditions which, in their aggregate, may contribute to a marine mammal stranding event.

The conditions to be considered during exercise planning include:

(1) Areas of at least 1000 m depth near a shoreline where there is a rapid change in bathymetry on the order of 1000-6000 meters occurring across a relatively short horizontal distance (e.g., 5 nm).

(2) Cases for which multiple ships or submarines (≥ 3) operating MFAS in the same area over extended periods of time (≥ 6 hours) in close proximity (≤ 10NM apart).

(3) An area surrounded by land masses, separated by less than 35 nm and at least 10 nm in length, or an embayment, wherein operations involving multiple ships/subs (≥ 3) employing MFAS near land may produce sound directed toward the channel or embayment that may cut off the lines of egress for marine mammals.

(4) Although not as dominant a condition as bathymetric features, the historical presence of a significant surface duct (i.e. a mixed layer of constant water temperature extending from the sea surface to 100 or more feet).

If the major exercise must occur in an area where the above conditions exist in their aggregate, these conditions must be fully analyzed in environmental planning documentation. Navy will increase vigilance by undertaking the following additional protective measure:

A dedicated aircraft (Navy asset or contracted aircraft) will undertake reconnaissance of the embayment or channel ahead of the exercise participants to detect marine mammals that may be in the area exposed to active sonar. Where practical, advance survey should occur within about two hours prior to MFA sonar use, and periodic surveillance should continue for the duration of the exercise. Any unusual conditions (e.g., presence of sensitive species, groups of species milling out of habitat, any stranded animals) shall be reported to the Officer in Tactical

Command (OTC), who should give consideration to delaying, suspending or altering the exercise.

All safety zone requirements described in Measure 20 apply.

The post-exercise report must include specific reference to any event conducted in areas where the above conditions exist, with exact location and time/duration of the event, and noting results of surveys conducted.

IV. Coordination and Reporting

27. Navy will coordinate with the local NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live/dead or floating marine mammals that may occur at any time during or within 24 hours after completion of mid-frequency active sonar use associated with ASW training activities.

28. Navy will submit a report to the OPR, NMFS, within 120 days of the completion of a Major Exercise. This report must contain a discussion of the nature of the effects, if observed, based on both modeled results of real-time events and sightings of marine mammals.

29. If a stranding occurs during an ASW exercise, NMFS and Navy will coordinate to determine if MFAS should be temporarily discontinued while the facts surrounding the stranding are collected.

APPENDIX B- RESULTS FROM USWEX 08-1 AERIAL MONITORING

<u>Final Report</u>: Aerial Surveys of Marine Mammals

Performed in Support of USWEX Exercises

Nov. 11-17, 2007

Photo by J. Mobley, NOAA Permit No. 810

Submitted to:

Environmental Division

Commander, U.S. Pacific Fleet

Submitted by:

Joseph R. Mobley, Jr., PhD

dba: Marine Mammal Research Consultants

Date: January 28, 2008

Summary

Aerial surveys were performed in support of the US Navy Undersea Warfare Exercise (USWEX) on November 11-12 and 15-17, 2007. The mission was to detect, locate and identify all marine mammal and sea turtle species observed within a specified 6,174 km^2 grid (Figure 1) and during circumnavigation of the islands of Oahu and Molokai. For marine mammal species, additional observation time was spent characterizing behavior at the time of sighting. Target species were observed on two of the five survey days, primarily corresponding to those days with more favorable seastate conditions and the greater visibility of some species (e.g., sea turtles) during circumnavigation (Table 1). Effort comprised 17.15 hrs of survey time, involving a linear distance of approximately 3,150 km. A total of 26 sightings were recorded involving five identified species (Green sea turtles, short-finned pilot whales, Hawaiian spinner dolphins, bottlenose dolphins and Hawaiian monk seals) and four unidentified species (*Stenella* species, unidentified turtle, dolphin and whale) (Tables 2-3). Based on behavioral observation of the marine mammal species, no indications of distressed or unusual behavior were seen. The circumnavigation survey (Nov. 15) yielded no evidence of stranded or near stranded animals.

Background

The US Navy Undersea Warfare Exercise (USWEX) was proposed as an advanced Anti-Submarine Warfare Exercise to be conducted by U.S. Navy Carrier Strike Groups (CSGs) and Expeditionary Strike Groups (ESGs) within the Hawaii Range Complex. Since the exercise involved deployment of mid-frequency active sonar, concerns over possible impacts on protected marine species dictated that a parallel monitoring program be conducted. For the Nov. 07 USWEX, this monitoring involved systematic surveys using both shipboard as well as aerial platforms. This report is specific to the aerial monitoring portion only. Aerial surveys of a pre-determined 56 x 111 km grid as well as coastal areas of the islands of Oahu and Molokai were conducted on five days during the period November 11-12 and 15-17, 2007. The mission was to document incidence, location, and species identity of all marine mammal and sea turtle species within those regions. Additionally, for marine mammal species, additional observation time was spent characterizing behavior at time of sighting.

Method

Three aircraft were utilized. For the transect grid surveys a twin-engine Partenavia Observer (P68) (Nov. 11-12) and Britten Norman Islander (Nov. 16-17) were used. For the circumnavigation portion (Nov. 15), a Robinson 44 helicopter was used. The transect surveys utilized design and methods prescribed by accepted distance sampling theory (Buckland et al., 2001). Survey crew and pilot were not informed as to the status or location of navy exercises to minimize observational bias. Six north-south transect lines 111 km long were placed 9 km apart to cover the 6,174 sq km target area (Figure 1). Random longitudinal startpoints were used so that the exact trackline configuration varied on each survey. Aircraft flew at 100 knots ground speed and altitude of 244 m (800 ft). Survey crew consisted of two experienced observers, one on each side of the plane, and a data recorder. When target species were detected, an angle was taken to the sighting using hand-held Suunto clinometers, typically followed by orbiting to

identify species and in the case of marine mammals, to characterize behavior. Environmental data (Beaufort seastate, glare, visibility) were taken at the start of each transect leg or when conditions changed. Positional data via GPS were automatically recorded every 30-sec and manually when sightings occurred.

Table 1. Summary of USWEX aerial surveys

Date	Survey Type	Hrs Effort	No. Sightings	Mean Seastate
Nov. 11	Transect grid	3.85	0	3.7
Nov. 12	Transect grid	4.15	7	2.7
Nov. 15	Circumnavigate Oahu & Molokai	2.53	19	3.7
Nov. 16	Transect grid	2.92	0	5.5
Nov. 17	Transect grid	3.70	0	4.1
	Totals:	17.15	26	3.84

Results and Discussion

The five days of aerial surveys consisted of a total of 17.15 hrs effort, comprising approximately 3,150 km of linear distance. Target species were observed on two of the five days surveyed (Table 2), corresponding to days with more favorable seastate conditions as well as the greater visibility of some species (sea turtles) during circumnavigation of inshore waters (Tables 1 & 2). The total of 26 sightings included three identified species of odontocetes (Hawaiian spinner dolphin, short-finned pilot whale, and bottlenose dolphin), one pinniped species (Hawaiian monk seal) and one sea turtle species (green sea turtle) (Table 3). The only baleen whale sighting was an unidentified species sighting on Nov. 12 that occurred in the eastern portion of the grid (Figure 1). The animal was seen diving but from the body outline it did not appear to be a humpback whale. The three positively identified odontocete species represent ubiquitous species that are among the top five most commonly seen in Hawaiian waters based on the 1993-03 Hawaii survey results (Appendix). The two Hawaiian monk seal sightings included one of a single seal swimming in the waters off Barbers Pt as well as two seals observed resting on a southwestern Molokai beach. These two sightings are noteworthy since sightings of monk seals in the main Hawaiian Islands are relatively rare.

The total of 7 odontocete species observed across the 3,150 km of linear effort corresponded to an average encounter rate of .002 sightings/km. This is considerably less than noted in previous surveys of Hawaiian waters. For the 2005 summer RIMPAC exercises, odontocetes were seen at a rate of .004 sightings/km (Mobley, 2006) and during the 1993-03 Hawaii statewide surveys (period Feb-Apr) they were observed at a rate of .005 sightings/km (Mobley, 2004). The lower encounter rate observed during the USWEX surveys is likely attributable to two factors: a) the average seastate conditions during the present surveys were less favorable than prevailing conditions during the other series mentioned; and b) a greater portion of effort during the

USWEX surveys was spent in deep water greater than 1829 m (1000 fathoms) where odontocetes may be less abundant.

Notes regarding the general behavior of the marine mammal sightings are summarized in Table 2. None of the behavioral descriptions indicated the presence of unusual or distressed behavior (e.g., tight or unusual aggregations, strandings or near strandings).

Overall there were no indications of any deleterious effects of the USWEX exercise on the indigenous marine species observed. It should be noted of course that the absence of such indications does not necessarily imply the absence of any negative effects, merely that no overt indications of such effects were detected.

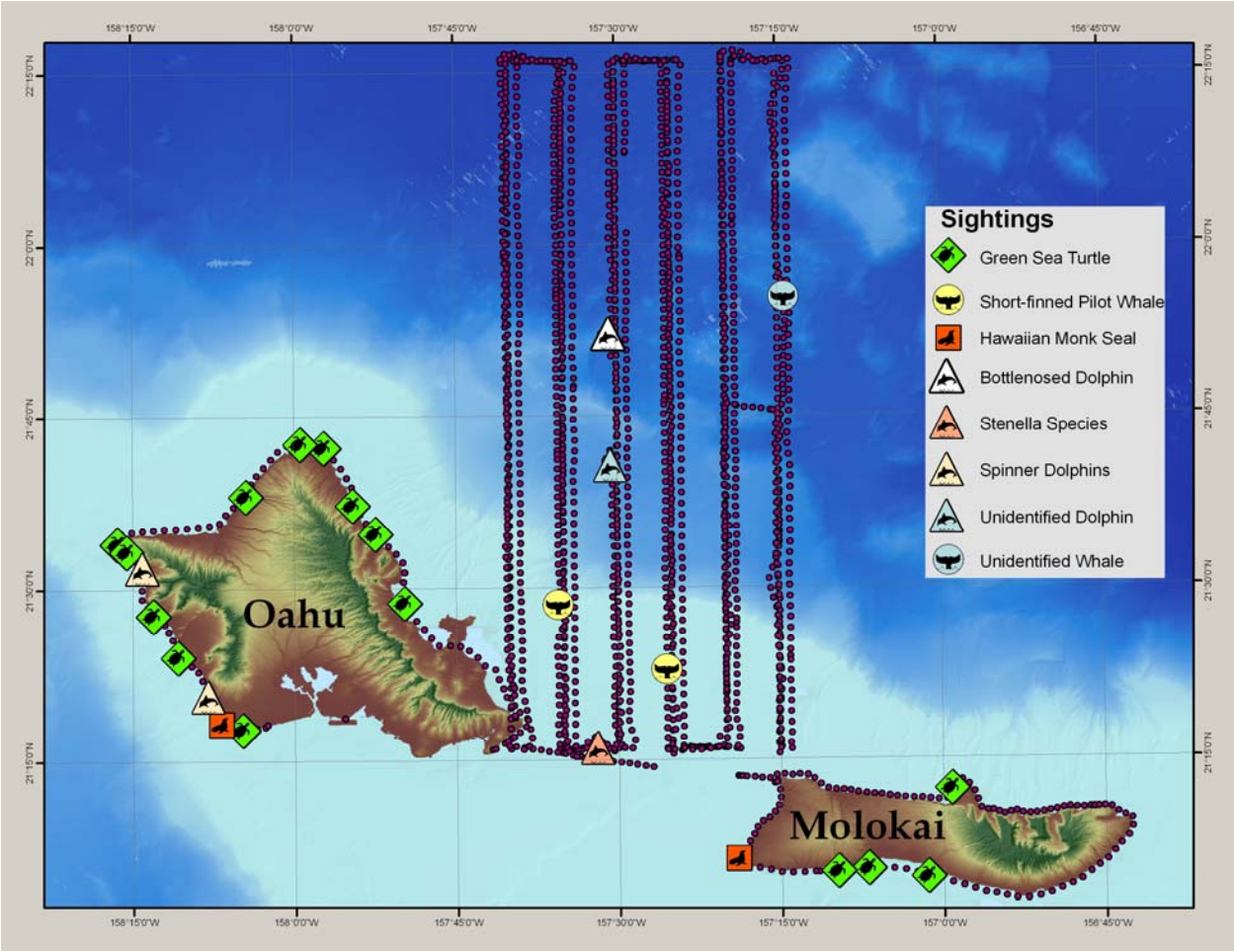

Figure 1. Summary of Effort and Species Sightings. Based on GPS data. For transect grid, random longitude start points were used so the exact trackline varied on each survey date. Note: South shore of Oahu not covered due to Class B airspace restrictions.

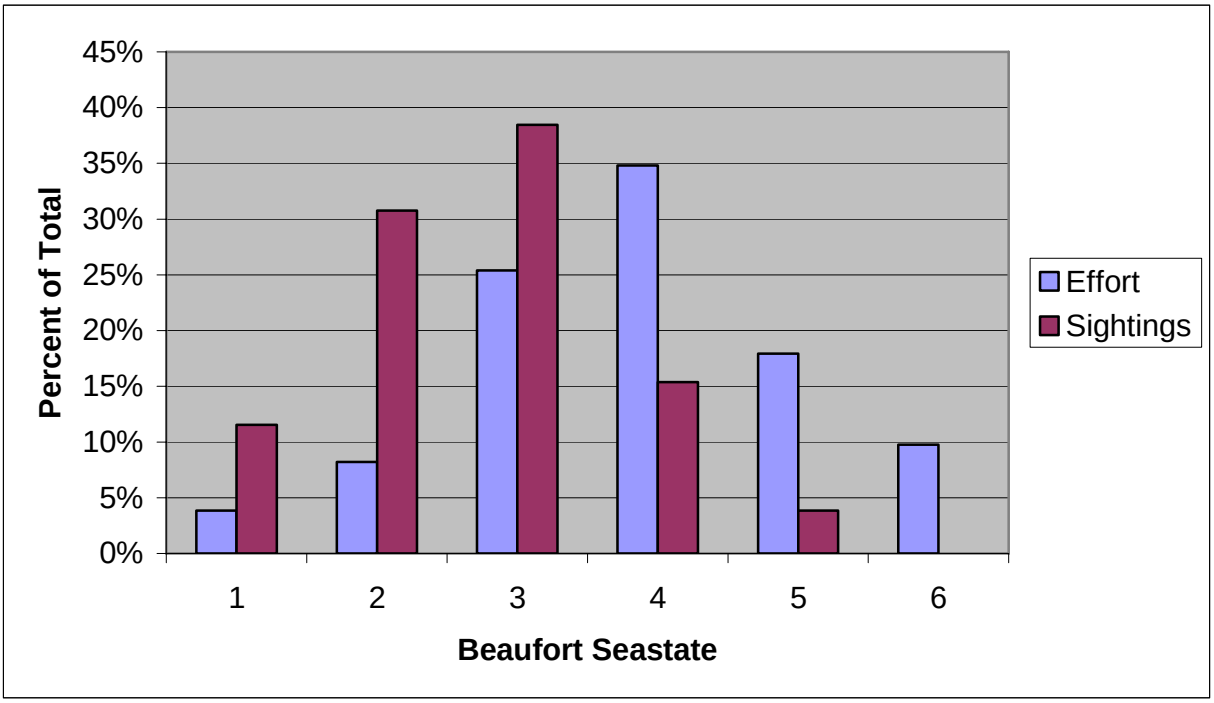

Figure 2. Summary of Beaufort Seastate. As shown, the majority of effort was spent in Beaufort seastate greater than 3 (63%) whereas the majority of sightings occurred in Beaufort seastate 3 or less (81%). Seastate is the primary factor affecting sighting probability of free-ranging marine mammals.

Table 2. Summary of individual sightings

Date	Number	Spp	Time	Seast	Londec	Latdec	Behavioral Description
11/15/2007	14	CM	9:49:31	3	157.8291	21.4781	
11/15/2007	6	CM	9:55:52	3	157.8741	21.5792	
11/15/2007	1	CM	9:57:31	3	157.9093	21.6202	
11/15/2007	1	CM	10:00:43	3	157.9536	21.7047	
11/15/2007	1	CM	10:01:53	3	157.9898	21.7104	
11/15/2007	2	CM	10:05:45	3	158.0747	21.6336	
11/15/2007	3	CM	10:13:02	2	158.2733	21.5659	
11/15/2007	2	CM	10:13:49	2	158.2590	21.5542	
11/15/2007	1	CM	10:24:06	2	158.2176	21.4611	
11/15/2007	1	CM	10:27:04	2	158.1800	21.4006	
11/15/2007	1	CM	10:39:42	3	158.0800	21.2950	
11/15/2007	1	CM	13:05:03	5	156.9861	21.2047	
11/15/2007	1	CM	13:33:24	4	157.0240	21.0772	
11/15/2007	2	CM	13:36:01	4	157.1159	21.0898	
11/15/2007	1	CM	13:37:21	4	157.1626	21.0857	
11/12/2007	1	UT	12:21:44	1	157.4183	21.3762	
11/12/2007	12	GM	10:37:50	1	157.5927	21.4753	scattered; milling
11/12/2007	19	GM	12:19:12	1	157.4252	21.3810	slow travel
11/15/2007	1	MS	10:35:33	3	158.1111	21.3031	slow swimming
11/15/2007	2	MS	13:44:24	4	157.3142	21.1048	sunning on beach
11/15/2007	24	SL	10:15:19	2	158.2321	21.5304	slow swimming
11/15/2007	60	SL	10:30:02	2	158.1310	21.3440	milling; slow swimming
11/12/2007	31	SS	10:55:42	2	157.5298	21.2667	scattered; milling
11/12/2007	5	TT	11:27:12	3	157.5087	21.8691	fast swimming
11/12/2007	1	UD	11:17:38	2	157.5071	21.6769	Dove
11/12/2007	1	UW *	15:56:27	3	157.2400	21.9230	submerged swimming

Species code: CM = green sea turtle; UT = unidentified turtle; GM = short-finned pilot whale; MS = Hawaiian monk seal; SL = spinner dolphin; SS = unidentified *Stenella* species; TT = bottlenose dolphin; UD = unidentified dolphin; UW = unidentified whale

Table 3. Summary of sightings by species

Species	No. Sightings	No. Individuals
Green sea turtle (*Chelonia mydas*)	15	38
Short-finned pilot whale (*Globicephala macrorhynchus*)	2	31
Hawaiian spinner dolphin (*Stenella longirostris*)	2	84
Bottlenose dolphin (*Tursiops truncatus*)	1	5
Stenella species	1	31
Hawaiian monk seal (*Monachus schauinslandi*)	2	3
Unidentified turtle	1	1
Unidentified dolphin	1	1
Unidentified whale	1	1

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Appendix:
Summary of 1993 - 2003 Hawaiian Islands Aerial Survey Results

Species Name	No. pods	No. indiv.
Humpback whale (*Megaptera novaeangliae*)	2352	3907
Spinner dolphin (*Stenella longirostris*)	52	1825
Spotted dolphin (*Stenella attenuata*)	31	1021
Short-finned pilot whale (*Globicephala macrorhynchus*)	73	769
Melon-headed whale (*Peponocephala electra*)	6	770
Bottlenose dolphin (*Tursiops truncatus*)	54	492
False killer whale (*Pseudorca crassidens*)	18	293
Sperm whale (*Physeter macrocephalus*)	23	106
Rough-toothed dolphin (*Steno bredanensis*)	8	90
Blainville's beaked whale (*Mesoplodon densirostris*)	9	32
Pygmy or dwarf sperm whale (*Kogia* spp.)	4	28
Striped dolphin (*Stenella coeruleoalba*)	1	20
Pygmy killer whale (*Feresa attenuata*)	2	16
Cuvier's beaked whale (*Ziphius cavirostris*)	7	13
Risso's dolphin (*Grampus griseus*)	1	8
Killer whale (*Orcinus orca*)	1	4
Fin whale (*Balaenoptera physalus*)	1	3
Unid. Dolphin	96	452
Unid. Stenella spp.	11	196
Unid. Whale	28	39
Unid. beaked whale	9	23
Unid. Cetacean	14	27
Totals:	2801	10134

APPENDIX C- RESULTS FROM USWEX 08-1 VESSEL MONITORING

Marine Mammal and Sea Turtle Monitoring Survey in Support of Navy Training Exercises in the Hawai'i Range Complex

November 11-17, 2007 - Field Summary Report

Authors: Mari A. Smultea,
Julia L. Hopkins and Ann M. Zoidis

January 2008 - Final Report
Contract # N62742-07-P-1915

Submitted to:
NAVFAC Pacific
EV3 Environmental Planning
258 Makalapa Drive, Ste. 100
Pearl Harbor, HI 96860-3134

Submitted by:
Cetos Research Organization
11 Des Isle Ave / 33 Echo Ave. Ste. 5
Bar Harbor, ME 04609 / Oakland, CA 94611
www.cetosresearch.org

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Bar Harbor, ME 04609 / Oakland, CA 94611
www.cetosresearch.org

Authors: Mari A. Smultea, Julia L. Hopkins and Ann M. Zoidis

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Appendix

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

A visually based monitoring survey for cetaceans and sea turtles was conducted by Cetos Research Organization from 11 through 17 November 2007 in Hawaiian waters E and NE of Oahu, in portions of the Hawaii Range Complex, from aboard the 96-ft M/V *Searcher*.

The goals of this project were to monitor, identify, and report surface behavior of marine mammals observed before, during and after the scheduled training exercise, particularly any injured or harmed marine mammals and/or any unusual behavior or changes in behavior, distribution, and numbers of animals. A complimentary goal was to attempt to remain within view of any opportunistically encountered Navy vessels while conducting surveys and focal sessions. Effort was focused in a designated Survey Box ~30 nm wide by ~70 nm long (~55 km by ~130 km).

To meet the project goals, systematic line-transect surveys and focal animal behavior sessions were conducted. Effort focused on priority species including beaked whales, and federally listed species (e.g., sperm, blue, fin, humpback, and sei whales). Experienced marine mammal observers conducted visual observations in the Survey Box using the naked eye, handheld binoculars, and two sets of "Big Eyes" binoculars. The primary objectives were to collect location data and scan samples of behavior of all cetaceans encountered, and to locate in particular, priority cetaceans for the purposes of conducting focal behavior follows. Another objective was to collect bathythermograph (XBT) data during the survey.

ES.2 RESULTS

Surveys were conducted in all four sub-areas within the Survey Box on seven consecutive days, 11-17 November 2007. A total of 65.95 hours (h) or 911 km were visually surveyed. Most (90% or 817 km) of this effort consisted of line transect survey effort, 105 km while Navy vessels were within view. A total of 63 km (7%) of the total 911 km consisted of focal animal observations. Navy vessels were opportunistically encountered on 13 and 14 November and were within view for a total of 8.1 h at distances of over 3 nm (5.6 km). Beaufort sea state ranged from 1 to 6, with most observations conducted in a Bf 5, followed by Bf 3 (27%) then Bf 4 (23%).

A total of eight cetacean groups were sighted during the entire 7-day cruise. No sea turtles were sighted. Five cetacean species were confirmed during the entire survey period: sei whales, Brydes' whale, humpback whales, Risso's dolphins, and spinner dolphins (Table 3, Figure 4). One unidentified small whale was observed and considered to be a probable Cuvier's beaked whale. In addition, a small group of medium-sized delphinids (considered to be probable pygmy killer whales) were sighted. A total of two sightings of sei whales were made on two different days.

Extended focal follows were conducted on four cetacean sightings: a single sei whale, a single Bryde's whale, a group of three subadult sei whales, and a group of three humpback whales. Focal sessions ranged in duration from 50 - 145 minutes, with the longest continuous observation session of 145 minutes occurring with a single sei whale. Longer time was spent with those species with federal listing under the Endangered Species Act (ESA), i.e. the sei whales and humpback whales. Because sei and Bryde's whales can easily be confused, we stayed with these focal animals until a positive identification was made as documented with photographs and detailed survey observations on natural history characteristics by senior observers. Photographs were taken during all focal follows.

ES.3 CONCLUSIONS

Systematic vessel-based survey effort is limited and scant in the Survey Box E and NE of Oahu. Our research effort was successful despite both marginal weather and sea conditions on most days. We were able to collect new and important information on a variety of species in a little-studied area in a relatively short period of time. This included the first verified sighting of a Bryde's whale in the main Hawaiian Islands. In addition, the two sei whale sightings we made represent the first such sightings off Oahu. The presence of three subadult sei whales combined with past rare reports of sei whales off Maui and the Big Island of Hawaii suggest that the main Hawaiian Islands may be an important breeding area for the little-known N Pacific sei whale. The use of Big Eyes binoculars improved the effectiveness of our observations. Successfully remaining within view of Navy vessels, including while following cetaceans, suggests that this monitoring approach is a feasible consideration on an opportunistic basis with respect to monitoring relative to Navy training exercises. Finally, the *Searcher* proved to be a useful and tenable platform from which to conduct visual observations, including under marginal conditions, and has potential for use in multi-day offshore survey efforts.

Information collected during this Cetos survey sponsored by the U.S. Navy contributes to the limited database existing on offshore Hawaiian cetaceans. This information can be used towards efforts to effectively mitigate, monitor, and manage protected marine resources relative to Navy exercises. The survey also provided a platform for evaluating the feasibility of potential monitoring approaches, including in combination with concurrent aerial surveys. Suggestions and recommendations for future monitoring-related efforts have been collected, including comparisons with previous Cetos Research Navy monitoring surveys. Topics identified include holding a workshop to discuss the

pros and cons and coordination of past and future monitoring efforts, as well as evaluating protocols that may improve the effectiveness of related vessel-based, aerial, and acoustic survey efforts.

The results of this study illustrate the effectiveness of visual methods, and were successful due to support from the U.S. Navy, the expertise and broad experience of our scientific team, our qualifications gained from conducting previous surveys in conjunction with naval training exercises, and because of the unique capabilities of the research platform (M/V *Searcher*) and crew.

Citation for this report is as follows:

Cetos 2007c. Final Field Summary Report. *Marine Mammal and Sea Turtle Monitoring Survey in Support of Navy Training Exercises in the Hawai'i Range Complex November 11-17, 2007*. Prepared by: Cetos Research Organization, Oakland, CA, under Contract No. N62742-07-P-1915, Naval Facilities Engineering Command Pacific. EV2 Environmental Planning, Pearl Harbor, HI. Authors: Smultea, M.A., J.L. Hopkins, A.M. Zoidis. January 30, 2008.

Photo Credits on Cover: Vessel Photo: Lori Mazzuca; Whale Photos: Cetos Research Observer Team

SECTION 1
INTRODUCTION

Cetos Research Organization (Cetos) was contracted by the U.S. Navy (Navy) to conduct a monitoring survey for marine mammals and sea turtles concurrent with naval exercises in Hawaiian waters, in the Hawaii Range Complex (HRC), from aboard the vessel (M/V) *Searcher*. Marine mammal monitoring surveys were performed in conjunction with USWEX exercises from November 11 – 17, 2007.

This report focuses on our visual survey results from HRC waters north and east of Oahu from November 11-17, 2007. In addition to presenting results, we evaluate the effectiveness of survey techniques and provide recommendations by Cetos for improving methods of monitoring and for surveying marine species relative to the short- and long-term goals summarized in the BO for the USWEX (NMFS 2007). All data gathered are included in this document as requested by the Navy Scope of Work (SOW).

SECTION 2
METHODS

We conducted modified line transect vessel surveys and opportunistic behavioral sampling for priority cetaceans and sea turtles from aboard the M/V *Searcher* from November 11 – 18, 2007 (including transits). Data collection protocols and forms are provided in Appendix A. The primary study area surveyed was north of Oahu in a rectangular box (referred to herein as the Box) of approximately 30 nm by 70 nm (55 km by 130 km), with the southern border encompassing the northern end of the Kaiwi channel which lays between the eastern tip of Oahu and northwestern Molokai and within the Navy operational area (OPAREA).

The primary goals of this project were to monitor, identify, and report surface behavior of marine mammals and sea turtles observed during the training exercise. Of particular interest were any potentially injured or harmed marine mammals and/or any unusual behavior or changes in behavior, distribution, and numbers of animals observed during the training exercise. Additionally, the research vessel was directed to observe any marine mammal interactions with Navy ships from a safe distance (>3 nm [> 5.5 km]). To meet these goals, six experienced marine mammal observers conducted line transect surveys and focal cetacean behavior sessions in the study area. Our observer team included three senior [>15 years visual marine mammal survey experience and experienced in identification of tropical Pacific species and marine mammal behavior] members. Our primary objectives were to collect location data and scan samples of behavior of all cetaceans and sea turtles encountered, and to locate in particular, "priority" cetaceans for the purposes of conducting focal behavior follows.

Priority species for this project are those identified in the project SOW. These include five ESA-listed species known to occur in Hawaiian waters and beaked whales. According to the SOW, special consideration was to be given to the following species if encountered: "beaked whales and federally listed species including sperm whales, blue whales, humpback whales, fin whales, and sei whales."

Data to be gathered included information on marine mammal species and location, group size and composition, surface behavior and "disposition" (e.g. alive, injured, stranded), and direction of travel. All species were considered for data collection. When possible, photographs and/or video data were to be collected, especially of any unusual circumstances.

To meet survey goals, modified line transect surveys were conducted throughout the study area to locate focal animals for extended behavioral observations, preferably while within view of Navy operations. The methodology and sampling design for this survey were submitted and approved in advance, per the SOW, to the NTR (Cetos 2007b). Once a species of interest was located, "focal animal follows" were opportunistically conducted to monitor behavior, occurrence, and distribution of marine mammals or sea turtles before, during, and after the Navy exercise. Pre- and post-exercise observations were conducted for baseline and comparative purposes with observations during the exercise. The primary goal was to monitor behavior of marine mammals or sea turtles within approximately 3-5 nm (5.5- 9 km) of a Navy vessel (but no closer than 3 nm) as feasible (i.e., when weather and conditions allowed). Focal animal follows involved monitoring animals with "big eyes" binoculars, observing and recording their behavior, and collecting photo-identification and species verification photographs as possible. If any marine mammals were deemed to exhibit unusual behaviors, they were to be monitored by spending extra time with the animal(s) to quantify the behavior with detailed behavioral logs, including descriptions of why and how they were thought to be unusual. The survey was to remain in the designated Survey Area Box unless a sighted animal exhibited anomalous behavior outside the Box or if a focal follow effort led outside the Box. Any marine mammal found to be injured or in distress was to be immediately reported to the COMPACFLT Environmental Representative.

In addition, oceanographic data was recorded using T-7 XBTs, launched twice daily. Information was recorded on sea surface temperature, Beaufort sea state and temperature profiles (Appendix B).

VISUAL OPERATIONS

Visual surveys were conducted to meet the Navy goals outlined in the SOW and were adapted to both the in-situ and predicted weather conditions, as well as to naval activities.

Survey Design

The survey transect design was based on general standard distance sampling methodology and techniques described in Buckland et al. (2001). As indicated above, the survey was designed to systematically locate and monitor marine mammals and sea turtles in conjunction with the Navy's USWEX Training Exercise November 2007 within the designated Survey Area "box" (Box). This was accomplished by conducting line transect surveys until animals of interested were located, then breaking off the survey line to follow and conduct focal animal behavioral sampling of these animals

and/or to remain within view of Navy operations. For surveys, the Box was divided into four equal-sized, replicate sub-areas (Cetos 2007b) (Figure 1). Three north-south transect lines were located and surveyed within each sub-area in the Box. Lines were spaced equidistant from each other (approximately 4 nm [7 km]) and the edges of the Box (approximately 3 nm [5.5 km]). Equal coverage of each sub-area following pre-set transect lines was attempted. However, real time and prevalent weather conditions (e.g., large swells, high winds, strong sun glare) sometimes necessitated modifying survey line orientation in conjunction with direction on safest routes from the Captain of the vessel. Survey line position was also modified by up to 30 degrees when needed to improve sighting conditions and effectiveness (see Table 1). In addition, effort deviated occasionally from pre-set lines to a) conduct focal animal follows, to b) remain within view of Navy operations, and to c) transit to and from lines between protected nighttime anchorages. Wind and swell conditions also sometimes made it difficult to maintain a specific line position.

Using the above approach, the study area was monitored. We documented occurrence, distribution, numbers, surface behavior, and/or disposition (injured or dead) of marine mammal and sea turtle species Additional observation effort was focused to the extent practical near and where Navy training exercises were occurring or had occurred, ideally while within view of active Navy vessels (but no closer than 3 nm [5.5 km]) as feasible during the days when training exercises were noted.

Observation Platform

Visual survey effort was conducted from the M/V *Searcher,* a 96-ft. American Bureau of Shipping classed vessel (see http://www.searcherhawaii.com/searcher/index.html for further description). This vessel includes a flying bridge platform located at an eye-level elevation of 7.97m above sea level (ASL). On this deck two pedestal-mounted 25x big eyes binoculars supplied by the Navy were located at each forward (bow) corner. Visual distance to the horizon from approximate observer standing eye height was ~8 nm (15 km). To the maximum extent practicable considering observer safety, three visual observers were posted on the flying bridge during all "on transect effort" visual survey periods.

Two observers scanned the water with the big eyes binoculars during survey efforts. Each observer scanned an approximate 90° arc from dead ahead (0 degrees) to just past the beam on their respective side of the vessel. A third observer scanned the region nearest the vessel and out to the horizon area with the unaided eye or with 7x50 West Marine reticle binoculars. The third observer also functioned as the dedicated data recorder. Observers rotated between watch positions every 20-30 minutes to reduce observer fatigue. A typical observer rotation consisted of 30 min as right big eyes

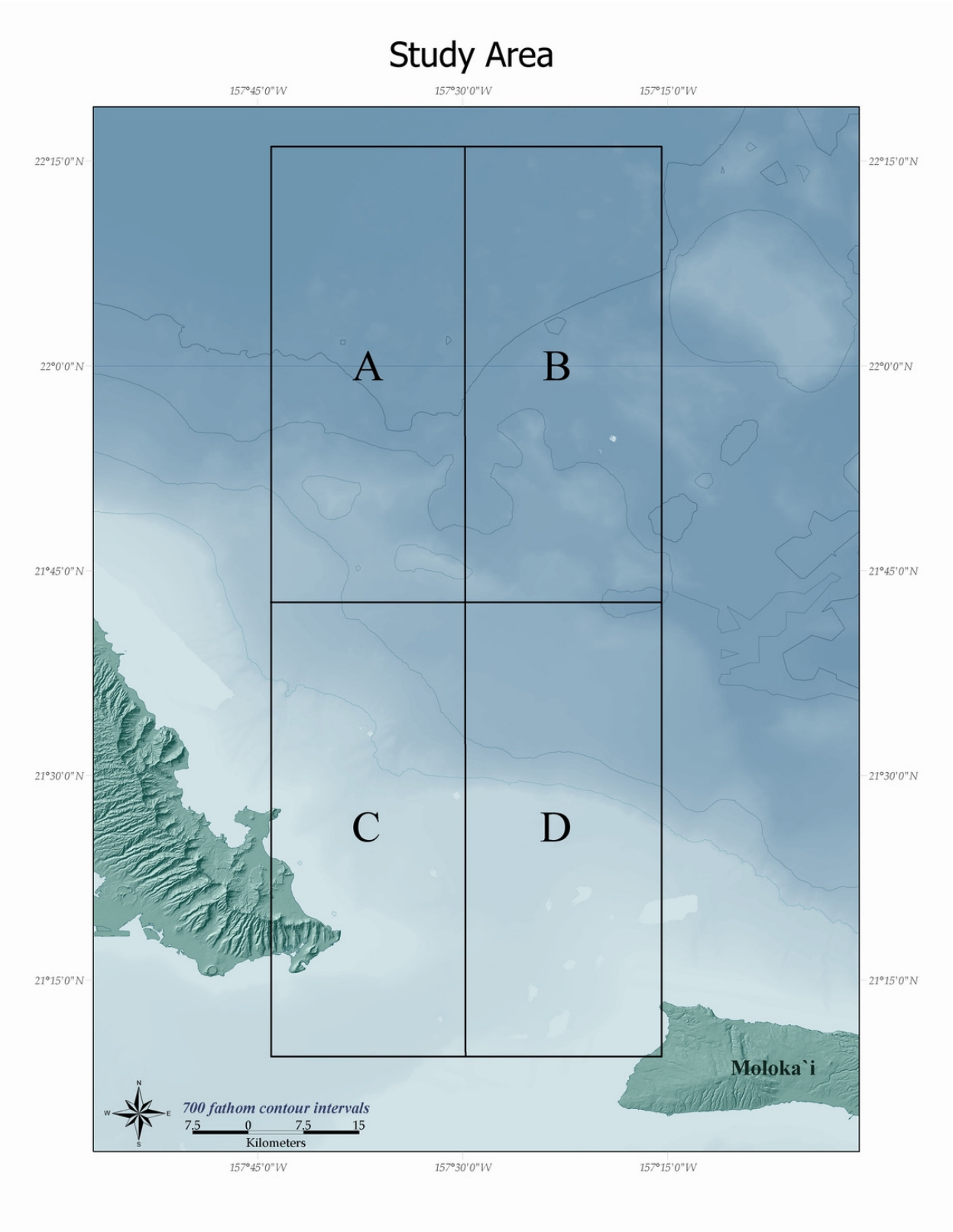

Figure 1. Study Area

observer, followed by 30 min as center observer with naked eye or 7 x 50 binoculars, and 30 min as left big eyes observer, then one hour off.

Data Collection Protocol

When a cetacean sighting was made, the distance and horizontal bearing to the center of the group or individual were estimated using reticle binoculars or the naked eye. In addition, the time, species identification (or lowest taxonomic level that could be confidently discerned), estimated group size, sighting cue, and other associated information were entered by a dedicated recorder into WinCruz, a Windows-based data logging program for recording line-transect data for marine mammals (developed by NOAA Fisheries' Southwest Fisheries Science Center [SWFSC], La Jolla, CA). WinCruz acquires GPS-derived latitude and longitude data to plot sighting and ship-track data. Additional details regarding this program are available online at the following website: http://swfsc.nmfs.noaa.gov/PRD/software/WinCruz.pdf. A WinCruz User's Guide is available in the appendix of our previous Final Field Summary Report (Cetos 2007a).

We used a Garmin GPS Map 76 handheld GPS to collect location data at 1-2 minute intervals throughout the sighting. Weather, swell, Beaufort wind force (sea state), visibility conditions, observers and observer positions, and observation effort status were recorded in WinCruz on every change of observers and at any other time that conditions changed. At the end of each day, a summary of the day's activities and observations were recorded in a field journal kept by the survey leader and a daily sighting log data sheet was filled out.

Visual data collected using WinCruz were reviewed and edited daily while in the field by one assigned visual observer experienced with WinCruz. These data were later exported to a custom-designed (under Cetos contract) summary program specifically created for post processing WinCuz data for the purposes of these surveys. Data then were imported into an Excel database where they were quality-checked twice. GPS data and sighting locations were plotted geographically using GIS software to produce maps. For the purposes of this report, sighting locations were plotted at the location on the ship track where they were initially sighted (Figure 4).

A detailed sighting form was filled out for all sightings by the observer(s) who sighted the animal(s). The sighting form was the same as that used by NOAA Fisheries on their cruises for marine mammals in the Pacific Ocean (NMFS/SWFSC http://www.corporateservices.noaa.gov/~foia/asdhome/frmscat.pdf). The information recorded included a detailed description and sketch(es) of the diagnostic features of the animal(s), a description of the animal's general behavior, speed, and direction of movement, closest observed point of approach to the vessel, whether photographs or video were taken, a standardized questionnaire as to any observed reactions to the vessel, etc., and as delineated in the SOW.

BEHAVIORAL SAMPLING

Behavioral sampling was conducted in two formats. First, we employed focal animal sampling (Altmann 1974) on selected cetacean groups with the intent of focusing on the Navy's prioritized species (beaked whales and sperm, blue, humpback, fin and sei whales). Secondly, for all cetaceans encountered, we used scan-sampling protocol (Altmann 1974) to record behavioral information as described below.

Notably, close approaches to, or behavioral harassment of, certain cetacean species were permitted under the auspices of Cetos' NOAA/NMFS federal and Hawai'i state scientific research permits; however, this permit did not cover sperm, beaked, sei, or fin whales. Any cetacean behavior considered potential harassment as defined under the MMPA or ESA was recorded.

Focal Animal Sampling

Focal animal behavioral sampling was undertaken on selected priority cetacean species using a standard behavioral observation form designed for this survey (Appendix A). Information was collected on species, group size, number of calves, start and end times of observations, unusual and/or surface active (i.e., splash-creating) individual behaviors (e.g., spyhop, breach, head slap, tail slap, etc.), blow and dive times for large whales, distance from the vessel, direction and speed of travel relative to vessel, position of cetaceans relative to vessel, observers/recorders, photos/video taken, and visibility conditions. Ad libitum (Altmann 1974) detailed notes were also taken in the comments column of the form on school configuration, unusual behaviors or circumstances (e.g. birds feeding nearby), and/or any observed reactions to the vessel. A summary was also recorded and described for all focal animal encounters on the SWFSC sighting forms, as explained above.

Scan Sampling

A modified scan sampling protocol (Altmann 1974; Smultea 1994) was used to collect behavioral information on all cetacean groups encountered during the survey, as possible. This information included behavioral state and/or individual behavior, estimated speed of movement, and heading/orientation relative to the vessel. The first datum was recorded in the comment format of WinCruz; the second and third data were also recorded in WinCruz in prompted data entry boxes.

ANCILLARY RESEARCH ACTIVITIES

Oceanography

One observer with prior related experience was the designated oceanographer and collected subsurface oceanographic data using expendable bathythermograph (XBT) probes provided by the Navy. Two XBT T-7 launches were made per day at 0900 and

1500 hours local ship time and after focal follow sessions. Data were recorded for each drop using WinMK21 SURFACE (Lockhead Martin Sippican, v2.7.1 2006) software.

Photography/Videography

Photo-identification (Photo ID) of animals was conducted opportunistically using a Canon EOS 20D camera with 70-200 mm zoom (f 2.8) lens and a Canon L series 300 mm zoom (f 2.8), with a Canon 1.4X converter and a Canon EOS 30D camera with a 100-400 mm (f 2.8) lens. Data forms were used to track the information (see Appendix A). Photographs were attempted for close encounters with cetaceans in order to both facilitate species identification and to document any deemed unusual behaviors. Photographs also facilitate re-identifying individuals in these waters during past or future Navy exercises or studies.

In addition, video recordings were made for encounters where behavioral sampling occurred using a Sony DCR-PC330 3 mega pixel digital video camera.

SECTION 3
RESULTS

SURVEY EFFORT

Surveys were conducted in all four sub-areas within the Box on seven consecutive days, 11-17 November 2007. A portion of 11 November (5.08 hours [h]) was spent in transit to the survey location. A full chronology of events is given below in Table 1. A total of 65.95 h were spent conducting visual observations. In general, survey effort occurred from sunrise to sunset, averaging approximately 10 h (10.30 h) of effort per day. An exception was 11 November, when a portion of the day was spent in transit and 4.3 h was spent on visual survey. However, poor weather conditions interrupted surveys for short periods on 12 November (0.58 h) and November 14 (0.04 h), totaling 0.62 h off effort. No survey effort occurred on 18 November due mainly to weather. In addition, the vessel was located at the southern tip of the Box at day break, so the vessel was only in the survey area for a limited time that day. Sea state was a Beaufort 6+ and there was a preponderance of wind and rain on the 18th; it was determined to not be conducive to any systematic effort. Nonetheless, one person was kept on watch. Eventually it was determined that effort was ineffective due to high winds and prevailing weather.

Given the size of the survey Box, observers were not always able to locate Navy ships/activities. Surveys conducted on 11-12 November occurred prior to observing Naval exercises in the Box. However, Navy vessels were observed in the Box on 13-14 November. On these days, the Navy was in view (including near and over the horizon) for a total of 8.12 h. The longest day of visual contact with Navy vessels (~6.75 h) was 13 November during which time we conducted survey line effort, a focal follow on a Bryde's whale, and attempted to "shadow" (i.e., follow at a safe distance) a Navy ship (Table 1). At one point we were within 5 nm (9 km) of a Navy ship near where a sei whale sighting had been made the previous day. We took that opportunity to actively follow/ shadow the Navy ship to observe for marine mammals and sea turtles. We followed at a >3 nm (> 5.5 km) distance for 0.25 h. The Navy ship changed its course and we moved away to maintain the >3 nm (> 5.5 km) distance. Shortly thereafter, we opted to return to our survey trackline both as the Navy vessel was headed in a direction

Table 1: Chronology of events during the 11 - 17 November 2007 Marine Mammal and Sea Turtle Survey near the Island of Oahu.

Date	Time	Event
11 Nov	8:20	Depart Ko Olina Marina, Koonelani Harbor to transit along south shore of Oahu to Survey Box ENE of Oahu.
11 Nov	13:25 - 17:43	Conduct observations.
12 Nov	7:08 - 17:44	Conduct observations.
12 Nov	12:25- 12:45	Sighting #1: 1 unid. small whale (possible beaked whale), one blow seen, attempted focal follow, unable to re-sight for positive identification.
12 Nov	13:45- 16:00	Sighting #2: 1 sei whale, focal follow.
13 Nov	7:04 - 17:52	Conduct observations.
13 Nov	10:15- 17:00	Navy vessels in view.
13 Nov	10:30- 11:20	Sighting #3: 1 Bryde's whale, focal follow.
14 Nov	7:15 - 17:40	Conduct Observations
14 Nov	9:24- 9:34	Sighting # 4: 6 Risso's dolphins, attempted focal follow, unable to re-sight.
14 Nov	~14:00 - 15:22	Navy vessels in view: 4 ships, helicopters and plane.
15 Nov	7:37- 17:02	Conduct observations.
15 Nov	13:23 – 13:44	Apparent Navy helicopter circled *Searcher*. Two vessels and possibly a submarine detected by Searcher's radar (potentially related to Navy activities but not confirmed visually).
15 Nov	16:55- 17:03	Sighting #5: 10 spinner dolphins, did not attempt focal follow as darkness imminent.
16 Nov	7:31 - 17:45	Conduct observations, headed directly to previous locations of Navy vessels on 13 Nov.
16 Nov	11:15 - 11:35	Sighting #6: 5 unid. small delphinid (probable blackfish, possible pygmy killer whale), attempted focal follow, unable to re-sight for positive identification.
16 Nov	14:30- 15:34	Sighting # 7: 3 subadult sei whales, focal follow.
17 Nov	6:57 - 16:54	Conduct observations.
17 Nov	10:09- 11:19	Sighting #8: 5 humpback whales, focal follow, obtained photos for ID.
18 Nov		Outside Survey Area Box at day break and Beaufort 6 conditions. In transit back to Ko Olina Marina. No Survey conducted.

away from our vessel and as it was travelling at a fast speed which our vessel could not keep up with; we observed them until they headed over the horizon. On November 14, we headed N on survey effort along the far E edge of the Box. In the afternoon, Navy ships came into view while we remained on our transect headed towards the NE corner of the Box (Table 1). The Navy vessels remained in view as we finished that survey line and headed W to start the adjacent survey line headed S. After ~1.37 h with the Navy vessels in view, the Navy vessels then headed quickly out of sight at a speed at which we

could not keep up, so we continued our on-line survey effort headed S. No marine mammal sightings were made while within view of the Navy vessels on this day.

On November 15, a helicopter believed to be associated with the Navy circled our vessel at 5-8 nm (9-15 km); two other unknown vessels appeared on the ship's radar near this time at distances of ~1.7 to 3.5 nm (3-6km), respectively, but were not seen visually at any point (Table 1). These vessels then appeared to increase speed and head away from us over the horizon, again at a speed at which we could not keep up. The *Searcher*'s radar occasionally detected an object which may have been a submarine near the water surface for a short time. The total duration of the latter activities was 0.35 h.

The final two days (16-17 November) of survey were done with no observations of Navy vessels or activities. Survey effort on 16 November was directed toward the location near where Navy vessels were observed on 13 November. On 17 November, we attempted to fill in the gaps in survey line effort at the southern end of the Box. Difficulties with competing swell direction and prevailing winds, in addition to sun glare, made the transect lines more irregular than previous days in order to marginally improve sighting conditions.

Visual effort occurred during most daylight periods (weather permitting) on each of the seven days. Periods when WinCruz operated were categorized as either "on effort" or "off effort" Figure 2. The former portion consisted of two sub-categories: *(1) Survey Effort*, when the visual transect survey protocol was followed with at least three dedicated observers on continuous search effort during a transect within the Box (see Methods) *(2) Survey while Navy in View*, same as Survey Effort but with Navy ships in view on the days during the Navy's exercises. "Off Transect Effort" observations were divided into four categories: *(1) Focal Follows*, when scanning effort was suspended for focal animal behavior follows, (*2) Transit*, when the ship was transiting to the start of a transect line within the Box *(3) Off Weather*, when rain squalls precluded visual surveys, and *(4) Navy Focal Follow*, when the ship attempted to shadow a Navy vessel at a distance of 5 nm (9 km) to observe for any marine mammals or turtles. A total of 491 nm (911 km) were visually surveyed during the seven-day period. Overall, observations occurred during 489 nm (905 km) of this area, representing approximately 99% of the total available daylight watch periods within the Box (Table 2). A summary of visual survey effort (km) by effort type is presented in Table 2.

Sea state conditions ranged from 1 to 6 on the Beaufort (Bf) scale (Table 2). Most (40%) visual observations were conducted in a Bf 5, followed by Bf 3 (27%) then Bf 4 (23%). Sighting of marine mammals and sea turtles is greatly hampered above Bf 5 conditions. Additionally, on several occasions the direction and height of sea swell made observations with the big eyes binoculars impossible. In these cases, hand-held binoculars (7x25 or 7x10) were substituted until observers could return to the big eyes. Beaufort 4 and above conditions were encountered on each day, except 12 November, which was calmer (Figure 3). Conditions of Bf 5 and 6 were encountered on three of the seven days (14 – 16 November).

Table 2. Summary of survey effort (km) and Beaufort sea state (Bf) during the 11 - 17 November 2007 Marine Mammal and Sea Turtle Survey near the Island of Oahu.

Effort Type:	**Total (km)**
Survey Effort	712.3
Survey while Navy in View	104.6
Focal Follow	63.4
Transit	25.5
Off due to Weather	5.8
Total	**911.6**
Beaufort	
1-2	47.0
3	248.0
4	211.5
5	361.3
6	42.2
>6	0.0
Total	**910.0***

* Beaufort readings were recorded within a few minutes after going "on effort" leading to the discrepancy between total km of effort and total km of Beaufort.

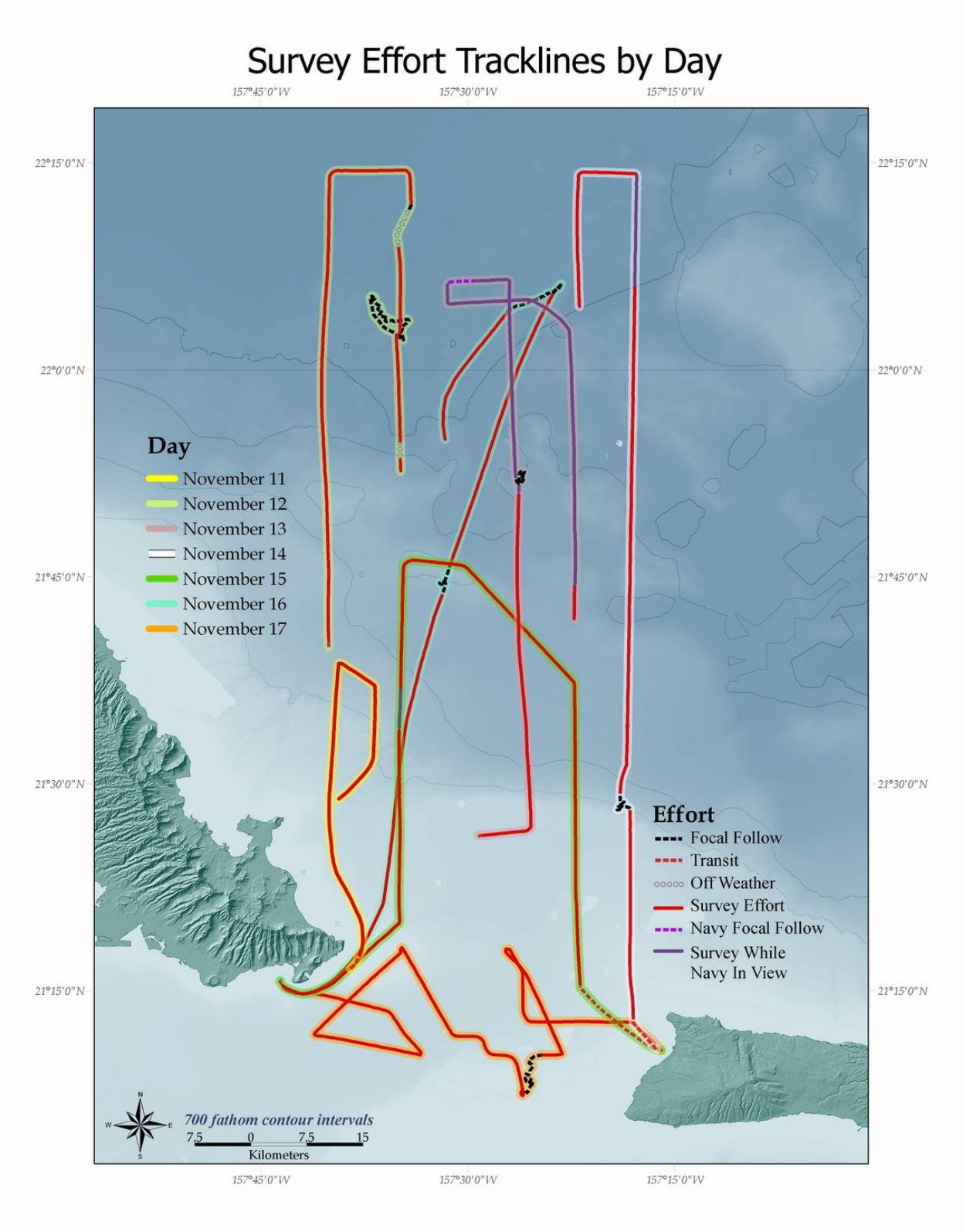

Figure 2. Map Summary of Survey Effort including "On Effort" Transect Survey Tracklines Aboard the M/V Searcher During the 11 - 17 November 2007 Marine Mammal and Sea Turtle Survey Near the Island of Oahu.

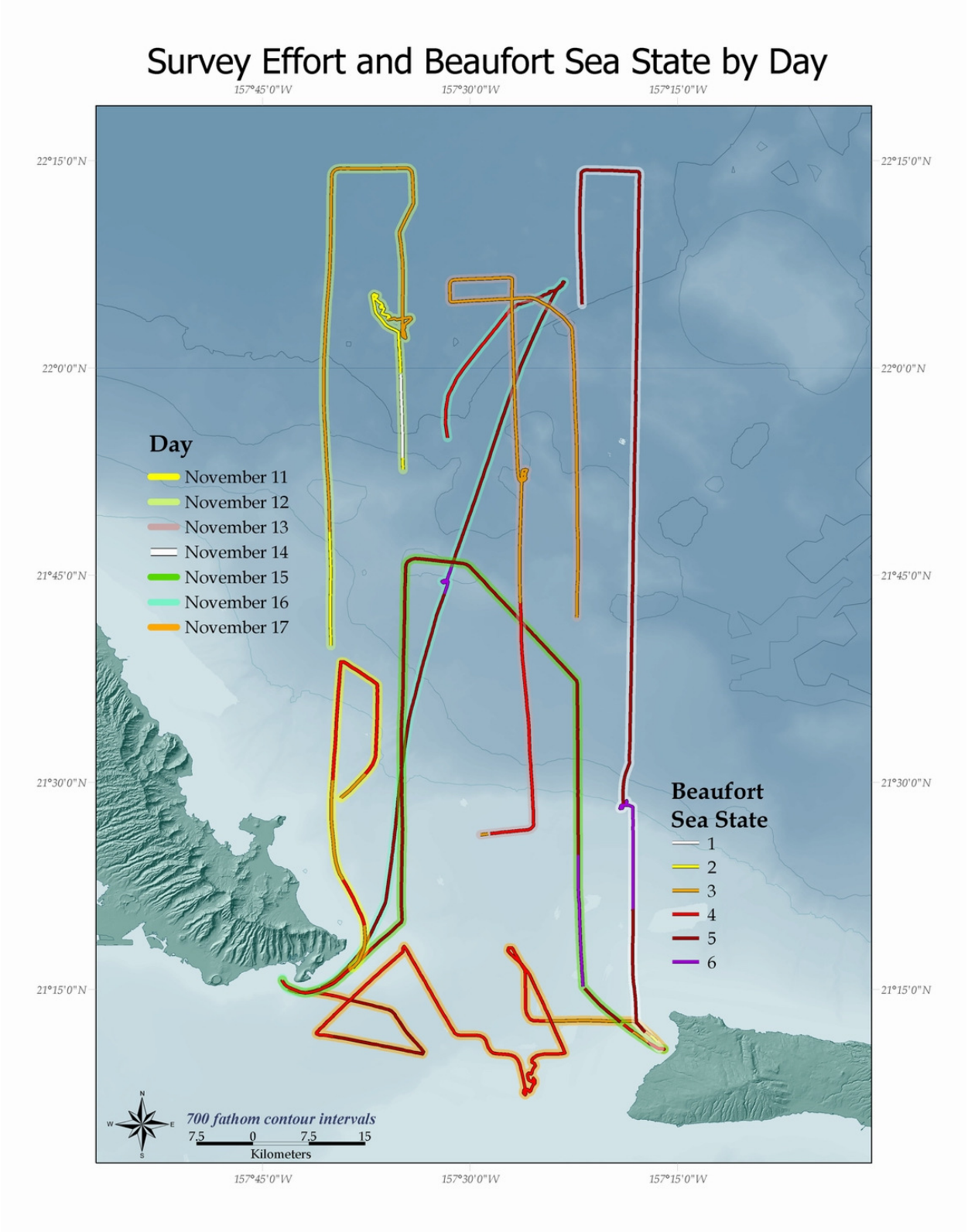

Figure 3. Map Summary of Beaufort Sea States aboard the M/V Searcher During the 11 - 17 November 2007 Marine Mammal and Sea Turtle Survey Near the Island of Oahu.

VISUAL RESULTS

A total of eight cetacean groups were sighted during the entire 7-day cruise (Table 3, Figure 4). No sea turtles were sighted. Five cetacean species were confirmed during the entire survey period: sei whales, Bryde's' whale, humpback whales, Risso's dolphins, and spinner dolphins (Table 3, Figure 4). In addition, one unidentified small whale was observed (probable Cuvier's beaked whale) as was a small group of medium-sized delphinids (probable pygmy killer whales).

In the best judgment of the team of experienced, seasoned observers, no "harassment" under the MMPA or ESA occurred during this survey. Close encounters with cetaceans typically resulted from the animals approaching the survey vessel and no "flee" or avoidance type behavior was observed.

Unidentified Small Whale

Sighted 12 November. Single blow sighted at initial distance of 2 nm (4 km) (Table 3) in the NE quarter of subarea A (22º09.66 N, 155º37.21 W) (Figures 1 and 4). Appeared to be a single animal. After 20 minutes we were not able to resight to confirm species, number of animals, or group composition. Water depth and blow characteristics with back lighting led the observer to an initial unconfirmed identification of Cuvier's beaked whale (*Ziphius cavirostris*). No photo or video were taken.

Sei whale (*Balaenoptera borealis*)

Sighted 12 November. Initial sighting was made of 12-15 ft blow at 1.8 nm(3.2 km), at 200 degrees to right of bow heading to the south near the center portion of Box subarea A (22º02.53 N, 157º34.95 W). We moved closer to the single adult whale to conduct a focal follow (see Behavioral Results). The whale seemed unconcerned with the ship and repeatedly closely (~20 to 30 m) approached the *Searcher* as it was maneuvered in order for observers to take photos and video. The whale repeatedly surfaced to breathe, two times in succession, every 8-12 min while maintaining slow surface travel of 3-4 kts. A total of 145 min were spent with this whale during which time it made occasional no-blow rises, logged just under the surface, and traveled at a slow speed parallel to the ship. Positive identification was made through photos and visual cues.

Table 3. Cetacean species sighted during visual survey 2007 during the Marine Mammal and Sea Turtle Survey near the Island of Oahu. There were no sea turtle sightings. See Figure 4 for a map of all sighting locations. The groups followed for extended periods to conduct focal behavioral sessions are indicated in boldface type. See Table 4 for further details on these focal groups.

Date	Species	Initial Sighting Distance (km)	Beaufort Sea State	Group Size/ Composition	Photos/Video Taken	Summary of Observed Behavior
12 Nov	Unid. small whale (possible *Ziphius cavirostris*)	4.0	3	1/unk	No	Unable to resight. Probable beaked whale.
12 Nov	**Sei whale (*Balaenoptera borealis*)**	3.2	2-3	1/A	Yes/Yes	26 resights of 1 sei whale in 2.25 h. It repeatedly approached boat; blows every 6-12 min.
13 Nov	**Bryde's whale (*Balaenoptera edeni*)**	<1.6	3	1/A	Yes/Yes	11 resights of 1 Bryde's whale. Whale approached boat to within ~65 m.
14 Nov	Risso's dolphin (*Grampus griseus*)	0.05	6	5/A	No/No	Sighting made near bow in proximity to previous location of yellow-fin tuna school.
15 Nov	Spinner dolphins (*Stenella longirostris*)	0.32	4	10/A	No/No	Three subgroups totaling ~10 dolphins swam close and parallel to shore as we headed into mouth of bay at dusk; approached and crossed our bow.
16 Nov	Unid. medium delphinid (possible *Feresa attenuata*)	0.8	6	5/unk	No/No	Unable to re-sight. Probable pygmy killer whales.
16 Nov	**Sei whale (*Balaenoptera borealis*)**	2.9	4	3/SA	Yes/Yes	Appeared to be ~1-2 year old whales.
17 Nov	**Humpback whale (*Megaptera novaeangliae)***	1.6	3	3/1SA, 2A	Yes/Yes	May have been up to 5 different animals, seen 1-2 at a time. Other blows seen near horizon on Penguin Bank.

unid. = unidentified
unk. = unknown composition
A = adult
SA = subadult

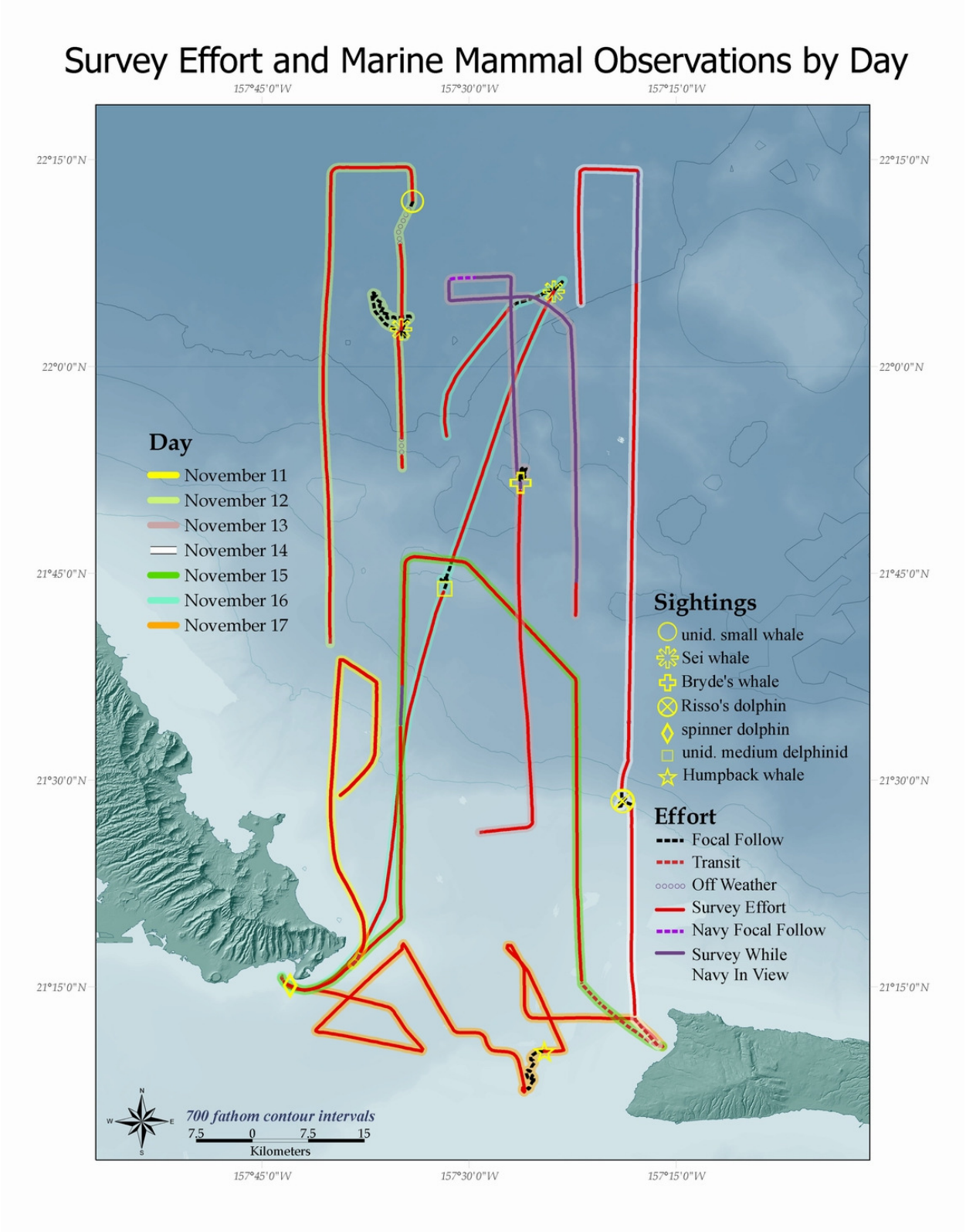

Figure 4 Map Summary of Visual Detections of Marine Mammals during Visual Observations from Aboard the M/V Searcher During the 11 - 17 November 2007 Marine Mammal and Sea Turtle Survey Near the Island of Oahu.

Bryde's Whale (*Balaenoptera edeni*)

Sighted November 13. A whale blow was seen at the initial distance of <0.86 nm (1.6 km), in the SW quarter of Box subarea B (21°51.90 N, 157°26.20 W), and was re-sighted 13 min later at a distance of 0.06 nm (0.11 km). During a 50-min focal follow the whale was observed swimming at slow speeds (3-5 kts), blowing and remaining submerged from 4-14 min. The whale exhaled underwater at least three times. The whale did not seem to actively avoid the ship and approached the ship maintaining its behavior state of slow travel on numerous occasions. We noted 12 cookie cutter shark marks/bites on this single adult. During this encounter, a Navy vessel was in sight over the horizon to our NW (320 degrees magnetic) at approximately 15 nm (28 km) at which time the whale was traveling to the NNE. Positive identification was made with photographs.

Risso's Dolphins (*Grampus griseus*)

Sighted 14 November. These dolphins were sighted just off the bow of the ship (.003 nm [6 m]) in the NE quarter of Box subarea D (21°28.60 N, 157°18.60 W). Initial sighting was 2 animals crossing the bow heading ESE at a moderate speed. The second sighting at 0.22 nm (400 m) indicated 6 adults traveling at a moderate speed continuing to head SE. The sighting was made in Bf 5-6, while the ship was traveling at 8 kts. We were not able to resight for photo/video or focal follow. This sighting was made in the vicinity of previously sighted yellow-fin tuna school and feeding birds.

Spinner Dolphins (*Stenella longirostris*)

Sighted 15 November. Three subgroups totaling ~10 dolphins (minimum of 5, 3 and 2 adults in each subgroup) seen near dusk in the SW quarter of Box subarea C (21°15.34 N, 157°42.74 W). The first subgroup was seen within .05 nm (100 m) of the ship at 60 degrees off the starboard bow. They were re-sighted as two subgroups traveling slowly parallel to the vessel with a heading of 0 degrees relative to the bow. As they approached to within 0.14 nm (250 m) they increased their speed and changed their heading to 350 degrees (relative). A third group was seen at 330 degrees off the port bow moving away from the ship. In the 8 minutes spent sighting and resighting no photos or video were acquired.

Unidentified Medium Delphinid

Sighted 16 November. A group of 5 delphinids was seen traveling slowly (1-3 kts) in rough Bf 6 conditions within ~0.14 nm (250 m) ahead of the ship, traveling to the east. Three dorsal fins were initially seen as they slowly rolled at the surface; another animal was sighted as its head broke the water surface. Identified characteristics were similar to pygmy killer whales (*Feresa attenuata*). No unusual behavior was seen; the animals were not resighted despite 20 minutes of searching in the SE quarter of Box subarea A where they were initially seen (21°49.00 N, 157°22.29 W). No photo or video was obtained.

Sei whales (*Balaenoptera borealis*)

Sighted 16 November. This was our second sighting of sei whale, and at a similar latitude (22 º 05.70 N) as the sighting on 12 November (22 º 02.53 N) (~20 km apart; Fig. 4). This time the sighting was in the NW quarter of Box subarea B (22 º 05.70 N, 157 º 22.59 W). Initial sighting was a blow at 1.5 nm (2.9 km) to the north. Group consisted of three subadult sei whales estimated to be about the same size at ~8 to 11 m long. Throughout the total 64 min of observations, the three subadult sei whales traveled slowly (1-3 kts) and appeared to be "riding" or "surfing" the swells. They usually traveled just below the surface taking visible breaths every 8-10 minutes, sometimes logging at the surface. On numerous occasions, they crossed the bow, approaching the *Searcher* to within 15 m. Their general travel direction was south. Two of the whales generally remained within approximately 1-3 body lengths of one another. All three whales seemed unconcerned with the movements of the ship and did not exhibit any fleeing or evasive movement or behavior. Numerous photos (n = 337) were taken, many showing confirmational identifying characteristics for sei whales.

Humpback Whale (*Megaptera novaeangliae*)

Sighted 17 November. A blow identified this group of 2 adults and 1 subadult initially traveling fast headed south toward Penguin Bank in the southern end of Box subarea D (21 º 09.60 N, 157 º 25.36 W). Part-way through the observations near the time a breach was observed, one of the adults left the group. The next time humpbacks surfaced, we were not sure if they were the same individuals. However, close examination of photo-identification photographs may reveal the fluke identification and/or the actual number of individuals we followed. We observed typical respiratory and non-respiratory behaviors (breaching, peduncle and flipper splashing, tail swishing) and obtained underside fluke and dorsal photos for individual identification. The subadult breached three times and was recorded on video. Two to three other humpback pods were seen near the horizon. During the course of the focal follow, we moved SW out of the Box to continue behavioral observations.

BEHAVIORAL SAMPLING

Focal follows were conducted on four cetacean sightings: a single sei whale, a single Bryde's whale, a group of three subadult sei whales, and a group of three humpback whales. Details of these focal pod follows are described in Table 4. Focal follows were conducted in three of the four subareas in subareas A, B, and D (Figure 2) Focal behavioral sessions ranged in duration from 50 - 145 minutes, with the longest continuous observation session of 145 minutes occurring with the first sei whale. Longer time was spent with those species with federal listing under the ESA, i.e. the sei whales and humpback whales.

Sei whales and Bryde's whales can easily be confused. We spent additional time on the focal follow of the Bryde's in order to make a positive identification of the animal. Photographs were taken during all focal follows. Video was obtained during the sei

Table 4. Behavioral sampling results of focal animal follows 11 - 17 November 2007 Marine Mammal and Sea Turtle Survey near the Island of Oahu.

Date	Species	Total Time With Animal/s	Depth (m)	Group Size/ Composition	Behavior State	Individual Non-Blow Behavior	Comments
12 Nov	Sei whale (*Balaenoptera borealis*)	145 min	2500	1/ adult	Slow travel	No blow rise.	Maintained slow travel throughout observations, often logging just below water surface; repeatedly approached/paralleled *Searcher*.
13 Nov	Bryde's whale (*Balaenoptera edeni*)	50 min	4500	1/ adult	Slow travel	No blow rise, underwater blow.	Maintained slow travel speed throughout observations; approached Searcher several times. Navy vessel in view over the horizon during encounter.
16 Nov	Sei whale (*Balaenoptera borealis*)	64 min	5000	3/subadults	Logging, slow travel	No blow rise, "surfing swells", "bow riding"	Repeatedly followed vessel, crossed bow and "surfed" bow wave and swells. Whale movement appeared to be propelled by swells.
17 Nov	Humpback whale (*Megaptera novaeangliae)*	70 min	40	3/2 adult, 1 subadult, may have been as many as 5 animals.	Fast and medium travel, surface-active travel	Breach, peduncle slap, pectoral fin slap, tail swish, fluke up, peduncle arch, no blow rise	Frequently changed travel directions in apparent response to other nearby humpbacks; appeared to be a disaffiliation then an affiliation of humpbacks associated with surface-active behaviors.

whale focal follow on 12 November and the humpback whales focal follow on 17 November.

Ad libitum continuous sampling was conducted on all focal follows of baleen whales. This resulted in continuous or nearly continuous records of all blows, surfacings, and conspicuous individual behaviors (e.g., breaches, pectoral fin slaps, tail swishes, etc.). In addition, closest inter-individual spacing (estimated in relative body lengths), distance and bearing from the observation vessel, behavioral state, speed of travel, and orientation of whales relative to the vessel were recorded at least once during each

surfacing sequence. The latter typically was recorded at the beginning and sometimes the end of the surfacing. The presence, number, distance and activity of all vessels and aircraft within view at the time of focal observations were also regularly noted. Five to 11 observers, including the Cetos team of professional marine mammal observers and additionally up to five crewmembers, were involved in extended focal sessions of baleen whales typically from the flying bridge. Additional observers aided in the resightings of whales between surfacing bouts. Two to three professional marine mammal observers focused on logging behaviors, one or two of which observed the animals and the other whom recorded information on data sheets and Wincruz (the latter for successive lat/long positions). Another professional marine mammal observer took video, while one to two other professional marine mammal observers took digital photographs. The photographer also called out behavioral-related data in the case of multiple whales in a group.

This protocol approach as described allowed us to obtain continuous or nearly continuous, detailed data on the small groups of baleen whales encountered and followed for extended periods. In all cases, focal observation sessions ended at the discretion of the lead scientist in order to meet other goals of the study. Furthermore, none of the whales followed during focal sessions exhibited any notable evasive or disturbance behavior related to the observation vessel or as defined under the MMPA. Other than the repetitive "bow riding" and "surfing" behavior exhibited by the three subadult sei whales, no "unusual" behavior was noted. The former behavior was deemed unusual because very little is known about sei whale behavior as reported in available literature, particularly of subadults/juveniles (e.g., Reeves et al. 2002; Jefferson et al. 2008). It was the opinion among the assembled professional observers (with an average field experience of 24 years) that such continuous, repetitive, "leisurely" "surfing" behavior among sei whales has not been commonly observed either by any of them nor has it been reported to occur in the literature. This behavior was considered attributable to the relatively large swells that day (0.9 to 1.5 m [3 to 7 ft] swells) and the movement of the observation vessel through the water and swells. Again, the whales did not exhibit any distress or otherwise recognizable evasive or adversely disturbed behavior. In contrast, they appeared to be attracted to the vessel and the bow waves/swells/currents it generated at its bow as it traveled at approximately 1-3 kt.

ANCILLARY RESEARCH ACTIVITIES

Oceanography

A total of 13 bathythermograph (XBT) launches were successfully conducted during the Marine Mammal and Sea Turtle Monitoring Survey 11-17 November 2007 as launched from the stern of the *Searcher*. Related results, figures, and discussion are provided in Appendix B.

Photography/Videography

Photographs were taken during all focal follows (see Behavioral Sampling). Certain photos assisted with positive identification in 3 of 4 focal follows. Sei and Bryde's whales can easily be confused and are frequently misidentified. The photos were definitive in these cases. Photos taken of the humpback whale focal group may be of use in identifying individuals using existing photo ID databases. Both cameras produced photos on all focal follows. The photographic data obtained is presented in Table 5.

Table 5. Photo/video results from 11 - 17 November 2007 Marine Mammal and Sea Turtle Survey near the Island of Oahu.

Date	Species Sighting	Total Photos	# Frames utilized for Species ID	Min of Video
12 Nov	Sei whale (*Balaenoptera borealis*)	124	14	4:04
13 Nov	Bryde's whale (*Balaenoptera edeni*)	67	9	-
16 Nov	Sei whale (*Balaenoptera borealis*)	337	7	-
17 Nov	Humpback whale (*Megaptera novaeangliae)*	143	-	2:29

Video was taken during two of the four focal encounters. Technical difficulties with the equipment during the focal follow on 16 November, were resolved and video recording was resumed for the focal follow on 17 November. Video on 12 November produced limited useful footage. Video on 17 November recorded a near full breach by the sub-adult humpback whale, two dives, and footage of dorsal hump, back and caudal peduncle of the humpback whales.

SECTION 4
DISCUSSION

The occurrence of cetacean species is not well documented in the HRC off the windward-facing NE shore of Oahu, particularly in waters >25 nm (46 km) from shore. This is due to predominant strong NE tradewind and wave conditions that typically preclude effective visual observations as well as minimal survey effort in waters >25 nm (46 km) from shore. Prior to our survey, the most recent and comprehensive systematic survey that included waters of the HRC was a NOAA Fisheries-sponsored line-transect vessel-based survey of the U.S. Exclusive Economic Zone (EEZ) and an area outside the EEZ around the Hawaiian Islands chain including the Northwest Hawaiian Islands from August to November 2002 (Barlow 2003, 2006; Barlow et al. 2004). The latter survey was focused on odontocetes (toothed whales), primarily delphinids (dolphin species), in pelagic waters near some of the islands; very little effort occurred in the HRC (Barlow 2003, 2006; Barlow et al. 2004). While some aerial survey transects have occurred in the HRC, relatively few cetacean sightings have been made in the usually rough sea conditions encountered there (e.g., Mobley et al. 1999a, 1999b, 2000, 2001, 2004). It is not known, however, whether this is because the density is truly low, or whether it is a factor of poor observation conditions. Thus, there is a considerable data gap in the distribution and occurrence of cetaceans in the HRC off the NE coast of Oahu.

Despite relatively poor weather and sea conditions during much of the survey, our research effort was successful on several fronts, as follows:

- We documented the first occurrence of the Bryde's whale near the main Hawaiian Islands. Previous verified sightings from the Hawaiian Islands region have occurred only in the leeward Northwestern chain of the Hawaiian Islands at least ~1160 km WNW of Kauai (Barlow 2003, 2006; Barlow et al. 2004).

- We documented two rare sightings of sei whales composed of 4 individuals NE of Oahu. Sei whales were only recently (in 2002) documented and confirmed to occur in waters surrounding the Hawaiian Islands (Shallenberger, 1981; Mobley

et al. 2000; Mobley 2002; Barlow 2003, 2006; Barlow et al. 2004; Rankin and Barlow 2007). Within the main Hawaiian Islands, previous sei whale sightings occurred ENE of Molokai and off the E side of the Big Island of Hawaii, with no sei whale sightings near Oahu (Barlow et al. 2004; Rankin and Barlow 2007). Another important factor from our survey related to sei whales is that one of our sei whale sightings consisted of three juveniles estimated to be 1-2 years old. Winter breeding/calving grounds of North Pacific sei whales have not been located, although they are known from whaling data to breed and calve during fall (Reeves et al. 2002; Jefferson et al. 2008). The latter sighting of young sei whales combined with other sei whale sightings during fall suggests that some sei whales use the offshore waters of the Hawaiian Islands during the fall breeding season.

- We demonstrated that opportunistically "shadowing" / "following" Navy exercise vessels at a safe distance (>3 nm [> 5.5 km]) for an extended period (up to ~8 hours) is possible, at least under the circumstances we encountered. It was also possible, under the circumstances we encountered, to conduct a focal follow of a whale sighting while within view of Navy exercise vessels.

- We demonstrated that using two sets of Big Eyes in addition to a naked-eye observer from the *Searcher* improves the effectiveness of sighting cetaceans during conditions of Beaufort sea state <6 and limited swell conditions. Two of the eight total cetacean sightings were initially made with the Big Eyes (vs. six were made with the naked eye initially). However, when heading into swells over approximately 5-6 ft in height from the Searcher, the ability and efficiency of using the Big Eyes is compromised due to instability of the observation platform. This effects can be somewhat mitigated by shifting the vessel's heading. Big eyes also facilitated confirmation of species identifications by allowing for more detailed sightings.

- Data collected during this study contribute to baseline data important in developing and implementing effective marine mammal monitoring for the Undersea Warfare Exercises proposed to continue to be conducted through January 2009 in the HRC.

- This Cetos survey was also important in identifying both limitations of and recommendations for future monitoring-related efforts as discussed in the following section.

It is not possible in this report to assess potential effects of the Navy exercises on marine mammals as we were not provided with detailed information on the nature and timing of their activities. Therefore, we can not make correlations between behaviors and Navy actions.

SECTION 5
RECOMMENDATIONS

A list of recommendations for future monitoring efforts relative to the survey design and its implementation has been compiled by Cetos Research Organization for use in future monitoring efforts. These recommendations are based on results of and events relating to this survey, as well as on our previous experience with and knowledge of relevant mitigations and of monitoring surveys, including past USWEX monitoring surveys (e.g., Cetos 2005, 2007a). Below is a short summary of these recommendations.

A. Monitoring Workshop

Cetos highly recommends that a workshop be held on behalf of the Navy to identify and synthesize the effectiveness and feasibility of various monitoring approaches that could be implemented in association with USWEX Navy exercises and other such Navy activities. A brief synopsis of some of our recommendations is provided below. Greater detail could be provided and developed in a workshop as suggested above, which would be designed to address this type of survey project. A workshop on this topic would allow for the following:

- This workshop could pull together experts and professionals knowledgeable about Hawaiian cetaceans, those with considerable marine mammal monitoring experience with the species of concern, and others with relevant expertise (e.g., survey design, behavioral reactions to anthropogenic sounds, etc.) that could contribute to the goals of the workshop.

- In particular, this format could be used to develop an approach to determining the minimum sample sizes needed to address monitoring concerns, and aid in selecting approaches that are feasible given the limitations of the issue(s) of concern (e.g., species density/attainable sample size vs. ability to determine effects, etc..

B. Feasibility of Monitoring Near Navy Activities/Vessels

Based on our results, on an opportunistic basis, it is possible to remain within view and a safe distance (>3 nm [> 5.5 km]) from the USWEX Navy exercises encountered during this survey. This approach should be implemented as a potentially viable monitoring measure as part of vessel-based monitoring for marine mammals and sea turtles during future activities. Related future recommendations include:

- If the survey vessel encounters Navy vessel activities, the survey vessel should stay within view but >3 nm (> 5.5 km) from the vessels for as long as feasible. This would facilitate identification of any marine mammals and sea turtles of concern that may exhibit reactions to the Navy activities.

- If the Navy vessels move out of sight faster than the survey vessel can follow, the survey vessel should remain in the vicinity where the Navy activities occurred to identify any potential changes in animal behavior or reaction, and/or to obtain "post Navy activity" behavioral observations

- Cetos recommends using a small aircraft to monitor behavioral observations in addition to vessel-based monitoring. If the aircraft is kept at a sufficient radial distance from the animals of concern (i.e., out of hearing range given Snell's cone—see Richardson et al. 1995), then potential confounding effects of the aircraft on whale behavior can be discounted. Aerial surveys have been shown to be effective for assessing disposition of marine mammals as well as to determine abundance, and even photographic identification of individuals (Barlow and Gisiner 2006) Aerial surveys in conjunction with vessel-based surveys offers an optimal platform for monitoring. Note: for vessel-based behavioral observations, it can be problematic to separate out behavioral effects from the vessel. However, the vessel, combined with aerial surveys, remains a logical platform to identify the disposition of marine mammals (e.g., unusual behaviors, injured animals, etc.). Combined aerial and visual surveys took place during this training exercise i.e. aerial surveys were done in addition to the shipboard survey, although under separate contract.

C. Vessel-Based Survey Protocol

Based on our findings from this and other surveys, vessel based surveys are effective for monitoring during Navy training exercises. Data collection and relevant information gathering would be enhanced by incorporating our suggestions and recommendations below. These include:

- A minimum of six marine mammal visual observers as used during this survey are warranted to provide effective data gathering in various weather conditions. After experimenting with more and fewer observers, having a team that is comprised of six individuals is our recommendation. This ensures adequate coverage, and effective observations as well as data collection.

- A navigating program should be purchased and used from the observer station in conjunction with the data collecting PC. A program of this type was used by the Captain and crew of the Searcher during the survey; however, it could not be used in real time by the observers because the monitor was located in the enclosed bridge. . This necessitated that an observer would have to take several minutes to leave the observation station on the flying bridge, go below, and obtain information of interest. In order to do this, the observer in question was required to actually observe the monitor located in the bridge (i.e., the information could not be effectively communicated via radio from the bridge to the flying bridge). A real time charting program improves effectiveness of observations by:

    - Providing a real-time image of proposed, past, and recent ship tracks relative to survey design/track lines, sighting locations, locations of Navy activities, etc.;

    - Provides ability to quickly calculate distances and estimated time to arrive at destinations; this aids in survey planning that can be readily adapted to changing conditions (e.g., sighting Navy vessels, species of concern sightings, winds, currents, swells, glare, etc.); and

    - Data layers that can be displayed graphically in real time include bathymetry, bottom topography, currents, winds, other vessels, shoreline, tracks, sightings etc. Information can also be edited (e.g., shown or deleted, etc.) and printed out to provide maps for in situ adaptive survey planning purposes, data analyses, reports, etc.

- Wincruz is considered awkward and inadequate for the purposes of monitoring surveys. This has been the assessment of our monitoring team since our first survey (Cetos 2005) and we remain confidant that it is not the best program for these surveys as it was designed to be executed for different survey goals. We recommend obtaining ***Noldus,*** a program designed specifically for monitoring animal behavior, and having the engineers assist in creating the program designed for these surveys. The ***Noldus*** program can be specifically tailored to meet the needs and interests of any user, in this case, the Navy's monitoring program. (http://www.noldus.com/site/nav10000). Our conclusion is based on the following:

    - In particular, it is currently impossible to collect individual data on all whales in groups of >2 animals using Wincruz and hand-taken notes/data sheets. Noldus provides a small PDA, optionally with a touch screen, that speeds up the data recorder's ability to take detailed behavioral observations, including for more animals. Noldus also reduces the need for multiple entries on different sources by combining all needed data into one program/computer.

- Noldus can be designed with specific statistic tests in mind so that various hypotheses can be addressed, with the statistical power warranted.

Noldus must be obtained with enough lead time so that the tailoring of the program could be done prior to survey start. This program would provide ongoing support to Navy exercises on a continual basis, and greatly increase the relevance and usefulness of collected data. The data gathered would be more in alignment with the goals of the monitoring study.

D. Survey Preparation

We recommend six weeks absolute minimum lead time to allow for appropriate survey preparation which in turn will allow for better collection of data. This lead time is a minimum to allow us to amass the appropriate (professional and trained in marine mammal observing) staff, who are often scheduled months in advance. It will also allow us to prepare/procure the appropriate equipment, and allow for less expensive travel (air tickets) i.e. with advance ticket purchases. Advance time will allow us to reserve charter vessels and in many cases will create the opportunity to obtain a less expensive rate which will save funds. In terms of mobilization, a minimum of two days prep time is recommended in order to set up equipment on the boat. Particularly in terms of big eyes, 2 days is a minimum and in many cases, more time will be needed especially without local onsite help which is only occasionally available. Lead time will allow us to continue to develop database programs which enhance analysis. In the case of this survey, for example, we had enough time to develop a needed program based on our experience from our last survey. We contracted a programmer to design a program to post-process the WinCruz data so that data was summarize correctly.

E. Future Vessel-Based Surveys

The Searcher and its crew are considered sufficiently safe, seaworthy, amenable, and adequate to conduct vessel-based monitoring surveys in other areas of concern to the Navy in Hawaii that are further offshore, e.g., the Navigator Seamounts.

F. Coordination with Aerial Surveys

When vessel-based and aerial surveys are to occur concurrently in the same area, they should be coordinated prior to and during the surveys for the following reasons:

- If an animal of concern is found by either team, but particularly initially by the vessel team, exhibiting unusual behavior or disposition, the aerial team is capable of following the animals over a wider range and performing a longer term case study of the animals' disposition;

- The aerial survey team can also take photographs from a different perspective that can aid in species ID and behavioral descriptions; and

- Vice versa, i.e. if the aerial team identifies a species of concern as such to the vessel, and subsequently needs to leave the area, they can inform the vessel team of the animals' exact whereabouts (possibly even staying on station until the vessel arrives) allowing the vessel continue following the animal and collecting data for the sighting.

G. Aerial Survey Recommendations to Identify Potential Strandings

Cetos recommends that aerial surveys circumnavigate nearby islands (in the vicinity of the training) to search for stranded, injured, or unusually behaving species of concern. This additional tracking should be scheduled as follows:

- First, this survey would occur once before the Navy activities begin. This would allow for the ID'ing any strandings that may exist before activities begin, to eliminate potential cause and effect links to Navy activities for such strandings;

- Subsequently this survey would occur at minimum once during Navy activities. The aerial survey should be scheduled considering the distance of the Navy activities to the nearby land, and also with the predominant current and wind speed and direction relative to the location of Navy activities addressed. By assessing these factors, the survey can be conducted with the provision for enough time to create the opportunity to sight any potentially stranded animals i.e. animals that may have had a reaction to training would have had sufficient time to potentially be stranded. For example, if the activities occur 30 nm (56 km) from shore, and the predominant current speed is 3 kt toward an island, then it could take 30 nm (56 km)divided by 3 nm (5.6 km)/h = 10 hr for a dead or injured animal to land on the beach.

- Finally, this survey should occur at minimum once after Navy activities have ended, with timing coordinated to consider factors identified above (e.g., distance to study area, currents, wind, etc.)

H. Acoustic Monitoring Via Array

We continue to believe that using acoustic research equipment would aid in monitoring for the Navy exercises. A towed acoustic array that is capable of localizing vocalizing cetaceans is recommended to be used along with associated software and hardware for the following reasons (also see Cetos 2005 and 2007a):

- It can be used to increase the detection rates of cetaceans that vocalize but are not seen, and when visual observation is not possible;

- Marine mammals can be recorded vocalizing or not vocalizing before, during, and after Navy exercises; and

- Acoustic monitoring team can assess marine mammal activity at night; we recommend monitoring should include at least two dedicated acoustics specialists who can alternate shifts over nighttime monitoring

SECTION 6
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APPENDIX A

FORMS AND PROTOCOL

Appendix A: Forms and Protocols

1. Beaufort Sea State Criteria
2. Ethogram of Marine Mammals
3. Photo and Video Camera Log
4. Behavioral Monitoring Data Entry Form
5. Daily Sighting Summary Form
6. WinCruz Code Definition Sheet - Survey Nov. 2007
7. XBT data collection form
8. MMPA take form

1. Beaufort Sea State Criteria

(Beaufort Scale* or *Beaufort Wind Force Scale)

Beaufort number 0 - Calm

Wind speeds: less than 1 knot (<1 mph; <1 kph; <0.3 mps)

At sea: Sea like a mirror, calm

Sea disturbance number: 0

Probable wave height: flat (0 ft; 0 m)

On land: Smoke rises vertically

Beaufort number 1 - Light Air

Wind speeds: 1-3 knots (1-3 mph; 1-5 kph; 0.3-1.5 mps)

At sea: Ripples with the appearance of scales are formed but without foam crests

Sea disturbance number: 0

Probable wave height: 5-10 cm (2-4 in) (0 ft; 0 m)

On land: Direction of wind shown by smoke drift, but not by vanes

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Beaufort number 2 - Light Breeze

Wind speeds: 4-6 knots (4-7 mph; 6-11 kph; 1.6-3.3 mps)

At sea: Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break

Sea disturbance number: 1

Probable wave height: 10-15 cm (4-6 in); (0-1 ft; 0-0.3 m)

On land: Wind felt on face; leaves rustle; ordinary vane moved by wind

---

Beaufort number 3 - Gentle Breeze

Wind speeds: 7-10 knots (8-12 mph; 12-19 kph; 3.4-5.4 mps)

At sea: Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses

Sea disturbance number: 2

Probable wave height: 60 cm (2 ft); (1-2 ft; 0.3-0.6 m)

On land: Leaves and small twigs in constant motion; wind extends light flag

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Beaufort number 4 - Moderate Breeze

Wind speeds: 11-16 knots (13-18 mph; 20-28 kph; 5.5-7.9 mps)

At sea: small waves, becoming longer; fairly frequent white horses

Sea disturbance number: 3

Probable wave height: 1 m (3.5 ft); (2-4 ft; 0.6-1.2 m)

On land: Raises dust and loose paper; small branches are moved

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Beaufort number 5 - Fresh Breeze

Wind speeds: 17-21 knots (19-24 mph; 29-38 kph; 8.0-10.7 mps)

At sea: Moderate waves taking a more pronounced long form; many white hourses are formed; chance of some spray

Sea disturbance number: 4

Probable wave height: 2 m (6-7 ft); (4-8 ft; 1.2-2.4 m)

On land: Small trees in leaf begin to sway; crested wavelets form on inland waters

---

Beaufort number 6 - Strong Breeze

Wind speeds: 22-27 knots (25-31 mph; 39-49 kph; 10.8-13.8 mps)

At sea: Large waves begin to form; the white foan crests are more extensive everywhere; probably some spray

Sea disturbance number: 5

Probable wave height: 3 m (9-10 ft); (8-13 ft; 2.4-4 m)

On land: Large branches in motion; whistling heard in telegraph wires; umbrellas used with dificulty

---

Beaufort number 7 - Near Gale / Moderate Gale

Wind speeds: 28-33 knots (32-38 mph; 50-61 kph; 13.9-17.1 mps)

At sea: Sea heaps up and white foam from the breaking waves begins to be blown in streaks along the direction of the wind

Sea disturbance number: 6

Probable wave height: 4 m (13-14 ft); (13-20 ft; 4-6 m)

On land: Whole trees in motion; inconvenience felt when walking against wind

---

Beaufort number 8 - Gale / Fresh Gale

Wind speeds: 34-40 knots (39-46 mph; 62-74 kph; 17.2-20.7 mps)

At sea: Moderately high waves of greater length; edges crests begin to break into spindrift; the foam is blown in well-marked streaks along the direction of the wind

Sea disturbance number: 6

Probable wave height: 5.5 m (18 ft); (13-20 ft; 4-6 m)

On land: Breaks twigs off trees; generally impedes progress

Beaufort number 9 - Strong Gale

Wind speeds: 41-47 knots (47-54 mph; 75-88 kph; 20.8-24.4 mps)

At sea: High waves; dense streaks of foam along the direction of wind; crests of waves begin to topple, tumble and roll over; spray may affect visibility

Sea disturbance number: 6

Probable wave height: 7 m (23 ft); (13-20 ft; 4-6 m)

On land: Slight structural damage occurs (chimney post and slates removed)

Beaufort number 10 - Storm / Whole Gale

Wind speeds: 48-55 knots (55-63 mph; 89-102 kph; 24.5-28.4 mps)

At sea: Very high waves with long overhanging crests; resulting foam in great patches is blown in dense white streaks along the direction of the wind; on the whole, the surface of the sea takes a white appearance; tumbling of the sea becomes heavy and shock-like; visibility affected

Sea disturbance number: 7

Probable wave height: 9 m (29 ft); (20-30 ft; 6-9 m)

On land: Seldom experienced inland; trees uprooted; considerable structural damage occurs

Beaufort number 11 - Violent Storm / Storm

Wind speeds: 56-63 knots (64-75 mph; 103-117 kph; 28.5-32.6 mps)

At sea: Exceptionally high waves (small and medium size ships might be for a time lost from view behind waves); sea is completely covered with long white patches of foam lying along the direction of wind; everywhere the edges are blown into froth; visibility affected

Sea disturbance number: 8

Probable wave height: 11 m (37 ft); (30-45 ft; 9-14 m)

On land: Very rarely experienced; accompanied by widespread damage

Beaufort number 12 (-17) - Hurricane

Wind speeds: 64 knots and greater (> 75 mph; >117 kph; >32.7 mps)

At sea: The air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected

Sea disturbance number: 9

Probable wave height: 11 m and more (> 37 ft); (>45 ft; >14 m)

On land: Very rarely experienced; accompanied by widespread damage

2. Ethogram of Marine Mammals
Navy Marine Mammal Monitoring Survey 003
Cetos 2007

BEHAVIORAL STATES
(FOR SURVEY SCANS AND FOCAL ANIMAL FOLLOWS)
(i.e., activities with duration that are mutually exclusive of one another,
Not individual or instantaneous behaviors)
During focal animal follows, note the behavioral state every min or at least when it changes.

TRAVEL (Fast or Slow):	point to point directed movement in one direction by the majority of a group.
MILL:	continuous changes in headings, asynchronized orientations of majority of individuals (i.e., majority of group orientation is not synchronized in one direction)
SURFACE-ACTIVE:	individual behaviors that cause conspicuous splashes (e.g., breaches, tail slaps, flipper slaps, peduncle slaps, chin rises or slaps, porpoising, etc)
SURFACE-ACTIVE/ MILL:	Mill with at least one individual in the group displaying behaviors that cause conspicuous splashes (see above)
COMPETITIVE:	Includes surface active behaviors but is more specifically about a group size>3 with males competing for female attention (humpbacks only)
REST:	remaining in one location with no forward movement; only surfacing to breath and return to depth
FEEDING:	for cetaceans other than humpbacks; visible foraging behaviors

Also Note if animals appear to be feeding, social/touching, bird presence, "play", etc. in comments

DISPOSITION
I = Injured
D = Dead
O = Ordinary

INDIVIDUAL BEHAVIORS
FOR FOCAL ANIMAL BEHAVIORAL SAMPLING/ FOLLOWS
(To be used primarily with whales or small groups of animals as possible)

BL BLOW
FU FLUKE UP
BR BREACH
FS FLUKE SLAP
PS PECTORAL FIN SLAP
NR NO BLOW RISE (BODY VISIBLE WITH OUT VISIBLE BLOW)
HS HEAD SLAP
LO LOGGING AT SURFACE
HR HEADRISE

ALSO NOTE THE FOLLOWING INFORMATION ON FOCAL GROUPS ~1 min if possible (i.e., scan sampling):

- Largest distance between individuals in a group (in body lengths)
- Closest distance between individuals in a group (in body lengths)
- Bearing of animal/center of group in degrees L or R relative to bow of vessel where bow is 0 degrees
- Heading/orientation of animal or majority of group relative to bow of vessel in degrees L or R where bow is 0 degrees
- Any unusual behavior

3. **Marine Mammal Survey Photo and Video Camera Log**

Date_____Month/day/year Camera or Video_____ Page_____of_____
List which still camera if more than 1 used

CREW:

Photographer/Videographer: _____ Data Taker:_____ _____

TIME START	TIME END	FILM ROLL OR VIDEO NUMBER	FRAME OR COUNTER NUMBER	DESCRIPTION

4. Behavioral Monitoring Data Entry Form:

(only headers included).

Date: **Species:**

Observer: **Focal Group #:**

Lat/Long @ Start: **Wincruz ID #:**

Lat/Long @ End: **Group Size:**

WS/WE: **# Calves**

Visibility: **Water Depth:**

Behavioral States: **T**=travel, **M**=mill, **SAT**=surface active travel, **SAM**=surface active mill, **R**=rest

Indiv. Behav. Codes: **BL**= blow, **BR**= breach, **FU**= fluke up,
FS= fluke slap, **HR**= head rise, **HS**= head slap,**NR**= no blow rise,
LO= logging, **PS**= pec fin slap,

Boat Activity (Motor, Sail, Drift)											Comments
	Time			Behavior		MM Bearing relat to vessel (0=dead ahead)		Distance		Speed (S, M, F)	
	Hr	Min	Sec	Behav State (1x/ min)	Indiv. Beh Code	Where At	Where To	# Ret or Eye	# m		

5. Daily Sighting Summary Form

(only headers included).

Daily Sighting Summary Form Recorder:

Sight-ing #	Date	Time (start time/ end time)	Start Lat - 3 decimal places	Start Long - 3 decimal places	End Lat - 3 decimal places	End Long - 3 decimal places	Species	# Animals (Group Size	Group comp	Depth	Behav State	Orientation	Speed	Anim Head-ing	Anim Bear-ing	Beaufort	Comments

6. WinCruz Code definitions Sheet – Survey Nov. 2007

WINCRUZ CODES

P	Observers	F6
301	Gary Friedrichsen	
302	Tom Jefferson	
303	Mari Smultea	
304	Chris Cutler	
305	Julie Hopkins	
306	Kalyn Quintin	

V	Viewing Conditions	F7
Beaufort	1 thru 6	
Swell height	feet	
Swell Direction	degrees	
Wind Speed	mph	

N	Navigation	F8
Course	degrees	
Speed	knots/hr	

W	Weather	F9
Rain/fog	1=none, 2=fog, 3=rain, 4=both,	

S & A	Sightings	F2
Sighting #	assigned	
Observer	number	
First Cue	1=bird,2=splash,3=mm,4=ship,5=?,6=blow,7-helo	
Method	1=eye,2=7x,4=25x,5=not25x,6=other,7=helo	
Bearing	left is negative	
Initial ID	spp #	
Reticle	to animal	
Distance	nmi to sighting	
Course	direction of animal	
Speed	of animal	
ID Label	letter for map	
A		
Sp Code1-3	most likely to 3rd choice, spp #	
Photos	y or n	
Birds	y or n	
School size	per species estim.	

	5=haze
Wind Direction	degrees
Visibility	miles

Species numbers

2	Stenella Attenuata (offshore) Pantropical	70
3	Stenella longirostrus, Spinner	71
5	Delphinus spp.	72
13	Stenella coeruleoalba, Striped	73
15	Steno bredanensis, Rough-toothed	74
18	Tursiops truncatus, Bottlenose	75
21	Grampus griseus, Risso's	76
22	Lagenorhynchus obliquidens, Pac white-side	77
26	Lagenodelphis hosei, Fraser's	78
31	Peponcephala electra, Melon-headed whale	79
32	Feresa attenuata, Pygmy killer whale	80
33	Pseudorca crassidens, False killer whale	96
36	Globicephala macrorhynchus, Short-finned pilot	97
46	Physeter macrocephalus, Sperm whale	98
47	Kogia breviceps, Pygmy sperm whale	177
48	Kogia sima, Dwarf sperm whale	277
49	ziphiid whale	377
51	Mesoplodon spp.	477
53	Mesoplodon hectori, Hecto's beaked whale	
57	Mesoplodon ginkgodens, Ginkgo-toothed	
59	Mesoplodon desirostris, Blainville's beaked	
61	Ziphius cavirostris, Cuvier's beaked whale	
65	Indopaecetus pacificus, Longman's beaked	

7. XBT data collection form

(only headers included).

XBT Launch for Oceanographic data

Date	Time	Type of XBT	Routine or Focal Follow	Comments

8. MMPA take form

(only headers included; broken up into 2 sections to fit on page).

TABLE ONE: **TABULATED PERMIT INFORMATION**

Date (dd/mm/07)	Location (descriptive)	GPS start (3 decimal places; at encounter start)	GPS end (3 decimal places; at encounter end)	Pod #/Sighting #	Type of Species	Time Encounter Start	Time Encounter End	# animals in pod (high/med/low)	Pod Composition (HUWH = MC, MCE, etc)	Pod Behavior (note start, mid, and end behaviors)	
		Take mid encounter GPS readings if it goes on for longer than 30 minutes		*Pod # = sequential i.e. 1, 2, 3; Sighting # = wincruz #*						*rest, mill, sing, Slow Travel (ST), Fast T (FT), Surface Active, Competitive, etc.*	

Number of Animals Approached	Number of Approach Episodes Conducted	Number of Takes (total)	Number of Times Each Animal was Harassed	Observed Reactions of Animals to Research	Mitigation Measures Utilized to Minimize Reactions	Total # harrassments by species:	Total Time With Animals	Summary of Observed Behavior

APPENDIX B
XBT OCEANOGRAPHIC SUMMARY

A total of 13 bathythermograph (XBT) launches were successfully conducted during the Marine Mammal and Sea Turtle Monitoring Survey 11-17 November 2007 from the *Searcher*. Figure B-1 shows XBT launch locations overlaid with satellite-derived sea surface temperature (SST) and ocean color (chlorophyll *a*) measurements. This presentation provides a basis by which to compare and interpret the associated *in situ* expendable temperature data that were collected,

Oceanographic conditions during the survey were characterized by a moderate latitudinal, or north-south gradient in sea surface temperature (Figure B-1, left panel). SST values at the northern end of the survey area (north of 21.8°N; XBT drops 2, 3, 11, 5, 7) were approximately 0.4 – 1.0 °C cooler than surface temperatures measured near the southern end (south of 21.6 °N; XBT drops 1, 4, 6, 8, 9, 10, 12, 13). Surface-ocean color, a satellite-based measurement of chlorophyll *a* and a proxy for productivity, shows an increase in chlorophyll concentrations with increasing proximity to land (Figure B-1, right panel), with particularly high concentrations observed on the windward (eastern) sides of Oahu and Molokai. The southern end of the survey was conducted within the vicinity of these two islands, where chlorophyll *a* values were greater (~0.05 – 0.1 $\mu g\ l^{-1}$) when compared to the northern portion of the survey.

Temperature data obtained from XBT drops are plotted in Figures B-2 and B-3 with XBT locations shown in Figure B-1. Data statistics are provided in Table B-1. In general, temperature profiles extended down to ~750 m for 11 of the 13 drops; drops XBT-1 and XBT-2 ceased collecting data at ~200 m for unknown causes. When comparing all XBT drops, temperature data show a moderate separation, or spreading, between profiles, likely indicating an asymmetry in physical oceanographic forcing within the survey region (Figure B-2). Examining the upper 100 m highlights this spreading of profiles and brings attention to the substantial differences in mixed layer depth and mixed layer temperature (Figure B-3). XBT drops 2, 3, 11, 5, and 7 are all located at the northern portion of the survey area and exhibit strong vertical mixing with surface-mixed layers extending down to 92 m (range: 60 – 92 m) and mixed layer temperatures of approximately 25.5 °C (range: 25.43 – 25.53). In comparison, XBT drops performed at the southern end are highly stratified and are characterized by shallow (range: 5-62 m) and warm (25.75 – 26.6 °C) surface-mixed layers. This observed north-south difference in upper ocean stratification may also account for the patterns observed in satellite-derived chlorophyll *a* concentrations. A stratified water column, or a column of water with monotonically decreasing water temperature with depth, allows for increased nutrient retainment in the euphotic zone, eventually leading to enhanced phytoplankton growth and surface productivity. Well-mixed waters, such as those observed to the north of the survey area, have a low retainment of nutrients and therefore are typically less productive.

When comparing *in situ* sea surface temperatures with satellite SST, slightly warmer temperatures are observed in the XBT data. This bias in temperature measurements can be attributed to diurnal heating and cooling of the ocean surface. XBT drops were performed during the day, when SSTs are generally warmer, while satellite measurements are an average of day and nighttime temperatures, leading to slightly cooler measurements.

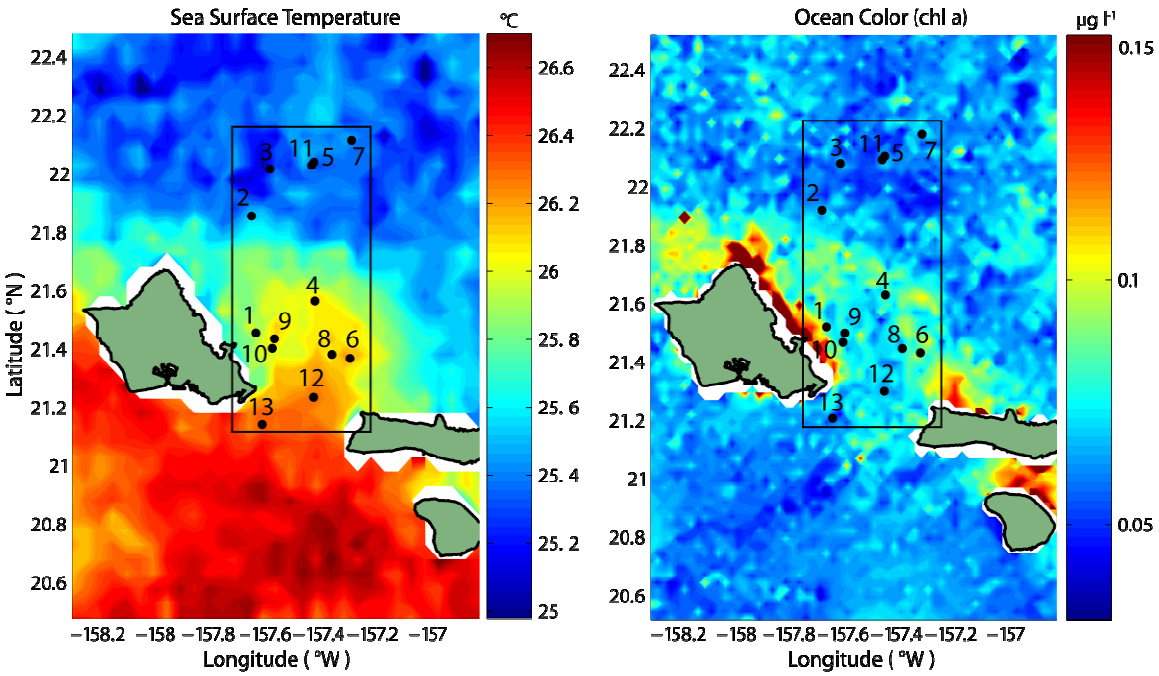

Figure B-1: Expendable Bathythermograph (XBT) drops (black dots) performed during the Marine Mammal and Sea Turtle Monitoring Survey 11-17 November 2007, overlaid with GOES 5.5 km sea surface temperature (SST) (left) and MODIS Aqua 2.5 km ocean color (chlorophyll *a*). SST and ocean color are 14 day means centered on November 15th, 2007. Data was obtained from NOAA's Coastwatch (http://coastwatch.pfel.noaa.gov). The black square indicates the area surveyed.

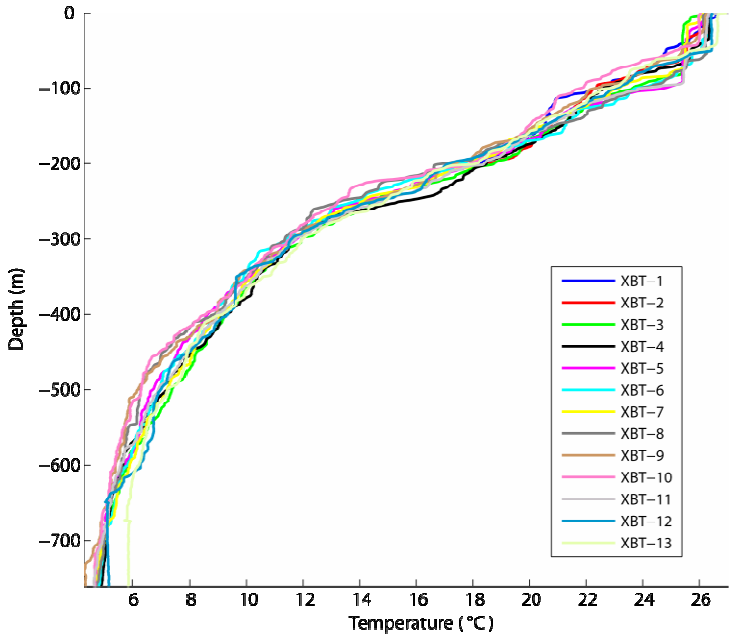

Figure B-2: Expendable Bathythermograph (XBT) profiles obtained from 11-17 November 2007 during the Marine Mammal and Sea Turtle Monitoring survey. XBT locations are shown in Figure B-1.

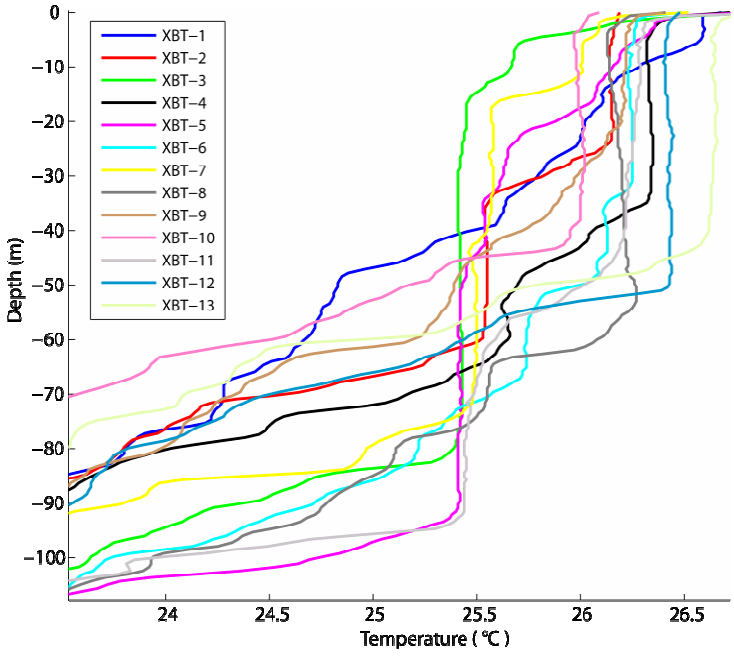

Figure B-3: Expendable Bathythermograph (XBT) profiles for first 100 m depth showing mixed layer depth and temperature profiles. Marine Mammal and Sea Turtle Monitoring survey, 11-17 November 2007. XBT locations are shown in Figure B-1.

Table B-1: Data statistics from each of the XBT drops performed during the Marine Mammal and Sea Turtle Monitoring survey 11-17 November 2007. Mixed layer depth and max depth are given in meters while mixed layer temp, surface temp, and bottom temp are measured in °C.

	Mixed Layer Depth	Mixed Layer Temp	Surface Temp	Bottom Temp	Max Depth
XBT 1	5	26.58	26.59	18.2	200
XBT 2	60	25.53	26.17	18.54	200
XBT 3	80	25.4	26.17	4.75	750
XBT 4	35	26.32	26.38	4.95	750
XBT 5	92	25.41	26.36	4.7	750
XBT 6	65	25.75	26.27	4.86	750
XBT 7	72	25.4	26.09	4.74	750
XBT 8	55	26.2	26.19	4.82	750
XBT 9	25	26.12	26.25	4.36	750
XBT 10	40	26	26.02	4.68	750
XBT 11	92	25.43	26.31	4.66	750
XBT 12	50	26.4	26.43	5.18	750
XBT 13	40	26.6	26.67	5.87	750